Reliability of Heliostats

By: Charles Boyles

ctb0001@uah.edu

RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Introduction

- Energy
  - Non-renewable
  - Renewable
- Necessity
- Availability

RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Current Technology

- Solar Panels
- Heliostats
- Wind Energy
- Hydro Power
- Biomass
- Biofuel

RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

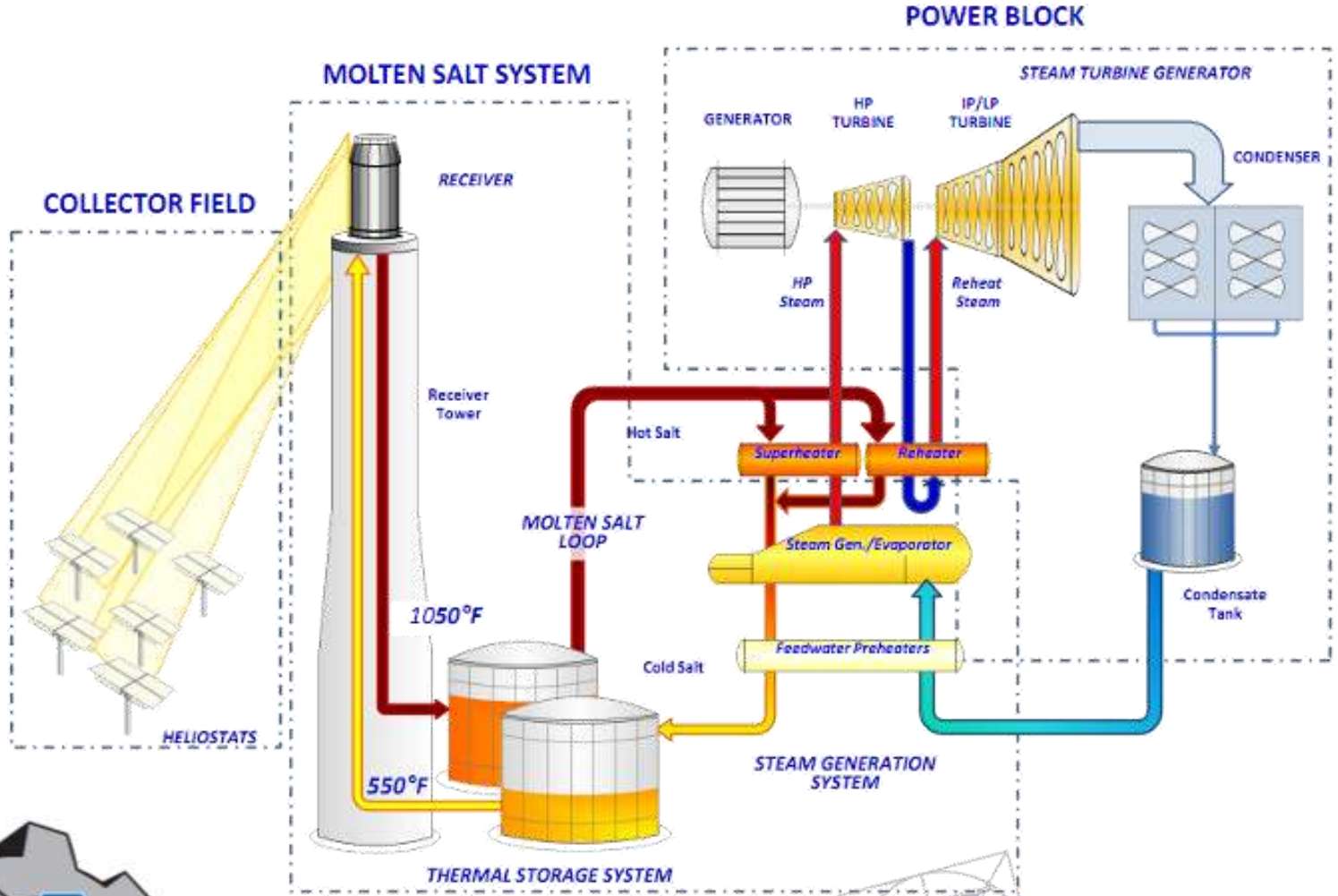
Current Issues

- Heliostat
  - Reflectors
  - Drive Motors
  - Azimuth Drive
- Solar Panels
  - Inverters
- Wind Turbines
  - Transmissions

RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

What is a Heliostat



RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Heliostat Project

- Purpose
  - Improve the Heliostat system
    - Increase Reliability
    - Decrease Cost
    - Simplify Manufacturing
- End Goal
  - Cheaper Heliostats
  - Third World Producible

RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Areas Of Focus

- Collectors
  - The Glass Reflectors
  - Mechanical Azimuth Drive
  - Drive Motor

RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Glass Strengthening

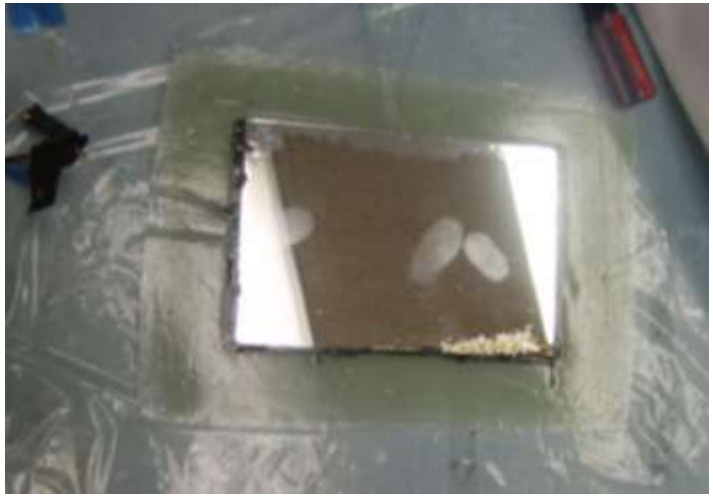
- Preloading
- Coating/Tempering
  - Large Increase in strength
  - Huge increase in cost
  - Complexity of Manufacturing Process

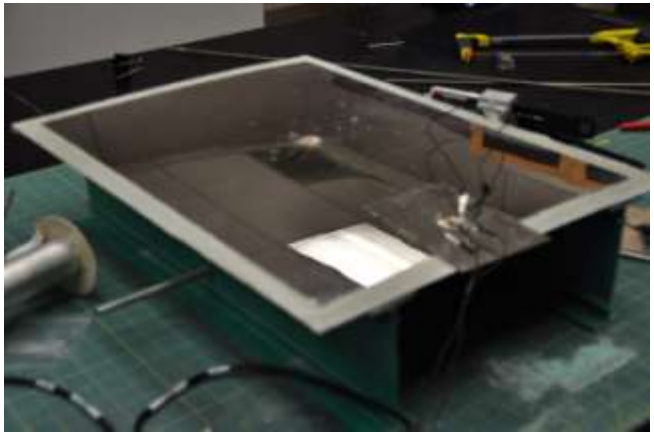
RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Preloading

- Mechanical Compression
- Thermal Compression
- Natural Material Shrinkage



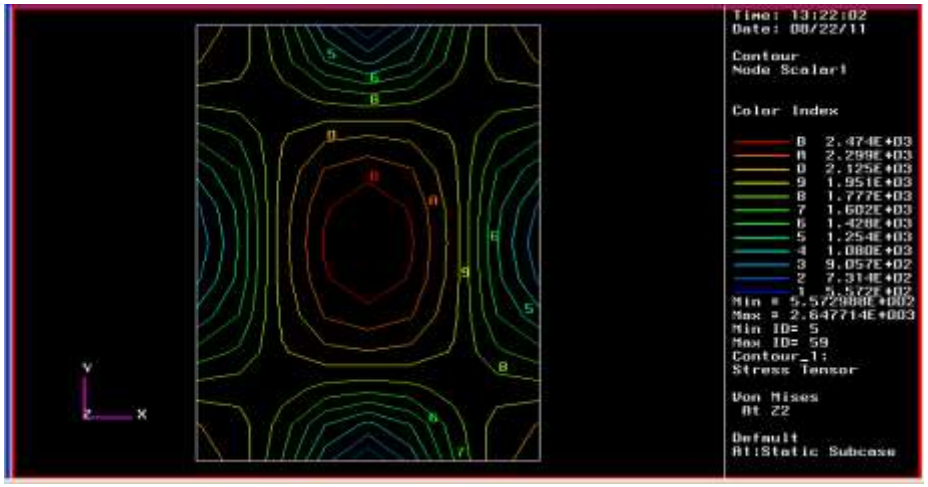


RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Finite Element Analysis

- Determine Stress Levels of Glass
  - With and without preload
  - Location of high stress points on the Mirror



RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Initial Sample Design

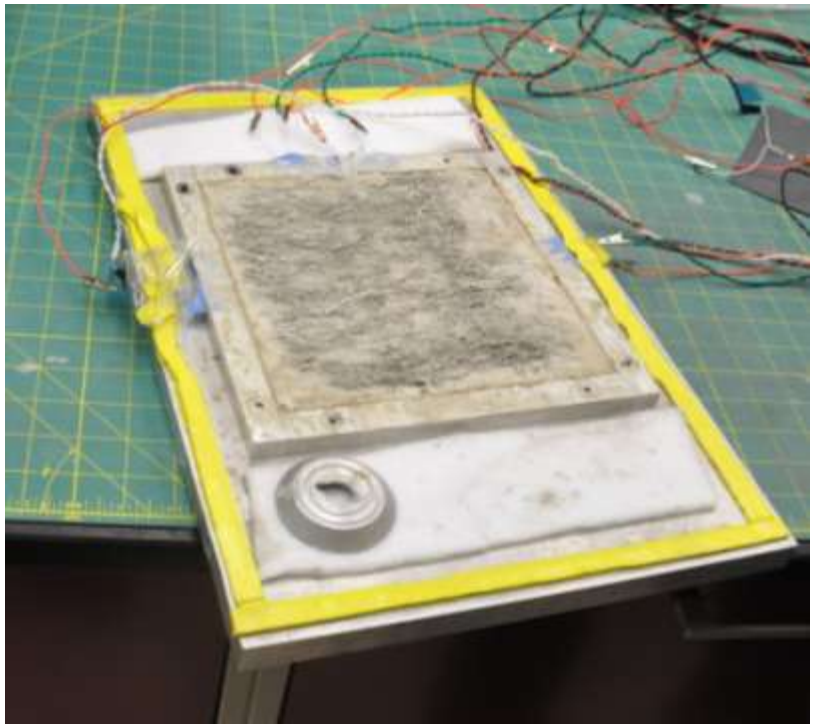
- Epoxy Resin
  - No Fillers
  - 2 Room Temperature Cures
  - 1 Elevated Temperature Cure
- Fiberglass
  - 45-45 weave
  - 0-90 weave
- Data acquisition issues

RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Sample Development

- Switched to Polyester Resin
- Switched to only elevated temperature cures
- Added powdered chalk as an additive

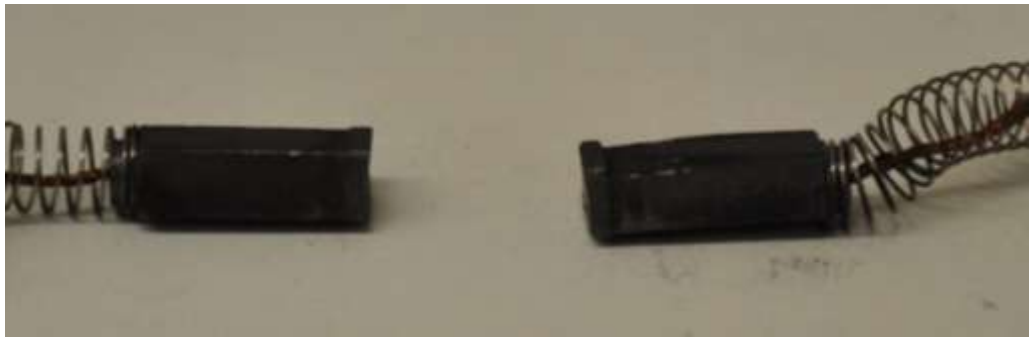


RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

ALT Testing

- Mechanical Reliability
- Azimuth Drive
- Two main points of Failure
  - Chain System
  - DC motor



RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

ALT Testing

- Observed Failures
  - Bearing Wear, Chain Slippage, Motor Wear

RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Environmental

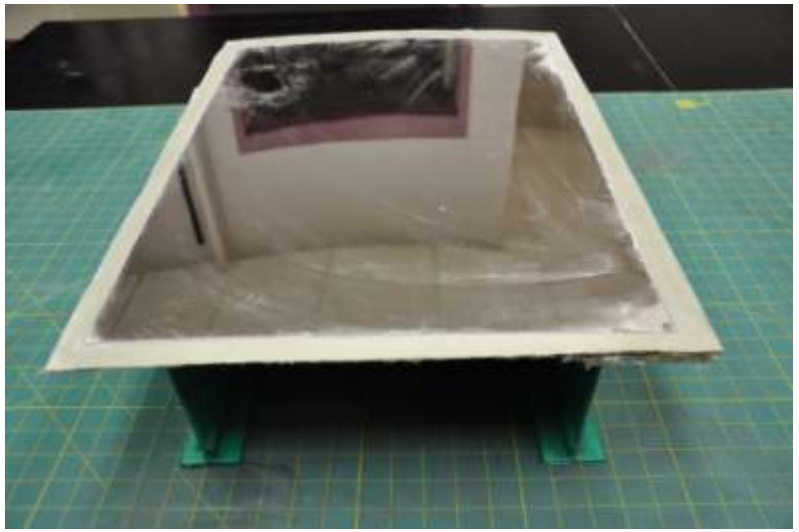
- DC motor
- Reflector Samples
- Thermal Parameters:
  -20°F to 140°F

RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Results

- Facet
  - Size:18”x24”
- Failure Modes
- Initial Redesigns
  - Stepper Motor
  - 2nd Chain Tensioner



RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Questions

Charles Boyles

(ctb0001@uah.ed)

Rfal.uah.edu

RELIABILITY AND FAILURE ANALYSIS LABORATORY
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE