BATTERY HANDLING INTO AND AT THE INSTALLATION SITE. ARE YOU DOING IT RIGHT?

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ABSTRACT

Most accidents that happen in stationary battery locations occur when batteries are being delivered, installed, replaced or removed. Handling batteries in dedicated battery rooms, equipment rooms, data centers and remote sites has never been easy. The same old handling equipment seems to have been around for ages and some that is being used is not really suitable for the job. It is the author's experience that things are getting more difficult as batteries are increasingly being deployed in non-traditional locations. Some battery units (modules), particularly Valve-Regulated Lead-Acid (VRLA), are getting heavier and are being squeezed into tighter and less accessible spaces. Increasingly, untrained and unqualified personnel are being used for battery work and consequently, safer handling methods are required.

This paper examines the current battery handling techniques and problems including transporting, moving and positioning batteries. Codes are examined to determine what is applicable. The lack of specific codes and standards is also highlighted and discussed. The paper offers possible and realistic solutions. Special attention is paid to personnel and equipment safety issues and code compliance.

INTRODUCTION

Recently, the author was asked to conduct a Battery Safety and Handling course that was contractually required as part of a large battery replacement project. The course content was not defined and in putting together a syllabus the author started to research codes, standards, methods, equipment and other pertinent information. The author was very familiar with all aspects of battery handling and installation and thought that there would be no problem in coming up with a lot of reference material. This was to prove wrong!

PACKING AND MOVING

The first thing that one should consider in battery handling is the transportation of batteries to or from the installation location. At first glance, this may seem to be outside the scope of this paper but considering the fact that staging batteries and moving them to the installation position and more so, the removal of spent batteries, requires the compliance with certain stringent code requirements, this area had been included.

The Department of Transportation (DOT)[1] regulatory requirements affecting the packaging and transportation of all batteries containing acid or alkali are contained in the Code of Federal Regulations, Title 49 CFR Section 173.159[2]. All too often the mind set is that the DOT regulations only apply to over-the-road freight trucks but the regulations are equally applicable to the installation or service company's box truck that move the batteries to or from the installation site. It is here that a lot of accidents occur. Careless transportation methods are not only a violation of Federal Regulations but are downright dangerous. Packaging and preparing batteries for transportation is also important.

Vented Lead-Acid (VLA) and other batteries containing liquid (free) electrolyte.

DOT Title 49 CFR 173.159 (a) states that "Electric storage batteries, containing electrolyte acid or alkaline corrosive battery fluid, must be completely protected so that short circuits will be prevented; they may not be packed with other materials except as provided in paragraphs (g) and (h) of this section and in 173.220 and 173.222."

- Paragraph (g) refers to "Electrolyte, acid, or alkaline corrosive battery fluid, packed with storage batteries wet or dry"
- Paragraph (h) refers to "Dry storage batteries or battery charger devices."
- 173.220 deals with battery powered vehicles and equipment and is not applicable for stationary batteries.
- 173.222 deals with dangerous goods in equipment, machinery or apparatus and is not applicable.

The CFR goes on to say that the batteries must be “secured to skids or pallets capable of withstanding the shocks normally incident to transportation, are authorized for transportation by rail, highway, or water. The height of the completed unit must not exceed 1 1/2 times the width of the skid or pallet.” and "The unit must be capable of withstanding, without damage, a superimposed weight equal to two times the weight of the unit” Also “Battery terminals must not be relied upon to support any part of the superimposed weight.”

VRLA batteries and other non-spillable batteries.

DOT Title 49 CFR 173.159 (d) states that “A non-spillable wet electric storage battery is excepted from all other requirements of this subchapter under the following conditions:

- The battery must be protected against short circuits and securely packaged.
- The battery and outer packaging must be plainly and durably marked "NON-SPILLABLE" or "NON-SPILLABLE BATTERY"
- The battery must be capable of withstanding the Vibration and Pressure Differential tests specified in 49 CFR 173.159(d)(3)(i) and 49 CFR 173.159(d)(3)(ii).
- At a temperature of 55°C (131°F), the battery must not contain any unabsorbed free-flowing liquid, and must be designed so that electrolyte will not flow from a ruptured or cracked case.”

What this is saying is that VRLA batteries must have their terminals insulated to protect against short circuits and have been tested in the manufacturing stage in accordance with certain vibration and pressure requirements.

In addition to the above requirements, DOT Title 49 CFR 173.159 requires that all batteries, alkaline, lithium, lead, nickel metal hydride, etc; or battery powered products containing batteries are subject to 49 CFR 173.21(c) in the U.S. hazardous materials regulations. This provision prohibits "the offering for transportation or transportation of … (c) Electrical devices which are likely to create sparks or generate a dangerous quantity of heat, unless packaged in a manner which precludes such an occurrence.” Basically, the regulations above mean that in the case of noncompliance, the offender is in violation of the regulations and may be subject to civil penalties. Most violations seen at the installation site are when spent batteries are prepared for removal.

The U.S. Department of Transportation defines hazardous materials and specifies the type and number for each hazardous material (hazmat) placard used in transportation. The United States Code of Federal Regulations (49 CFR) also known as the Federal Motor Carriers Safety Regulations (FMCSR)[3] requires the use of hazardous materials placards when shipping hazardous materials cargo and dangerous goods in the United States. Canada, Mexico and many other countries have similar regulations that also require the use of these placards.

> Lithium and lithium ion cells and batteries are listed as Class 9, Miscellaneous Hazardous Materials, in the U.S. and thus are subject to specific packaging, marking, labeling, and shipping paper requirements and shippers must still comply with requirements of 49 CFR 173.21(c). That is, the cells and batteries must be securely packaged and offered for transportation in a manner that prevents the dangerous evolution of heat and short circuits. The regulations that govern the transport of lithium and lithium-ion cells and batteries were recently amended and can be very confusing. Therefore, prior to transporting these cells and batteries for transport, the regulations should be carefully reviewed.
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> Lead acid batteries are listed as Class 8 corrosive hazardous materials in the U.S. and other international hazardous materials regulations and are also subject to specific packaging, marking, labeling, and shipping paper requirements.
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> However, like shippers of lithium and lithium-ion cells and batteries, shippers of "non-spillable" lead acid batteries are provided an exception to the regulations if certain testing and marking requirements are met. These batteries can then be shipped under Class 9. For batteries manufactured after September 30, 1995, the battery and outer packaging must be plainly and durably marked "NONSPILLABLE" or "NONSPILLABLE BATTERY.”A non-spillable lead acid battery that does not meet the testing requirements noted above must be shipped as a Class 8 Corrosive hazardous material.

PHYSICAL BATTERY HANDLING CODES AND REGULATIONS

The first agency that was examined for some battery handling codes and regulations was the Occupational Safety and Health Administration (OSHA).[4] Well, there are lots of references to batteries, mainly dealing with safety but there was nothing specific to battery lifting or moving. Under 1910.268 – Telecommunications, 1910.268(b) (2) (i) Battery Handling, the only subjects addressed are eye protection and electrolyte issues. One specific OSHA reference in 1917.157(k) which deals with Marine Terminals caught the author's attention. This states that "Battery handling equipment which could contact battery terminals or cell connectors shall be insulated or otherwise protected." The author's first reaction was that of battery lifting devices being used and how inadequate many of them were for the purpose having seen many "arcs and sparks" caused by them coming into contact with battery terminals and exposed connections.

Realizing that battery safety is adequately covered in many other documents including manufacturers' instructions, IEEE standards and guides and similar documents, the search for battery handling information was narrowed down to battery moving and lifting. Not really comfortable in the revelation that the searches for rules and regulation in OSHA documents for battery lifting were negative, three Environmental Safety Experts were contacted and they agreed that they too could not reference or find lifting information of any kind in OSHA.

The author was referred to National Institute of Occupational Safety and Health (NIOSH).[5] According to a Safety Management Specialist with EMC Insurance Companies, (http://www.emcins.com/lc/niosh.htm) "Low back pain and injuries attributed to manual lifting activities continue to be one of the leading occupational health and safety issues in workplaces across the nation. According to the National Safety Council, overexertion injuries represent more than 30 percent of all workplace injuries. In addition, overexertion injuries of the back, shoulders and knees are some of the most costly to workers' compensation systems.
In order to assist employers in reducing the risk of lifting-related injuries, NIOSH has developed a lifting equation designed to determine the safety of lifting tasks. The NIOSH lifting equation is one of several important tools used in a comprehensive effort to prevent overexertion injuries. "

A calculator has been developed by NIOSH and upon entering the necessary information, one can determine if the lifting task is safe or if changes are needed. Please be aware that the NIOSH lifting equation is designed only for two-handed manual lifting tasks. The author entered the data for a typical lift of a battery from the floor onto a 36" shelf and the calculator advised that only a weight up to 25 lbs was advisable. The requirements of most battery installations would fall outside the scope of the NIOSH calculator and would require some form of lifting device.

