

Good Money After Bad

Common Auditing Mistakes and Their Consequences

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What Are We Talking About, Here?

There is only one objective of this presentation.

It has many facets, all of which cannot be covered in the time allotted. But here is the bottom line:

We must create a mental connection between the data we collect in our audits, and how it affects the outcomes of a project.

- ▶ Identify weaknesses in our data acquisition techniques.
- ▶ Improve the sophistication of our physical and mental toolkit.
- ▶ Address cognitive biases in our audits, and correct them.

A Tale of Two Screw-Ups

(The two most pervasive types of mistakes that get made)

Type 1: Errors in Acquisition

Audits are purely an exercise in data acquisition. The better the data, the better the audit. Time constraints and financial obstacles conspire to abrogate the quality of this process.

The Worst Offender: Poor data collection practices

- ▶ Did you really come back without the energy consumption records or at least a copy of the bills?
- ▶ Did you bring tools?
- ▶ Failure to note control valve types and 3D valve position.
- ▶ Failure to determine system configuration accurately.
 - ▶ Constant volume? Variable flow? Multizone or CV with reheat? Ventilating or not?
- ▶ Failing to note condition of equipment.
- ▶ Believing the customer.
 - ▶ Trust, but verify!
 - ▶ Equipment lists and as-builts are often wrong or out of date.
- ▶ Over-reliance on pictures.
 - ▶ Annotate your pictures.
 - ▶ Take thorough written notes.
 - ▶ Make sketches and one-lines for anomalous systems.
- ▶ Collecting the wrong information.
 - ▶ Failing to recognize when equipment is defunct or abandoned.
 - ▶ Noting motor HP but not collecting pump data.
 - ▶ Collecting "model number" data from a modular AHU.

The Audit Bag: Your constant companion.

A good audit is like a Doctor's visit: It should be mildly invasive. You will need to access things in weird places and that will often mean removing covers, opening panels, and occasionally removing doors so you can escape a locked military facility.

When this happens, you would be well-served to have the right tools with you.

Essentials:
Showing up
without
these items
is
inexcusable.

- Camera
- Flashlight
- Multi-tool
- Writing pad and multiple writing implements.

Non-
essential
but a good
idea:

- IR gun
- Tape measure
- Light meter
- Allen wrenches

Now you're
just
showing
off...

- Manometer/anemometer
- Multimeter
- IR camera
- Combustion tester

Consequences!

The Error

- ▶ Error 1: A young energy auditor is collecting data at a sewage treatment plant. Collects 60 motors' worth of data but does not get the pump data.
- ▶ Error 2: Auditor takes 75 pictures of equipment at large office building. Notebook gets lost in transit.
- ▶ Error 3: Large ESCO secures job for a customer with (12) VFDs. Customer had 3-way valves on all coils.

The Consequence

- ▶ Consequence 1: GPM and head are what tell us how hard the motor is working. Father is disappointed and work had to be repeated.
- ▶ Consequence 2: Audit has to be repeated.
- ▶ Consequence 3: No savings. Lawsuit. Unemployment.

Pop Quiz!

A high school gymnasium has a 20,000CFM AHU with a 15HP fan, DX cooling, and a natural gas burner. Your vendor wants to install a VFD to modulate fan speed.

What could go wrong?



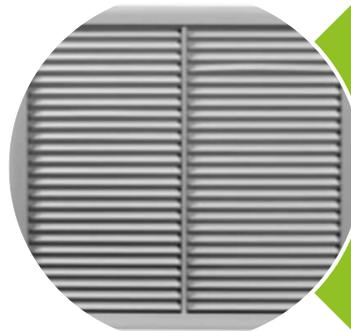
VFD may never modulate, since system pressure will never change. Because a VFD is only 97% efficient, the fan will actually consume 3% more energy than before.



Insufficient airflow can cause overheating of a heat exchanger in a gas-fired unit, and now you have burned your building down.



