Hazards of the Consolidated Industries H-Series Horizontal Atmospheric Furnace

By Michael Whedon
Licensed, Certified, Private Fire Investigator.

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During the mid and late 1980's there was a tremendous building boom throughout the State of California. Thousands of new housing developments appeared seemingly overnight and every new home required one or more furnace units depending on the amount of square footage and whether the home was one or two stories. In an effort to keep their construction costs as low as possible, builders installed horizontal furnaces within the attic space of many of these homes. The horizontal furnace is one that is relatively low in cost and is easy to install because the majority of the duct system is exposed within the attic space. One of the horizontal furnaces used in many of the new homes was a furnace manufactured by Consolidated Industries. This furnace was designated as the H-Series atmospheric furnace and was sold under the "Premier" label by Consolidated Industries. Many other companies purchased these furnaces from Consolidated and sold them under their own labels. The term "atmospheric" refers to furnaces that are naturally draft vented.

H-Series furnaces manufactured by Consolidated Industries were also marketed under other labels. Some of those labels are:

Weatherking	Amana	ACPO
Arcoaire	Northrup	Bard
Coleman	Duo-matic-Olsen	
Olsen	Airco	Trane
Franklin Electric		GMC
Hamilton Electric		Janitrol
Johnstone	Liberty	Century
Comfort Aire	Keeprite	Magic Chef
Heatmaster	Premier	Sunburst
Sun Glow	P.F.C.	Kenmore
Sundial	American Standard	
American Best	Goettl	

In 1979 Consolidated Industries had been faced with a business decision. The tooling for their current line of furnaces was wearing out and they needed to decide whether to retool for the existing furnace line or create a new model. The decision was made to design and build a new model. Between 1979 and 1983 the H-Series atmospheric furnace was designed and tested. The H-Series furnace began general manufacturing in 1983 and continued until 1991. The changes in the H-Series from the previous horizontal furnaces included new burner assemblies, new heat exchanger design and a different blower position.

There were three different designations for the atmospheric H-Series furnaces. The first model was the HAC. The letter H indicates the furnace is a horizontal model; A indicates it is the first in the model series; C indicates the heat exchanger is formed from cold rolled steel. The HAC series furnaces were manufactured between 1983 and 1985.

In 1984, due to air quality requirements in the State of California, Consolidated made a change in the furnaces being sold within California. The change was the addition of 1/8-inch stainless steel rods located on the burner tubes above the gas port openings. The addition of the rods was to absorb heat from the burner flame which effectively reduced the temperature of the burner flame thereby reducing the nitrate emissions from the combustion process. During the combustion process the nitrate mixes with the oxygen present in the air to form nitrous oxide. The purpose of the rods was to lower the amounts of nitrous oxide emissions during furnace operation to meet the California air quality standards. The rods came to be known as "NOX" rods. Although the furnaces with NOX rods were designed for sale within the State of California, some of these furnaces found their way into other areas of the country. Additionally, not all areas of California required the reduced nitrous oxide emissions. San Diego, Ventura, Sacramento and San Luis Obispo areas are areas within the state where large numbers of H-Series furnaces without NOX rods are regularly encountered.

During 1985, as a result of some changes in ANSI standards for furnaces, the HCC and HCA series were introduced by Consolidated. The letter designations for these furnaces were H indicating horizontal; C for the second in the model series (there was no B model in the atmospheric line); and C indicating cold rolled steel. The HCA series designation was H for horizontal; C for second in the series; and A indicating an aluminized steel heat exchanger. It appears that the HCA furnaces were only manufactured during 1985 and 1986 The HCC model continued to be manufactured until 1991.

Consolidated Industries stopped manufacturing the H-Series atmospheric furnaces in late 1991 because they no longer met the Federal efficiency standards. Although sales of the furnaces continued for some time due to inventories on hand at various distributors, manufacturing formally ceased in 1991. Between 1983 and 1991 Consolidated reportedly manufactured somewhere between 750,000 and 1.2 million of these furnaces which were distributed nationwide.

In 1994, North Carolina, Texas and California began to report an unusually large number of failures of the H-Series furnaces. Heating and air-conditioning contractors began seeing large scale failures of the burner assembles and heat exchangers in housing developments using the H-Series furnaces. Due to the large number of these units that were sold, various investigations were initiated in an attempt to learn the cause of the failures. It was the position of Consolidated Industries that the failures were the result of improper installation and/or improper maintenance of the furnaces.

