Simple Easy Low Cost/No Cost Ways to Save Energy

presented by

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Identifying Problems, Implementing Solutions & Saving Energy For YOU! Call Me!

20 Low Cost/No Cost Ways to Save Energy

1. Walk, Listen, Observe.
2. Make sure what **should be off** is **really off**.
3. Equipment you can probably turn off forever.
4. Use tight sealing automatic control dampers.
5. Use ultrasonic leak detectors to find leaks.
6. Take advantage of roofs for better or worse.
7. Use self-contained temperature control valves with integral sensors.
8. Replace missing or failed gaskets on doors.
9. Use brush seals in raised floors of computer rooms.
10. Eliminate three-way valved bypasses on all steam traps.

20 Low Cost/No Cost Ways to Save Energy

11. Test steam traps often.
12. Use variable frequency drives (VFD's).
13. Use electronic data loggers.
14. Replaced missing or failed piping insulation.
15. Take a hard look at air filtration.
16. Install properly sized condensate "P" traps on all air handling units.
17. Make your energy management system (EMS) work harder for you.
18. Establish a good set of mechanical guide specs.
19. Utilize mechanical plan review.
20. Have ongoing training for your maintenance personnel so they can work smarter.

1. Walk, Listen, Observe

- Once a week, before going to your office, walk through a different building.
- Take pictures of possible ways to save energy with your digital camera.
- Record sound bytes with each picture you take.
  - Example: ***Why is cabinet unit heater in south vestibule of Lorton Hall running in July?***
- Send these pictures and notes to your staff persons who can investigate, report back to you, and make the necessary changes happen.
- Visit your mechanical equipment rooms.
- Are lights left on?
- Is anything running that does not have to be running?
- Take pictures of anything that is out of the ordinary.
  - Example: Why is apparently defective 20 HP motor sitting on floor of MER 205 in Fox Chase Building? Is this motor rally defective? How did it fail? Should it be rewound? Please have it removed!
- Once a month, visit your facility at night. Once a month visit your facility on a weekend. What's happening during off hours?
- ***When the cat's away, the mice will play!***
  - Keep good notes in a spiral bound notebook. Use a different notebook for each building for which you have responsibility.
  - Take an infra-red gun with you to easily find things that are hot or cold that should not be hot or cold.
  - Example: ***Failed or missing insulation on hot water or chilled water lines or cold refrigerant lines.***

1. Walk, Listen, Observe

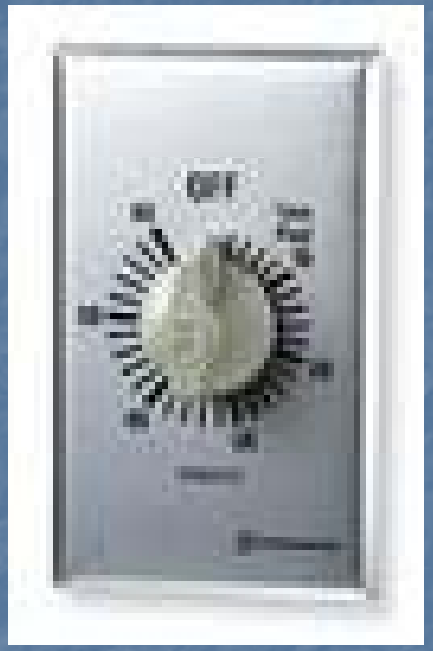
Raytek Infra-red Guns

2. Make Sure What Should Be Off Is Really Off

- Is outside lighting on operating during daylight hours?
- Is a condenser water pump on a water chiller or a cooling tower fan operating even though the water chiller is shut down?
- Are lights left on (not night lights) in offices, classrooms, shops, manufacturing areas, warehouse areas, etc., even through it's after hours and nobody is there?
- Are man cooler fans in maintenance shops still running after hours?
- Are domestic hot water recirculation pumps running after hours when there is little or no need for domestic hot water?
- Is your outdoor water chiller running even though it is 55^{o}F outside temperature on an early spring or fall morning?
- ***Example: Outdoor water chiller at my church in Baltimore was running in late September at 8:30 AM when it was 55^{o}F outside. Outdoor thermostats are cheap.***
- Is your heating system still running in a maintenance, warehouse or manufacturing area even though large overhead doors have been wide open over 10 minutes? ***Door switches and elapsed timers are cheap.***
- Is steam still flowing to an air handling unit in a maintenance shop which has its fan turned off and which only needs to run in the very coldest of weather.

2. Make Sure What Should Be Off Is Really Off

Paragon Off Delay Timer



Spring Wound Timer

3. Equipment You Can Probably Turn Off Forever

- Unit heaters in mechanical rooms.
- Unit heaters in electrical equipment rooms.
- Cabinet unit heaters in entry ways and stairwells.

4. Use Tight Sealing Automatic Control Dampers

The Problem

- Conventional steel dampers can easily leak 10% or more of rated air flow.
- This causes:
  - Artificial cooling loads
  - Artificial heating loads
  - Reduced effectiveness when using outside air for free cooling

4. Use Tight Sealing Automatic Control Dampers

The Solution

- Test dampers for tight closure. **If light is passing through when damper is "closed," so is air**!
- Check damper linkage to make sure it is operating smoothly. The best linkage is no linkage!
- Use quarter turn direct connected damper actuators to minimize the use of linkage.
- Use a separate damper to satisfy minimum outside air requirements. Do not introduce "minimum outside air" through the "100% outside air damper" used for free cooling.

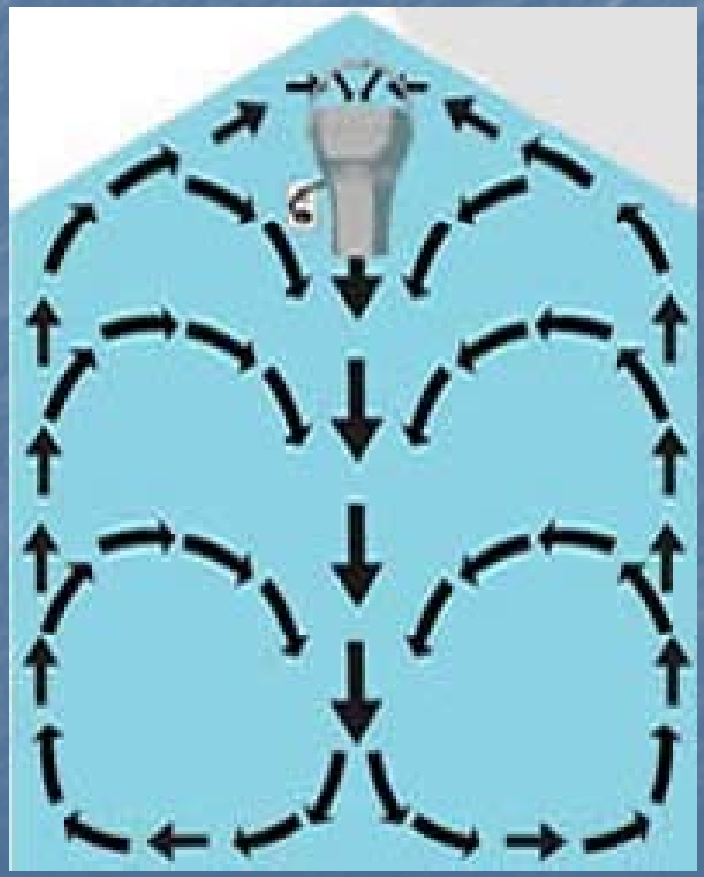
5. Use Ultrasonic Leak Detectors to Find Leaks

- Air leaks in compressed air lines and fittings.
- True for both high pressure process shop air and 20 PSIG pneumatic automatic temperature control air.
- Failed or failing gaskets on walk-in coolers or walk-in freezers.
- Air leaks in flex connectors on discharge side of air handling unit fans.
- Air leaks at joints in supply air ducts, return air ducts, and outside air ducts.
- Air leaks in flimsy access doors.

6. Take Advantage of Roofs for Better or Worse

- Use ceiling fans on roofs 20 feet and higher to recirculate hot air that gravitates to roof during heating season.
- Take advantage of temperature stratification on air conditioned buildings with high ceilings by dropping supplies and returns down to the 10-12 foot level.
- Use evaporative roof-cooling to get rid of the tremendous solar load that comes into a building through its roof.
- Great for 1 story air conditioned buildings
- Uses small controlled amounts of water to reduce roof temperature from as high as 150^{o}F to a max of 90^{o}F.
- There are several manufacturers of these easy to install systems.
- Evaporative roof cooling should not be confused with **flooded roofs**.

6. Take Advantage of Roofs for Better or Worse



Arius Air Flow Pattern

6. Take Advantage of Roofs for Better or Worse

7. Use Self-contained Temperature Control Valves with Integral Sensors for Steam and Hot Water Unit Heaters

The Problem

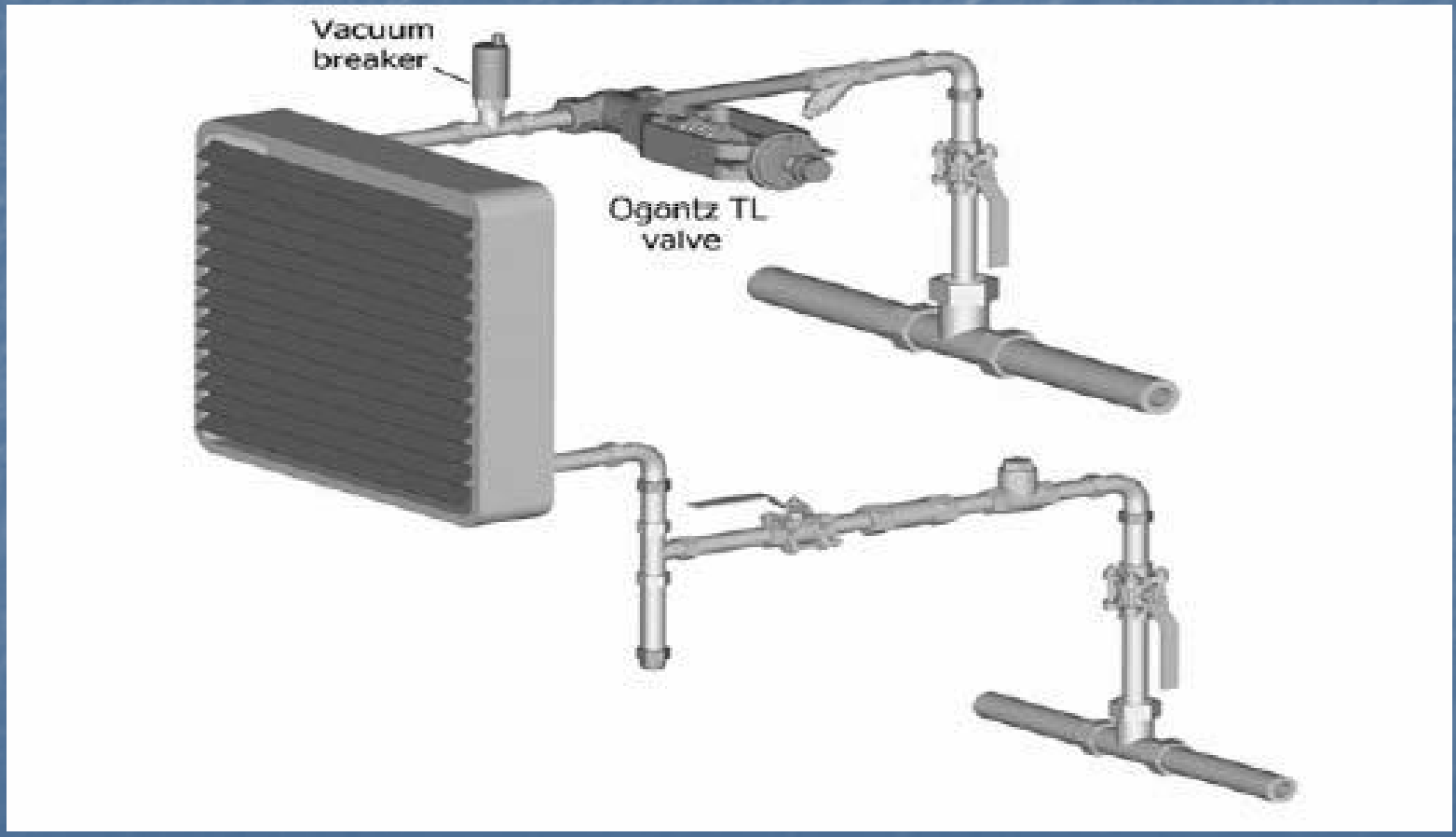
- Steam and hot water vertical and horizontal discharge unit heaters are often used to heat large open spaces such as maintenance shops, warehouses, and manufacturing areas.
- Temperature control is usually achieved by wall or column-mounted thermostats which simply cycle unit heater fans on and off.
- When the fan is cycled off, steam or hot water continues to flow through the unit heater wasting huge amounts of energy.

7. Use Self-contained Temperature Control Valves With Integral Sensors for Steam and Hot Water Unit Heaters

The Solution

- Install self-contained temperature control valves with integral temperature sensors.
- These self-contained (no wiring required) valves will shut off steam or hot water flow automatically when the temperature set point is reached.
- Use a strap-on aquastat on the condensate or hot water return line to cycle off the fan when the control valve goes closed to save even more energy.
- Some condensate repiping may necessary on steam unit heaters to ensure gravity condensate return.

7. Use Self-contained Temperature Control Valves With Integral Sensors for Steam and Hot Water Unit Heaters



Ogontz TL Valve

7. Use Self-contained Temperature Control Valves With Integral Sensors for Steam and Hot Water Unit Heaters

Ogontz TL Valve

8. Replace Missing or Failed Leaking Gaskets on Doors

The Problem

- Personnel doors to outside
- Revolving doors
- Overhead doors – big leakers
- Roof hatches
- Walk-in refrigerated coolers
- Walk-in refrigerated freezers
- Reach-in refrigerators and freezers
- Access doors on rooftop units
- Access doors on air handling units and in both supply and return ductwork
- ***N.B. Don't forget about abandoned-in-place vent lines through roofs and outside walls. These are easy to cap.***

8. Replace Missing or Failed Leaking Gaskets on Doors

The Solution

- Test gaskets for leakage.
- Dollar bill test
- Light test (test when dark - if light is getting through, so is air)
- Listen for leaks with naked ear on rooftop and air handling units
- Smoke tests
- Ultrasonic test (Warbler)
- Install good quality gaskets.
- Do dollar bill testing after new gasket has been installed.
- Avoid gaskets with pressure sensitive backing, if possible.
- Brush gaskets may be the answer where conventional gaskets are not suitable.
- On leaking access doors in ductwork, consider replacing with tight fitting access doors similar to those made by **DuctMate**.
- Remember, HVAC access doors in ductwork can leak in both directions.

9. Use Brush Seals to Reduce Conditioned Air Leakage in Computer Rooms

The Problem

- Most computer rooms and data centers have raised floors.
- Those raised floors provide a plenum to distribute conditioned air through perforated tiles in the raised floor.
- This plenum also provides a place to run power and communication cables to computer room equipment in a neat out of the way manner.
- Large openings, typically 6” x 9” are field-cut in floor tiles to accommodate these large, multiple, odd-shaped flexible cables.
- Lots of conditioned air leaks out through these hard to seal cable openings, causing a loss of static pressure in the raised floor plenum. This makes it more difficult to maintain the .7 – 1.0 inch static pressure recommended to distribute the conditioned air to where the heat producing equipment is located.
- To overcome this problem, many users install additional computer room air conditioning units to discharge more air into the raised floors. **The real problem is improper air distribution.**

9. Use Brush Seals to Reduce Conditioned Air Leakage in Computer Rooms

The Solution

- Use high quality brush seals to seal off these numerous raised floor cable openings.
- Use similar brush seals to prevent air leakage at the gaps where raised floors abut computer room walls and where cables penetrate computer room walls beneath the raised floor.

10. Eliminate Three-way Valved Bypasses on Steam Traps

The Problem

- Human nature is flawed!
- **If something can be bypassed, it will be bypassed!**
- Bypassed traps typically stay bypassed. They look identical to traps that are operating properly.
- A bypassed steam trap will waste 10 to 20 times as much steam as a wastefully blowing steam trap!
- Sometimes the bypass valve will not reseat tightly when and if it is reclosed.
- There are **16 additional potential leak points** for every three-way valved steam trap bypass.

10. Eliminate Three-way Valved Bypasses on Steam Traps

Solution

- Eliminate three-way valved bypasses on all traps.
- They serve no useful purpose.

11. Test Steam Traps Often

The Problem

- A single passing high pressure steam trap can easily cost you $5,000 a year in lost steam.
- Very few owners do steam trap testing.
- Very few owners know how many traps they have; the makes, types and sizes; what they are serving, and their locations.
- Many traps are virtually inaccessible.
- Occasionally, steam traps are buried beneath insulation.
- Traps can only be tested when steam is **ON!**

11. Test Steam Traps Often

The Solution

- Inventory your traps.
- Keep your inventory up to date.
- ***N.B. This is time consuming and tedious but very worthwhile.***
- Test your steam traps frequently.
  - Ultrasonically
  - Visually
  - **Steam Eye** (automatic wireless system offered by Armstrong Steam)
- In a large facility, consider having one person dedicated to such steam trap testing.
- He can also test many other items such as bearings, compressed air leaks, gasket leaks, etc. with the same ultrasonic tester.
- He can also do other testing such as vibration analysis.
- Do not use infra-red for testing traps; it only tells you whether trap is hot or cold, not whether they are blowing.
- Watch out for oversized traps. They are huge energy wasters!
- **Be extremely skeptical about using fixed orifice/venturi steam traps! Unlike mechanical traps, they clog more easily, cannot be tested, and typically do not have published capacity data!**

12. Use Variable Frequency Drives (VFD's)

- Benefits of Variable Frequency Drives (also known as Variable Speed Drives or Adjustable Frequency Drives)
  - Tremendous energy savings in many electric motor applications.
    - Pumps
    - Fans
    - Cooling Tower
  - Eliminate the need for a conventional across-the-line or reduced voltage motor starter.
  - Provide a soft start which increases motor, coupling, V-belt and bearing life.

12. Use Variable Frequency Drives (VFD's)

- Take advantage of fan and pump laws.
  - **Energy use decreases as the cube of speed.**
  - **10% reduction in speed saves 27% in energy.**
  - **25% reduction in speed saves 60% in energy.**
- **Typical VFD Drive Characteristics**
  - Compact
  - Wall hung
  - Built-in diagnostics
  - Available with build-in disconnect switch and automatic bypass
  - This 24" high x 8" wide x 9" deep enclosure can handle up to a 25 HP motor
  - 97-98% efficient

12. Use Variable Frequency Drives (VFD's)

- **Good Applications for VFD's**
  - Where there are lots of running hours, typically 2000 or more per year, and where load varies significantly.
  - Pumps
  - Air handling units
  - Cooling towers

OR

  - Where constant speed equipment is oversized
  - Where replacement parts are not readily available for magnetic starters

12. Use Variable Frequency Drives (VFD's)

- **Air Handling Units**
  - Older variable air volume systems which use bypass dampers, throttling dampers, or variable inlet guide vanes are typically great applications for VFD's.
  - You eliminate difficult to maintain mechanical dampers, inlet vanes, linkages and damper motors and replace them with a VFD which has no moving parts.
  - And you save huge amounts of energy in the process.

12. Use Variable Frequency Drives (VFD's)

- **Pumps**
  - Chilled water pumps
  - Limitations
  - ***You may have to convert from three-way control valves to two-way control valves on air handling units to get the full benefit.***
  - ***You can safely reduce flow only so much through a water chiller.***
- Hot water pumps
  - Virtually no limitations
- University of Virginia Hot Water Pump Example
  - An engineering building with 5 wings had a separate perimeter hot water heating system for each wing. Total BHP was 23.5. All five hot water systems were manifolded together and retrofitted with a single 10 HP pump. This is controlled by a VFD and typically operates at about 5 BHP.

Original	Retrofitted	Operation with VFD
23.5 MHP	**10 MHP**	**5 BHP**

12. Use Variable Frequency Drives (VFD's)

Grundfos Magna VFD

12. Use variable frequency drives (VFD's)

- **Cooling Towers Fans**
  - These are generally excellent applications for VFD's, especially in hotter climates with lots of operating hours.
  - Sometimes it is better to expend additional energy running the cooling tower fan wide open to drive leaving cooling tower water temperature further down, thereby saving chiller energy.
  - On a 3 cell cooling tower, 2 fans might have constant speed drives and the third fan could have a VFD.

