Infrared Drone Inspection of an Air Cooled Condenser

EPRI with NYPA Zeltmann Station

Keith Paul
Principal Technical Leader EPRI Program 223

Air Cooled Condenser Overview

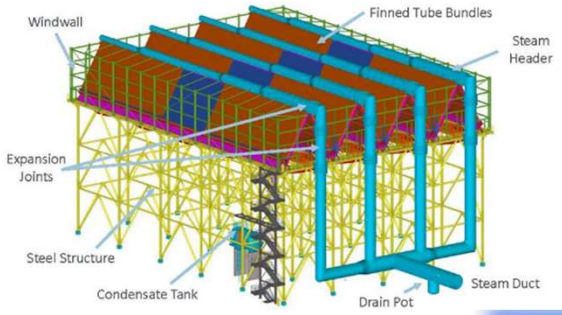
The steam exits the steam turbine into a duct that exhausts out to the air cooled condenser. At the air-cooled condenser this duct splits and rises up on top of the air cooled condenser and down a single duct that is referred to as a street. The streets have two heat transfer surfaces that exhaust down from them to the condensate header at the bottom. A middle section of each street contains the air removal section of the air cooled condenser. This is called the dephlegmator section. This section separates out the non-condensable gases, commonly referred to as air. These gases are pulled out by the steam jet air ejectors (SJAE) at Zeltmann station.

Generic/typical Air Cooled Condenser Design

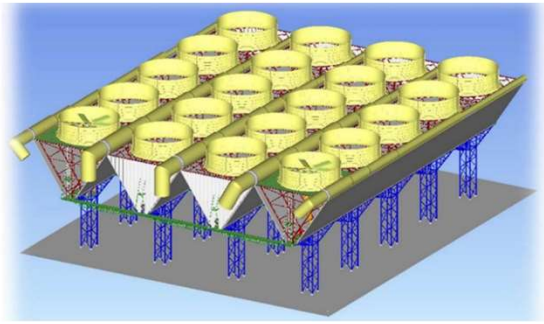
Not easily accessible

The photos at right show some of the difficulties accessing the upper steam duct or street, where all of the tubes connect into on a A style air cooled condenser.

Below are diagrams of A-type and Inverted A frame style ACC's



A-Type ACC



Inverted A-Type ACC

The Drone

- DJI M300 Drone with an H20T IR Camera payload
- Drone Consultant

  United Dynamics and AT Corporation

  Brandon Schulz

  Aero Division Manager

  Office: 502-957-7525

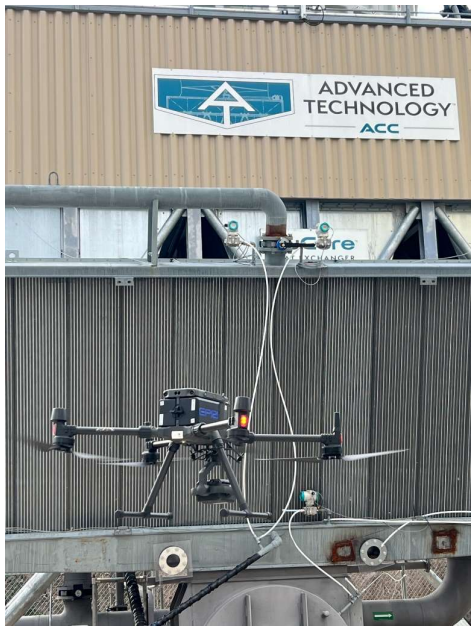
- Permitting
  - Government Agencies
    - FAA, FBI, CIA, ATF, DHS, USSS, etc.
  - NYPA Zeltmann is located 1300 feet from LaGuardia glidepath
  - Flew under NYPA's FAA permit
  - Registered drone equipment with proper authorities thru NYPA
  - Even with all permits if a dignitary visited NYC we would not be allowed to fly.