During the same time period, fire investigators began to see an increase in fires occurring in homes equipped with the Consolidated H-Series furnaces. These Consolidated furnaces had been installed in attic spaces on plywood decks or set perpendicular across wooden ceiling joists. The initial theorization was that although the furnaces were rated for installation on combustible surfaces, heat was passing from the burner compartment through the bottom panel of the furnace and igniting the wood decking or joists below. The official fire cause was listed as "pyrolysis," which is simply the decomposition of a fuel due to heat. Not realizing the commonality of the furnaces involved in the problem, some fire department and building department in a joint effort began requiring that all horizontal furnaces installed in attics be placed on non-combustible flooring.

Extensive examination of the furnaces involved in these fires along with furnaces in other houses within the same tracts where fires were occurring revealed that the burner assemblies and the heat exchangers in the furnaces had all failed in a similar manner. It was readily apparent there was a deeper problem than simply pyrolysis which was the cause of the increasing number of furnace failures and fires.

The burner assemblies or trays within the H-Series furnace contain the individual burner tubes, the gas manifold, orifices, pilot assembly and the combination gas valve. During the fabrication process, the burner tubes are formed from flat pieces of .030-inch thick aluminized steel. The gas port openings are punched into the metal and then the metal is bent to form the tube assembly. Depending on the size of the furnace there can be between two and five burner tubes. The individual burner tubes are square, 29-inches in length and each contains two rows of 33 gas ports positioned lengthwise along the top edges of each of the tubes. The individual gas port openings measure 9/16 by 3/32 inch. When a furnace is operating properly, there is a flame above each individual port opening that measures between 3/4 and 1-inch in height. Combustion gases are vented out of the furnace and discharged into the atmosphere.

It was determined through observation and testing that small cracks were forming in the metal webs between the gas port openings in the individual burner tubes. After the cracks formed, continued use of the furnace caused the cracks to grow. This resulted in the eventual splitting of the metal between the individual ports which enlarged the port openings to many times their original size. Part of the failure problem was due to internal stresses in the metal caused by the bending in the fabrication process. The problem was further exacerbated by the continuous expansion and contraction of the metal due to heating and cooling caused by operation of the furnace.

In some burner assemblies examined, holes measuring three to four inches in length and 3/4-inch in width were found. It follows that the larger the hole, the more gas/air can pass through the opening and burn above the burner tube. The normally small, controlled gas flames are replaced by large, irregular shaped flames. Depending on the degree of the failure in the burner assembly, the resulting flames can reach nine or more inches in height. These irregular flames impinge directly on the bottom of the heat exchanger cells which are normally offset and two to 2-1/2 inches above the burner assembly.

Heat exchangers are made of 18 gauge stamped steel which is machine welded together to form cells or tubes. The purpose of the heat exchanger is to warm the air passing through the furnace before it is discharged into the duct system for distribution into the living space of the house. The metal from which the heat exchanger is formed did not have the ability to withstand the direct impingement of the flames from the damaged burners. Additionally, the weld seams themselves, located along the bottom of the heat exchanger tubes, were also being subjected to this direct flame impingement. These weld seams, which are of relatively poor quality, would fail quickly when exposed to the direct flame contact. Lateral cracks would begin to form in the weld seams leading to horizontal cracks in the walls of the heat exchanger cells. Under continued use, these cracks widen and grow in length.

Eventually the metal crystallizes and begins to literally fall apart. This results in holes appearing in the heat exchanger cells. The holes continue to grow larger in size each time the furnace is used.

Whenever the blower within the furnace begins to operate, circulation air is pushed through the furnace at a high pressure. This air is drawn from inside the residence into the furnace (return air) and passes through the furnace picking up heat from the heat exchanger. The heated air is then discharged (circulation air) into the living spaces of the house through the duct system. In a properly operating furnace, the circulation air never enters the burner chamber of the furnace and the combustion gases never enter the circulation air system. In a furnace with a failed heat exchanger, a portion of the high pressure air passes through the cracks and holes into the burner chamber and portions of the combustion air pass into the interior of the heat exchanger and mix with the circulation air.

