Canadian Standards Association
Mississauga, Ontario
To the Part I Committee

Subject No. 3071 Chair: R. Leduc Date: March 11, 2003

Title: Ventilation of Battery Rooms, Rule 26-546(1)

Submitted by: Richard Ferguson of ATCO Power – Sheerness Plant, Tel: (403) 854-5122, Fax: (403) 854-5151 on July 9, 2002.

Proposal: Revise Rule 26-546(1) to read:
"Storage battery rooms or areas shall be adequately ventilated to prevent the accumulation of hazardous concentrations of explosive gas."

Reasons for Request:

Section 26 covers the installation of storage batteries and other equipment in a battery room. Rule 26-546(1), Ventilation of Battery Rooms or Areas (see Appendix B), states, "Storage battery rooms or areas shall be adequately ventilated." Appendix B comments:

Sufficient ventilation should be provided to prevent the hydrogen gas from building up to a level of 2% by volume in the room air at any time.

When batteries are operated in constant-voltage-float service and the float voltage is maintained at appropriate levels, generation of gas is very slight.

The rate of ventilation required to maintain the volume of hydrogen gas below the 2% level in a battery room may be calculated in accordance with IEEE Standard 484. [A sample calculation follows.] and

However, a minimum of 1 to 4 air changes per hour in the battery room are recommended to prevent pockets of hydrogen gas from accumulating and for the comfort of the maintenance personnel.

Thus, an oblique reference is made to Section 18. Two per cent (2%) hydrogen by volume is 50% LEL. This appears to be inconsistent with the definition in Rule 18-002: Adequate ventilation means natural or artificial ventilation that is sufficient to prevent the accumulation of significant quantities of vapour-air or gas-air mixtures in concentrations above 25% of their lower explosive limit. I believe this inconsistency in Appendix B should be remediated by changing "2%" to "1%" and noting that the Rule 18-002 definition applies. IEEE Standard 484 can be referred to as a guide.

The suggested wording makes it clear that ventilation is not for corrosive gases or the comfort of maintenance personnel, but pertains to hazardous locations.

Rule 26-554, Wiring Methods and Installation of Equipment in Battery Rooms, makes the blanket statement, "The installation of wiring and equipment in a battery room shall be in accordance with the requirements for a dry location." The Rationale for Rule 26-554 makes the point that "electrical wiring other than that associated with the batteries can be done in accordance with the requirements for a dry location." This is an oblique reference to Section 22 and is understandable in that context.

However, the Intent goes on to say:

Although the electrolyte used in batteries is quite corrosive and hazardous gases are produced during the charging process, a battery installation complying with these Rules is not to present any problem to other electrical wiring and equipment in the vicinity of the battery equipment. Thus, we intend that the area be considered a dry location. It then makes a field recommendation that "only electrical equipment essential for the area be located in battery rooms. Lighting switches can be located outside the area and thermostats with capillary tubes can be used with the thermostat outside and the capillary tube inside."

This intent is confusing and begs the question regarding hazardous location issue of a battery room. It states the "corrosive and hazardous" battery room may be considered only a "dry" location, even though its subsequent field recommendation is consistent with a Class I hazardous location. This is very misleading. One might conclude that by providing "adequate" ventilation, equipment suitable for an ordinary "dry" location would be safe and acceptable for a battery room.

I suggest that wording of the intent be clarified to state:

Although the electrolyte used in batteries is quite corrosive, a battery installation complying with these Rules will not present a corrosion problem to other electrical wiring and equipment in the vicinity of the battery equipment. Thus, we intend that the area be considered a dry location.

The Field Considerations for Rule 26-554 would be better included in the Intent for Rule 26-546, Ventilation of Battery Rooms or Areas, where they have application.

One further point. The Intent for Rule 26-546 states:

Appendix B notes that "when batteries are operated in constant-voltage-float service and the float voltage is maintained at appropriate levels, generation of gas is very slight...."

This statement is also very misleading. It applies strictly to lead calcium batteries. Lead antimony batteries will release up to 20 times more hydrogen when the battery is new, and up to 100 time more hydrogen when the battery approaches end of life. These batteries will release even more hydrogen when operated above 25°C. This generation of gas could hardly be called "slight". This is the problem when the code presents design information that is not tempered by experience and knowledge.

The comments of the Intent and Appendix B would better serve the users of the CEC C22.1 if it directed their attention to IEEE Std 484 or advised them to consult with a design engineer. The CE Code, Part I, is a minimum Standard and should not be used as a design manual. As stated in Section 0, "This Code is not intended as a design specification nor an instruction manual for untrained persons." I believe the Intent and Appendix B comments have crossed over the line on this issue.

Chair's Comments: It is interesting to note the submitters connecting the rule to Rule 18-002. If indeed this rule is alluding to the possibility of a hazardous location becoming evident then we need to reconsider the wording of the Rule as well as the Appendix B Note.