Insufficient airflow can cause a DX coil to freeze and rupture.



Without a good handle on the pressure drop of the distribution system, it is possible to starve terminal units of sufficient airflow.

Pro Tip: Better tools!

Smart phones
and tablets
are amazing.

Make them
work for you!

The screenshot displays a mobile note-taking application. At the top, there are navigation options: 'New Note', 'All Notes', 'Sync', and 'Work Chat'. Below this is a search bar with the text 'Nantucket, Massachusetts'. The main content area shows a list of notes on the left and a detailed view of a note on the right. The detailed note is titled 'Snapshot @ Nantucket, Massachusetts' and dated '3/30/2015'. It contains the text 'How pump:' followed by a photo of a blue metal pump. The pump has a red label with the following text: 'ap AURORA', 'PENTAIR PUMP GROUP', 'CENTRIFUGAL PUMP', 'NO. 01-3-1594-1', 'G.P.M. 700', 'TYPE 44A BF', 'HEAD FEET 75', 'SIZE XSX11', and 'R.P.M. 1758'. The application interface includes a sidebar with a list of folders and notes, and a top navigation bar with various icons for editing and sharing.

Runner Up:

Doing a bad baseline.

- ▶ Last year's energy consumption is not the baseline.
 - ▶ It's indicative, but not representative.
- ▶ Load analysis helps paint the CORRECT picture of how that facility uses energy.
 - ▶ Systems interact with each other, and only by looking at the whole can you understand its parts.
 - ▶ Also, this will help prevent asinine savings numbers.
- ▶ Rules of thumb are for people who are all thumbs.
 - ▶ Avoid them. They are only good for reality-checking your calculations.
- ▶ Assumptions introduce error.
 - ▶ They are a necessary evil, but must be applied judiciously.

Consequences!

The Error

- ▶ Error 1: Mechanical contractor proposes a chiller replacement without baseline data.
- ▶ Error 2: ESCO sells small CHP to a hotel with poor load analysis.
- ▶ Error 3: Vendor is selling solar thermal DHW to a nursing home. Used average daily oil consumption on baseline.

The Consequence

- ▶ Consequence 1: Predicted savings exceed the customer's entire consumption. Contractor looks silly. (Still got the sale, though!)
- ▶ Consequence 2: CHP has to be de-tuned and excess heat is rejected. Customer experiences "negative savings."
- ▶ Consequence 3: Average included winter heating loads. Vendor claimed to be saving more oil per day than was consumed for 50% of the year.

Pro Tip: Assumption Consumption

Bad Assumption:

A
motor
at 7

Better Ass
A 10HP motor
na

Best Assumption: Plans call for 200GPM at 70' TDH (5hp). 10HP motor installed and 3D valve throttled to 42% flow. Pump likely oversized and running at 7.5HP.

Design Engineer calculated 200gpm and 70' TDh was needed. With a 50% safety factor added, the pump requirements were just over 7.5HP. 10HP system was selected because errors and omission insurance is expensive and pumps are cheap. System balanced and throttled for correct flows.

Type 2: Conceptual Mistakes

These are not mistakes of judgement or deficits in skill or knowledge. These are broad oversights in information-gathering processes that lead to fundamental errors when attempting to build predictive models.

Pedantic? Yeah, Probably.

The objective of every efficiency project is **not** to 'use less energy.'

It is to ensure a process is using only as much energy as is required to achieve the desired result.

These are not necessarily the same thing!

The Worst Offender: Failing to ask “Why?”

- ▶ “Always assume the enemy will act in his own best interests.”
- ▶ We see many strange things when we do an audit.
- ▶ When we see something we perceive as an error or a sub-optimal application of tech, we assume that at some point someone else made the error.
- ▶ This is a fundamental bias of the ego (sorry).
 - ▶ The assumption is that we know the ‘why’ already. Confirmation bias does the rest.
 - ▶ The problem is when we don’t get it right, there will be no one there to tell us.