Two life threatening conditions are now occurring within these damaged furnaces. First, combustion gases, including carbon monoxide (CO), which is an odorless, colorless and highly toxic gas, which normally is harmlessly vented to the exterior of the residence, are now drawn upward through the cracks and holes in the heat exchanger to mix with the heated air that is being circulated into the living space of the residence. The carbon monoxide gas being discharged into the living spaces is breathed in by the occupants during normal respiration. The amount of gas entering the residence depends on the extent of the internal damage within the furnace.

The hemoglobin in the blood system of human beings and animals has a greater affinity for absorbing carbon monoxide than for absorbing oxygen. As a result, during normal respiration, the body will absorb carbon monoxide much more readily than oxygen. This results in increased levels of CO within the body which is known as carbon monoxide poisoning. Symptoms of carbon monoxide poisoning are headaches, nausea and a general lethargic feeling. If the carbon monoxide is present in sufficient quantities, death can occur.

The second life threatening condition is the fire hazard. During the operation of a damaged furnace, if sufficient amounts of circulation air enters the combustion chamber, through holes in the heat exchanger, the burner flames can be pushed down against the bottom panel of the furnace housing as well as out the sides of the furnace through the combustion air intake openings. The combustion air intake openings are located along the sides of the furnace just above the bottom edge. This movement of flames and hot combustion gases out of the furnace is called “flame roll out.”

Because the H-Series furnaces are approved for installation on combustible materials, when unusual heating of the bottom panel occurs, the heat passes through the metal housing of the furnace into the combustible flooring below. When conditions of flame roll out occur, the flames and hot gases that are venting out through the combustion air intake openings are directed downward by the combustion intake covers and will immediately come into contact with the combustible wood platform or the wooden joists. When sufficient heating of the wood occurs, a fire begins. Because most attic spaces are not equipped with heat or smoke detectors, fires in attic spaces can burn for extended periods of time before they are discovered. If the fire occurs during the night time hours, when the occupants of the home are asleep, tragedy can easily occur.

It has been reported that some heating and air-conditioning contractors have offered to place a piece of sheet metal beneath the furnace as a method to make the furnace safe. Any contractor offering that fix shows an absolute lack of understanding of the principles of heat transfer. Heat passes quickly through metal by conduction. If there is sufficient heat to pass through the bottom of the furnace housing to the plywood, there will be sufficient heat to pass through any additional layer of sheet metal. It may take a few minutes longer, but the heat will pass through to the combustible wood below.

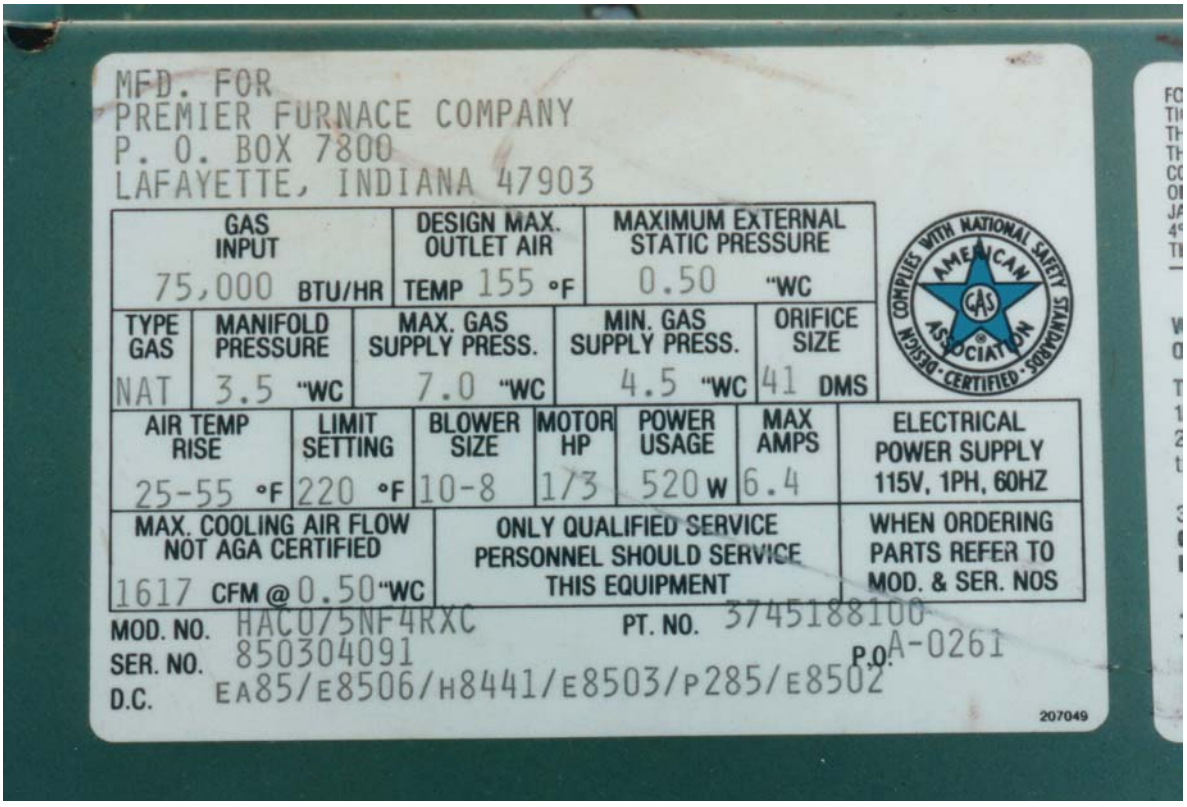
The speed at which a failure in these furnaces will occur is dependent entirely on the BTU rating and the amount the furnace is used. Furnaces that have higher BTU ratings inherently produce greater quantities of heat and will fail faster than furnaces with a smaller Btu rating. Also, furnaces that are infrequently used, even large Btu models, will last much longer than furnaces that are used on a regular basis. Larger BTU furnaces that are used on a daily basis have been found to fail in as little as four years. Furnaces that are seldom used, regardless of their size, show little signs of damage after as much as fifteen years.