The submitter also makes some comments on wording found in the Handbook. I suggest that these comments be submitted to the writer's of the handbook for their consideration.

In addition to the submitter's proposal to amend Rule 26-556(1), I suggest we also amend the Appendix B Note by replacing it with the following:

> 26-546 *Sufficient ventilation should be provided to prevent the hydrogen gas from building up to a level of 1% by volume in the room air at anytime (or 25% Lower Explosive Limit as defined by the definition of "Adequate Ventilation" in Rule 18-002). A qualified design engineer and IEEE Standard 484 should be consulted for proper ventilation design.*

Subcommittee Deliberations (1st Round):
9 of 13 members responded, 4 agreeing with the submission and 5 disagreeing.

It was brought to the attention of the Subcommittee that this Rule was the result of a Task Force recommendation in the mid ‘80s. There was a suggestion that because the original rule was the result of a recommendation of industry experts, perhaps a new task force should be organized to review the current submission and make appropriate recommendations.

Of those disagreeing, 3 simply agreed with the notion of having a task force look into the matter. 2 others offered the following comments:

- The existing Rule was deliberately written to refrain from referencing hazardous concentrations of explosive gas” and not intended to be treated as hazardous locations. The ventilation referenced in the Rule is intended to address a number of concerns, including such things as air quality. Therefore, it was deliberately intended that such rooms have “adequate ventilation” in the general sense and the Appendix B note provided guidelines for achieving this.
- Accepting the proposal essentially has the effect of challenging the direction intended by the Task force that suggested the existing Rule
- There are many different situations where we have battery rooms. Each one presents different concerns depending on the types of batteries used, number of batteries, size of room, natural ventilation, etc. Designers are responsible for considering all of these variables. If designers deem that a specific battery room installation can potentially produce enough hydrogen to justify a Class I classification, then the requirements of Section 18 would automatically apply in any case.
- Perhaps we need specific numbers or studies that provide enough evidence that the amount of hydrogen released in specific battery room installations is sufficient to produce a Class I location. If such evidence is substantiated, then perhaps we could develop an appropriate Rule in Section 20.
- A reference to a need for “a qualified design engineer” in this proposed Note is not appropriate, since such requirements (if they are deemed to be necessary) could be placed only by the regulatory bodies in their applicable administrative rules made in provincial/Territorial Regulations. The Code should be free from such references, as they tend to lead to a variety of legal implications.

One of the members disagreeing did however agree with the submitter’s notion that the explanation of the intent as shown in the handbook could be confusing to the Code users. The submitter’s suggested wording referring to corrosion (see the middle of the second page of the submitter's reasons for request) could be incorporated as new Appendix B Note on Rules 26-550 and 26-552 as follows:

> “Although the electrolyte used in batteries is quite corrosive, a battery installation complying with these Rules will not present a corrosion problem to other electrical wiring and equipment in the vicinity of the battery equipment. It is intended that the area may be considered as dry location for the purpose of Rule 26-554”

He went on further to propose the following:

(1) To leave Rule 26-546(1) without any changes;
(2) To add new Appendix B Note on Rules 26-550 and 26-552 as shown above;
(3) To amend existing Appendix B Note on Rule 26-546 by simply changing "2%" to "1%" in a first and third sentences, in two paragraphs associated with the examples of the calculations. Respectively, the result of multiplication of "30 x 2%" will be now "30 x 1%" and will be "0.3"
Respectively, the formula with a number "0.6" in the nominator will now read "0.3" and the result will be "9 days".

Chair's Comments (1st Round):

It is interesting to note that the current Rule did not intend to associate itself with hazardous locations yet the Appendix B note suggests the intent is to "prevent the hydrogen gas from building up…". That in itself implies that in certain situations, the possibility exists for an explosive gas atmosphere to develop. However, I also realize that the possibility for an explosive gas atmosphere to develop, even where the ventilation fails, is remote since other conditions would need to come into play (i.e., number of batteries, type of batteries, size of room, level of discharge, charging cycle, etc.).

Regarding the comment suggesting that it is not appropriate for the Appendix B note to guide users toward professional involvement, I would have to disagree. According to Clause C12.3 of Appendix C, Appendix B is intended to incorporate "recommendations or explanatory notes". The suggestion recommending professional involvement is not mandatory and therefore falls within the purview of an Appendix B note. I believe that an advisory for users to seek out professional involvement in designing battery rooms is a prudent approach.

I also agree that the determination of whether the battery room needs to be classified hazardous or not is more of a design issue and as such should not be mentioned in the rule since the scope of the Code stipulates that it is "not intended as a design specification…". In addition, it may be inappropriate to suggest in the Rule that ventilation is purely for the purpose of preventing the accumulations of hazardous concentrations of explosive gas because, as was already observed, it is also for the "comfort of maintenance personnel". Another factor is that not all batteries produce hydrogen, so we shouldn't paint all battery rooms with the same brush. There are many other variables that may need to be considered as well. Perhaps we can bring these concerns to light in a revised Appendix B note.

