Battery Room or Area Ventilation Engineering Application

Contents	Subject	Page

1. General

1.1
Purpose

This practice provides procedures on how to ventilate the battery room or area to remove hydrogen gas.

1.2
Filing
Instructions

File this practice in numerical order in your practices set. This practice supersedes Issue 4, November 1983. Remove and discard Issue 4.

1.3
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Responsibility

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1.4
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2. **Overview**

2.1 Introduction

This practice:

- Explains how to ventilate the battery room or area to remove hydrogen gas.

- Provides calculations for determining the volume of hydrogen being produced.

- Applies to the flooded cell type batteries and the "sealed", starved electrolyte valve-regulated battery technology.

2.2 Definitions

The following chart defines terms used in this practice:

Term	Definition
Ampere	Unit of electric current, or fate of flow of electricity.
Equalizing Charge	An extended charge to a measured end point that is applied to a storage battery. This ensures that the active materials in the plates of the ceils are completely restored.
Floating Charge	A method for maintaining a constant state of charge in a storage battery by applying a constant voltage to the battery's terminals. Also called a "trickle charge."
Gassing	The process during battery cell charging where electrolysis breaks down some of the water molecules in the electrolyte. This causes hydrogen and oxygen to bubble to the surface.
Secondary Battery ·	Cells that are designed to be: - Cycled. OR - Repeatedly discharged and recharged.

3. Hydrogen Gas

3.7
Definition

Every type of secondary battery, including the lead-acid type, produces hydrogen gas. Hydrogen gas is:

o   Lighter than air.

●   Colorless.

●   Odorless.

●   Tasteless.

●   Extremely flammable.

The gas gathers under the cover of each ceil in the battery.

3.2
Preventing
Ignition

Hydrogen gas is vented through the vent plugs of the battery into the air of the battery room area. Therefore, you must use explosion resistant vent plugs to prevent accidental hydrogen gas ignition. Vent plugs should be inspected frequently. Replace vent plugs that are damaged or cracked.

WARNING: **Do no**t **smoke or cause other conditions that could create sparks and flames In the battery room or area.**

3.3
Charging
Operation

Lead-acid batteries produce hydrogen gas primarily during the charging operation.

The...	Produce...
Floating charge operations	Very little hydrogen.
Equalizing charge operations	me most significant amount of hydrogen.

3.4
When Gassing
Occurs

Gassing occurs while the battery ceil is charging. The amperes supplied to the battery by the charger determine the volume of hydrogen generated from gassing. me charging amperes supplied are dependent on the ceil voitage as shown on page 6.

4. Calculating Hydrogen Volume

4.1
Introduction

When the battery ceil is fully charged, each charging ampere supplied to the cell produces about 0.016 cubic foot of hydrogen per hour from that cell. This volume applies at sea level, when the:

- Electrolyte is gassing or bubbling.

- Ambient temperature is about 77F (25C).

Keep the hydrogen content well below 1.5 percent to minimize the danger of exploding or burning. The maximum permissible design volume for hydrogen in a room or area is 1.5 percent.

4.2
Volume
Formula

Use the following formula to determine the hydrogen volume being produced by a fully charged battery:

V = NAIK, when:

$V =$ Volume of hydrogen gas produced per hour

$N =$ Number of ceils

$A =$ Ampere hours divided by 100

$I =$ Charging current in amperes

$K =$ Volume of hydrogen produced per ampere-hour per ceil, .016

4.3
Estimating
Hydrogen
Content

Use the following procedure to estimate the hydrogen content of a room:

Step	Estimating the Hydrogen Content
1	Caicuiate the interior volume (cubic feet) of the battery room or room in which batteries are co-located.

    Example: Assuming that the room ha6 a volume Of 900 cubic feet:

- me maximum permissible design volume of 1.5 percent is 13.5 cubic feet (900 x .015).

- A sample system with a 24-cell, 180 amp-hour, fully charged lead-acid battery, fioat charging at 2.17 volts per ceil.

(continued)

4. **Calculating Hydrogen Volume,** continued

Step	Estimating the Hydrogen Content
2	Calculate the total hydrogen production in cubic feet per hour.

Example: 24 x .160 x 180/100 x 0.016 = 0.11

A. Determine the number of cells (24)

B. Determine the charging current (Antimony) from the following chart:

NOTE: The current input to the lead-acid cells slightly Increases during the battery's life. During the day-to-day floating charge, the current Into the new lead-acid battery at 70F (21C) Is normally less than one percent of the elght-hour discharge current. It Is all that Is required to correct the mlnor current losses that occur when the fully charged cell Is standing Idle. Voltage values and current through fully charged statlonary lead-acid battery cells are shown below:

Voltage (volts per cell)	Antlmony new-old	Calcium
2.15	.030 - .120	- - -
2.17	.040 - .160	.004
2.20	.052 - .210	**.006**
2.23	.075 - .300	.008
2.25	.110 - .420	.011
2.27	.120 - .480	.012
2.33	.240 - .960	**.024**

C. Multiply the number of cells by the maximum charging current (Antimony) in amperes (.160).

D. Multiply the product of Step C by the ampere hours (180) divided by 100.

E. Multiply me product of Step D by the volume of hydrogen released (0.016).

The result (0.11) represents the volume in cubic feet of hydrogen gas that is produced per hour when the battery Is charged at a float current.

4. Calculating Hydrogen Volume, continued

**4.3
Estimating
Hydrogen
Content,
continued**

Step	Estimating the Hydrogen Content
3	Divide the room's 1.5 percent volume value (13.5 cubic feet) by the maximum hydrogen production value per hour (0.11 cubic foot.) This will indicate the minimum required ventilation rate.

> **Example:** **13.5 divided by 0.11.** = 122.0
>
> In this worst-case situation, the hydrogen content will be kept below 1.5 percent if a complete air change is made every 122.0 hours.
>
> 900 cubic feet/l22 hours = 7.4 cubic feet per hour
>
> 7.4 cubic feet per hour/60 minutes =
>
> 0.123 cubic feet per minute (CFM)

Step	
4	Assume this example is a battery room with a 100 CFM exhaust fan. Step 3 shows that the fan must run every 122 hours. You need to calculate how long the exhaust fan must run to provide a complete air change.

900 cubic feet/100 CFM = 9 minutes

Therefore, you must control the exhaust fan with a time clock to run a minimum of 9 minutes every 122 hours. This will maintain a hydrogen content below 1.5 percent.

4. Calculating Hydrogen Volume, continued

4.4
When to Use an Exhaust Fan

Use the following exhibit to determine when you need an exhaust fan to maintain hydrogen concentration levels below 1.5 percent.

NOTE: **The notes below the exhibit state certain condltlons and assumptlons used to develop the exhibit. If condltlons are dlfferent than those stated, use the previous formulas to calculate hydrogen gas production.**

Battery Size (AMP – Hour)	Building Area (Square Feet)				
	100 SF	25OSF	500SF	**750** SF	1000 SF
180 AH	**7.4/42**	7.4/105	7.41210	7.41315	7.4/420
84OAH	**34/42**	34/105	34/210	34/315	24/420
1500AH	**61/42**	61/105	61/210	61/315	61/420
255OAH	**104/42**	104/150	104/210	104/315	KM/420
3000AH	123/42	123/105	1231210	123/315	123/420
4OOOAH	164/42	164/105	164/210	164/315	164/420

1. This table applies only to buildings where batteries are co-located with telephone switching equipment.

2. Enter the table by the intersection of the building area and battery size. A point of intersection that is to the right of the line will not require an exhaust fan.

3. This table is based on buildings with a 10.5' ceiling height.

4. The table values are shown as x/y:

    "x" value =   Ventilation of new air (cubic feet/hr.) required to maintain hydrogen concentrations below 1.5 percent.

    "y" value =   Ventilation of new air (cubic feet/hr.) provided based on an infiltration rate of .04 air changes per hour.

4. Calculating Hydrogen Volume, continued

**4.5
Delivering
Ampere-Hours**

A battery capable of delivering 210 amperes of current for eight hours has a rating of 1,680 ampere-hours. This means that 210 amperes of current can be drawn for eight hours before the battery reaches its normal discharged condition of 1.75 volts. Therefore, a battery delivers more ampere-hours at a long, low, or intermittent rate of discharge than a short, high or continuous rate.

**4. 6
Normal Rate of
Discharge**

The number of hours a battery is expected to be the only source of power determines the normal rate of discharge for the battery.

5. Fresh Air Ventilation

**5.1
Areas
Containing
Batteries**

You must provide sufficient natural or mechanical fresh air ventilation in buildings containing batteries. The air ventilation is necessary to prevent hydrogen gas from accumulating in excess of 1.5 percent hydrogen in the air, the maximum permissible design volume as calculated in Section 4.

You can provide fresh air on a continuous or intermittent basis if mechanical ventilation is required.

**5.2
Batteries in
Separate
Locations**

You must provide the following where batteries are located in a room separated from all other functions:

- An exhaust fan or ventilation system to exhaust air to the outside of the building. Two methods of exhaust fan control are available:

    1. A time clock to operate the fan or system at regular intervals determined by Section 4.3, Steps 3 and 4 on page 7.

    2. A hydrogen detection sensor set to start the fan or system at 1.5 percent hydrogen concentration.

- A manual override time switch within the battery room. This is to be used to operate the exhaust fan or ventilation system when the battery equalizing charge takes place.

Put the point of exhaust near and above the battery rack.

6. Circulated Air

6.1
Air
Recirculation

In addition to the fresh air ventilation requirements outlined in Section 5, you must provide areas of a building containing batteries with sufficient mechanical air handling apparatus. The apparatus must provide complete recirculation of the room's air volume four times each hour.

This requirement prevents hydrogen gas from accumulating within an Isolated area or "pocket" to a concentration level that exceeds 1.5 percent.

6.2
With Other
Equipment

The building's heating and air-conditioning system will normally satisfy the circulated air requirement for those sites where batteries are co-located with switching equipment.

6.3
Isolated Battery
Room

There are two methods of design to satisfy the requirements for circulated air and fresh air ventilation for those sites where batteries are located in a separate room.

- The battery room may have its own heating and air-conditioning system independent of the heating and air-conditioning system of the rest of the building. In addition, a small exhaust fan must provide the fresh air ventilation requirement.

If the battery room does not have a heating and air-conditioning system, the exhaust system must be operated and sized to meet the higher of the fresh air ventilation or circulation requirements. In most cases, the circulation requirement will govern.

- The battery room may have a supply of conditioned air by way of the building's central heating and air-conditioning system. A quantity of air equal to the rate of supply must be exhausted to the outdoors since the battery room air must not be circulated throughout me rest of the building.

In most instances, an air flow rate to satisfy the circulation requirement will also exceed the fresh air ventilation requirement of the battery room.