13. Use Electronic Data Loggers

- The first step in solving any problem is defining exactly what the problem is.
- Data loggers help us define problems quickly and easily in these ways:
  - These small easy-to-conceal devices automatically monitor what's going on over long periods of time when nobody is present.
  - Hook-ups are wireless. No external power is required.
  - No paper charts are required.
  - Downloading data to a computer is simple.
  - Interpreting data is simple.
  - They don't lie!
  - **They are objective, not subjective**.
- What can't be measured can't be managed!

13. Various Types of Data Loggers

Great for measuring temperatures in spaces. Extremely compact!

Great for measuring temperature and humidity.

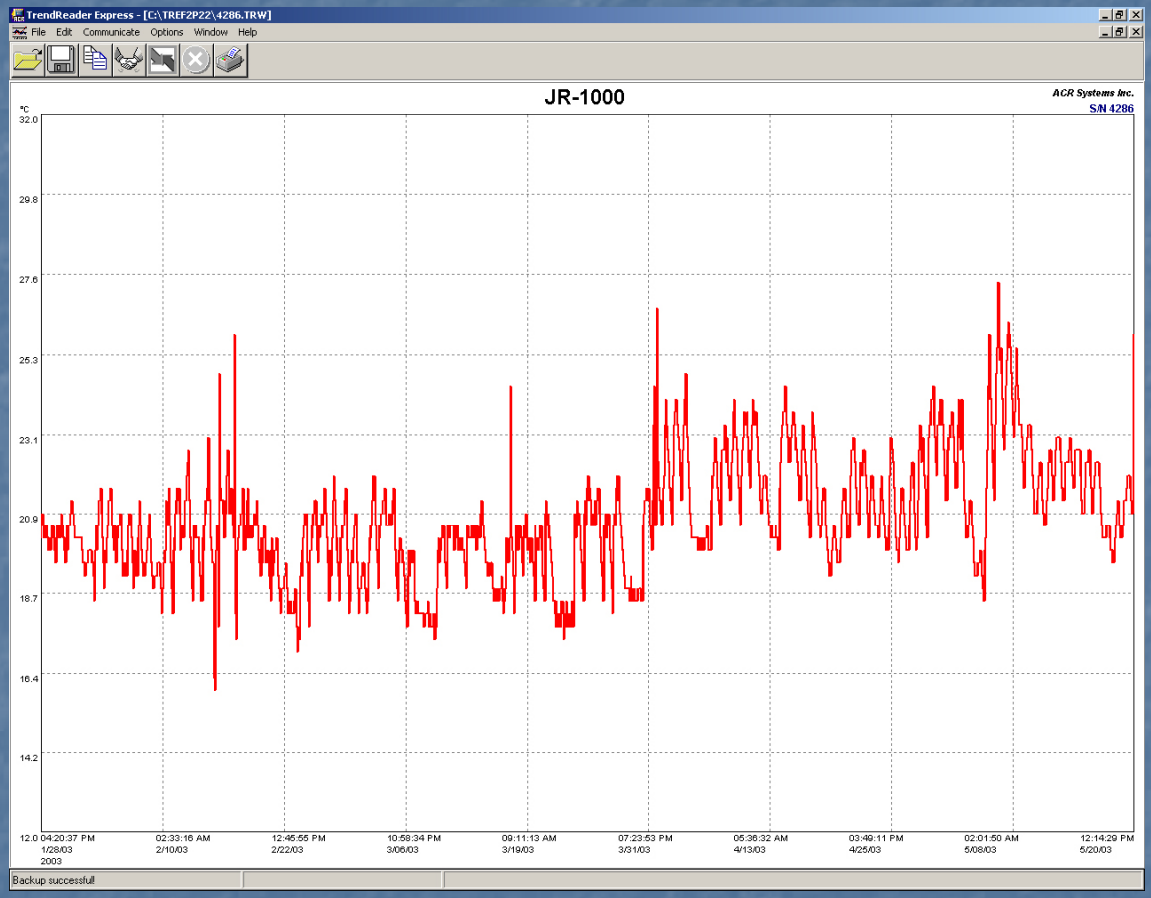
Great for measuring temperature and humidity. Built-in LED's energize if temperature or humidity go below or above user set limits.

Measures AMP draw on motors and other equipment.

Measures up to 8 different temperatures simultaneously. Great for air handling units and chillers.

Measures differential air pressure between various spaces or between inside and outside of building.

13. Typical Data Logger Display



Typical graph of downloaded temperature data logger.