Consequences!

The Error

- ▶ Engineer notices 15,000 CFM of 115-deg exhaust from textile dying operation.
- ▶ Institutes heat recovery measure employing Air-to air HEX and recovers 70% of waste heat to pre-heat rinse water.
- ▶ Engineer did not ask “why” there was so much exhaust and “why” the heat was being wasted in the first place.

The Consequence

- ▶ First week: Duct fire.
- ▶ Fire put out, cause unknown.
- ▶ Second week: Duct fire again.
- ▶ Heat recovery abandoned until cause/solution found.
- ▶ Engineer fears for his job. Pretends he is calm.
 - ▶ No one buys it.

What Happened?

Textile dyeing operation employs several VOCs that have to be diluted and evacuated. If allowed to condense or linger in contact with other VOCs, combustion is spontaneous (and energetic!)

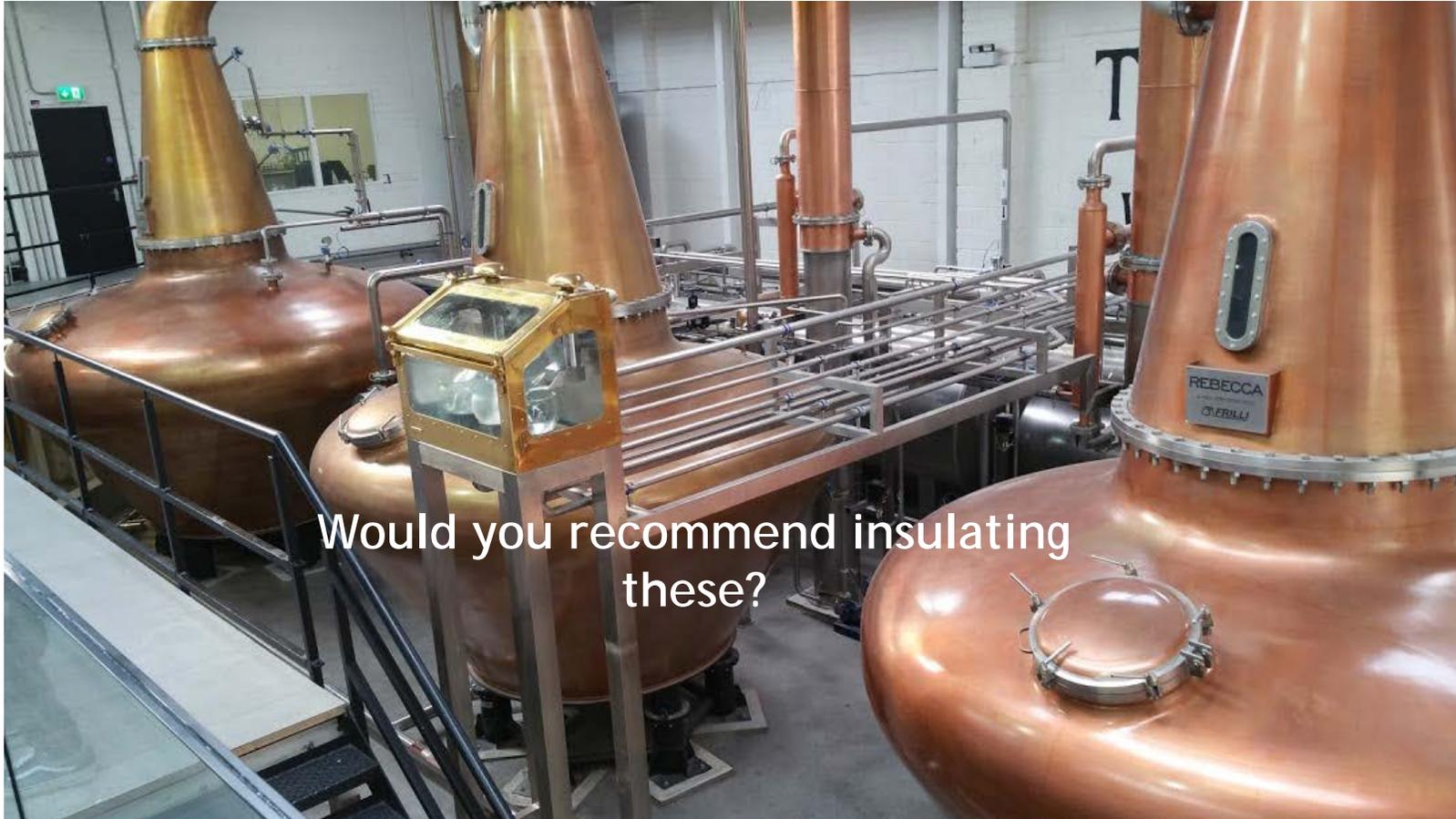
When heat was extracted from the airstream, VOCs condensed and were allowed excessive dwell time in contact with each other. Eventually, the correct combination of chemicals was achieved, and a fire started in a duct full of fast-moving air.

Oversizing the exhaust was the simplest and cheapest method for meeting environmental and safety requirements at the time of construction.

Confronted with the apparent oversized system, the auditor saw what he perceived to be an error on the part of the previous engineer, and forgot to ask "why would he do that?"

The local fire department did not appreciate their role in that facility's energy conservation plan.

Pop Quiz!



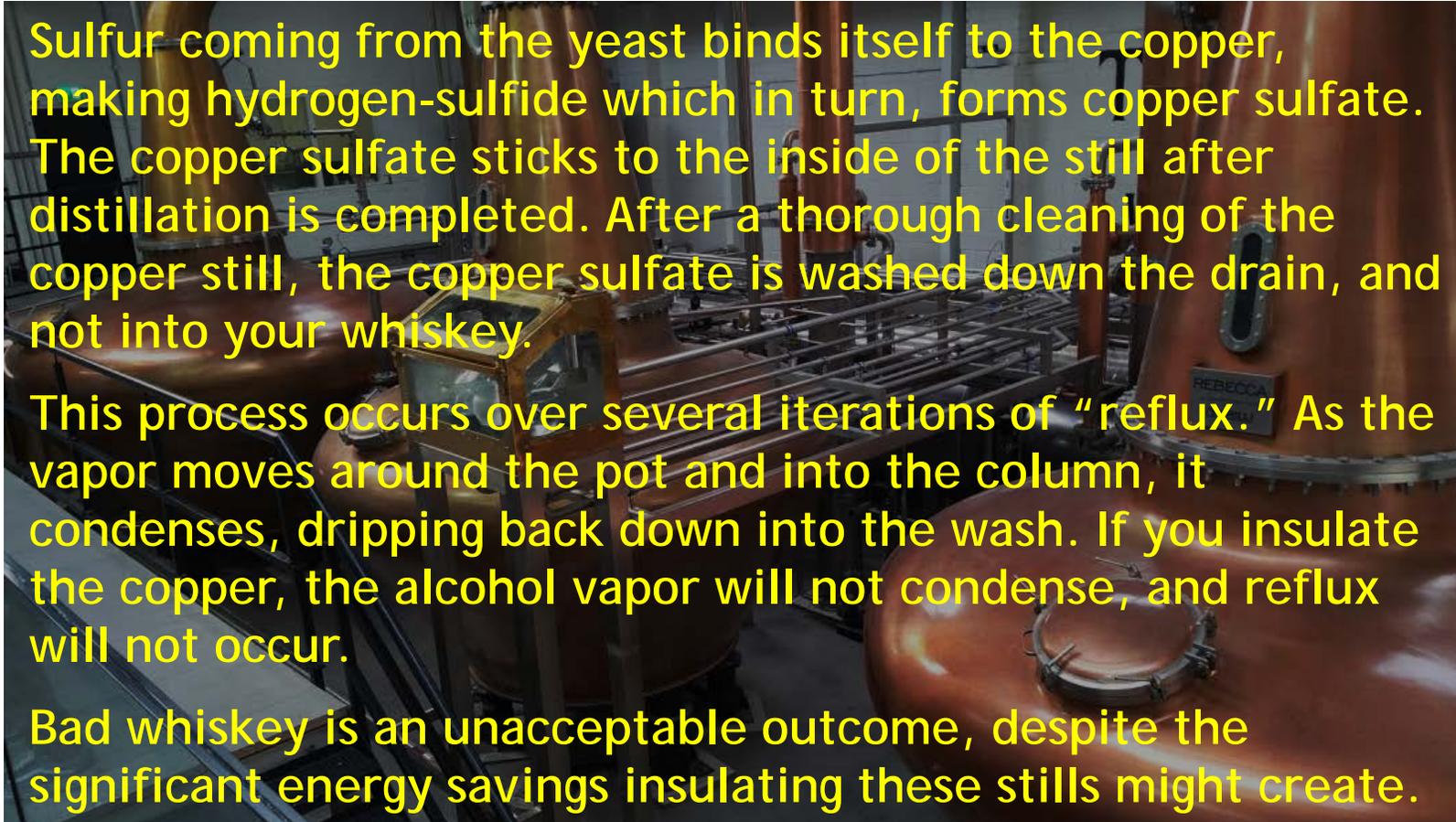
Would you recommend insulating these?

Pop Quiz!

Sulfur coming from the yeast binds itself to the copper, making hydrogen-sulfide which in turn, forms copper sulfate. The copper sulfate sticks to the inside of the still after distillation is completed. After a thorough cleaning of the copper still, the copper sulfate is washed down the drain, and not into your whiskey.

This process occurs over several iterations of "reflux." As the vapor moves around the pot and into the column, it condenses, dripping back down into the wash. If you insulate the copper, the alcohol vapor will not condense, and reflux will not occur.

Bad whiskey is an unacceptable outcome, despite the significant energy savings insulating these stills might create.



Runner-Up:

Tunnel Vision

- ▶ “When all you have is a hammer, everything looks like a nail.”
- ▶ Most of us work for a company. Companies sell products. Companies want us to sell their products; or engage in the services that best serve the bottom line.
 - ▶ This is not necessarily bad or a problem. But it remains a reality of our industry.
- ▶ We tend to see things and identify with systems through the lens of our own expertise.
 - ▶ Controls guys tend to find controls jobs, HVAC guys find HVAC, and lighting guys find lighting work.
- ▶ Time is precious, and time is money

Consequences!

The Error

- ▶ 225-room hotel needs relief from their high energy bills. They call an ESCO for a free energy audit.
- ▶ Lighting is 90% of this ESCO's business and the supply chains and workforce are well established for lighting jobs.
- ▶ ESCO Auditors were not trained to identify non-lighting measures. They have "Tunnel Vision."
- ▶ All measures recommended are lighting measures.

The Consequence

- ▶ Irritated hotel owners bring in another company. This company has a better-trained auditors and a broader set of services.
- ▶ First company misses a \$120k Lighting job, second company picks up a \$410k comprehensive job.
- ▶ First company has to listen to second company brag about landing that client at the next AEE networking event.

What Happened?

This one is easy: The first company took the easy road and punted on the hard stuff.

Essentially, the first company walked past (4) VFD measures, occupancy-based room setbacks, and demand controlled ventilation for the ballroom. The lighting proposals from both companies were essentially identical, making the second company look both more honest and more competent.

The tunnel vision afflicting the first company prevented them from actively addressing the real concerns of the hotel. They only brought a hammer, so all they saw were nails.

Remember:

The Energy Audit is the most important part of the project development process.

Do it right!

(or you may be sorry!)

Thank you for your time and
attention!



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