

Case History #3: LYONDELL-CITGO Refining

Houston, TX

UNDESIRABLE EVENT: Vacuum Column Bottoms Pump Failure

UNDESIRABLE EVENT SUMMARY: Recurrent failures of vacuum column bottom pumps (Figure 11.1). Both pumps came on-line in December 1996. The Mean Time Between Failure (MTBF) was very poor at three (3) months. Failures of mechanical seals, thrust bearings, impellers and case wear rings were very common.

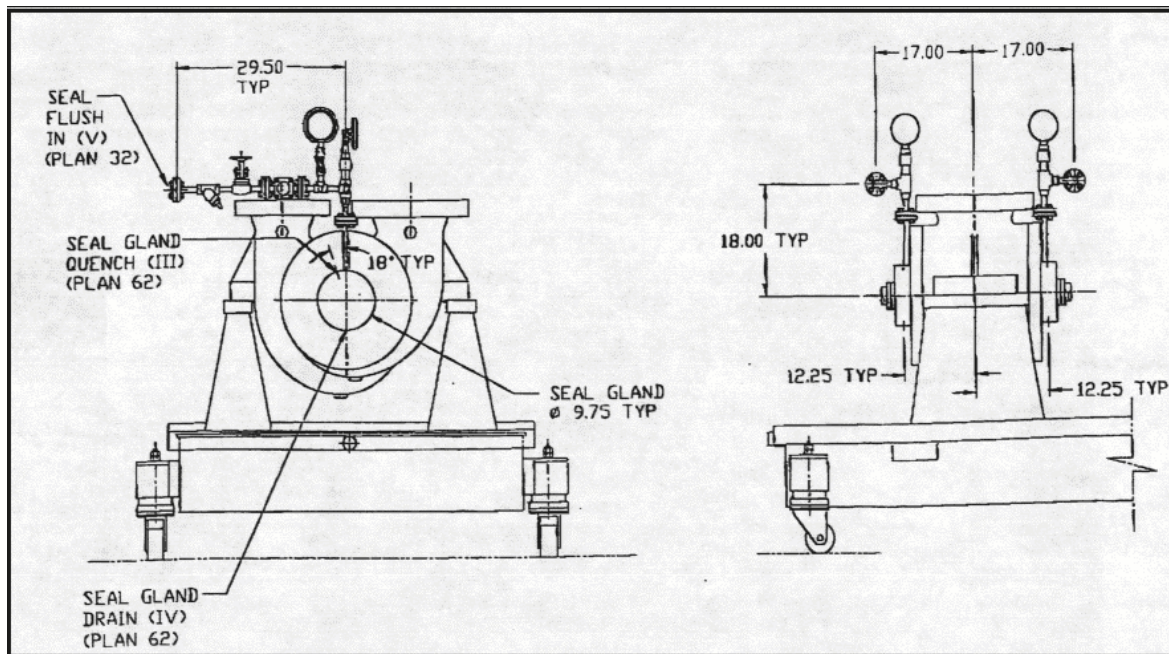


Figure 12.7 Vacuum Column Bottom Pump

Most of the failures occurred at start-up. The system operates with one pump as a primary pump and the other as a spare pump. Different attempts to correct the above problems failed. There was not a good understanding of the causes of these failures and most important how they correlated to each other. At times, both pumps would not be available. The impact on production and the excessive maintenance costs resulted in management appointing a Root Cause Analysis (RCA) team to find and implement final solutions to these problems.

LINE-ITEM FROM MODIFIED FMEA:

Sub-System	Event	Mode	Frequency	Impact/ Occurrence*	Total Annual Loss
Vacuum Column	Bottoms Pump Failures	Seal Failure, Bearing Failure and Wear Ring Failure	5/Yr	\$1,431,000	~\$7,150,000

* **Note 1:**
Impacts include Labor Cost, Material Cost and Lost Profit Opportunities from lost sales

Table 12.3: Line Item from Modified FMEA

IDENTIFIED ROOT CAUSES:

Physical Roots -

- Cooling Water Line Plugged
- Suction and Discharge Pipes Plugged
- Steam Trap Not Working
- Inadequate Clearance
- Uneven Thermal Growth
- Loose Wear Rings
- Minimum Flow Line Blocked In
- Heat Checking on Seal Faces
- Steam Tracing Not Working

Human Roots -

- Inadequate Design: Warm-Up Lines Too Small/Not Enough Heat Tracing
- Inadequate Warm-Up: No Temperature Check Before Start-Up
- Improper Start-Up: Cold Start-Up, Pump Operating at Dead-End for a Long Time
- Improper Installation
- Steam Trap Blocked in

Latent Roots -

- Inadequate Warm-Up Systems
- Incorrect Specifications and Procedures
- Inadequate Training on Bearing Installation
- Lack of Start-Up/Shutdown Procedures
- Inadequate Operating Procedures/Training

IMPLEMENTED CORRECTIVE ACTIONS:

Install Electrical Tracing on Suction/Discharge Pipes
Revise Cooling Water Line from Series to Parallel
Enlarge Warm-Up Line from ¾” to 2” Diameter
Revise Seal Flush
Relocate Flush Line from a 500°F source to Less than 200° F Source
Revise Standard Operating Procedure (SOP) and Train Operators on New Start-Up/Shutdown Procedures

EFFECT ON BOTTOM-LINE:

TRACKING METRICS:

Mean Time Between Failures (MTBF) Increased From Three (3) Months to Eleven (11) Months

BOTTOM-LINE RESULTS:

New Start-Up/Shutdown Procedures Have Proved to be Successful
Large Warm-Up Lines Have Avoided Blockage
Eliminated Impeller Wear Rings so those Failures have been Eliminated
Replaced Seal Flush with a Cooler Source
Pump Warm-Up is Controlled by Electric Tracing with Digital Read Out for a Total of Fourteen (14) Check Points
No More Cooling Water Line Blockage
Estimated Savings of \$7,150,000 (\$6,500,000 in Production Losses and Maintenance Labor and Material Costs of \$655,000)

CORRECTIVE ACTION TIME FRAMES:

Total of Five (5) Months
The RCA Team Expended Two Months
The Recommendation Implementation Took Three Months

RCA TEAM STATISTICS:

Start Date: August 4, 1997 **End Date:** September 26, 1997
Estimated Cost to Conduct RCA: \$40,000 **Estimated Returns from RCA:** \$7,150,000
Return on Investment: ~17,900%

RCA TEAM ACKNOWLEDGEMENTS:

RCA Sponsor: Jimmy McBride
Title: Manager, Mechanical Support and Reliability
Company: Lyondell-Citgo Refining
Department: Reliability Engineering
Site: Houston, TX

Principal Analyst: Edgar Ablan **Title:** Principal Engineer
Company: Lyondell-Citgo Refining **Site:** Houston, TX
Department: Reliability Engineering

Core RCA Team Members:

Terry Dankert
David Collins
Mahesh Patel

ADDITIONAL COMMENTS: The effort of this cross-functional team using the RCI method has proven that focusing on implementing solutions to the root causes of failures will improve equipment reliability and generate very attractive savings.

JIMMY MCBRIDE
LYONDELL-CITGO REFINING
HOUSTON, TX

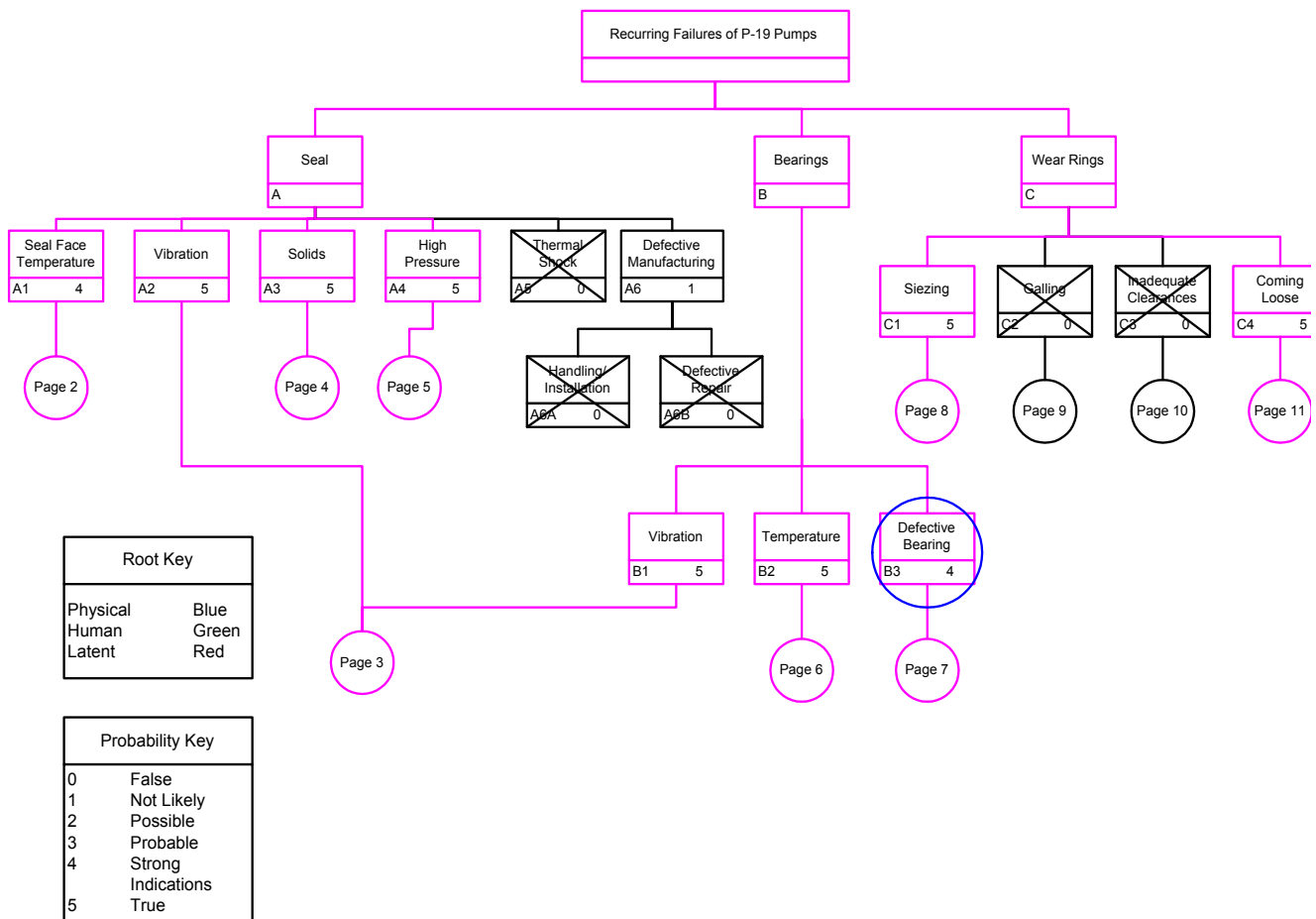


Figure 12.8: LYONDELL-CITGO Logic Tree

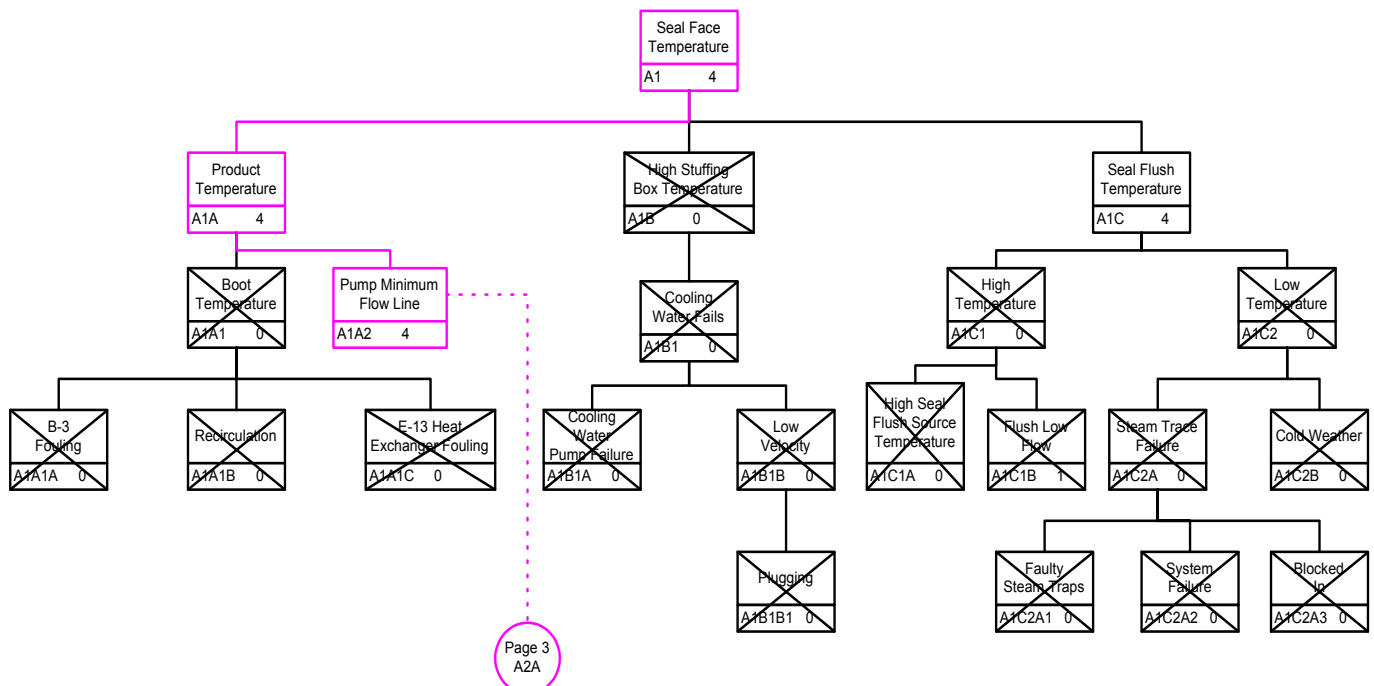


Figure 12.8: (Continued) LYONDELL-CITGO Logic Tree

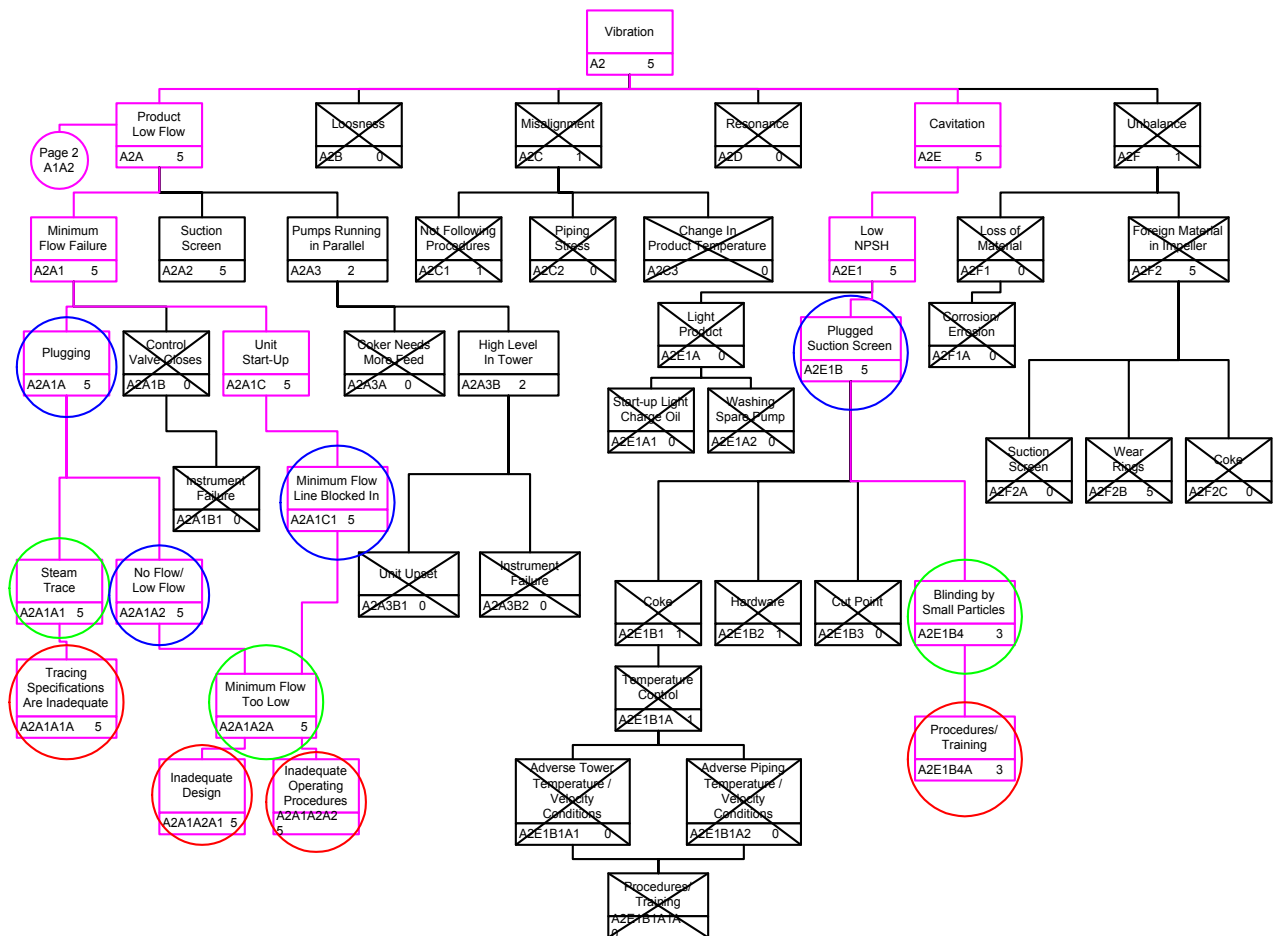


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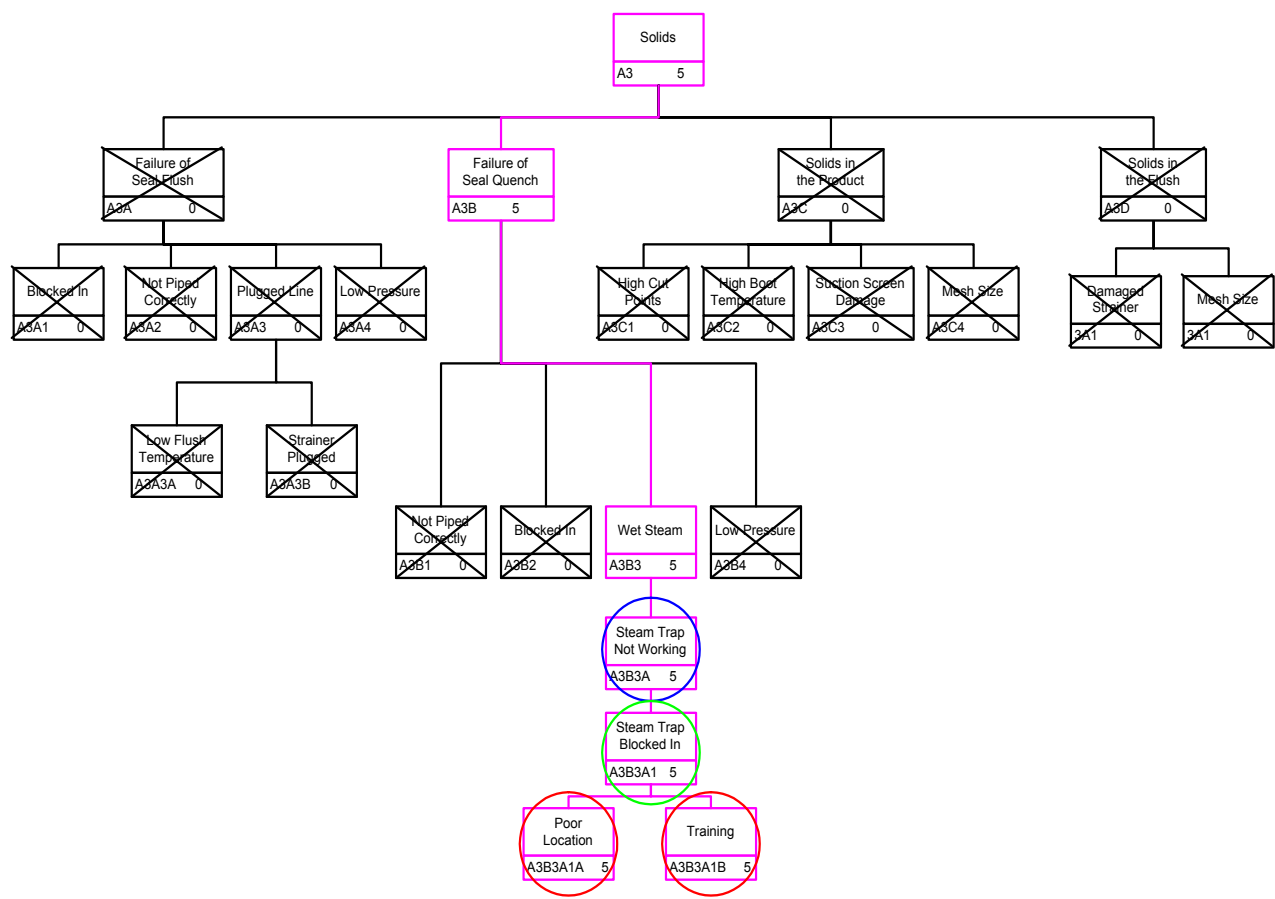


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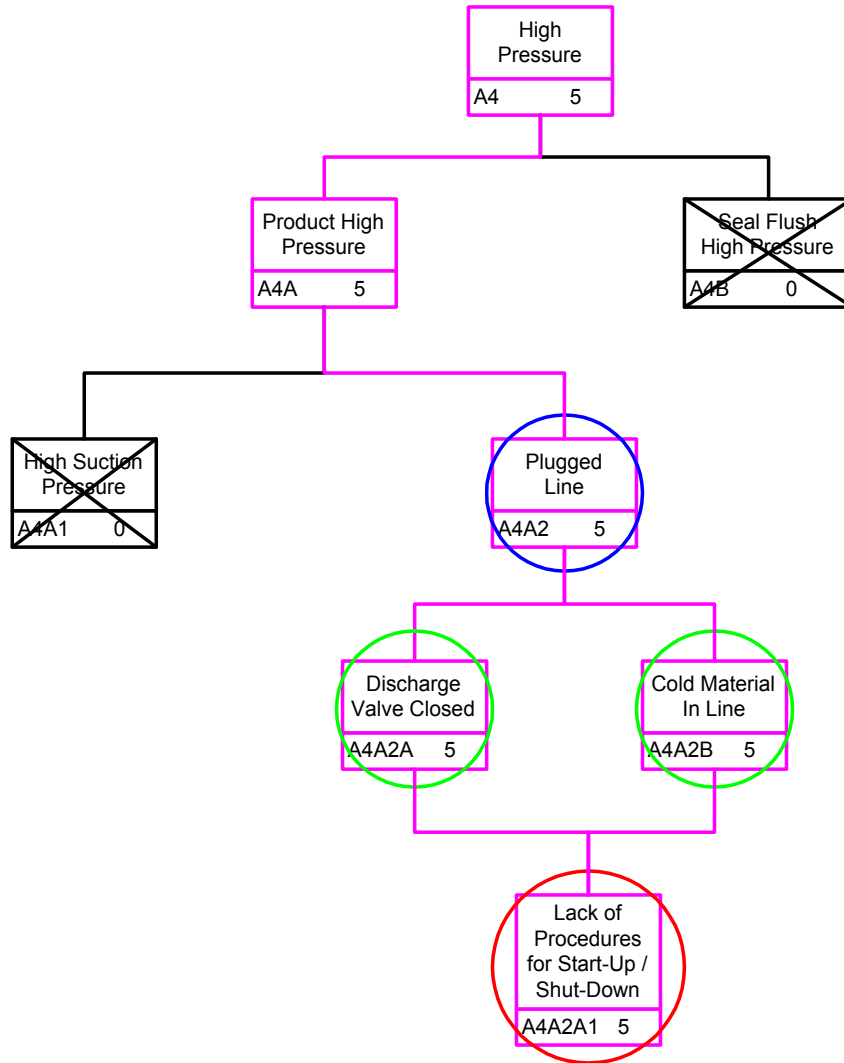


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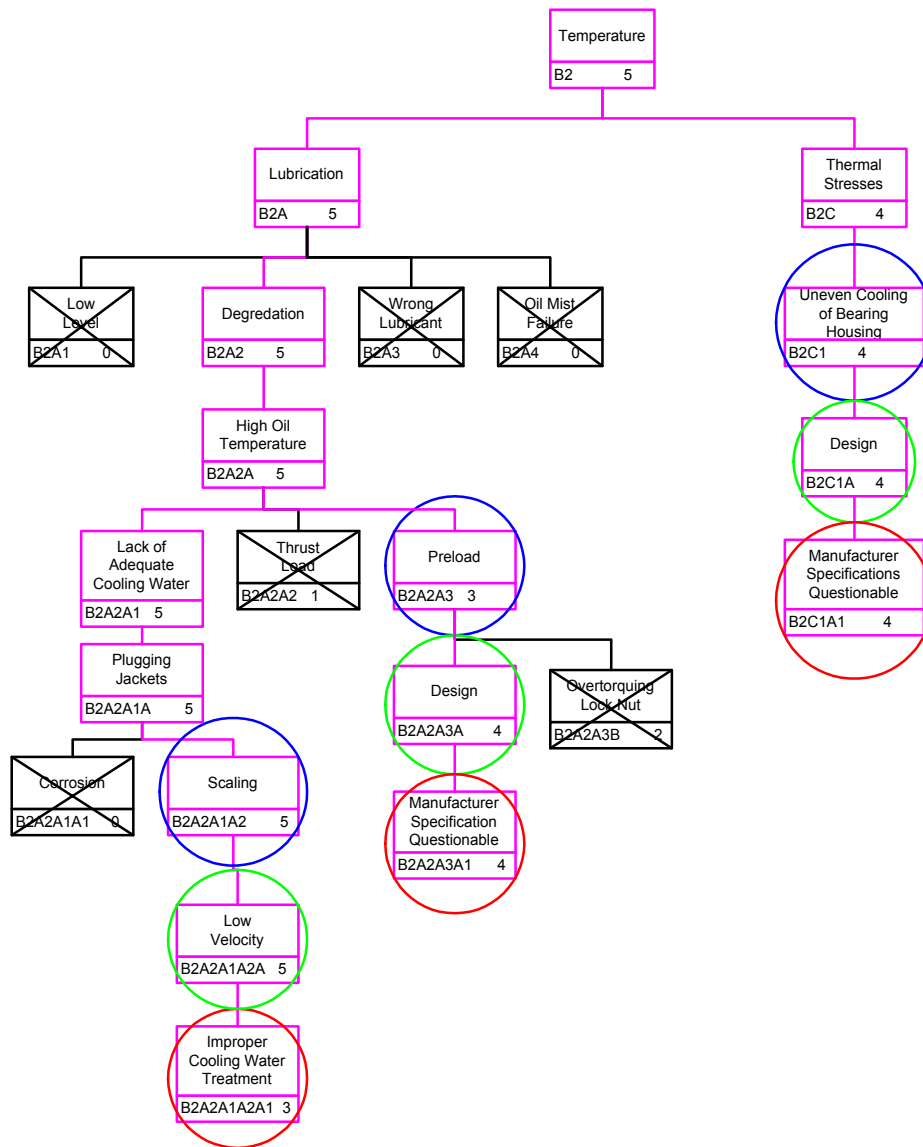


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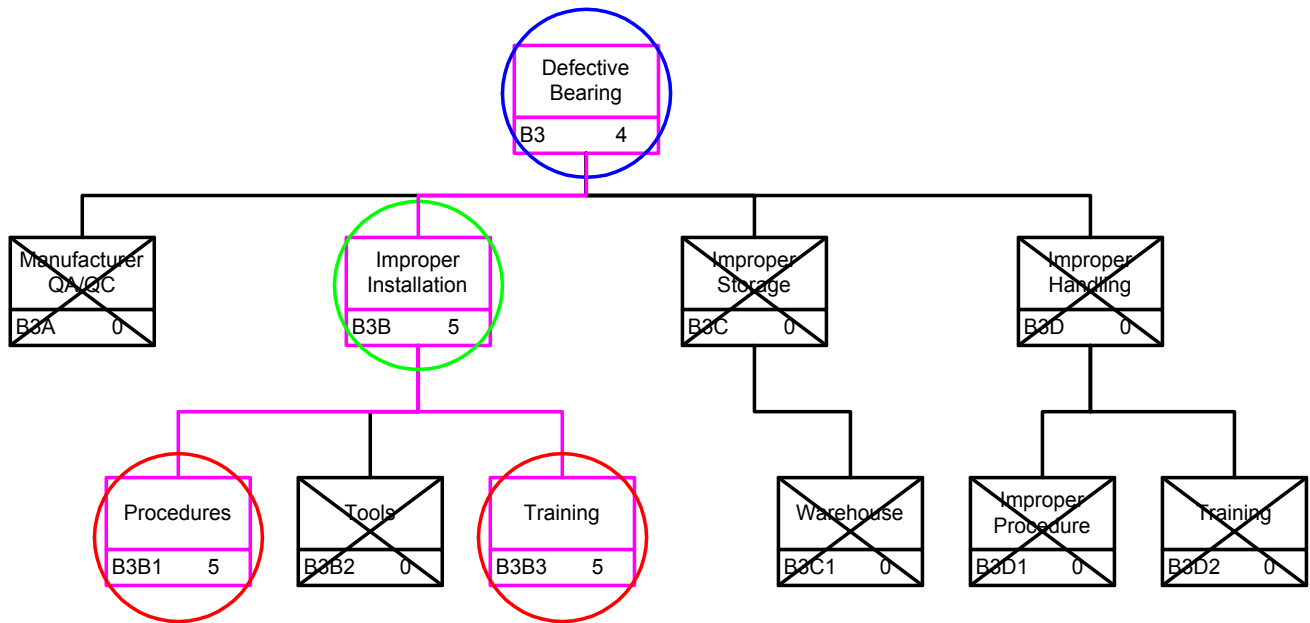


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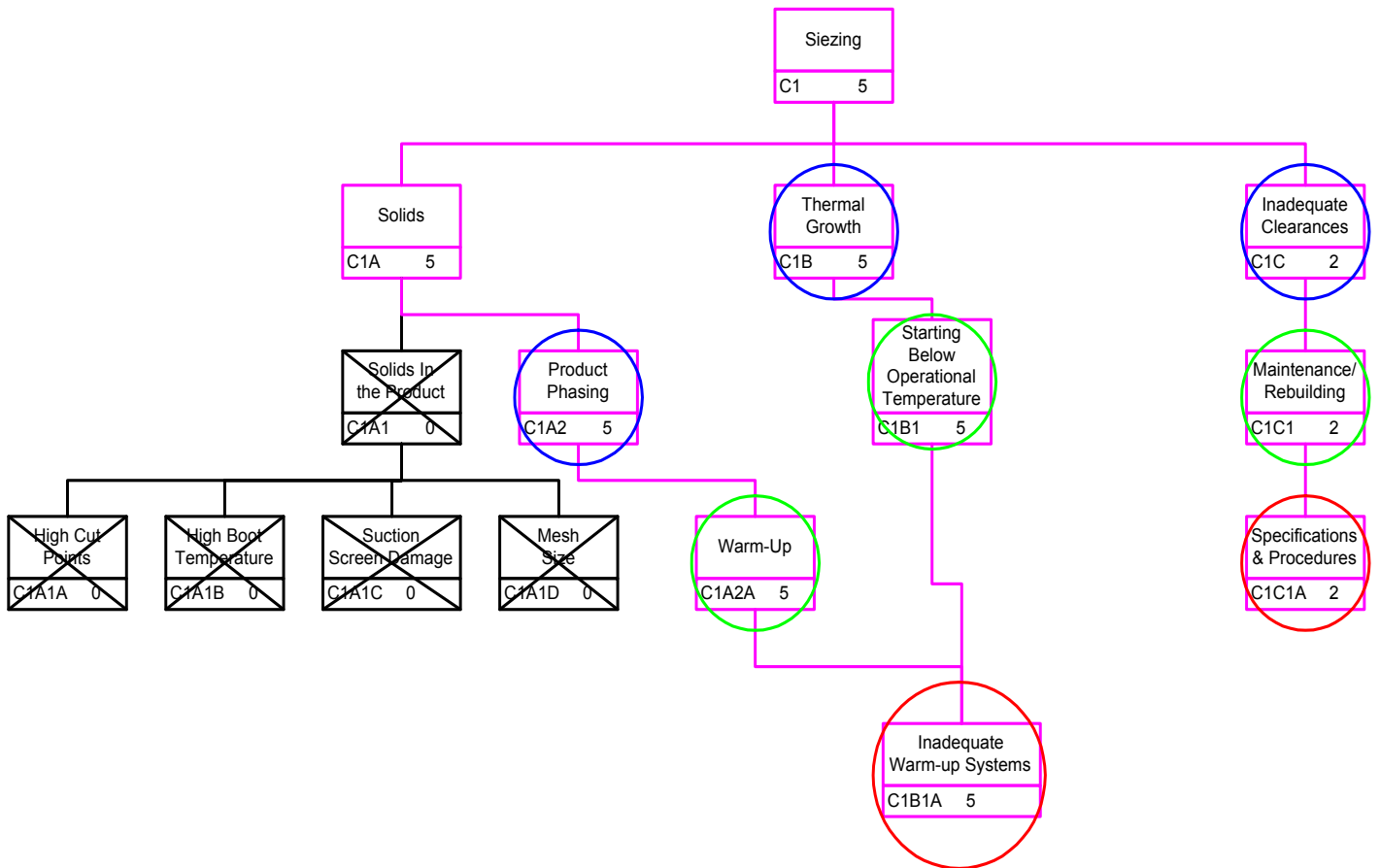


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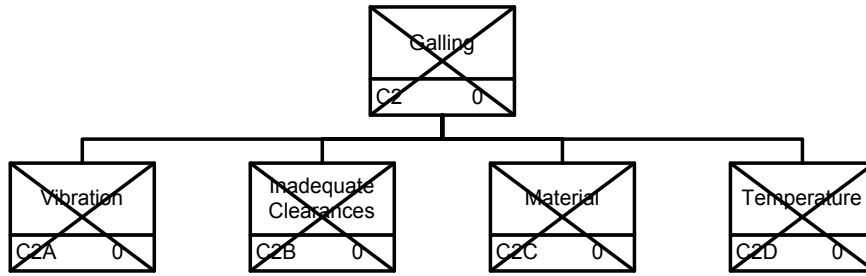


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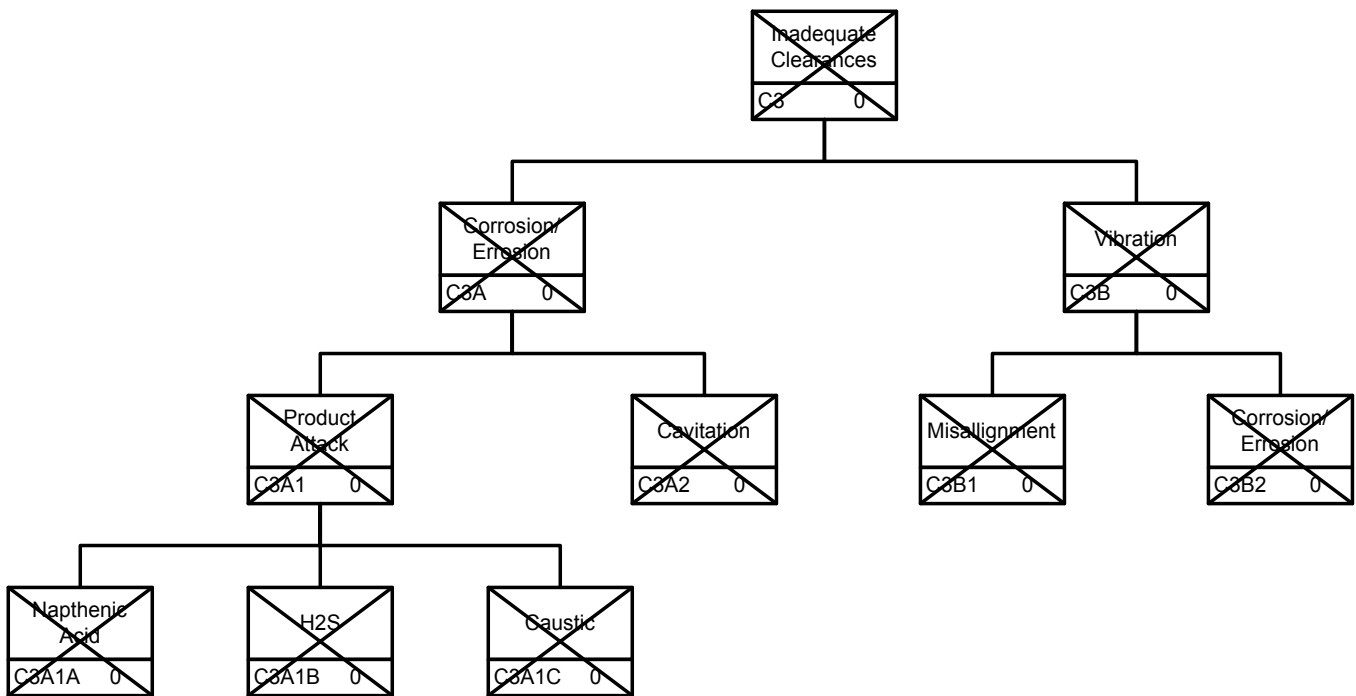


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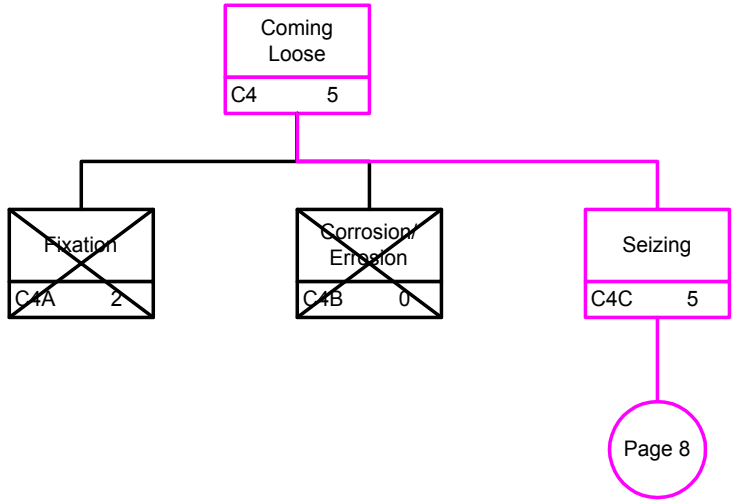


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