14. Replace Missing or Failed Piping Insulation

The Problem

- Failed or missing piping insulation wastes energy.
- If water gets inside insulation, it usually fails.
- Using insulated pipe lines as a step ladder is not uncommon and is never good for the insulation.
- Improper installation of insulation, especially on cold lines, can lead to premature failure.
- One type of insulation definitely does not fit all applications.
- Poorly designed and installed and overly complicated piping leads to insulation installation problems:
- **Examples:**
  - Three-way valved bypasses on traps and control valves create an additional need for insulation.
  - Three-way control valves also create an additional need for insulation
  - Ball valves without extended stems
  - When pipe fitter does not allow enough space for piping insulation
  - Example: a 6”Ø line with 2” Ø of insulation becomes a 10-1/2” Ø line

14. Replace Missing or Failed Piping Insulation

The Solution

- Keep your piping simple.
- Don't install things that you don't need, such as three-way valved bypasses.
- Use closed cell insulation on small chilled water lines, and cold refrigerant lines.
- Use closed cell insulation on chilled water pumps and other irregular shapes in chilled water lines.
- **Do not insulate** such items as check valves, steam traps, isolation valves, unions, strainers, control valves in steam, condensate, and hot water lines 2" Ø and smaller.
- If you use removable insulated covers for odd shapes such as large gate valves, only purchase custom fitted heavy duty covers that are simple, durable and **easy to re-install**.
- If you don't have a pipe insulator on staff for insulation repairs, structure an equitable blanket agreement with a reputable local insulation contractor to handle such repairs and replacements as they arise.
- Try to find a nearby retired pipe insulator who can work for you as needed.

15. Take a Hard Look at Air Filtration

The Problem

- Many cheap filters let fine dirt particles through.
- These dirt particles then adhere to the cooling coil which is wet and cooling coil efficiency is dramatically reduced.
- Cooling coils on some equipment such as fan-coil units are virtually inaccessible because coils are on the discharge side of the fan.
- Even when cooling coils are not operating, fine dust which passes through air filters winds up in drain pans, fans, and ductwork.

15. Take a Hard Look at Air Filtration

The Solution

- Use good quality pleated filters throughout your facility with sturdy cardboard frames in air handling units.
- Consider sock type filters on fan-coil units.
- Install permanent blank-offs in gaps on all air handling unit filter boxes to prevent air bypass.
  - ***Example: 63" long filter racks should have a 3" secured block off to accommodate 2-30" long end to end filters so as to prevent air bypass.***
- Access doors on filter boxes should be gasketed and tight closing to prevent air bypass.
- Eliminate bag filters, if possible. They are a pain and they are expensive!
- Consider eliminating bag filters downstream of pleated 2" pre-filters.
- Never use permanent metal filters! They are maintenance intensive!
- Where walk-in filter access is available, consider using V-cell filters which were extremely popular and effective in the virtually now defunct textile industry.
- Use Magnahelic gauges to monitor filter pressure drop.

16. Install Properly Sized Condensate "P" Traps on Air Handling Units

The Problem

- If there is insufficient height in a condensate "P" trap, air conditioning condensate will accumulate in the air handling unit drain pan.
- Some of this condensate will then become entrained in the air stream adding humidity to the conditioned space and causing other potential problems.
- Drain pans may rot out prematurely.

16. Install Properly Sized Condensate "P" Traps on Air Handling Units

The Solution

- Provide sufficient height in the "P" trap to overcome negative pressure caused by fan suction and allow complete condensate removal from drain pan.
- Drop in "P" trap should be rated static pressure of fan in inches plus 1 inch.
- "P" trap pipe diameter should be the same as drain pan connection.
- ***Example: An air handling unit rated at 3" SP should have a "P" trap with a 4" drop.***
- Install a portion of "P" trap into the concrete floor, if necessary, to achieve sufficient drop.

17. Make Your Energy Management System (EMS) Work Harder for You

The Problem

- Even when a central EMS exists, very often numerous buildings are not tied into it.
- In buildings served by the central EMS, **many potential points are not tied into it.**
- ***Examples:***
  - Humidity sensors in computer room
  - Moisture sensors underneath raised floors of computer rooms
  - Door switches on personnel doors and double doors that are frequently blocked open by UPS, FedX and other delivery drivers **and then stay open**!
  - Door switches on overhead doors
  - Equipment can be overridden **ON** by your **EMS** and can stay **ON**
  - Equipment that is controlled **OFF** can actually be **ON** because **hand-off-automatic** switches (**H-O-A's**) on motor starters are in the **hand ON** position.
  - Proprietary software from some **EMS** manufacturers makes it difficult to write your own software without going to the **EMS** manufacturer.
  - Various makes of **EMS** systems may not be capable of talking to each other.