The *Manual of Material Handling*[6] contains a Hazard Evaluation Checklist for Lifting, Carrying, Pushing, or Pulling which flags risk factors based upon simple "yes" or "no" answers. Responses to the questions asked indicate that it is unsafe to lift a battery weighing more than 50 lbs above three feet.

A search of battery installation documents that come under the auspices of the IEEE Power and Energy Society's Stationary Battery Committee (IEEE PES SBC) was conducted with respect to battery handling and lifting produced the following:

> IEEE Std 484-2002.[7]
> Under 4.1 Protective Equipment, "The following equipment for safe handling of the battery and protection of personnel shall be available: ... h) Lifting devices of adequate capacity, when required."
> Under 4.2 Precautions. "The following safety precautions shall be followed prior to and during installation:
> a) Ensure that metal racks are connected to an electrical ground in accordance with applicable codes and design considerations.
> b) Inspect all lifting equipment for functional adequacy."
> Under 5.1 Location. "c) … Space should also be provided to allow for operation of lifting equipment."
> Under 6.1.2 Unpacking.
> "a) When lifting cells, a strap and strap spreader should be used, if applicable.
> b) Always lift cells by the bottom, never by the cell posts."
> There is no other mention of battery handling or lifting.
>
> IEEE Std. 1106.[8] contains almost the exact same information with respect to handling and lifting as IEEE Std. 484.

IEEE Std. 1184-2002[9] contains the information above and has two significant additions:
Under 4.2 Precautions.
"The following protective procedures shall be observed … i) Follow the manufacturer's instructions regarding lifting and handling of cells."
Under 6.1.2 Unpacking.
"a) Never lift cells by the terminal posts.
b) When lifting cells or modules, use the proper lifting equipment as recommended by the manufacturer."

Based upon the above requirement of following the manufacturer's instructions and recommendations, a search was conducted of most of the major battery manufactures' installation and operating manuals. Well there is scant information from the manufacturers with respect to lifting and handling. Some even refer the reader back to the IEEE documents referenced above. Some do cover battery lifting using slings but fail to go into any detail of the lifting equipment. Some make a passing reference to platform lifts and lifting equipment but again fail to go any further. Most of the battery manufacturers belong to the Battery Council International (BCI)[10] but a search of the BCI documentation offers no information on battery lifting.

So where is one to go for information? How about the battery handling equipment manufacturers? A search of their web pages offered sparse information on methods, techniques or regulations. A search of Federal requirements revealed the following somewhat startling requirement under the Department of Defense Unified Facilities Criteria, UFC 3-520-05 April 14, 2008, "Battery lifting devices shall be insulated and tools shall be provided with insulated handles." The author is not aware of any insulated battery lifting device with the exception of some overhead beams.

Interim Summary.

To summarize what has been revealed so far:

- OSHA does not have any information with respect to battery lifting or handling, but they can impose penalties if anyone gets hurt as a consequence in the workplace!
- NIOSH has developed a mathematical model which helps to predict the risk of injury based on the weight being lifted and accounts for many confounding factors.
- The IEEE has several stationary battery related standards and methods that mention battery handling and lifting but there is no detailed information.
- Stationary battery manufacturers do not offer any significant information in their installation and operation documentation.
- BCI offers no information.
- Battery handling equipment manufacturers and suppliers do not offer any detailed information.

ACTING UPON THE LACK OF ADEQUATE INFORMATION

Because of the lack of any significant information regarding battery handling and lifting, persons who are very knowledgeable in the subject of material handling were consulted. The main thing that surfaced was that with the exception of a device developed for Lineage Power's Round Cell™; almost all of the stationary battery lifting equipment in use today is not really designed for the purpose. Most of them are basically pallet stackers designed for warehouse use. They are mostly constructed of steel, are heavy, unwieldy and are not really user friendly. Battery installers were interviewed and the following is a summary of the negatives regarding the existing equipment:

- They are unsafe because the bare metal is an electrical contact hazard.
- They are difficult to transport and move to the installation position because of size and weight.
- They are difficult to maneuver in narrow battery isles.
- Hand crank and foot pump lifts are slow and cause operator fatigue.
- A lot of time is wasted because of the slow operation of manual lifts.
- Most of the battery operated lifts are too big and heavy.
- Many lifts do not go low enough to transfer batteries safely from pallets.
- Many use a general purpose lift for both large VLA batteries and smaller VRLA batteries.
- Typical dollies used to move batteries from pallets to lifts are not low enough to allow the easy movement of batteries to the dolly.