Horizontal furnaces are very difficult to thoroughly inspect without a complete disassembly. If a visual inspection reveals damage to the burner assembly, there will almost always be some heat exchanger damage as well. The greater the damage to the burner, the greater the corresponding damage to the heat exchanger. If the burner tubes have failed and the heat exchanger is cracked or has holes in it, the furnace is a safety hazard.

If you have a horizontal furnace in your residence that was manufactured by Consolidated Industries, I strongly suggest you consider replacing the furnace immediately. If it has not already failed, **it will fail**. It is simply a question of when. An visual inspection of the furnace will only reveal the most obvious damage. Microscopic cracks in the heat exchanger, especially in the weld seams, are very difficult to detect. However, during use of the furnace the small cracks will expand in size due to expansion of the metal. The furnace may look fine today and crack the very next time it is used. If your furnace shows any signs of internal damage, do not use it, even for a few minutes. **Replace it immediately**. Replacing the burner assembly and/or the heat exchanger does not solve the problem. It merely replaces improperly designed and manufactured parts that will fail again, perhaps with catastrophic results.

To determine whether a furnace is one of the involved atmospheric H-Series, look on the control side of the furnace for the AGA furnace rating plate. This is a plasticized paper tag which has certain technical information about the furnace as well as the furnace's model number and serial number. (See photo below.) The rating plate may be located on the combustion air intake cover or it may be mounted on the fan door panel. It will always be on the side where the controls are located. The first two or three letters of the model number are used in recognizing the series, modifications, and heat exchanger steel code. The attached list of manufacturers' and model numbers covers furnaces with the Consolidated "Premier" label as well as furnaces sold to other companies and marketed under their labels. If the manufacturer and model number of your furnace appears on the list, you have one of the potentially hazardous models.

To determine when your furnace was manufactured, check the serial number on the rating plate. The first two digits of the serial number indicate the year of manufacture and the third and fourth digits indicate the month. For example, a serial number that begins with the first four numerals of "8706" indicates the furnace was manufactured in June of 1987. The involved H-Series furnaces were manufactured between 1983 and 1991.



Important Update

I have recently learned that some contractors and some insurance carriers have been incorrectly stating that only furnaces with an X in the model number are the ones that are in danger of failing. ***This information is not correct.*** The X in the model number simply means the furnace is equipped with NOX rods to cut down emissions of nitrous oxides. The problems discussed in this article are present in all H-series furnaces, whether they are equipped with NOX rods or not. The absence of NOX rods does not make the furnace safer. The same failures and thus the same hazards occur, at the same frequency rate, in furnaces that are not equipped with the NOX rods.

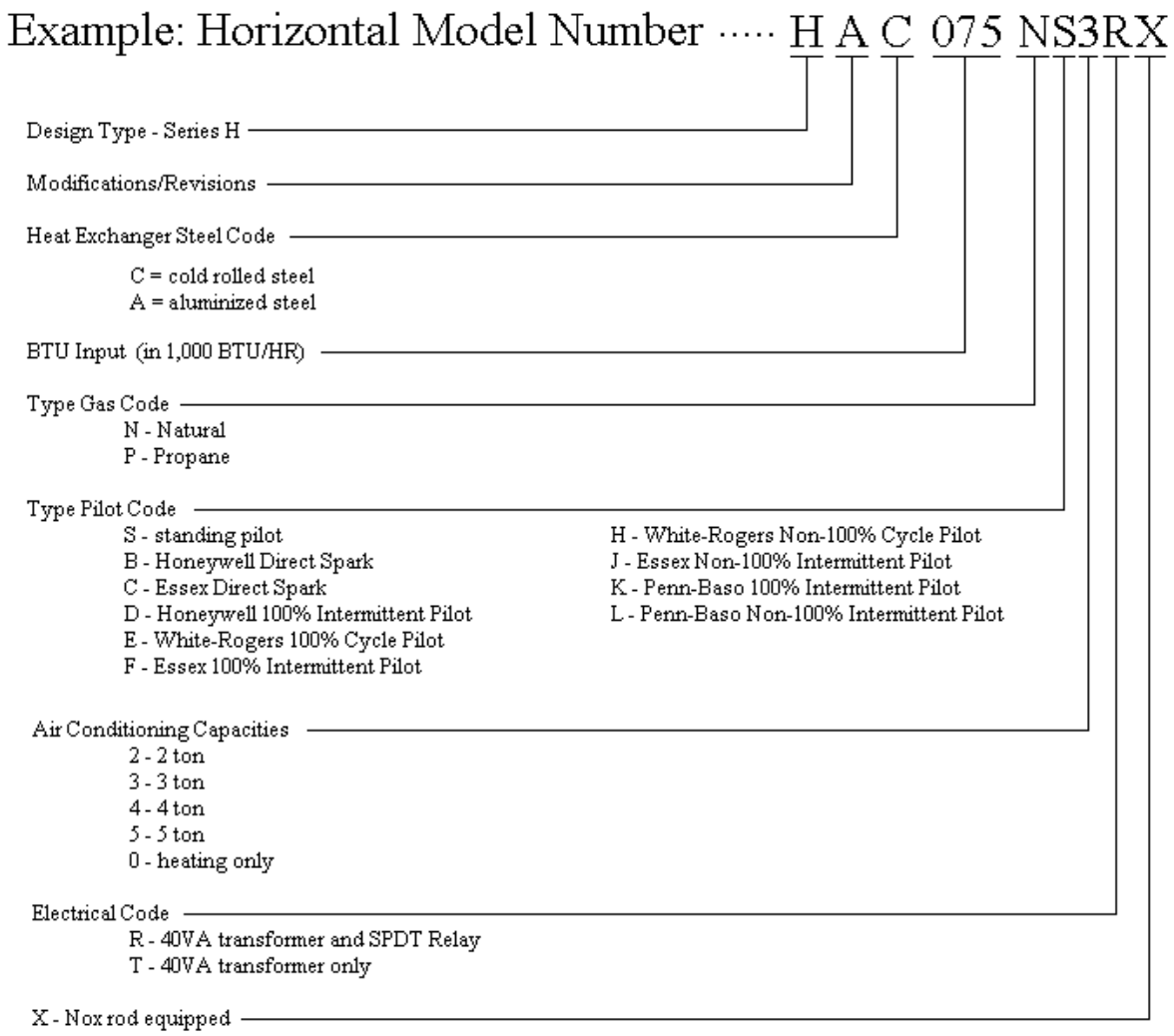
Lately there has also been some discussion regarding recommendations to remove the NOX rods from smaller furnaces (40-50,000 Btu rated) as a way of making the furnace safe for continued operation if no cracking has already occurred. Removing the NOX rods will not make the furnace safe. This is at best a stop gap measure that will slightly reduce internal heat on the burner tubes but does not correct the basic design and fabrication defects. The burner tubes **will** fail over time whether they are equipped with the NOX roods or not. While NOX rods may slightly accelerate the problem in some instances, they are not the root cause of the problems and their presence or absence makes no difference in the eventual failure of the furnace.

(Updated May 2004)

About the author:

Michael Whedon has been a fire investigator in the State of California for more than 23 years. He is a former law enforcement arson-bomb investigator and currently is a State-licensed private investigator. He owns and operates a company that specializes in the investigation of fires and explosions. He is a recognized expert in fires involving gas-fired appliances. He has done extensive inspection and testing of H-series furnaces manufactured by Consolidated Industries and has been involved in several successful product liability litigations against that company and other vendors of the H-Series furnaces. For additional information on horizontal furnaces, Mr. Whedon can be contacted at (909) 352-2780 or by e-mail at mwi@pacbell.net.

Model Number Code



COMPANIES THAT PURCHASED THE H-SERIES HORIZONTAL FURNACES FROM CONSOLIDATED INDUSTRIES AND SOLD THOSE FURNACES UNDER ANOTHER LABEL ARE LISTED BELOW WITH THE BRAND NAMES AND THE FIRST LETTERS OR DIGITS OF THE MODEL NUMBERS:

COMPANY NAME	TRADE NAME	MODEL
Addison Products Company	Weatherking	GHC
Amana Refrigeration	Amana	GSE-DN
Arco Comfort Products	ACP, Arcoaire, Northrup	GHB
Bard Manufacturing	Bard	HG, ESG
Coleman Company (Evcon Industries)	Coleman	2505-2509B/ 2505-2509C
Consolidated Industries Corp.	Consolidated	HAC/HCC
DMO Industries	Duomatic-Olsen Olsen, Airco	HCC
Goettl Air Conditioning Inc.	American Best Gottel	HCC
Goodman Manufacturing Company	Franklin Electric, GMC, Hamilton Electric, Janitrol Johnstone, Liberty	HAC/HCC
Heat Controller, Inc.	Century, Comfort Aire	GSH
ICG/Keeprite	Keeprite	HAC/HCC
Magic Chef Air Conditioning	Magic Chef	EG/ENG
MLX Refrigeration and Air Conditioning	Heatmaster	HAC/HCC
Premier Furnace Company	Premier, Sunburst, Sunglow P.F.C.	HAC/HCC
Sears	Kenmore	735
Square D Company	Sundial	GH
Trane Company	Trane (XE60, XE70), American Standard	THS, THN
Westbrook Distributing Inc.	Heatmaster	HAC/HCC

Photo One: Typical installation method for H-Series furnace.

Photo Two: Combustion air intake port at bottom edge of furnace housing.

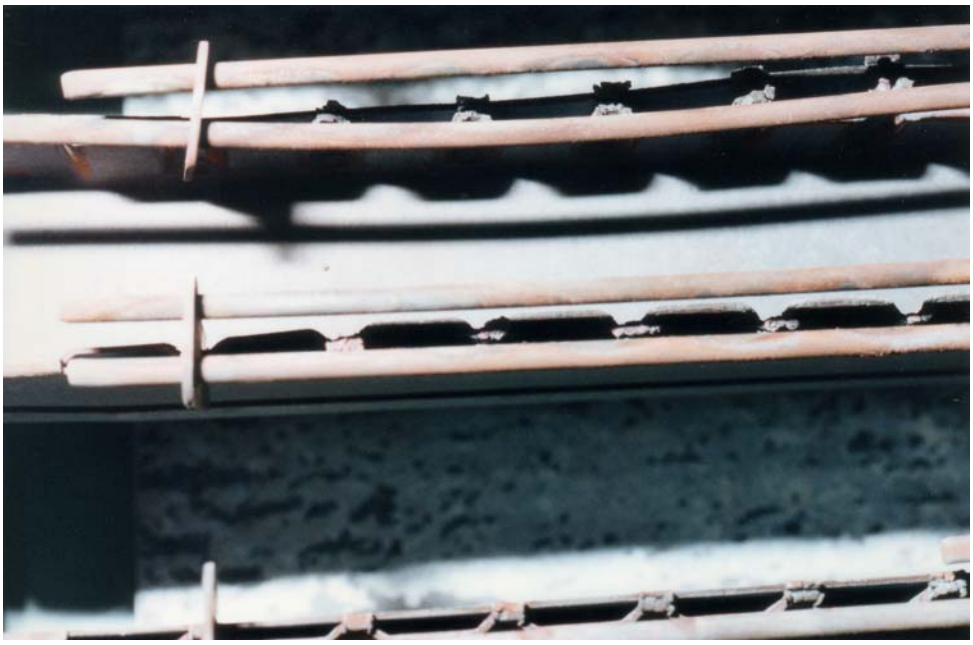


Photo Three: Close up view of cracks in the web between burner port openings resulting in the enlargement of the port openings.

