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Lab Assignment: Cool The Pharmacy Through Ventilation

Attached is a copy of an assignment I've created for my HAC 165-170 Sustainable Energy class. This assignment requires the students to calculate the heat load of a given space, calculate the amount of store air needed to properly ventilate the space to remove the heat load, make a judgment determination if the speed of that air is acceptable to working conditions and then formulate a response to a working supervisor.
The assignment starts by telling the students that they work for a national drug store chain. Their boss has just seen a 3 hour seminar on Sustainable Green Building Methods and has brainstormed an idea that he says will save the company energy, involve "green stuff" and make his name famous with the Board of Directors. He wants to get rid of the air conditioning in the Pharmacy and treat that area by using an exhaust fan to suck air through the pharmacy from the Sales Floor, since, in his words "We air condition the sales floor anyway". All the Boss's Managers are "yes men" who quickly jump on the idea and endorse it. They are just about to call channel 7 news to brag about it when the student, playing the part of the "new guy" with nothing to loose, decides to check out this idea to determine if, in fact, it will work.
Not only does the student have to use Math Skills and Critical Thinking, he also has to formulate an answer Pro or Con and present it to an ego driven back stabbing Boss. In other words, real life.
1. Name of workshop: GYC 101 Greening Your Curriculum
2. My info: Stevan Brasel, HAC 165-170 Sustainable Energy Practices
3. Title: Feasibility Study: Cooling the Pharmacy Through Natural Ventilation
4. List of Learning Outcomes for class: Critical Thinking, Problem Solving, Math Skills
5: List of Learning Outcomes covered in assignment: Critical Thinking, Problem Solving, Math Skills
6: Utilize Critical Thinking Skills: Students will assess the information given to determine a predicted outcome and apply reasoning skills to determine an acceptable answer.
7. Relevancy: relevant to normal job conditions
8. Show Assignment: See attached.

Background: **THIS IS A TRUE STORY**. The Director of Construction for a National Drug Store Chain has attended a 3 hour Webinar on Sustainability and Green Construction. He has now issued a directive that he will save energy costs and use less energy in the store by cooling the enclosed Pharmacy area by using store air drawn through the Pharmacy store front opening that connects to the sales floor. His reasoning is that since the store sales floor is cooled to 73 degrees, why not draw enough air through the pharmacy using an exhaust fan in order to cool it. That will use less energy and save construction costs, and he can be written up in “The Sustainability News” as a featured article.

You, as the young Energy Engineer, are the only one with enough guts to look at this critically and tell the boss if this will work, or not. Everyone else just says "yes sir". You need to put the answer in a term the Director can understand, so you decide to tell him what the Miles Per Hour of air will flow through the Pharmacy opening to cool down the Pharmacy.

Here is the physical information you will need:

1) The floor space of the pharmacy is 10 feet by 30 feet, or 600 square feet.
2) The pharmacy opening to the sales floor is 3 feet high by 10 feet wide, or 30 square feet.
3) The sales floor is kept at 73 degrees.
4) To convert Miles Per Hour (what he understands) to Feet Per Minute (what we understand), convert as follows:
   1 mile = 5,280 feet.
   1MPH = 5,280 feet per hour
   There are 60 minutes in an hour, so 5280/60 = 88 **Feet Per Minute**
   So, 1 MPH is 88 FPM

Here is the heat load information you will need:

1) Light load is 4 watts per square foot of floor space.
2) There is 3.4 BTUH per Watt
3) There are 4 people working inside the Pharmacy, each person puts out 450 BTUH
4) There are 2 computer terminals inside the Pharmacy, each terminal puts out 800 BTUH
5) The BTUH formula regarding CFM is: Qs = **1.08 X CFM X Temperature Difference**
6) **CFM = Velocity in FPM X Area in square feet**, so : **Velocity in FPM = CFM/Area in square feet**

A. Compute the BTUH load in the Pharmacy

1. Lights =
2. People =
3. Computers =
4. Total BTUH load I the Pharmacy =

B. Compute the CFM needed to remove the Pharmacy BTUH load. Keep in mind THERE IS NO DESIGN TEMPERATURE DIFFENCE between the Sales floor and the Pharmacy. So your formula now becomes: Qs = 1.08 x CFM. You know the Qs (BTUH load) from "A" above, so plug and chug and solve for CFM:

CFM = BTUH/1.08

CFM = _____

C. Convert CFM into Velocity (FPM). We need to do this in order to determine how many miles per hour the air is traveling through the Pharmacy opening.

FPM velocity = CFM/area in square feet of Pharmacy sales floor opening

Plug and chug the numbers, and you get :_____FPM

D. Convert FPM to Miles Per Hour

Remember there are 88 FPM to 1 mile per hour.
So take your FPM from the above and divide that by 88 and you'll get :

Miles per hour of the air moving through the Pharmacy sales floor opening, which is

_____MPH

Use the Beaufort Wind Scale below to determine what that MPH air going through the Pharmacy opening feels like:

The Beaufort Wind Scale categorizes wind speed up to hurricane strength.

The Beaufort Wind Scale categorizes various wind speeds up to hurricane strength (74 miles per hour) and is used in weather forecasting. The scale is named after its creator, Admiral Sir Francis Beaufort of the British Navy, who developed it in the early 1800's. It is still used heavily today, primarily with maritime forecasts.

The 13-point scale, from 0 to 12, defines breezes, gales and hurricane force winds and also gives information on how various wind speeds affect land and sea.

The number assigned to a wind speed category is called the "Beaufort Number". This number also indicates the wind's characteristics and possible damaging effects.

A Beaufort Number (BN) of "0" means that the wind is blowing at less than one mile per hour. This is defined as "calm". Smoke rises vertically and the sea is still.

The Beaufort Number 1 signifies a wind speed of one to three mph. This is considered a "light air". At sea, you could expect to see ripples in the water, but no waves large enough to form foam crests. No significant effects on land occur at this stage. Smoke slants and is carried by the wind.

BN 2, with winds four to seven mph, defines a light breeze. Still no significant effects can be noticed on land, but at sea, the ripples turn into small wavelets.

BN 3 signifies winds of eight to 12 mph. This is a gentle breeze, creating small whitecaps on the ocean water. The wind is now strong enough to extend flags.

BN 4 is a moderate breeze, with a wind speed of 13 to 18 mph. This wind is strong enough to lift small leaves and twigs off the ground and move small branches on trees. This wind also creates small waves in the ocean with numerous whitecaps.

BN 5, with winds of 19 to 24 mph, is a fresh breeze. This wind produces moderate waves out in the ocean with some spray. Small trees begin to sway.

BN 6, with winds of 25 to 31 mph, is a strong breeze. Large waves form in the ocean with abundant white caps and a lot of spray. On land, large branches on trees sway. This type of wind is also associated with the average thunderstorm or squall line on land.

Based on the above:

1. Would you recommend that the Director does this:
   Yes_____
   N0_____

2. If no, how would you tell this to the Director this. The worst thing you can do is make him feel stupid, so be creative: