Case Study

Polymer Science
Materials Science
Chemistry
Chemical Engineering

# Railroad Paint System Failure Investigation

**ESi investigated widespread paint bubbling and softness on 100 newly manufactured intermodal railcars, determining root cause through forensic analysis.**

## The Situation

A railroad car manufacturer faced a quality issue when 100 newly delivered, 3-unit intermodal railcars exhibited widespread surface defects including bubbling, softness, and rough surface texture. The railroad cars, manufactured between July and November 2019, were painted with a water-based acrylic coating system specific for application direct to metal surface. The paint failures were not immediately evident but rather developed months after delivery, with earlier-produced cars showing more severe defects than later units. The customer rejected the railcars, leading to litigation between the manufacturer and paint supplier. ESi was retained to investigate the root cause of the paint system failure and determine liability in this high-stakes dispute involving millions of dollars in damages and potential reputational harm to both companies.

## Our Approach

ESi conducted a root-cause failure analysis combining field inspections, laboratory analysis, and document review. Our multidisciplinary approach included on-site inspection of 60 railcars at storage facilities in Georgia, where we documented extensive paint bubbling, softness, and orange peel texture. We collected paint samples from multiple cars representing different stages of the production run.

**ESi Consultants:**

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**Services Utilized:**

- Failure Analysis
- Materials Testing
- Lab & Inspection Services

## Our Approach *cont.*

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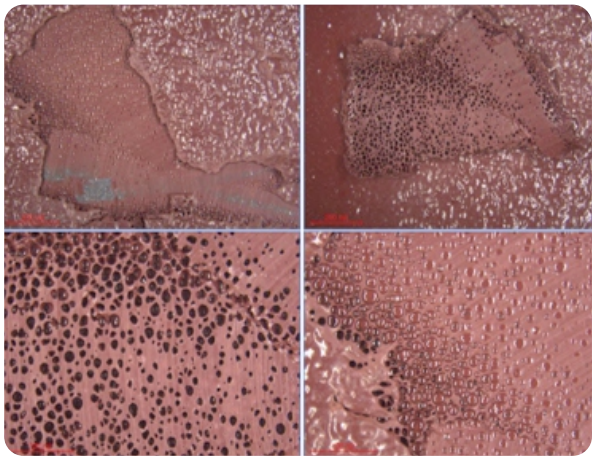
Our laboratory analysis employed advanced characterization techniques including Fourier Transform Infrared Spectroscopy (FTIR), Differential Scanning Calorimetry (DSC), Thermogravimetric Analysis (TGA), Energy Dispersive Spectroscopy (EDS), and Gas Chromatography-Mass Spectroscopy (GCMS). We conducted forced-curing experiments at 120°F for over 160 hours to determine if additional heat treatment could resolve the paint defects. Accelerated weathering tests evaluated the long-term performance of the affected coating system.

Critical to our investigation was the forensic review of paint formulation records, batch production tickets, and shipping documentation. We analyzed over 13 years of formulation change records and identified 21 apparent formula modifications during this period. Our analysis revealed that the defendant paint supplier had made undisclosed formulation changes and used inconsistent batch formulations, including producing one batch with an outdated recipe.

We also investigated similar paint failures on other railcars, including a 2017 hopper car that exhibited identical bubbling after 2.5 years of service, and documented a pattern of failures across multiple car builders and operators when this specific paint formulation was used.

## The Outcome

ESi's investigation determined that the paint failures resulted from formulation defects and quality control issues at the paint supplier, not manufacturing defects or application errors by the railcar manufacturer. Our analysis demonstrated that the railroad car manufacturer had properly prepared surfaces, applied paint to correct thickness specifications, and followed all prescribed procedures. The paint supplier's undisclosed formulation changes and use of inconsistent batch recipes caused incomplete curing, resulting in soft paint that developed internal bubbles over time.



*Macroscopic overview of a railcar exterior panel with blistered coating. (Left)*

*Microscopic images of blistered coating. Significant porosity was observed in bulk of the coating underlying the exterior skin layer. (Right)*

ESi

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