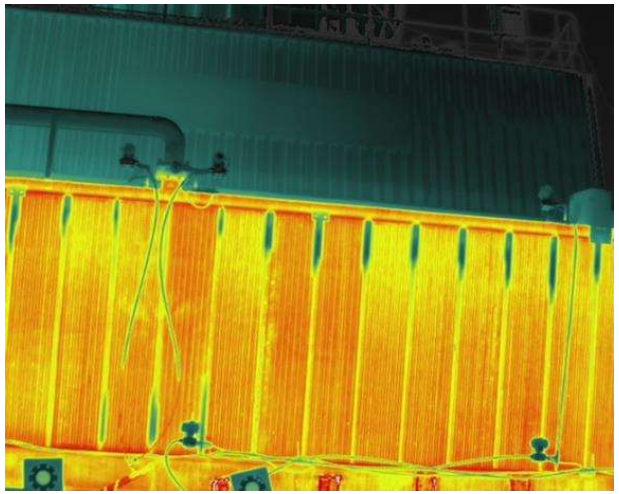
NYPA Eugene W. Zeltmann Power Project

- Zeltmann is a 576 MW 2x1 7FA Combined Cycle plant in Astoria, Queens County, New York that was commissioned in 2005
- Zeltmann is located 1300 feet from the LaGuardia Glidepath
- Special thanks to NYPA, and to Yefim Kashler in particular, for working with us and the NYPA team to get us plant permission and for all the local and corporate support working thru the New York City Drone permitting process.

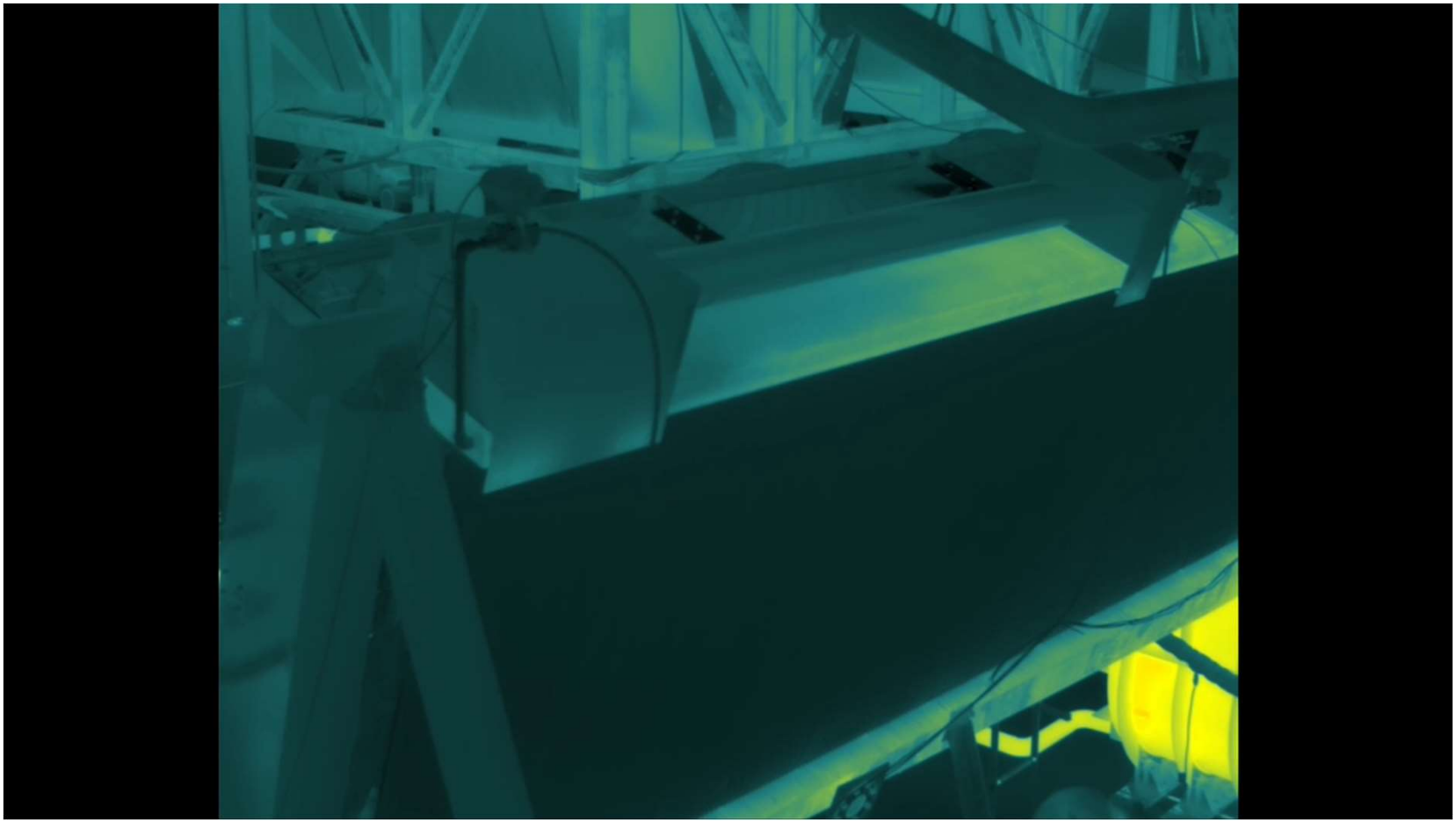
Calibration Runs

Prior to visiting NYPA Zeltmann, we conducted what we referred to as calibration runs at the Evapco Test Labs in Taneytown, Maryland. We ran the same drone, tested camera resolution, colors, and distances, and tested air in-leakage detection with intentional air in-leakage. We thank Evapco and their Advanced Technology laboratory team for their support.





Calibration Run Video



Air in-leakage Challenge

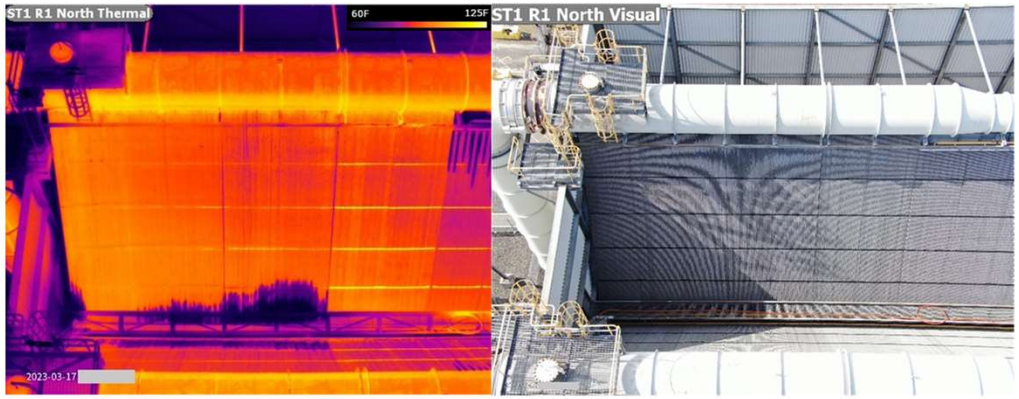
Leak detection has been expressed as an interest of NYPA's. Based on our experience here at NYPA
Zeltmann, and our experience at Evapco's test laboratory, we cannot say that infrared inspections provide
definitive leak detection services.

Acoustic Camera Potential

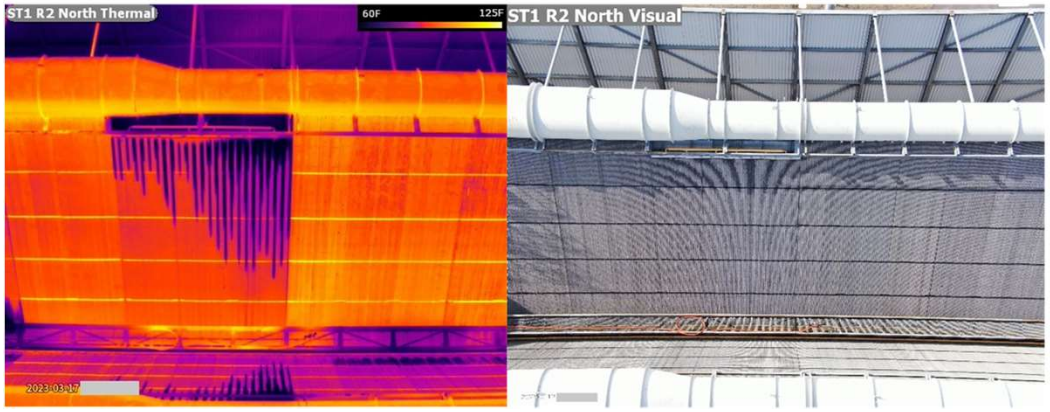
EPRI is developing a test methodology to utilize acoustic cameras mounted on a drone to inspect air cooled condensers. This methodology has been discussed by multiple members at EPRI, and Evapco has experienced success with handheld acoustic cameras. Mounting the acoustic camera on a drone would be new as far as we are aware. EPRI is continuing to develop this technology and hopes to apply it to condenser air in-leakage detection.

