

RCA: Improving Pump-Motors Reliability by Changing Structural Stiffness

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2012 Rotating Equipment
Roundtable Meeting



What is RCFA?

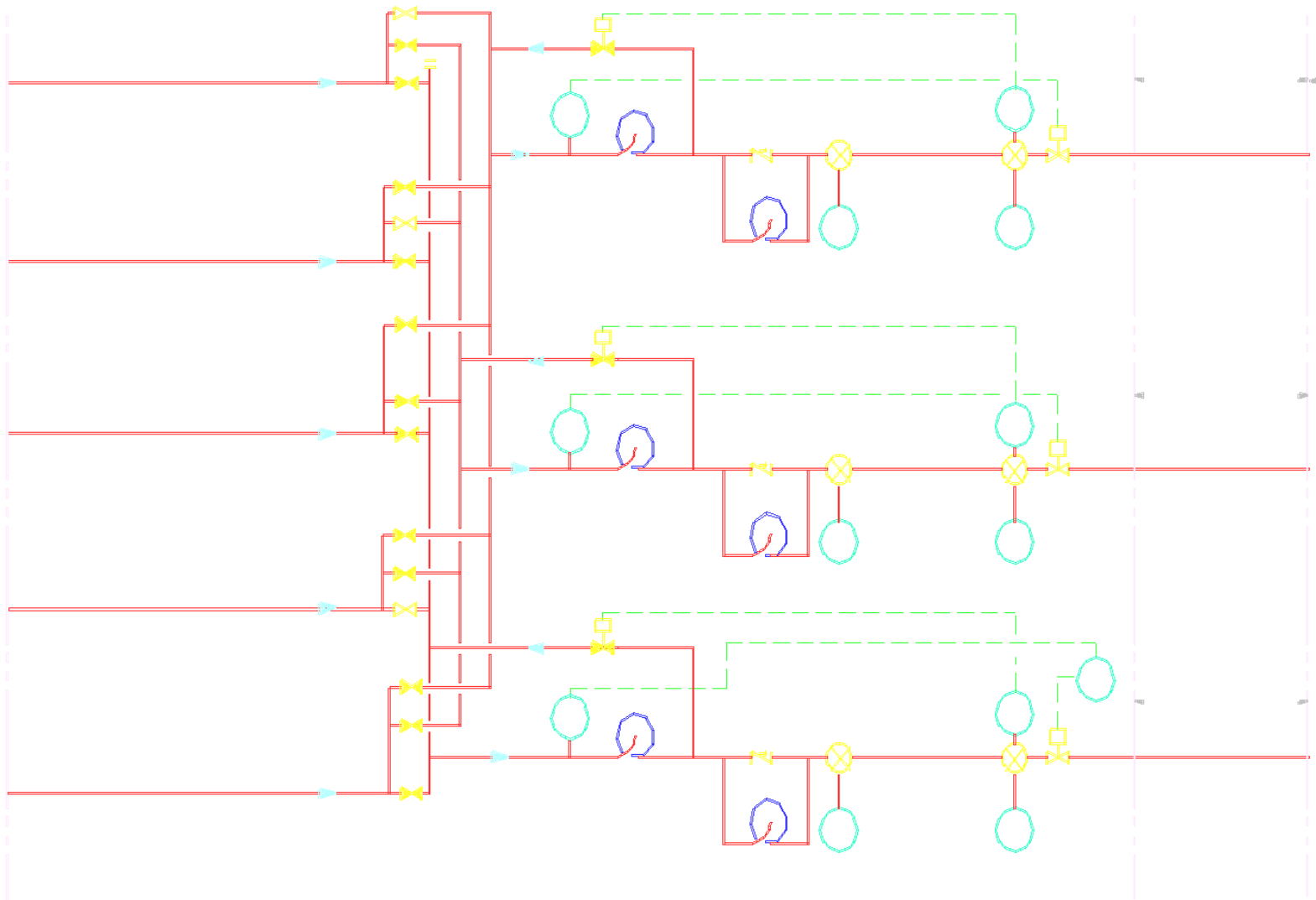
Root Cause
Failure Analysis
Techniques



OUTLINE

- **DRTs Pumping System Overview**
- **Vibration Problem Discussion & Analysis**
- **RCFA Logic Tree**
- **Repair Action**
- **Summary & Recommendations**

DRT Pumping System Overview



Crude Booster Pump-Motor

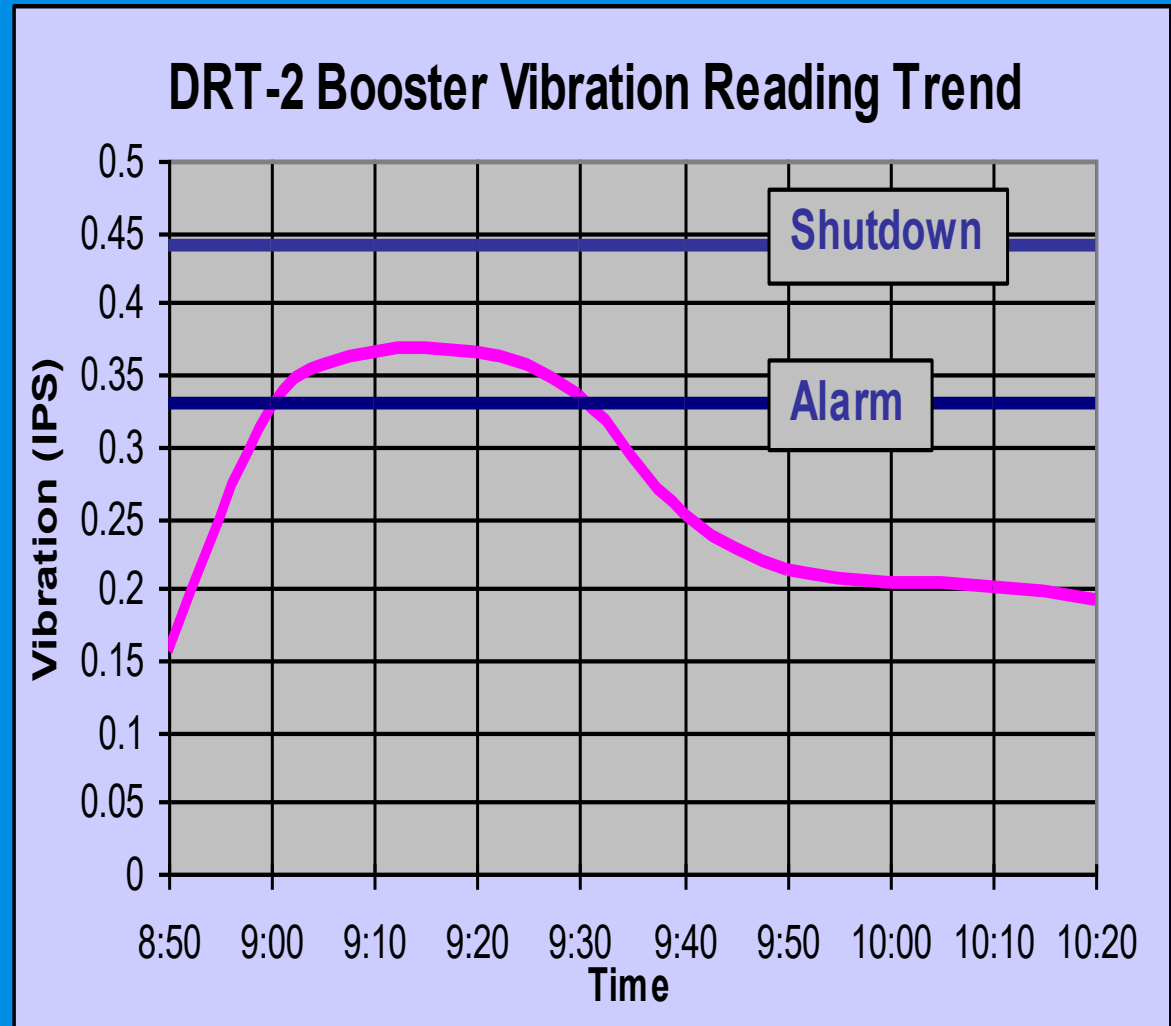
- **Motor speed 1800 RPM**
- **250 HP**
- **Experience a high vibration specially in summer**



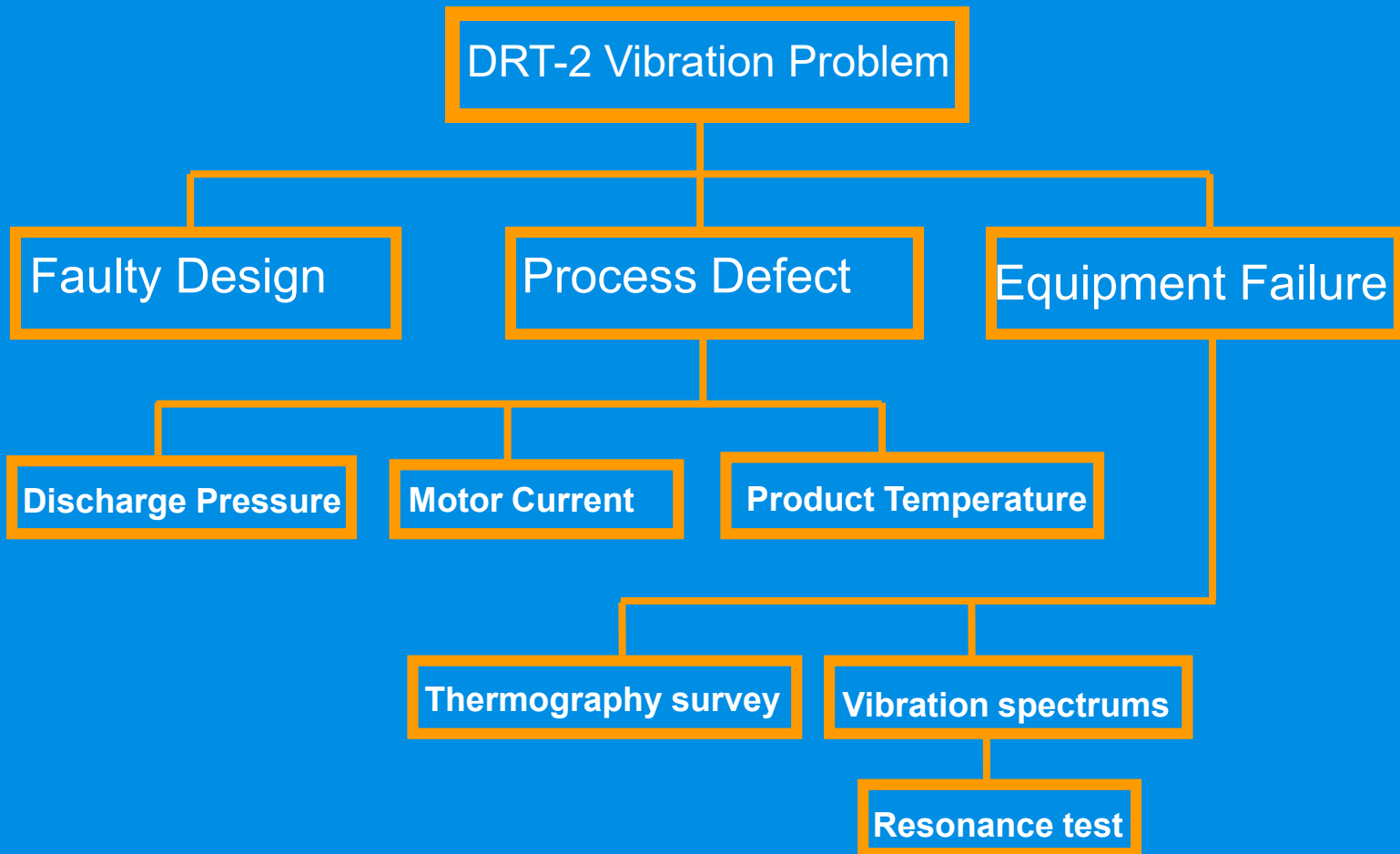
Vibration Problem Discussion

The vibration problem happened at the startup of DRT-2 booster motor. The vibration levels increased gradually to 0.38 in/s over a period of half an hour.

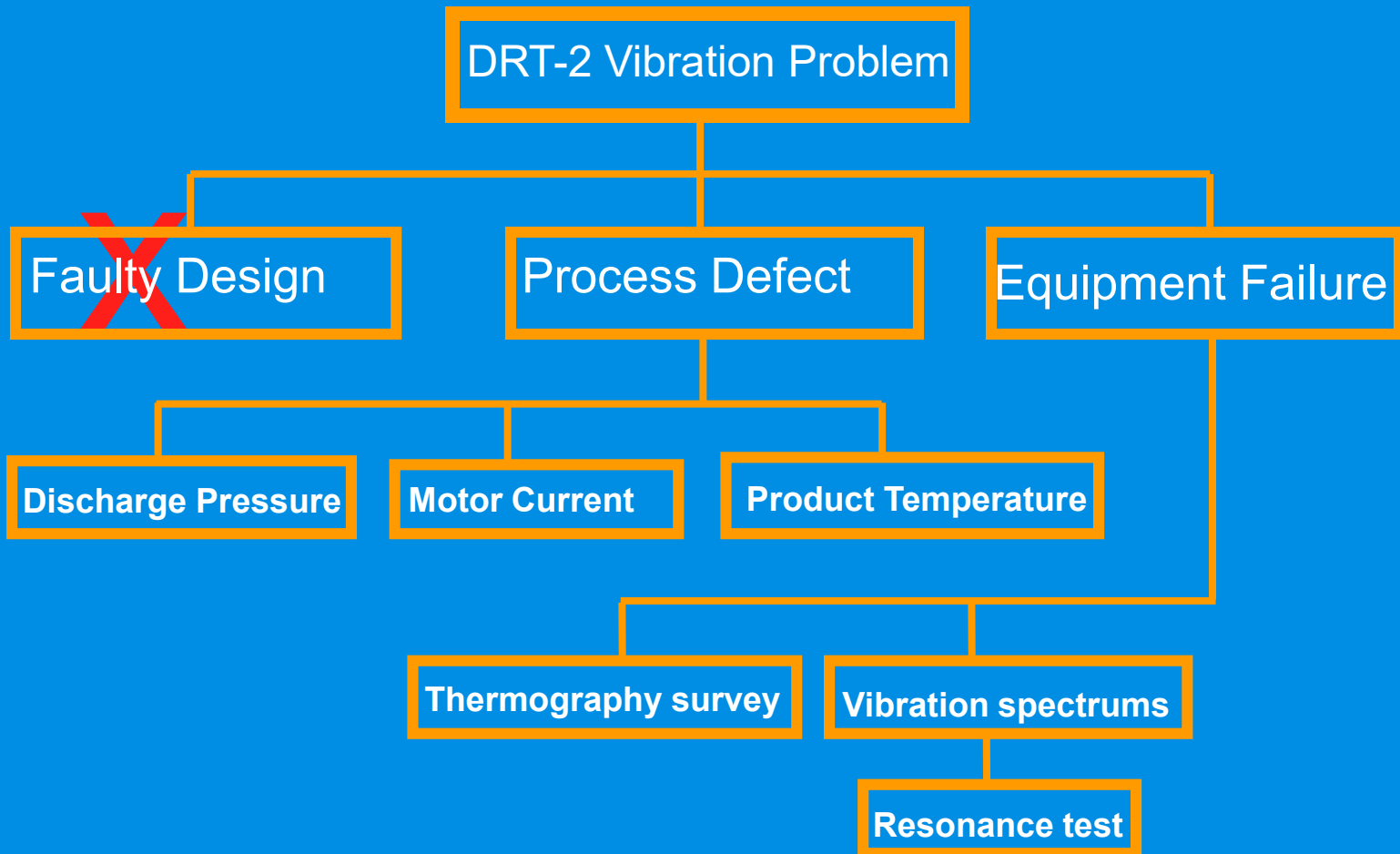
The vibration then decreased to 0.17 in/s over the next 30 minutes. The level remained constant there after. The alarm setting point is 0.33 IPS and the shutdown setting point is 0.44 IPS.



