

Generic Procedure for Thermographic Heater Tube Inspections

by Ron Lucier, EPRI Level III

The Global Leader in IR Thermography Training



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1. Purpose

1.1. This Inspection Department Administrative Procedure is written to ensure compliance with ABC Petroleum Co. LLC, ABC Refining Division's Process Safety Management Mechanical Integrity Program and ABC Refining Heater Best Practice. This procedure is specifically written to prevent premature heater failures, extend heater tube life, maintain personnel safety, continued efficient operations, and forecast accurate heater repairs.

2. Scope

2.1. All process heaters within the ABC Refining Division fall under this administrative procedure. This includes the following heaters:

1H-1 Vacuum Heater

1H-5 Crude Heater

1H-4 Unifiner Heater

1H-3 Alky Heater

10H-1 Cat Charge Heater

11H-1,2,3,&4 SR Platformer Charge & Intermediate Heater

12H-3 Stripper Reboiler

13H-4 NHT Charge Heater

14H-1 Reactor Intermediate Heater

15H-2 Reactor Charge Heater

16H-2 KHT Charge Heater

3. General

3.1. In general, heater thermography will be utilized to trend heater tube skin temperatures and to some extent to determine when heater tubes are exceeding design limits. In addition to tube skin temperatures, the heater casing shall also be surveyed for excessive temperatures indicating possible deterioration of the interior refractory lining. All information gathered during these inspections will be evaluated to determine remaining heater life and predict shutdown/turnaround repairs.

4. Frequency

4.1. Surveys will be completed quarterly on each heater to determine and trend tube skin temperatures as well as a survey of the heater casing to identify any deterioration of the heater refractory lining.

5. Qualification of Personnel

5.1. Infrared inspectors shall hold a valid Level I, II or III certification that meets the criteria set forth in ASNT-SNT-TC-1A (2000) for Thermal Infrared (TIR) testing.

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6. Inspection Preparation

- 6.1. Make sure all batteries are charged prior to any thermographic inspection.
- 6.2. Inspect the Inframetrics PM-390 for physical damage. In particular check the hand strap to make sure it is not cut or frayed.
- 6.3. Remove the lens and assure that the flame filter is not present.
- 6.4. Install the AC power supply and start up the camera. Note the time it takes for the detector to cool down and produce and image. If it takes in excess of 12 minutes to cool down or if there is no produced image, contact FLIR Systems Service Department.
- 6.5. Prior to traveling to the heater to be inspected, turn the camera off, put a battery on and turn the camera to STANDBY. This will save battery life.
- 6.6. Take all needed accessories and at least two spare batteries, one PCMCIA card and note paper or field data sheets.
- 6.7. Bring all required Personal Protective Equipment with you.

7. Pre-Inspection

- 7.1. Upon arrival at the jobsite, obtain a Hot Work Permit from the control room. Inform the helper that the Inframetrics PM-390 is NOT Intrinsically Safe.
- 7.2. Upon arrival at the heater, turn the camera to the ON position, allowing approximately one minute for it to complete startup.
- 7.3. Once an image has been obtained, from the ground perform a safety inspection of the heater noting any hot areas on the heater shell. Store images as necessary.

8. Heater Inspection

- 8.1. All inspections will be performed from the firebox site doors as listed in Table 1, "Heater Inspection Ports".
- 8.2. Remove the camera lens and install the 3.9 μ m Flame filter by aligning the white dot on the lens filter holder to the white dot on the filter. Replace the lens.
 - 8.2.1 If the camera has a message "Thermistor Failure", slightly rotate the lens until the message disappears. This message is an indication that the lens is not properly aligned.
- 8.3. Once the firebox site door has been opened, focus the camera on the far wall refractory, store this image.
 - 8.3.1. To measure the "Background Temperature", set the emissivity to 1.0 and measure the area average temperature on a section of refractory that appears uniform in temperature.
 - 8.3.2. Enter this value in Menu 1, "Background".
 - 8.3.3. Initially set the "Emissivity" value to 0.85

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- 8.4. Inspect the heater tubes by looking into the firebox site door, first looking downward at the floor and working your way upward. Store three or four images per firebox site door, noting the stored file numbers (e.g. C10, C11, etc.)
- 8.5. Note any obvious physical changes such as warping of the tubes, missing refractory, leaks, etc.
- 8.6. Continue this process until all firebox site doors as listed in Table 1 have been inspected.
- 9. Post Inspection**
 - 9.1. Assure that all firebox site doors have been closed.
 - 9.2. Pack all camera materials and accessories into their respective equipment cases for transport.
 - 9.3. Notify the Control Room when you have left the area and close out the Hot Work Permit as necessary.
- 10. Documentation**
 - 10.1 Copy all thermal images from the PCMCIA card onto a computer hard drive. Backup these images onto a CD as required.
 - 10.2 Using the ThermaCAM Reporter 2000 template "MAP Heaters" prepare the inspection report using the Report Wizard.
- 11. Image Analysis**
 - 11.1 Using the Reporter 2000 software, analyze the heater tube images, noting any excessive hot areas.
 - 11.2 Scale on the heater tube surface should look colder than the tube itself.
 - 11.3 To validate any temperature measurements, vary the emissivity from 0.80 to 0.90 and the background ± 100 °F. The measured temperatures should be noted as $\pm 2\%$ as stated by the manufacturer, FLIR Systems, Inc.

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APPENDIX

Table 1
Heater Inspection Ports

1H-1 Vacuum Heater	17	1-17 CW	
1H-1 Crude Heater	8	1-8 CW	
1H-4 Unifiner Heater	8	1-8 CW	
1H-3 Alky Heater	6	1-6 CW	
10H-1 Cat Charge Heater	8	1N-4N CW 1S-4S CW	North and South
11H-1 SR Platformer Charge	12	1-12 CW	
11H-2 SR Platformer Charge	12	1-12 CW	
11H-3 Intermediate Heater	12	1-12 CW	
11H-4 Intermediate Heater	12	1-12 CW	
12H-3 Stripper Reboiler	7	1-5 CW	Two not accessible from platform
13H-4 NHT Charge Heater	8	1-8 CW	
14H-1 Reactor Intermediate Heater	3	Not labeled	West end only
15H-2 Reactor Charge Heater	8	1-8 CW	
16H-2 KHT Charge Heater	5	1-5 CCW	Counter clockwise

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