NARSA
What does Durability Testing tell the Radiator Shop

Frank Perrone

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Overview

- The purpose of this presentation is to offer some guidelines for heat exchanger leak analysis and determining the potential “root cause” for failure, thus providing better service for customers

HOW!

- All product delivered for OEM applications is validated in both the Design & Launch Phase
- Rigorous testing is completed which is correlated to replicate known field failures, along with the identification of unknown issues
- Knowing the correlation of failure type to type of test run provides insight into why a heat exchanger may have failed, thus providing the Technician with information to help identify the “real” problem for heat exchanger failure
- By focusing on just 5 test types: Vibration, Thermal cycle, Pressure cycle, Salt Spray, & Coolant Degradation, the vast majority of all failures can be tied to the ”Real Root Cause”

Description of Validation Tests

- Thermal Cycle
  - Repeat cycling of hot & cold test medium (air, coolant, oil) through the component
  - Rapid Change between Hot & Cold – Creates Thermal Shock
  - Hot Temperature at maximum seen in vehicle – Thermal Expansion
  - Cold shock to create representative strain cycle and to accelerate test
  - Tested with external component that may restrict thermal expansion.
  - Opposing test mediums (ambient air, coolant) included where appropriate

- Pressure Cycle
  - Repeated Pressure Pulsations at Peak Pressure level seen in vehicle
  - Rapid Pressure Rise (< I seconds) to simulate spikes
  - High & Low Pressure - Held until stable at outlet – ensures complete cycle
  - Low Pressure - Atmosphere or Flow Pressure – ensures complete cycle
  - Test medium - heated to maximum seen in vehicle

Description of Validation Tests

- Vibration
  - Collect actual in-vehicle loads & cooling module response to identify damaging signals across the full range of chassis and engine frequencies
  - FEA & Single Axis electrodynamic vibration testing to specify isolators and structural designs that will provide good attenuation of the critical frequencies.
  - Conventional multi-axis shake test to evaluate lower chassis driven frequencies

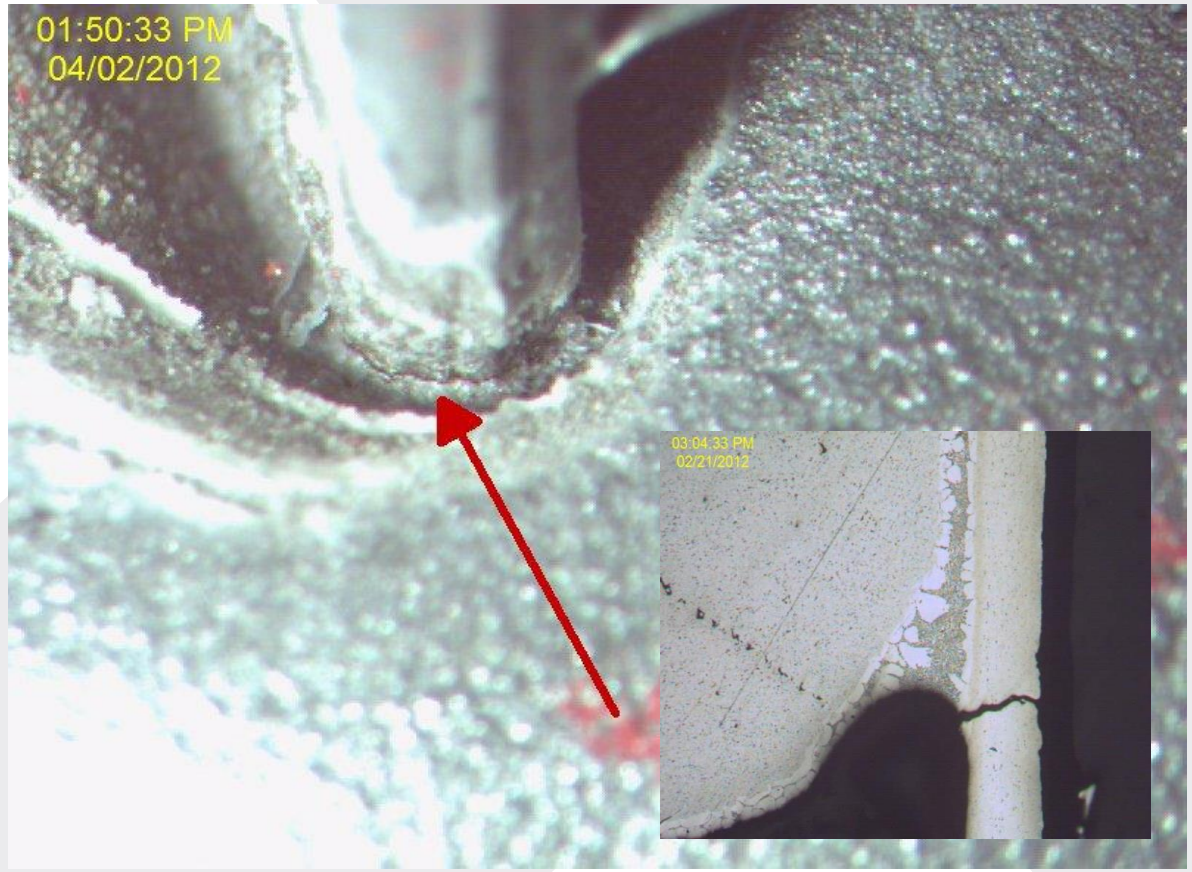
- Salt Spray
  - ASTM G85A3 – SWAAT Test (Sea Water Acidic Acid Test) – Part sits in a SWAAT fog/spray for 21 days at which time they are leak tested.
  - Conclusion from SAE Technical Paper 971857, Corrosion Performance Of Long-Life Automobile Radiators by Arthur C. Scott:
    - "4-8 days of SWAAT exposure are approximately equivalent to 7-10 years field exposure in severe conditions."

- Coolant Degradation
  - Cleanliness Testing of Heat Exchangers via SAE J-1726 or Customer Specifications ensure the Heat Exchanger will not cause a problem with coolant degradation
  - Various tests are used to identify that Coolant is degraded
    - Ion Chromatography (IC) – Tests for Glycolates in Coolant
    - pH testing
    - Atomic Absorption Spectroscopy (AAS) – Test coolants or deposits looking for metals like high levels of aluminum, copper, or iron

RADIATOR – Thermal Cycle

- How to identify:
- Tube at Header Leaks
- Typically tubes closest to side plates
- Side Plate Fractures

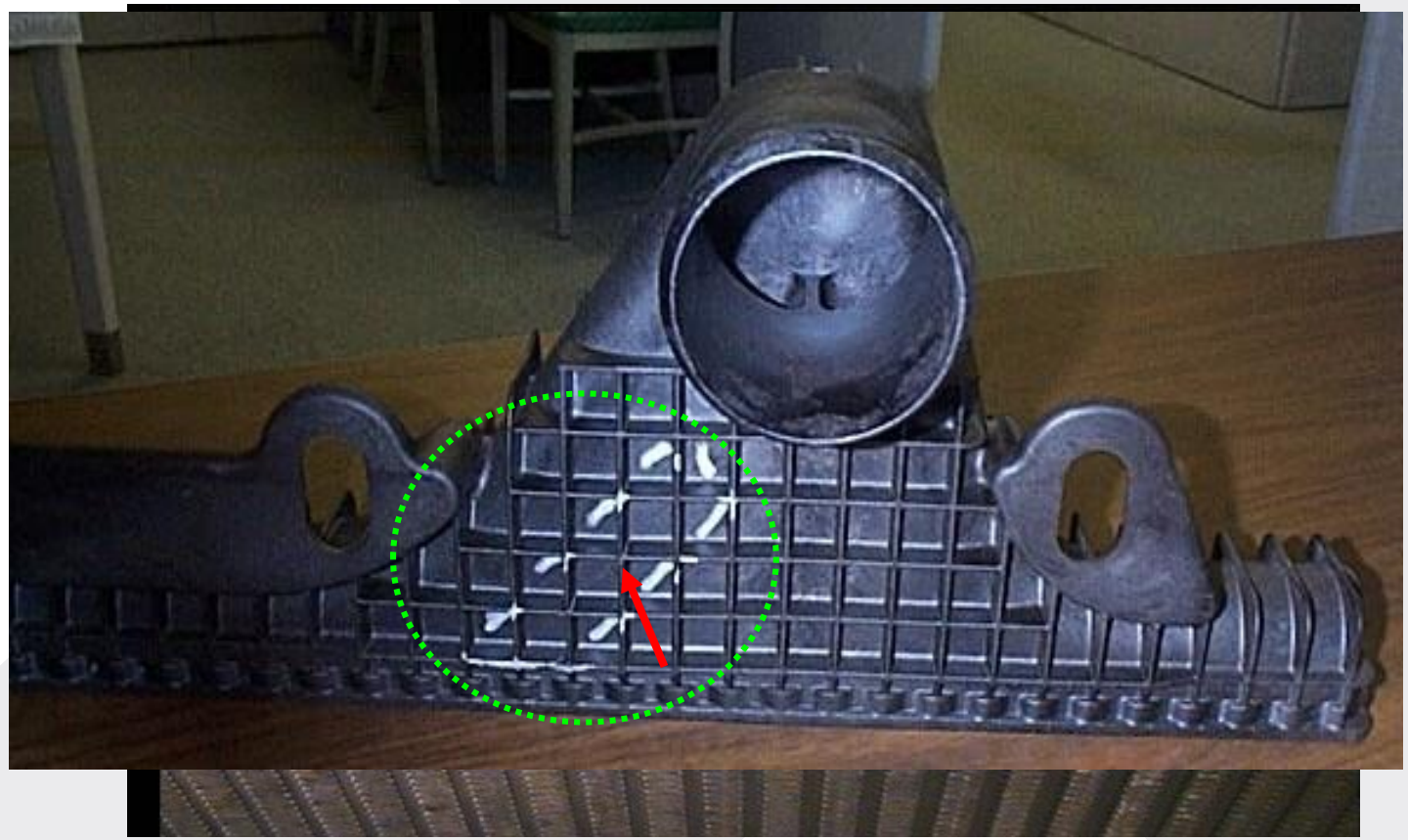
- What to look for:
- Mounting without thermal expansion
  - Lack of wear, isolators, structure
  - Hard mounts
  - Anything which does not allow for core growth
  - No Side Plate thermal break / cut
  - Generally a design issue



RADIATOR – Pressure Cycle (Tank & Crimp)

- How to identify:
- Crimp Leak
- Tank Fracture

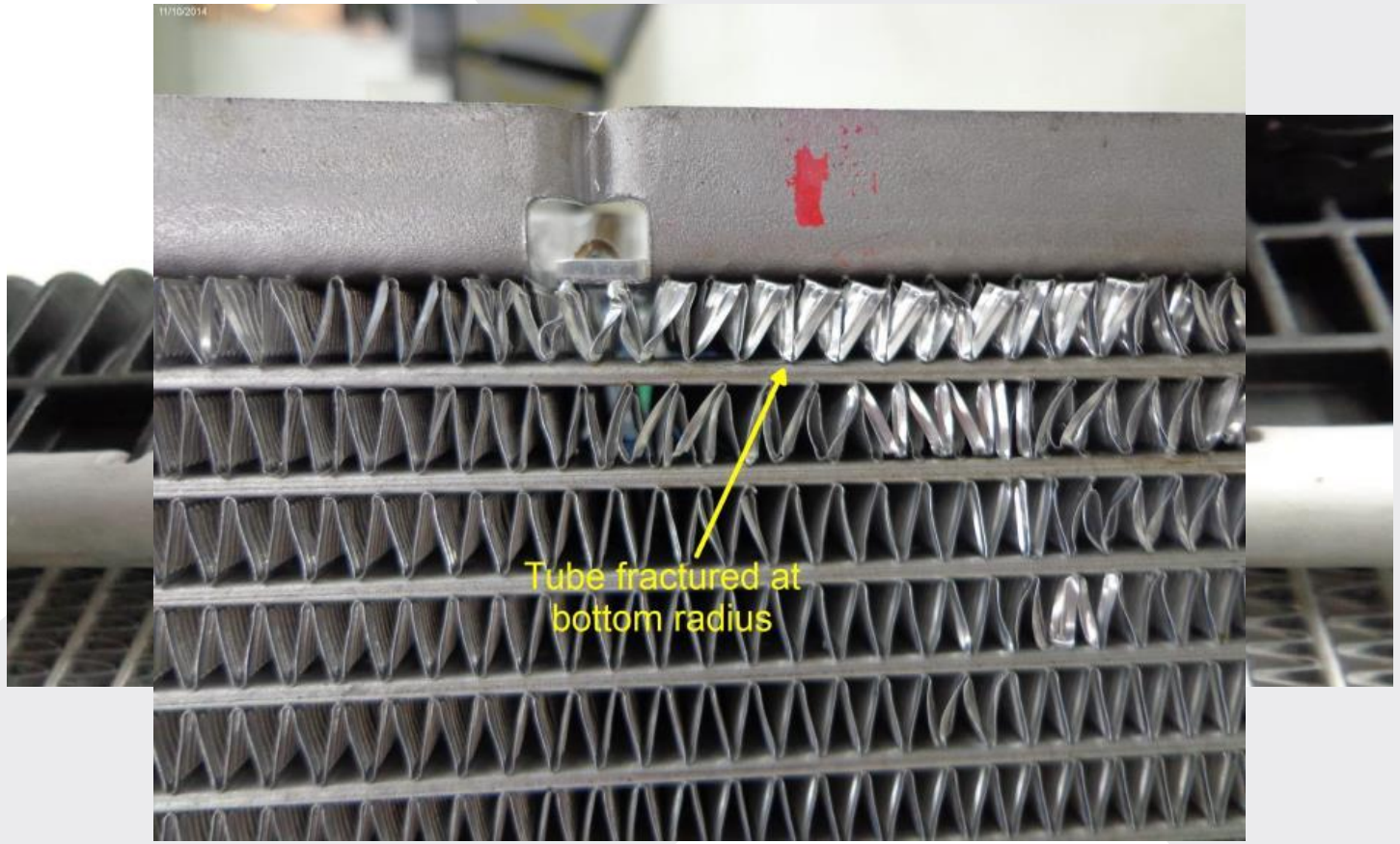
- What to look for:
- Large plastic tank deformation
- Large radiator hose deformation
- Without data collection, it is hard to identify whether Design or Vehicle conditions is the cause



RADIATOR – Pressure Cycle (Header & Core)

- How to identify:
- Tube Expansion, Crushed Fin
- Header Fractures

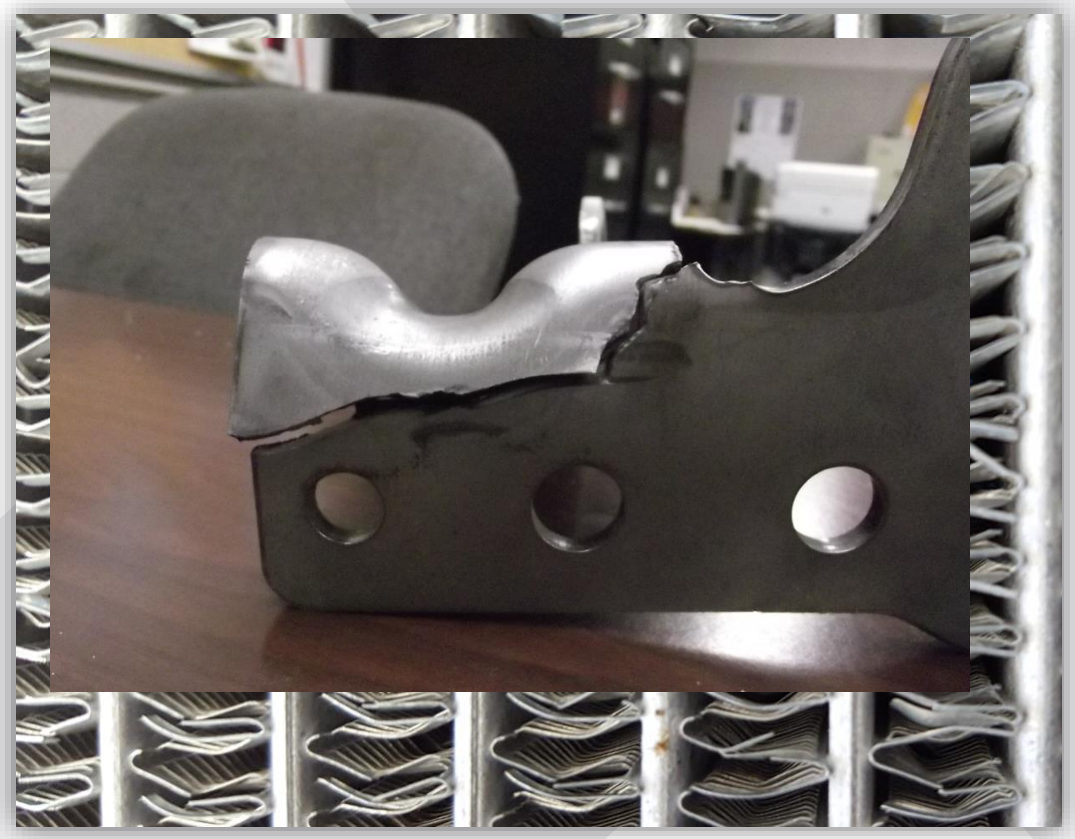
- What to look for:
- Large plastic tank deformation
- Large radiator hose deformation
- Without data collection, it is hard to identify whether Design or Vehicle conditions is the cause



RADIATOR – Vibration

- How to identify:
- Fin Cracking / Crush – leads to pressure cycle
- Tank Fracture
- Structure Fracture

- What to look for:
- Wear – where parts have rubbed together
- Isolator Wear
- Structure wear at mounting points
- Several other vehicle system failing
- Without data collection, it is hard to identify whether Design or Vehicle conditions is the cause



RADIATOR – Coolant Degradation

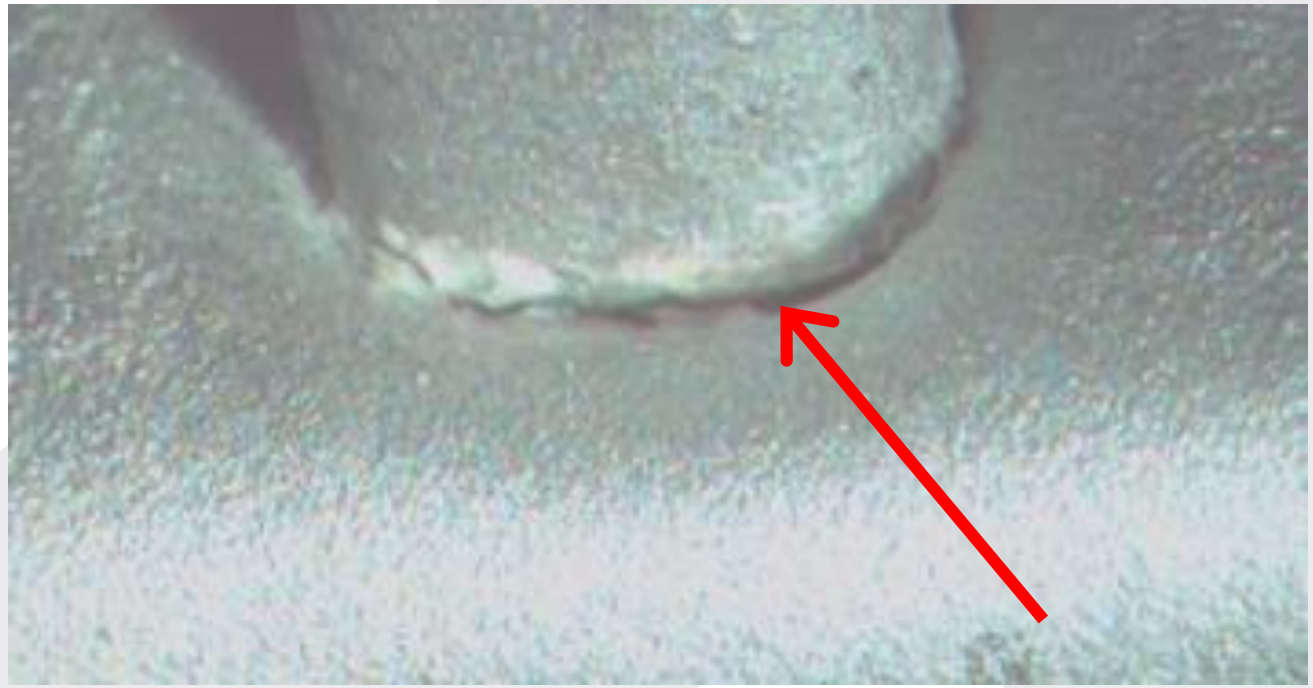
- How to identify:
- Solid deposits inside radiator
- Pugged Tubes
- Plastic Tank Degradation
- Coolant Sample Test

- What to look for:
- Coolant color change
- Amonia Smell
- Coolant pH outside of manufacturers specs
- Almost always a vehicle or maintenance issue

CHARGE AIR COOLER – Thermal Cycle

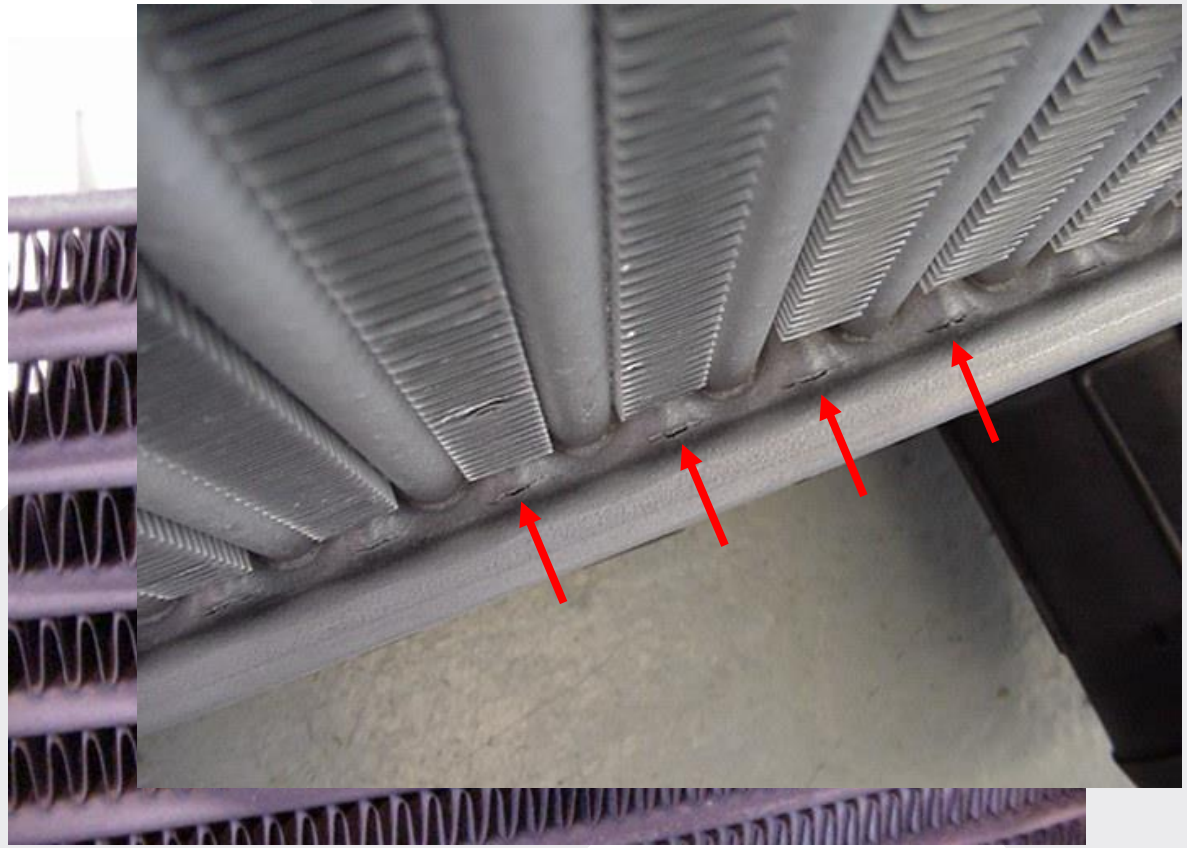
- How to identify:
- Tube at Header Leaks
- Typically tubes closest to side plates
- Side Plate Fractures

- What to look for:
- Mounting without thermal expansion
  - Lack of wear, isolators, structure
  - Hard mounts
  - Anything which does not allow for core growth
  - No Side Plate thermal break / cut
  - Without data collection, it is hard to identify whether Design or Vehicle conditions is the cause



CHARGE AIR COOLER – Pressure Cycle

- How to identify:
- Tube Expansion, Crushed Fin
- Header Fractures
- Tie Bar Fractures



- What to look for:
- Waste Gate Failures
- Turbo Blow By – Oil in CAC
- Hose failures, Blow offs
- Without data collection, it is hard to identify whether Design or Vehicle conditions is the cause

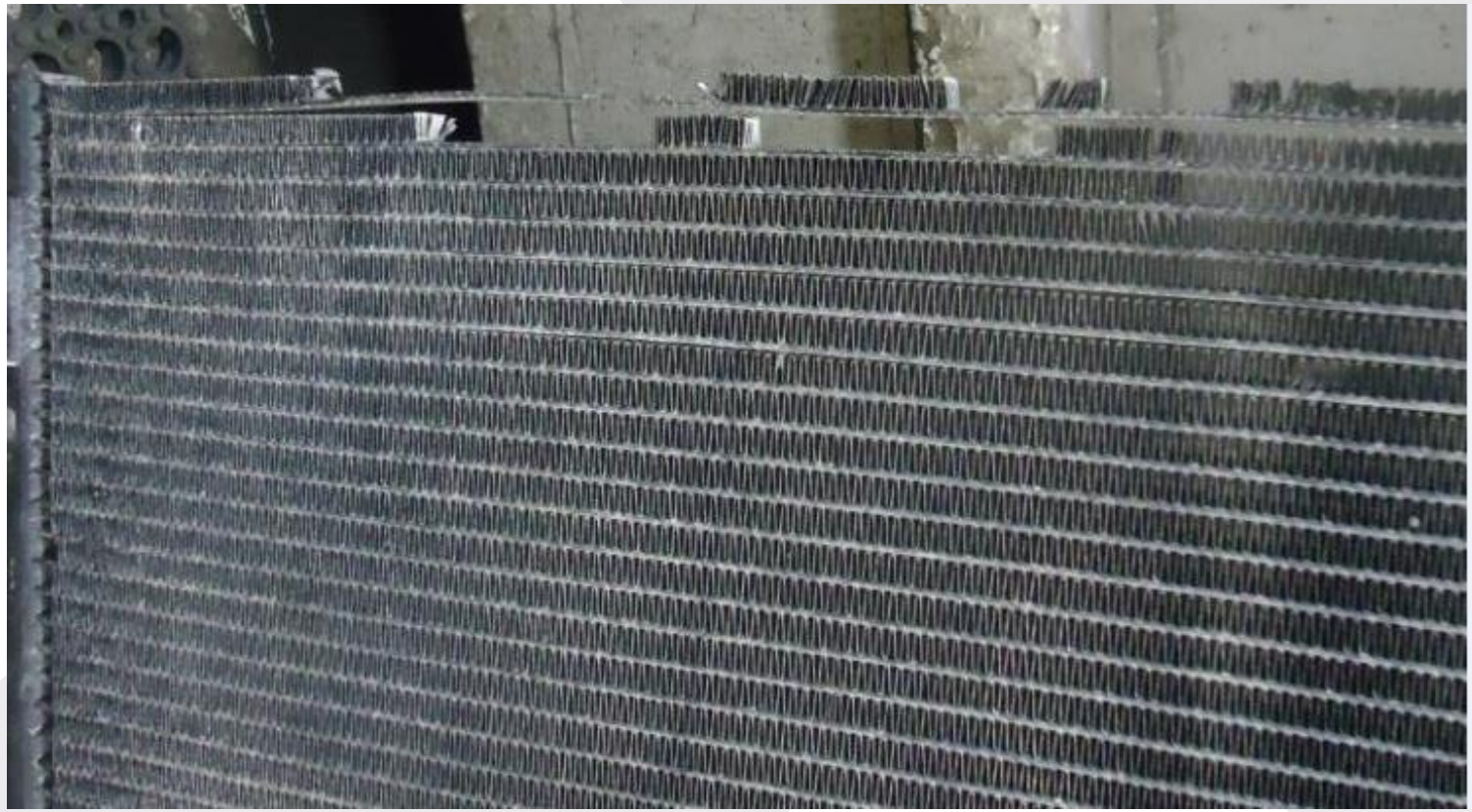
CHARGE AIR COOLER – Vibration

- How to identify:
- Cracks in mounting features
- Outside tube cracks

- What to look for:
- Wear – where parts have rubbed together
- Isolator Wear
- Structure wear at mounting points
- Several other vehicle systems failing
- Without data collection, it is hard to identify whether Design or Vehicle conditions is the cause

RADIATOR & CAC – Salt Spray

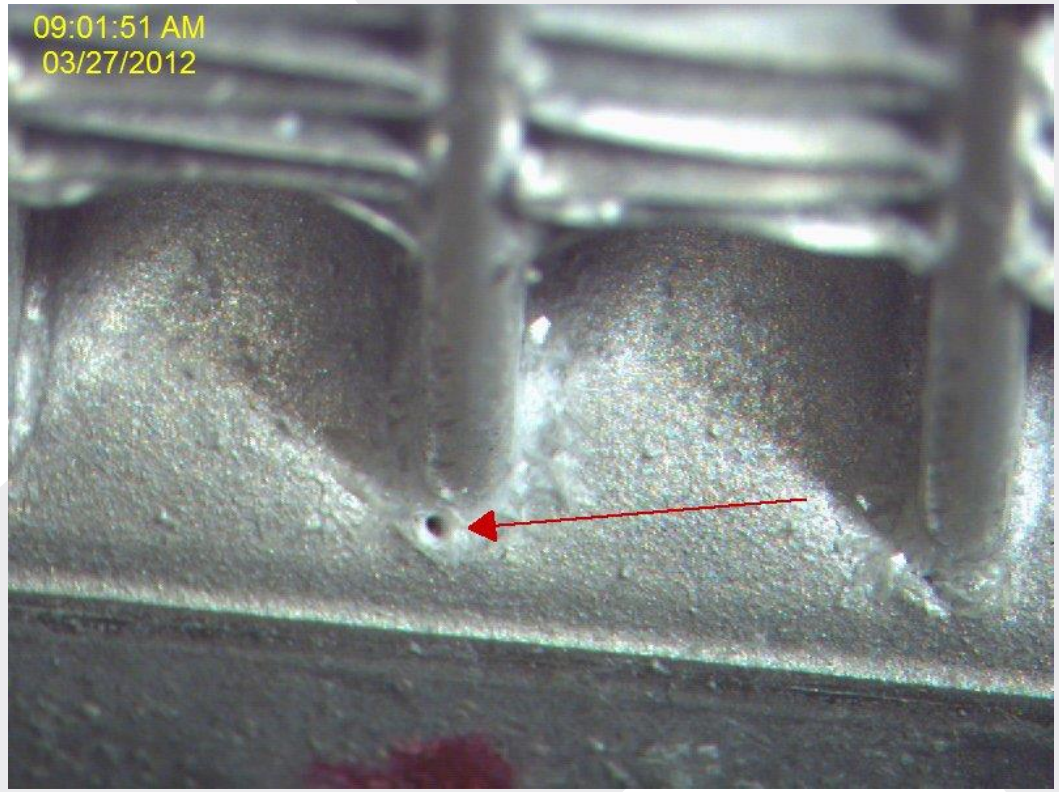
- How to identify:
- Corrosion pits
- White deposits
- Brittle fin, loose bond to tubes



- What to look for:
- Under Carraige Red Rust
- Structure Rust
- Heavy Salt Deposits
- Electrical failures
- Almost always a filed maintenance issue

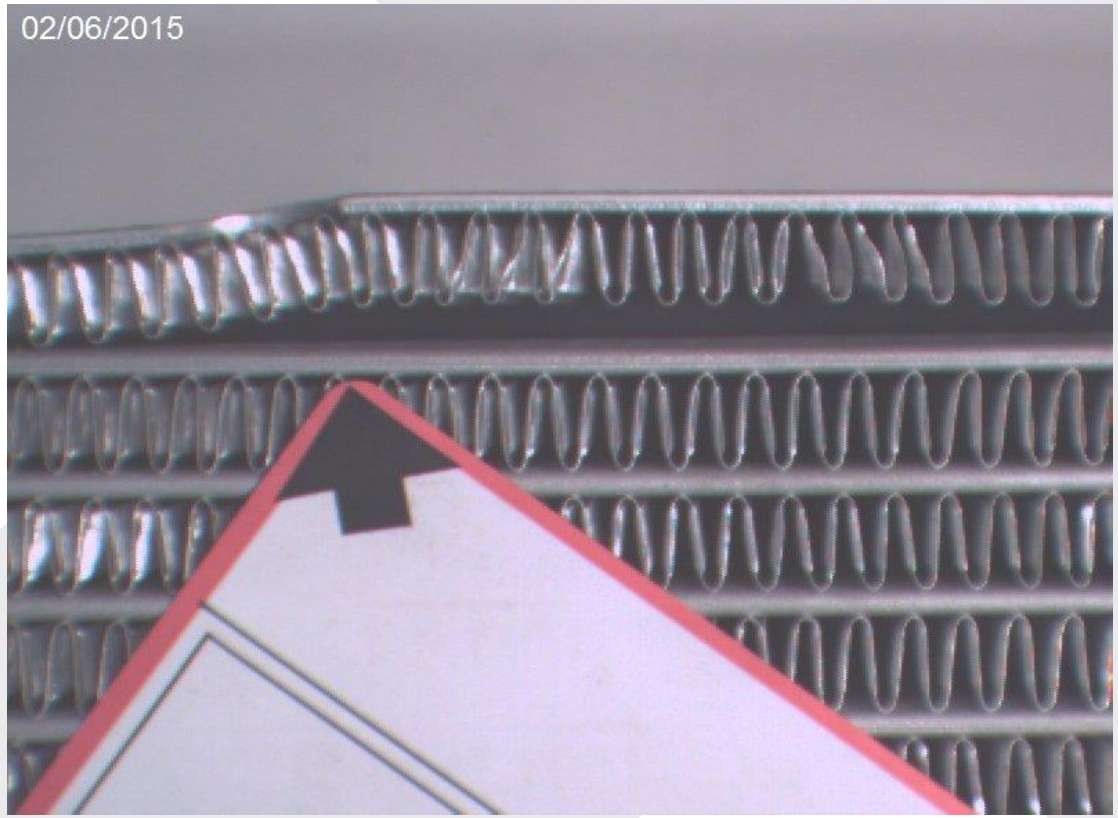
Other Failures – Manufacturing Defects

- Hole in braze fillet
  - Effects both Radiator and CAC



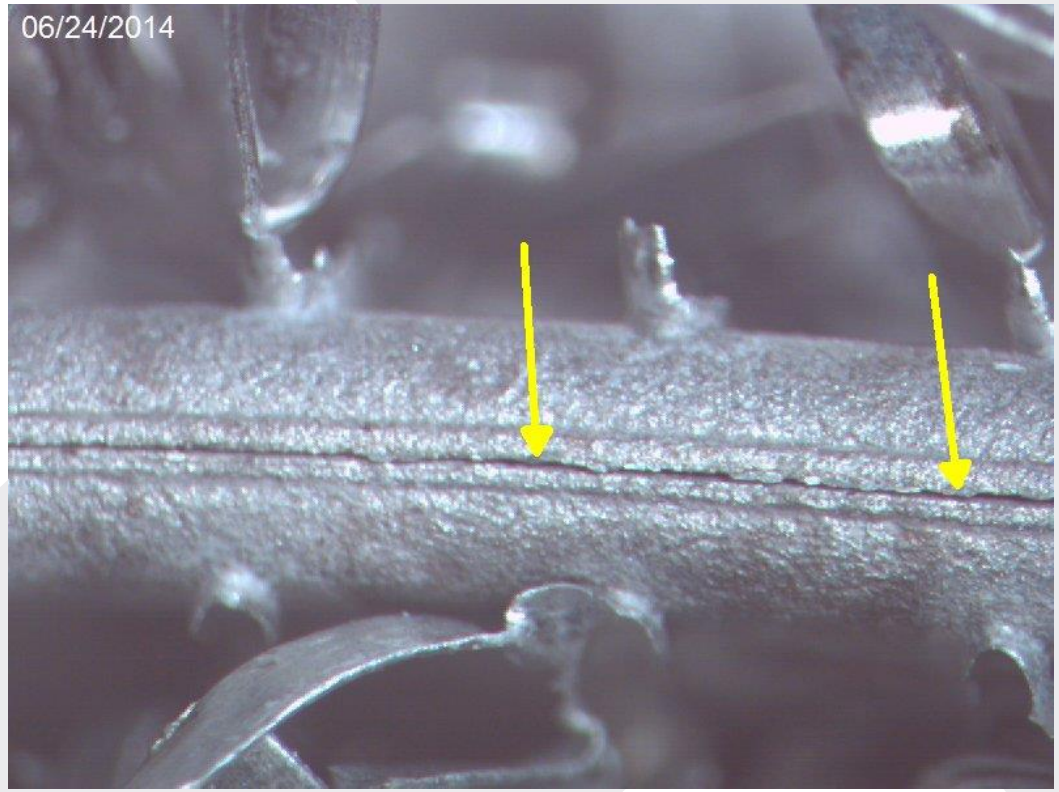
Other Failures – Manufacturing Defects

- Non Brazed Fin
  - Effects both Radiator and CAC



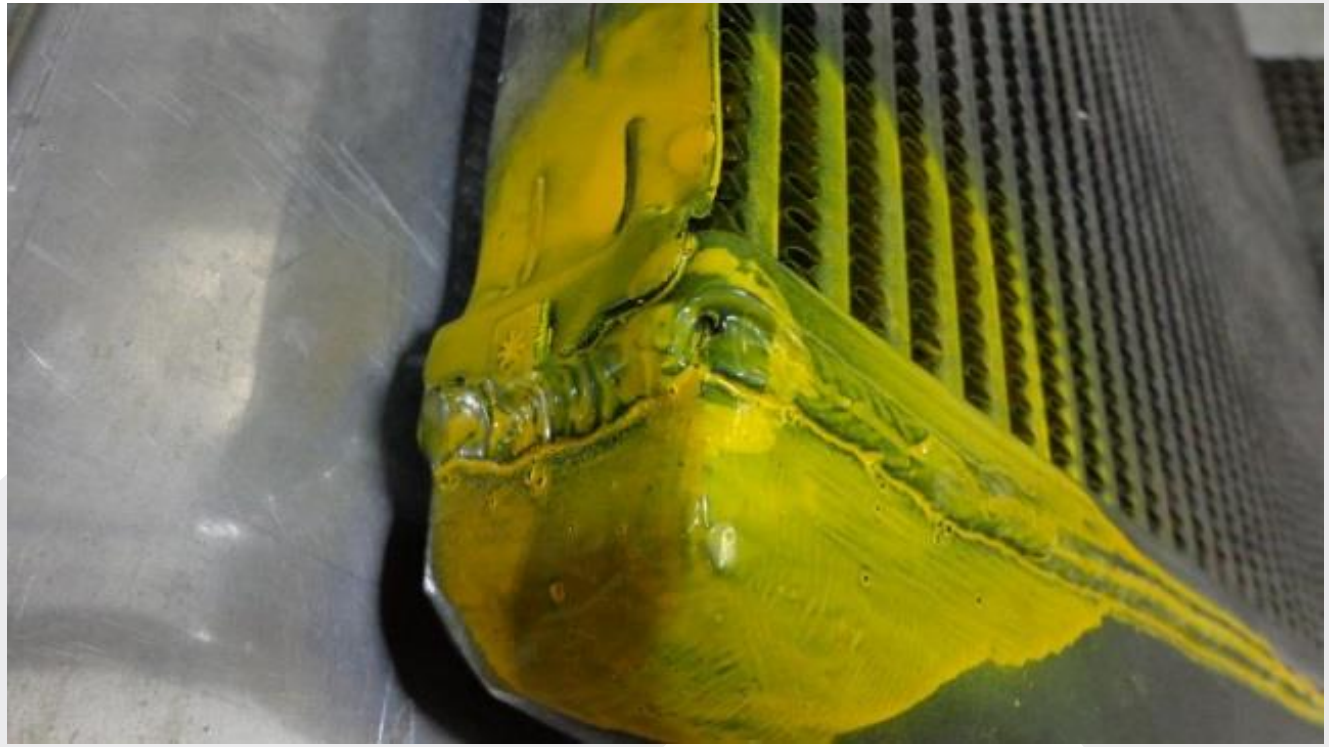
Other Failures – Manufacturing Defects

- Split weld on tube
  - Effects both Radiator and CAC



Other Failures – Manufacturing Defects

- Hole in weld
- Be aware that CAC's have an allowable leak rate
- Sometimes small leaks can be OK
- Follow TMC Reccomended guidelines
  - TMC RP 358



What Have We Learned??

- ✓ Product Validation is done for all OEM released product
- ✓ Validation Tests are specifically designed to correlate with field failures
- ✓ Field failures can be easily traced to the “real root cause” by matching the failure type with the test which causes it
- ✓ It is often very hard to identify if the failure is due to a lack of correct design, or the vehicle is operating over specification
- ✓ TItanX builds OEM Validated Product made every day

Thank you

WE HAVE YET TO SEE AN
ENGINE WE CAN´T **COOL**