Street 1 North

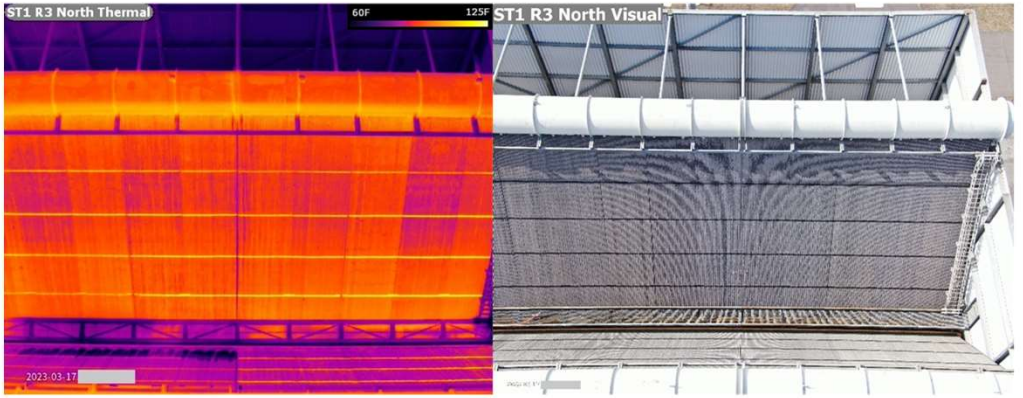
Row 1



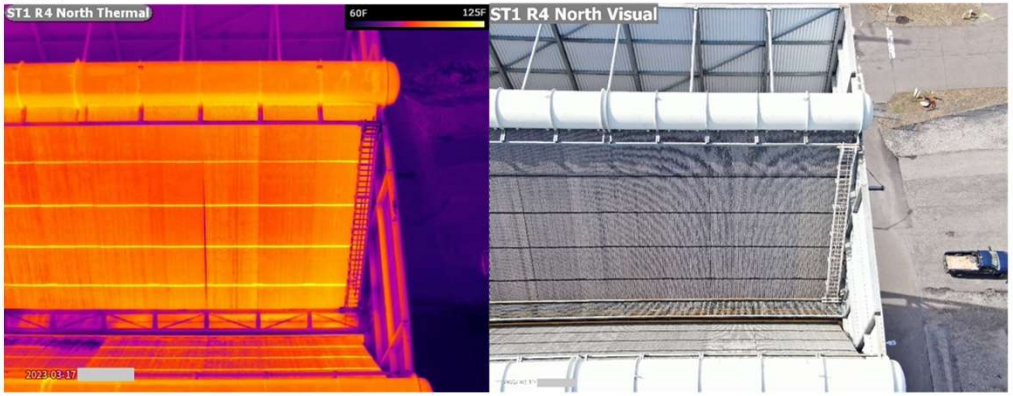
Row 2



Row 3

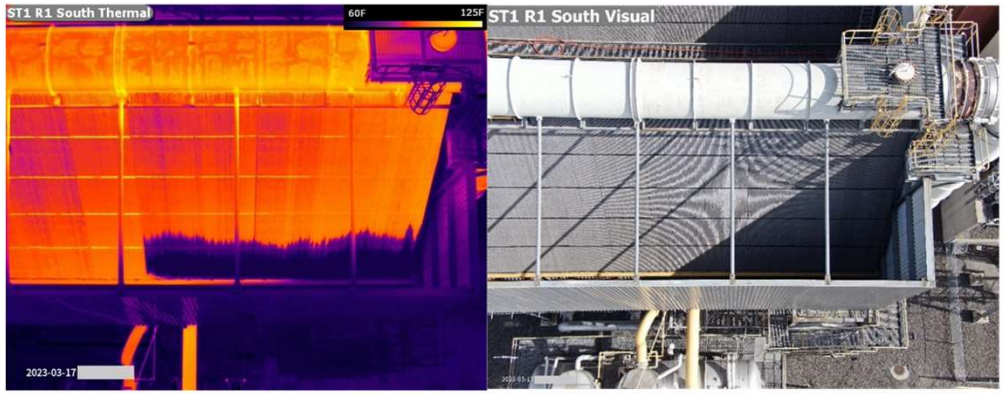


Row 4

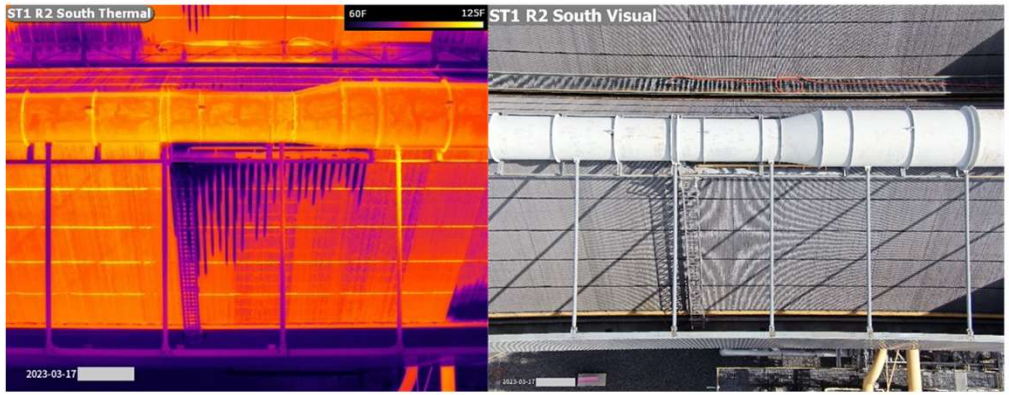


Street 1 South

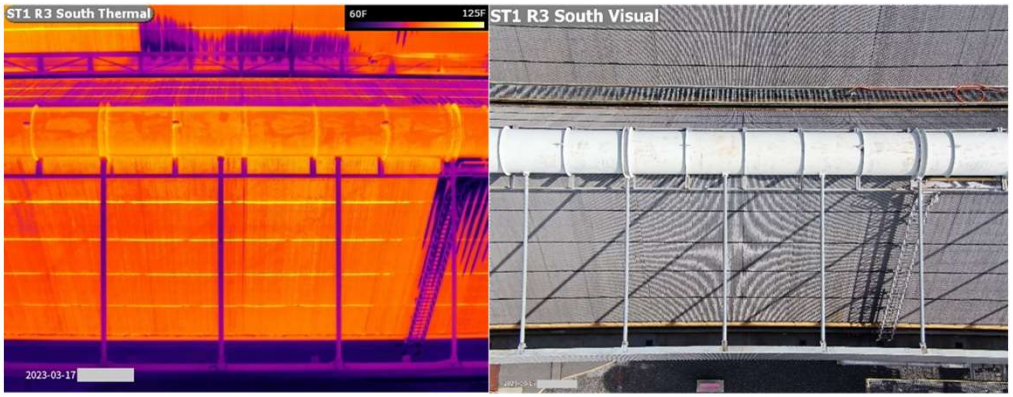
Row 1



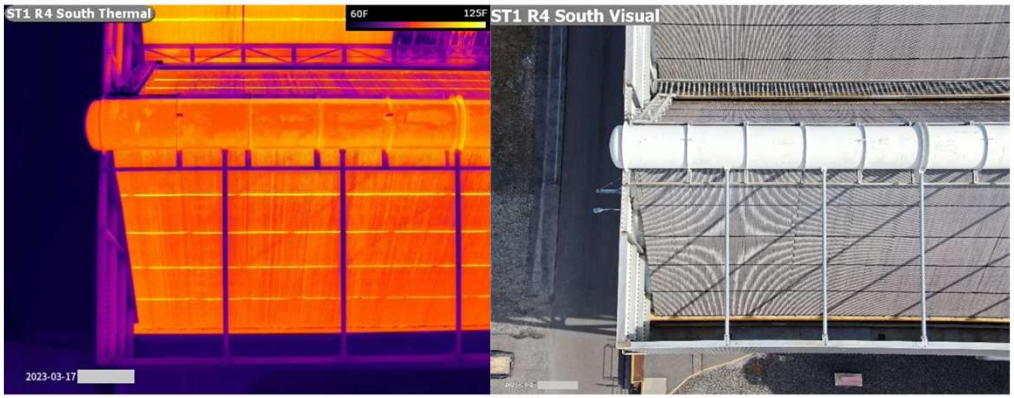
Row 2



Row 3



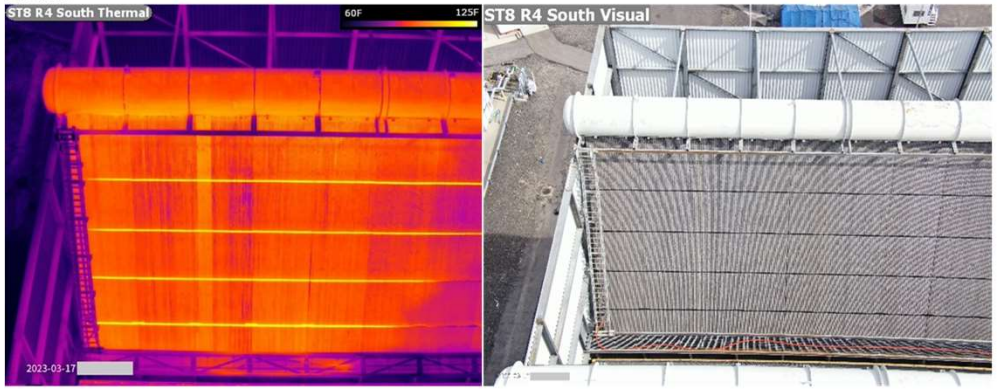
Row 4



Street 8 Row 4

North

South



Street 8
Row 4 North

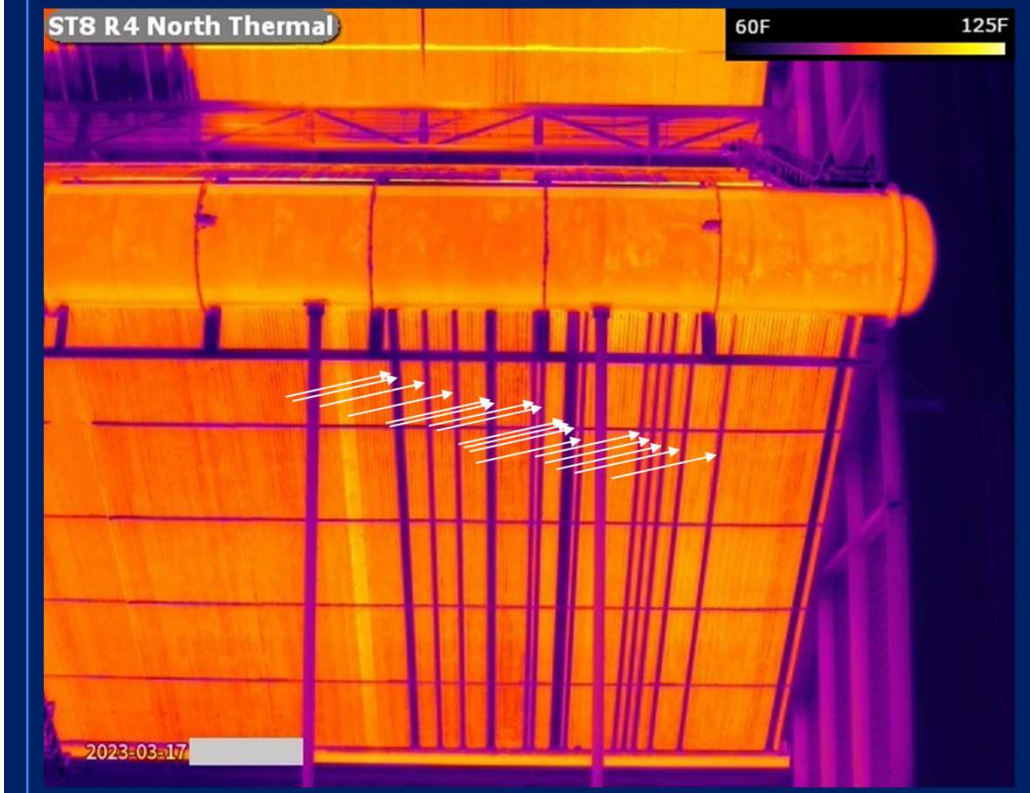
Street 8
Row 4 South

Problems identified

- The North Row is a separate heat exchanger from the South side, even though they are supplied with steam from the same Street, so they are distinct pieces of equipment.

Street 8 Row 4 North Detail

- The North side clearly has tubes that are cold, which means they are likely not full of condensing steam. Therefore, they are either air blanketed or are plugged as denoted by the white arrows in the image on the right. This reduces the capacity of the air-cooled condenser, and will increase condenser backpressure, decreasing steam turbine performance.

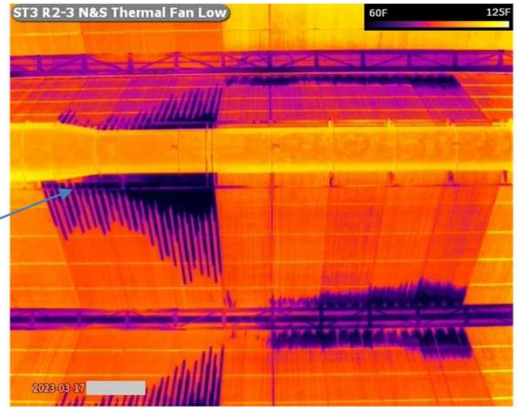


General Image

- This image shows multiple streets in their entirety from further away.

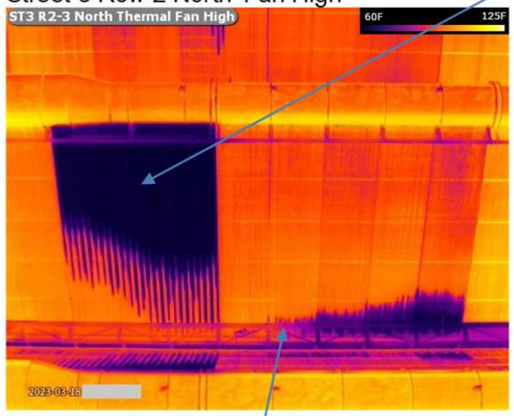
Street 3 Increased Dephlegmator Air Flow Test