RCFA Logic Tree

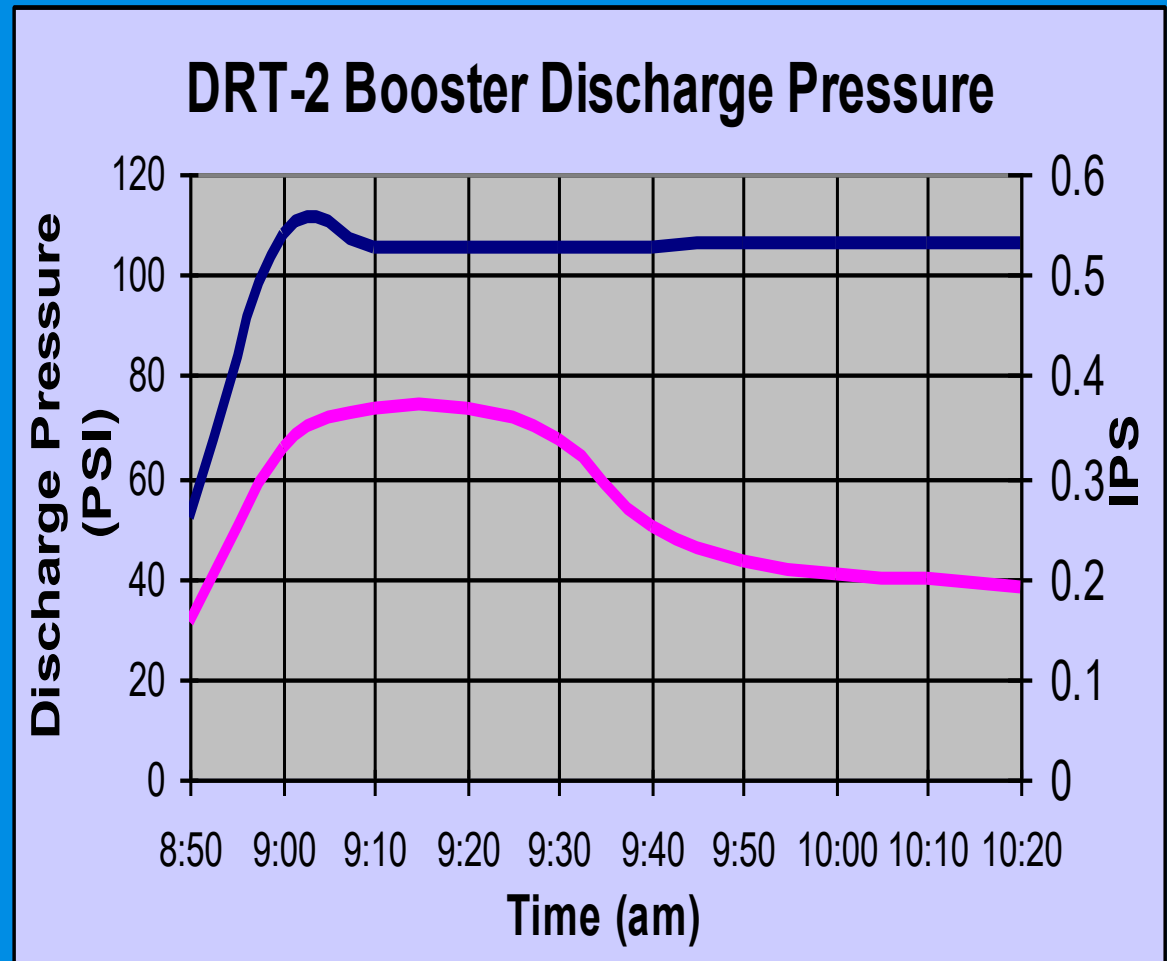


RCFA Logic Tree

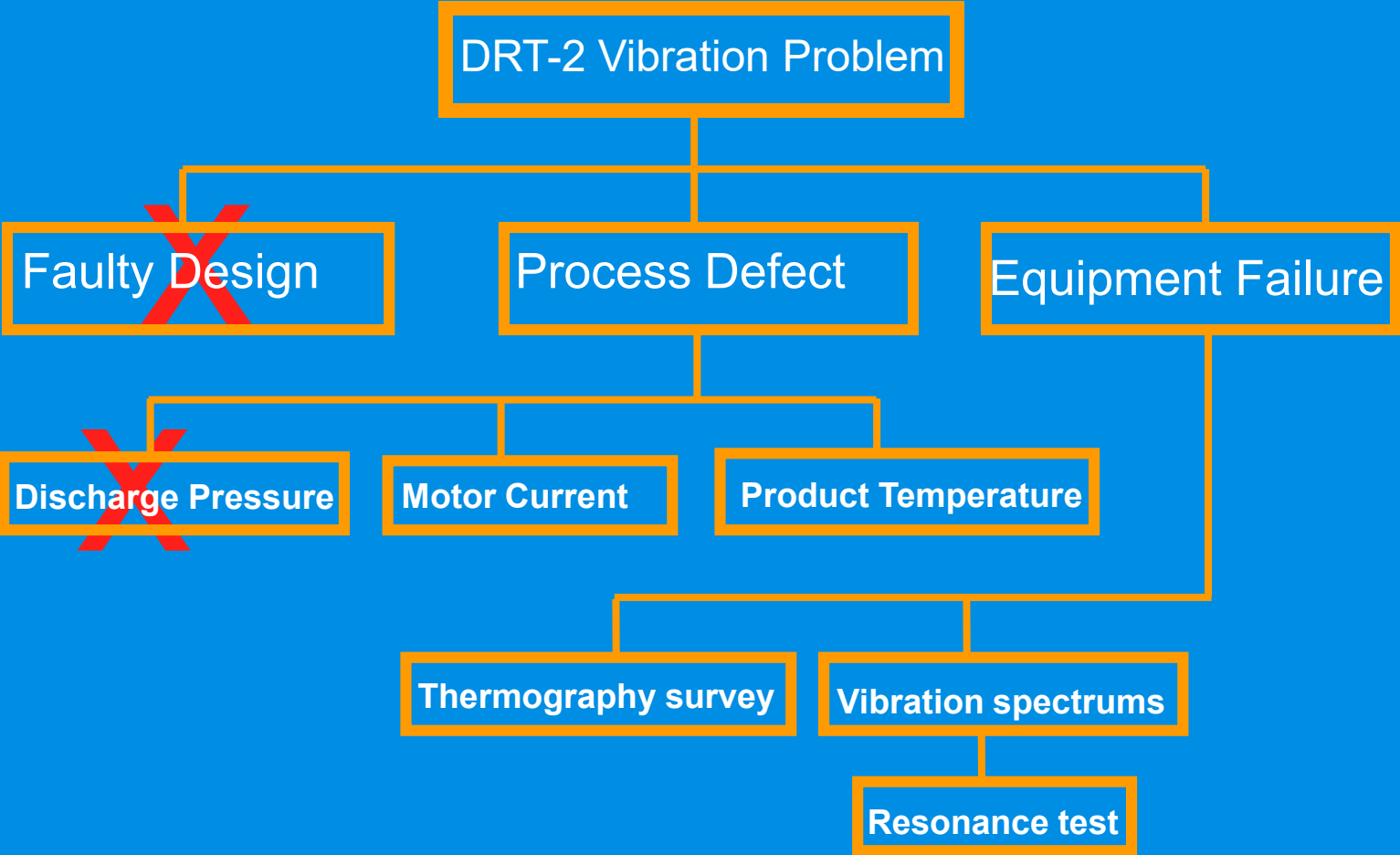


Possible Process Defect

It has noticed that during DRT-2 high vibration problem, the discharge pressure was constant at 105 PSI.