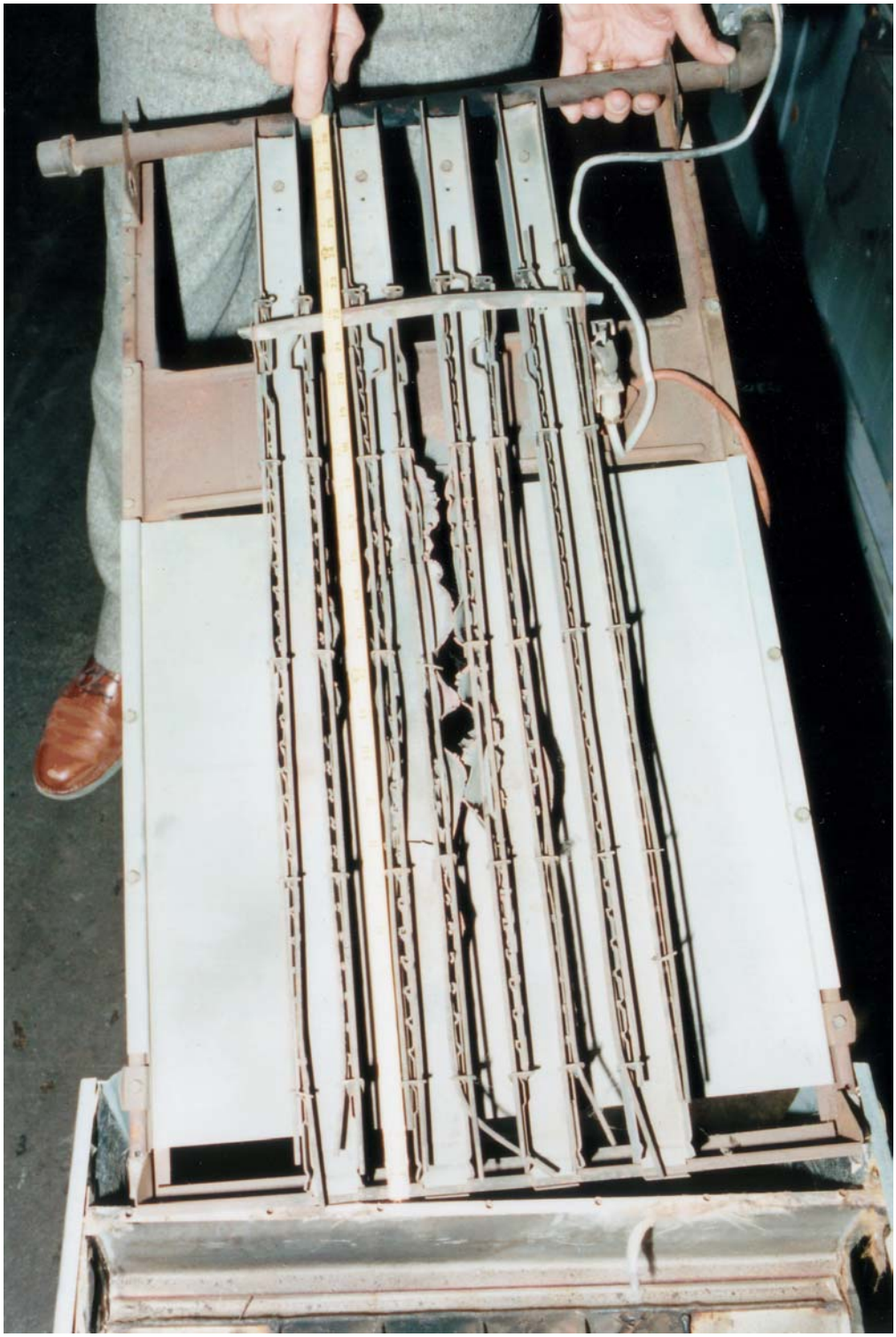


Photo Four: Damaged NOX rod equipped burner assembly.