Street 3 Row 2 North and South view



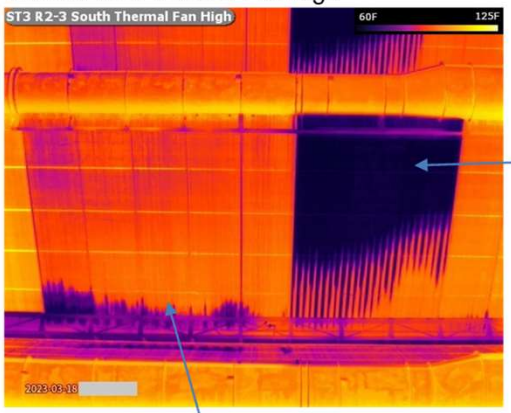
Potential increased air blanketing

Street 3 Row 2 North Fan High



Potential decreased air blanketing

Street 3 Row 2 South Fan High

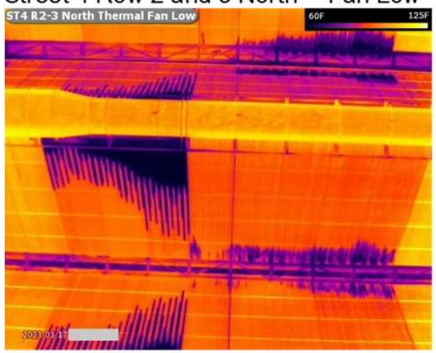


Potential increased air blanketing

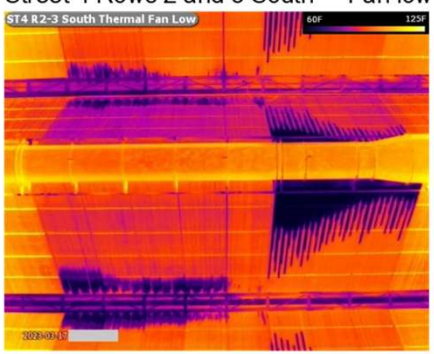
Potential decreased air blanketing

Street 4 Increased Dephlegmator Air Flow Test

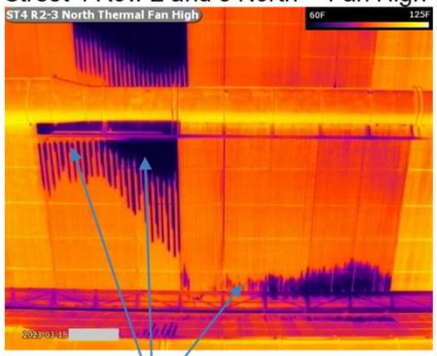
Street 4 Row 2 and 3 North Fan Low



Street 4 Rows 2 and 3 South Fan low

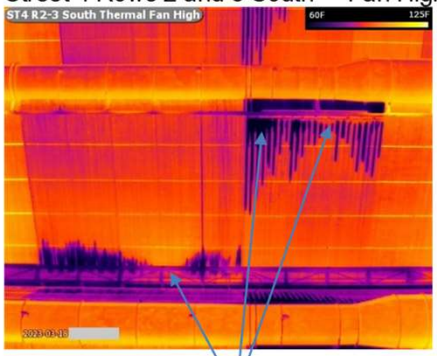


Street 4 Row 2 and 3 North Fan High



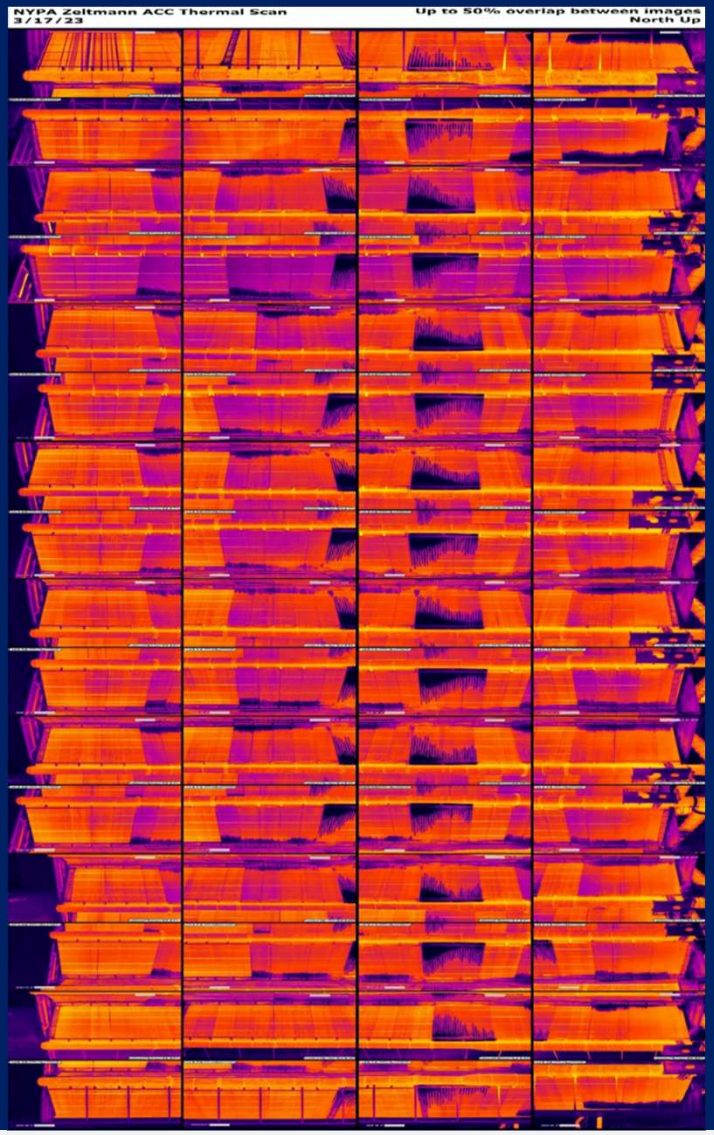
Clear decrease in air blanketing

Street 4 Rows 2 and 3 South Fan High



Clear decrease in air blanketing

IR Images of entire ACC stitched together



NYPA Follow-on

- Multiple tubes identified as cold in Street 8 Row 4, where we saw them with the drone, confirming drone IR inspection results. The drone results allowed the plant to focus on this section.
- Some may be plugged. Inspection, verification, and possibly repair may occur in the upcoming Fall 2023 outage.

Thank you

- Thank you to Evapco for their calibration support
- Thank you to UDC for working with EPRI to develop this technique
- Thank you to NYPA Zeltmann, specifically Yefim Kashler for his support developing these inspection techniques and applying them at Zeltmann Station.