• Visible Defects Heat Exchanger Inspection System

• Nu-Shield Coil and Surface Protectant
Visible Defects
Heat Exchanger Inspection System
In this presentation, you will learn about Nu-Calgon’s new Visible Defects Heat Exchanger Inspection system. Information in this presentation includes:

- Heat exchanger / furnace basics
- Why heat exchangers fail
- Why we inspect heat exchangers
- How to use the Visible Defects System
Furnace Basics - Anatomy of a Furnace

- Flue Blower
- Gas Line to Furnace
- Fan Control/Limit Switch
- Burner Assembly
- Blower Compartment
With the burner assembly removed, access to the heat exchanger is readily available.

Note the location of sheet metal screws, as they will be of use when using the Visible Defects Heat Exchanger Inspection System.

The Fan/Limit Control will also need to be removed in order to use VD System.
A heat exchanger is a combination of one or more chambers or ‘cells’ that heats the air in the home. It is designed to contain a fueled fire, transmit the fire’s heat to the living space while keeping toxic combustion byproducts (carbon monoxide) separate from the interior air.

Heat exchangers are made of one or more chambers called cells. Cells are formed from two fairly thin sheets of metal which are sealed around the edges to create a channel with an opening on each end.

One opening is for fire and flames to enter and the other provides an exit for exhaust and combustion gases.
Heat exchangers can fail for a variety of reasons, though the most common failures are **holes** and **cracks**.

**Holes** are usually caused by corrosion, due to the acidic moisture created by repeated heating and cooling of air in a fueled-fire environment. Over time, this moisture can penetrate the heat exchanger.

**Cracks** are usually caused by stresses caused by continual expansion/contraction of each heating cycle. Think of a paper clip that is continually bent back and forth until it breaks, the same type of stresses affect heat exchangers and cause cracks. Cracks are usually concentrated in a small location along a stamped area, called a stress riser.
Clamshell Heat Exchangers are of a hermetic design of two “half-shell” pieces of metal that are sealed together. It is a common design found in older furnaces.

The photo to the right illustrates the:

(A) Heat Exchanger Entrance
(B) Typical damage area for clamshell designs (heat and stress area) and
(C) Combustion gas exit
Serpentine Heat Exchangers are a common design in standard efficiency furnaces (<90% efficiency). The snake-like design provides more surface area than clamshell type, heating the air more efficiently.

Common defect areas are:
(a) Corrosion of the eyelets
(b) Silicon seal at entrance
(c) Corrosion at first bend (c)
A Tubular design is typically found in Nordyne, Amana, Goodman, Coleman, Luxaire and York equipment. This type of heat exchanger requires a different approach with the VD System.

As with the Serpentine heat exchangers, tubular heat exchangers are susceptible to cracks in the opening at the front of the tube as well as in the first bend.

Over-firing can also cause deterioration in cells not constructed of stainless steel.
Why Do We Inspect Heat Exchangers?

- Consumer Safety
- Liability Protection
- Equipment Sales
According to the American Gas Association, “Any visible crack or hole discovered in this [visual inspection] step is reason for requiring replacement of the heat exchanger or furnace.”

Not only does this protect the consumer from a potentially dangerous situation from faulty equipment conditions, but it protects your business from liability. Documenting a required shutdown enables you to prove you followed AGA guidelines in the event a homeowner disregards your warning(s). If any entity later pursues legal action, you have proof you followed industry guidelines.
The Visible Defects Heat Exchanger Inspection System provides a wealth of benefits to assist a technician with the visual inspection of heat exchangers, including:

- Can be used to evaluate clamshell, serpentine, and tubular design heat exchangers in standard efficiency furnaces.
- Provides a unique approach to visible inspections, helping technician to “highlight” a flaw in heat exchanger.
- Utilizes a special delivery method with spray wand/high pressure sprayer and formulated penetrant.
- Designed as an addition to a contractor’s existing toolbox in order to help them perform this vital check-up on heat exchangers.
- It will help technicians find more defects than without it.
Each Visible Defects Kit includes:

- 22” Spray Wand
- 12” Spray Extender/Injector
- Quart of Crack Finder penetrant
- High pressure sprayer assembly
- UV LED flex light/batteries
- UV protective glasses
- Acrylic inspection mirror
- Set of instructions
- AGA handout, DVD and customer handout. (This is a developing customer handout to educate them of service)

**Nu-Calgon p/n: 4385-00**

Replacement Parts also available – Sold Separately
Visible Defects – Crack Finder

Refills of Visible Defects Crack Finder Leak Detector Solution are available in replacement quart size bottles.

- Chemistry is safe, non-toxic and non-smoke generating fluorescent based penetrant.
- Sold in 6x1 quart case
- Nu-Calgon p/n: 4385-06
Application instructions for <90% efficiency furnaces (noncondensing types)

- Turn off furnace
- Remove burner assembly from furnace
- Place clean towel in blower compartment to absorb any penetrant that may drip from out of furnace
- Remove temperature limit control from furnace
- On serpentine designs, inspect integrity of rings that seal heat exchanger to other components
Application – Serpentine and Clamshell

- Inspect visible portions through temperature limit control port
- Remove burners from cells
- Visually inspect inside the chamber
- Assemble the Crack Finder quart bottle to high pressure assembly and connect 22” spray wand
- Insert spray wand through sheet metal screw holes for outside cell checking and temperature limit control port for middle cell inspection
Sheet metal screws would be removed for 22” spray wand insertion. It is important to pay particular attention to the outside cells when inspecting for deterioration, because the outside cells see less air flow from blower compartment.

This photo shows the temperature limit control still in the housing. When using the Visible Defects kit, this would be removed during visual inspection and spraying middle cells with VD penetrant.
Spray each side of cell with Crack Finder penetrant
  – Completely insert wand at start
  – Slowly spin wand and slowly move out to spray entire cell side
If furnace is too deep, the 12” extension/injector should be used
Inspect the combustion side of each cell with supplied UV LED flex light and inspection mirror for any penetrant that leaked through. This indicates a potential breach in the cell wall.

Always wear UV protective glasses!
Unlike clamshell design heat exchangers, serpentine types are not deemed hermetic until they are heated. Therefore, seeing residual amounts (weeping) of penetrant at seams and eyelets is normal and not grounds to condemn the heat exchanger!

In this situation, a contractor needs to look for a larger amount of penetrant signaling a crack or hole to confirm a condemnable heat exchanger for a potentially dangerous situation.

Bottom line – more investigation is required to locate the origin of the suspected defect in serpentine heat exchangers!
EXAMPLES OF DEFECTS

Far Left: View of a visual inspection of a heat exchanger

Left: The same view, using the Visible Defects Kit.

Right: View of a visual inspection of a heat exchanger

Far Right: The same view, using the Visible Defects Kit.
1. When finished with the inspection, disassemble the sprayer top from bottle, and replace with the quart’s original leak-proof cap. (The high-pressure sprayer assembly is not leak proof and it will leak inside the kit!)

2. Run blower 10 minutes before using furnace to evaporate penetrant.

3. Pump the sprayer assembly dry, removing any remaining Crack Finder Solution to prevent any freeze related issue with the assembly.

4. It is possible that the homeowner will notice a smell a few minutes after the blower is turned on as the penetrant evaporates from the cell surfaces. The chemistry is non-hazardous, and the smell is isopropyl alcohol (also used in fingernail polish remover).
5. If no defects are found, reassemble the furnace, dry-up any residual penetrant and continue normal safety inspection.

6. If a crack or other defect is suspected, it must be found verified and PROVEN to the owner of the furnace.

7. Once the crack or defect is proven, it is recommended to turn off the fuel valve, disconnect power and leave customer with a hazardous appliance tag (International Fuel Gas Code Recommendation).
• Follow similar preparation and blower removal process as outlined in clamshell and serpentine inspection instructions.

• When the blower assembly has been removed, dispense Visible Defects Crack Finder Penetrant INSIDE each cell.

• Check for penetrant leakage from the blower compartment with using the UV LED flex light and inspection mirror.
The Visible Defects Heat Exchanger Inspection System can be used to inspect Clamshell, Serpentine and Tubular Designs. For clamshell/serpentine types, spray penetrant on air side and inspect in combustion chamber. For tubular designs, spray in tube cells and check for a breach from the blower compartment.

Additional considerations should be taken when inspecting a serpentine heat exchanger, as they are crimped together and some penetrant seepage at the crimp is normal, and is not grounds for equipment to be condemned! Contractors should be looking for abnormal amounts of penetrant, signifying a potential defect.
If a leak is suspected, further inspection is required in order to verify and prove to the owner that a defect exists.

A contractor must “red tag” or condemn any equipment in which a proven defect or crack exists.

Remember:

• Industry guidelines mandate that a verified leak is grounds for the heat exchanger/furnace to be replaced. This is the legal obligation of the contractor.

• The Visible Defects Kit CANNOT be used on high-efficiency (condensing type furnaces). The disassembly of the secondary coil makes inspection of the heat exchanger difficult, and Nu-Calgon is currently investigating an alternative method for these types of equipment.

• ALL parts of the Visible Defects kit are available for purchase separately
• New hydrophobic (water repealing) chemistry in an aerosol canister
• Much more hydrophobic than current water based Cal-Shield

Degrees of Hydrophobicity

- Freshly Waxed Car: 90
- Teflon (Cooking Pan): 95
- Rain-X: 110
- Cal-Shield II: 160
Water Repellency

• **What does degree of hydrophobicity mean?**
  – The higher the number (contact angle), the closer it is to a perfect sphere
  – The more perfect the sphere, less contact area exists between the water droplet and the surface (less friction).
  – If less friction exists, the water droplet has a higher propensity to drop-off the protected surface since there is less force holding the droplet in place.

• **In essence with the application of Nu-Shield, one is trying to manage water on a protected surface**
Nu-Shield Properties

• Anti-Wetting
• Anti-Corrosion
• Reduces Icing
• Self-Cleaning
• Reduces Bacteria Growth
Nu-Shield Applications

• Refrigeration Coils (slows icing)
• Outdoor Coils
  – Added Corrosion Protection
  – Slows Grime On Coil
• Added Corrosion Protection
  – Filter-Driers
  – TEV elements
  – EPR valves
• Low voltage circuit boards
• Misc. Applications
  – Barrel Blower on Mini-Split
  – Ice Banks
  – Misc.