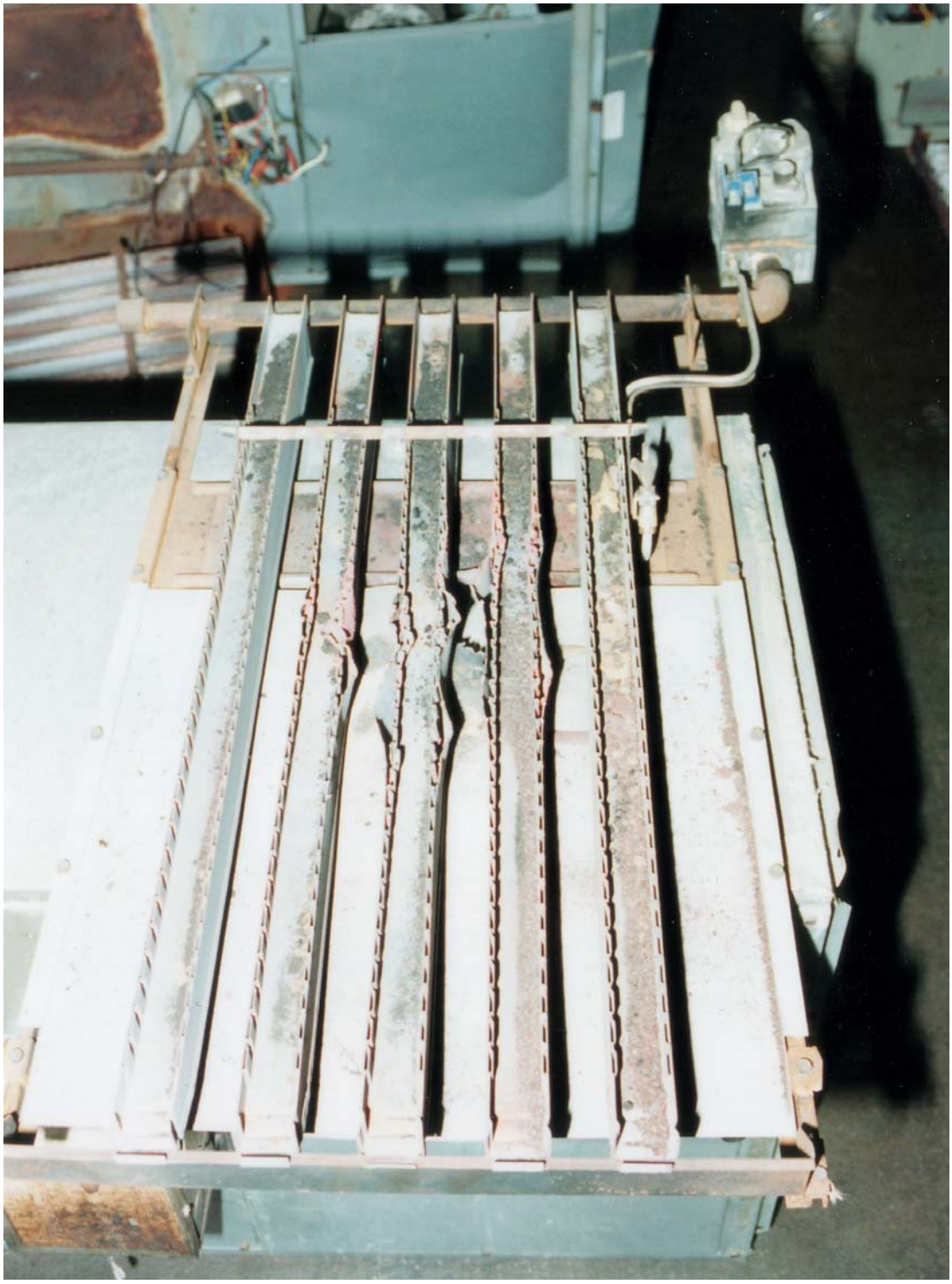


Photo Five: Damaged burner assembly <u>not</u> equipped with NOX rods.

Photo Six: Failed heat exchanger.

Photo Seven: Major failure of heat exchanger.