If the Subcommittee agrees with the comments above and feels we may be able to deal with the subject through an Appendix B note, we would not need to form a task force. Therefore, based on the comments above, I propose the following:

1. Add a new Appendix B note for Rules 26-550 and 26-552 as follows:

"Although the electrolyte used in batteries is quite corrosive, a battery installation complying with these Rules will not present a corrosion problem to other electrical wiring and equipment in the vicinity of the battery equipment. It is intended that the area may be considered as dry location for the purpose of Rule 26-554"

2. Revise Appendix B note to Rule 26-546 to read as follows:

26-546 *In addition to ventilation for environmental purposes ~~Sufficient~~ where the battery type produces hydrogen during the charging cycle, the ventilation system for battery rooms should be ~~provided~~ designed to prevent hydrogen gas from building up to a level of ~~2~~ 1% by volume in the room air at any time.*
When such batteries are operated in constant-voltage-float service and the float voltage is maintained at appropriate levels, generation of gas is very slight. Other conditions that may increase the risk of having

elevated levels of hydrogen being produced should also be taken into consideration (i.e., number of batteries, size of room, extended duration of deep-charge cycles, etc.).
The rate of ventilation required to maintain the volume of hydrogen gas below the 1% level in a battery room may be calculated in accordance with IEEE Standard 484. Qualified mechanical engineering should be considered for proper ventilation design.

As an example, the volume of hydrogen gas generated daily by a 60 cell, 840 ampere hour *lead calcium grid battery charging at* 2.2 V *per cell is determined as follows:*

Total m^3/min of hydrogen gas = number of cells × gas generation rate of battery type in m^3/min × float current in amperes × minutes/day.

Volume of gas production = 60 cells × 7.6×10^{-6} $\frac{m^3}{min} \times \frac{0.006\ A}{100\ A.H.} \times 840\ A.H. \times \frac{60\ min.}{h} \times \frac{24\ h}{day} = \frac{0.03309\ m^3\ gas}{day}$

For a room volume of 30 m^3, *the total volume of gas that should be allowed to accumulate in this room is* 30 m^3 × ~~2~~ 1% = 0.~~6~~ 3m^3.

Therefore, to meet this ~~2~~ 1% maximum level, one air change is required for each $\frac{0.6\ 3\ m^3}{0.03309\ m^3\ \frac{gas}{day}}$ = ~~18~~ 9 days

However, a minimum of 1 to 4 air changes per hour in the battery room is recommended to prevent pockets of hydrogen gas from accumulating and for the comfort of the maintenance personnel.

3. Submit this completed subject to the writer's of the CEC Handbook for information.

Subcommittee Deliberation (2nd Round)
Seven (7) members out of a possible 13 responded in favour of the chair's proposal in the 1st round with no comments.

Declaring consensus, the Chair offers the following:

Subcommittee Recommendation
To accept the proposal in the 1st round of deliberations:

1. Add a new Appendix B note for Rules 26-550 and 26-552 as follows:
"Although the electrolyte used in batteries is quite corrosive, a battery installation complying with these Rules will not present a corrosion problem to other electrical wiring and equipment in the vicinity of the battery equipment. It is intended that the area may be considered as dry location for the purpose of Rule 26-554"

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When such batteries are operated in constant-voltage-float service and the float voltage is maintained at appropriate levels, generation of gas is very slight. Other conditions that may increase the risk of having

elevated levels of hydrogen being produced should also be taken into consideration (i.e., number of batteries, size of room, extended duration of deep-charge cycles, etc.).
The rate of ventilation required to maintain the volume of hydrogen gas below the 1% level in a battery room may be calculated in accordance with IEEE Standard 484. Qualified mechanical engineering should be considered for proper ventilation design.

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Total m^3/min of hydrogen gas = number of cells × gas generation rate of battery type in m^3/min × float current in amperes × minutes/day.

Volume of gas production = 60 cells × 7.6 × 10^{-6}

$$\frac{m^3}{min} \times \frac{0.006\ A}{100\ A.H.} \times 840\ A.H. \times \frac{60\ min.}{h} \times \frac{24\ h}{day} = \frac{0.03309\ m^3\ gas}{day}$$

For a room volume of 30 m^3, the total volume of gas that should be allowed to accumulate in this room is 30 m^3 × 1% = 0.3m^3.

Therefore, to meet this 1% maximum level, one air change is required for each

$$\frac{0.3\ m^3}{0.03309\ m^3\ \frac{gas}{day}} = 9\ days$$

However, a minimum of 1 to 4 air changes per hour in the battery room is recommended to prevent pockets of hydrogen gas from accumulating and for the comfort of the maintenance personnel.

3. Submit this completed subject to the writer's of the CEC Handbook for information.