This feedback, along with information gathered from the field and accidents personally witnessed or reported by others, prompted the author, in conjunction with experts in the field, to write a sample requirement and specification for battery lifting and a battery lifting device. The intent was to determine if a safe, user friendly lifting device could be developed at an affordable price. Some of the key requirements in the specification are:

- All handling of stationary batteries during installation or removal by hand or in use with a lifting device/system should conform to all recommended industry standards, including but not limited to, NIOSH.
- Batteries whose weight and placement fall within the NIOSH lifting equation constraints can be handled by hand in accordance with recommended NIOSH practices.
- Batteries whose weight and placement fall outside of the NIOSH lifting equation constraints should be handled/supported with the aide of a lifting device/system that provides continuous, uninterrupted, support of the battery to final location.
- Lifting devices/systems should be in conformance with applicable industry standards.
- Lifting devices/systems should be designed and documented to handle as a minimum 125% of the rated weight, and shall be designed and documented such that they maintain positive stability in all directions while under load.
- The use of un-engineered, jury-rigged, slides, hoist, jacks, and other means of moving batteries should be considered unsafe and are to be avoided.
- Battery lifting devices for heavy or frequent lifting should be DC or AC powered so as to prevent personnel fatigue. Hydraulic or chain operations should be avoided when possible.
- Where possible, the use of modular construction should be used to prevent injury when moving the device to and from the battery installation or removal location. Individual components should not exceed 100lbs unless provided with suitable handles and lifting aids.
- Lifting devices should be constructed in such a way as to meet minimum battery aisle requirements.
- Lifting devices should have all components that could come into contact with the battery terminals insulated.

Battery powered lifts should be certified to be in compliance with the some established industry build and safety standards. Some of the industry codes and standards that could be reviewed include the following:

- ANSI A92.3-2006 Manually-Propelled Elevating Aerial Platforms.[11]
- ASME B56.1-2000 Safety Standard for Low Lift and High Lift Trucks ASME B56.10-1992 Safety Std. for Manually Propelled High-Lift Industrial Trucks.[12]
- IPC-A-600 Acceptability of Printed Circuits IPC-A-610 General Guidelines for the Acceptance of Printed Board
- Assemblies.[13]
- NEMA ICS-2-1993 Industrial Control Devices, Controllers, and Assemblies.[14]
- NEMA ICS-6-1993 Industrial Control and System Enclosures.
- NFPA 79. Electric Standard for Industrial Machinery.[15]
- OSHA 29 CFR 1910.212 General Requirements for All Machines.[4]
- OSHA 29 CFR 1910.219 Mechanical Power-Transmission Apparatus.[4]
- U.L. 583 Electric Battery Powered Industrial Trucks.[16]

As of this writing, a design is being carried out and a prototype is expected in the near future. The lifting capacities have yet to be determined and are pending engineering review but it is envisaged that there will be a 200 lb. and a 450 lb. class lift. The initial cost of such lifts may exceed manual lifts and battery powered lifts that are currently available; however, the return based upon labor saving and the reduced potential to personnel injury and material and environmental damage will far outweigh this obstacle.

The lack of adequate battery handling and lifting information was also raised at the most recent IEEE PES SBC[17] meeting and a Task Force was set up in order to look at the whole battery handling situation and ensure that adequate information was included in future revisions of all appropriate standards. This task force will be identified at Battcon and industry input is certainly welcomed.

SUMMARY

Are we doing it right? Well the answer is no as far as can be determined. Every battery installation, removal or change-out that the author has witnessed has demonstrated some form of unsafe battery packaging, transportation, handling and lifting. Hopefully, with a new generation of battery handling and lifting equipment and some new standards, codes and guides, we will get better at the task, many accidents will be avoided and personnel safety will be improved. It is time for the battery installation industry to move away from legacy handling devices that are in general, equipment that has been adapted from other applications, and to specify, design and use equipment that is really suitable for the purpose.

NOTE

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