17. Make Your Energy Management System (EMS) Work Harder for You

The Solution

- Make sure that whatever system you install is **BACNET** and **LONWARE** compatible for interoperability.
- Make sure you can write your own software without being held hostage by your **EMS** supplier.
- Expand your **EMS** to monitor additional points and buildings.
- Monitor more than just temperature.
- Use night and weekend setback on static pressure sensors on VAV systems.
- Monitor doors that stay open for extended periods.
- Establish good relationships between your **EMS** operator and your mechanical maintenance department.
- Make sure that if a piece of equipment is turned **ON** or **OFF** at the **H-O-A** switch, an alarm is generated by your **EMS**.
- Review daily all equipment that is overridden **ON** or overridden **OFF** by your **EMS**.

18. Establish a Good Set of Mechanical Guide Specs for New Construction and Renovation

The Problem

- Many owners don't have good mechanical guide specs to give to a consulting engineering firm for a new building or renovation project.
  - ***Example: Calling for steam powered condensate pumps in one paragraph and for electric powered condensate pumps in another paragraph. It's one or the other!***
- Many owners have no mechanical guide specs at all.
- Where guide specs exist, very often they are not up to date and do not to incorporate new technology.
- Poor or no guide specs lead to many products being specified or allowed which are not in an owner's best interest.

18. Establish a Good Set of Mechanical Guide Specs for New Construction and Renovation

The Solution

- Establish thorough reasonable guide specs.
- Rely on a good mechanical engineer with many years of HVAC experience to write them from scratch or review and improve what you already have.
- Get valuable input from your maintenance personnel as to their likes and dislikes and their reasons for such likes and dislikes. They are a great source of information!
- Get valuable input from a reputable mechanical contractor whom you trust.
- Review and update your guide specs every two to three years.

19. Utilize Mechanical Plan Review

The Problem

- Even with good guide specs and a good consulting engineering firm, things get specified and designed which are not in your best interest.
  - Examples:
    - Poor equipment access
    - Overly complicated systems
    - Poor quality isolation valves
    - **Insufficient numbers of drawings, especially elevation, section and isometric drawings**
    - Insufficient details
    - Out of date details
    - Brand X equipment is often allowed
    - Often, the consulting engineering firm is working for your architect instead of directly for **YOU** the owner. **This invariably creates huge problems!**

19. Utilize Mechanical Plan Review

The Solution

- Periodic review of plans at 25%, 50%, 75%, and 95% of completion by a qualified experienced mechanical engineer who knows what he is looking at.
- Periodic reviews at the same stages by your own experienced maintenance personnel who know how to read plans and understand mechanical systems.
- Have an engineering firm that works directly for you, the owner.
- ***N.B. Even with all this in place, review of equipment submittals, shop drawings and on-site construction oversight by experienced personnel are also an absolute must!***

20. Have Ongoing Training for Your Maintenance Personnel

The Problem

- You probably don't have nearly enough qualified highly skilled maintenance mechanics.
- The baby boomers who have served you so well in the past are either nearing retirement or have already retired.
- Mechanical systems are becoming more complex.
- Having people with a good attitude who show up every day and do an honest day's work for an honest day's pay is becoming more and more difficult.
- Many of your mechanical and HVAC systems were designed and installed improperly **and you and your maintenance personnel are now the unfortunate victims of these mistakes!**

20. Have Ongoing Training for Your Maintenance Personnel

The Solution

- Have surveys of existing mechanical systems by qualified experienced engineers to identify problems and then use your own maintenance personnel to eliminate them whenever possible.
- On-site, ongoing maintenance training by qualified personnel for your maintenance mechanics so they can identify problems, solve problems, and save energy.
- **Knowledge is Power!**
- ***N.B. Energy conservation should be part of your mechanical and electrical maintenance department. It should not be a separate effort!***

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presented by

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Problem Solving Engineer

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