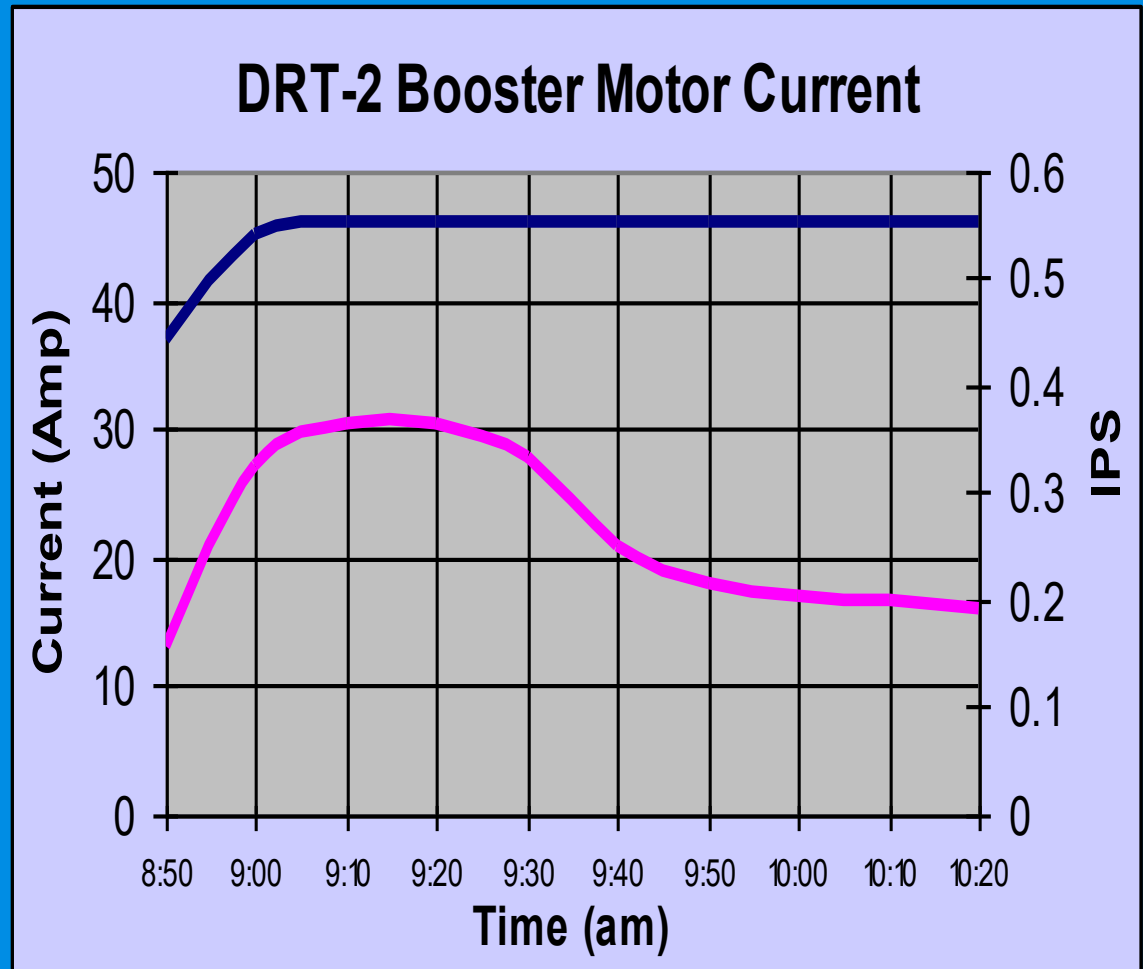


RCFA Logic Tree

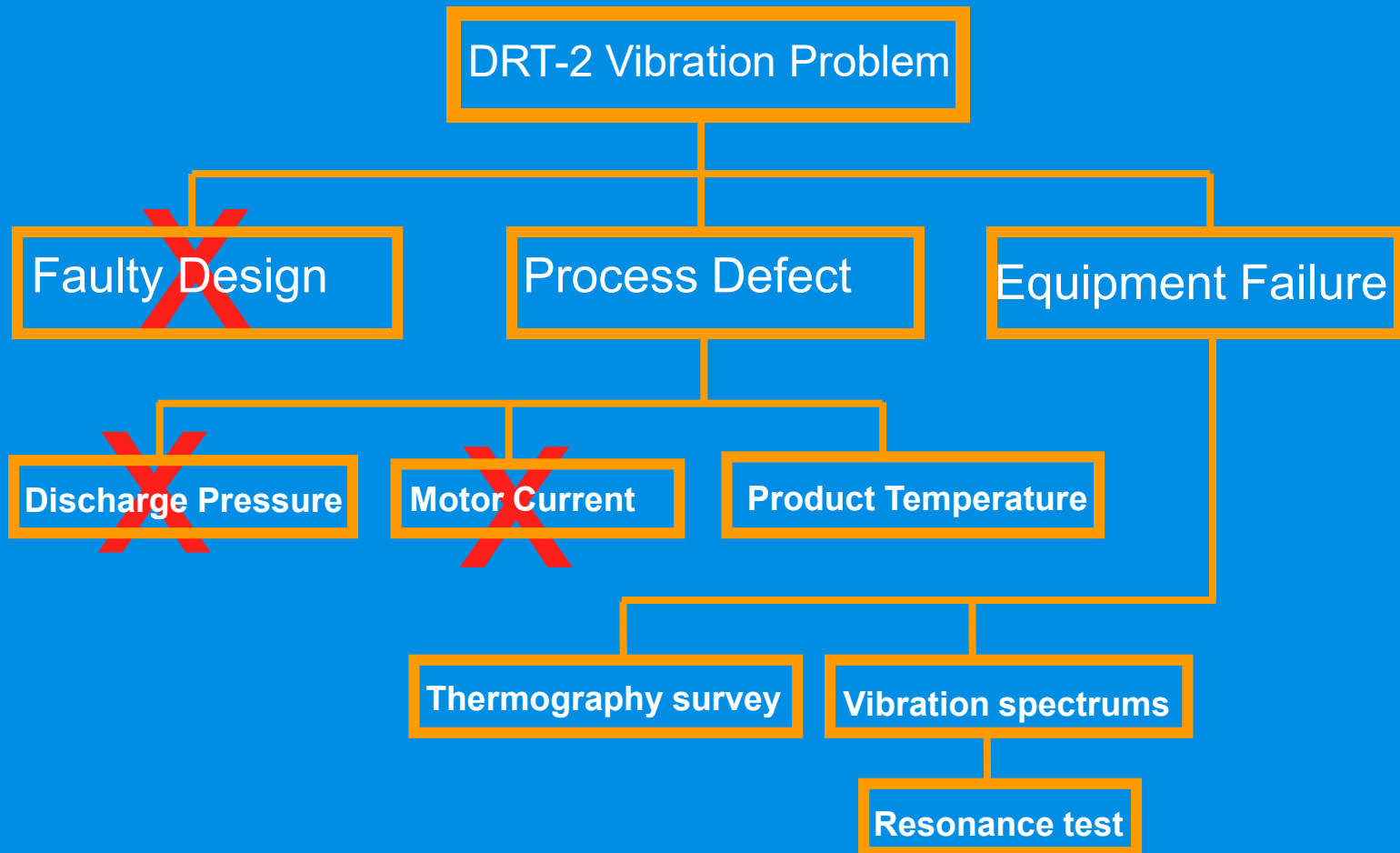


Possible Process Defect

During DRT-2 high vibration problem, motor current stays constant at 46 Amp.

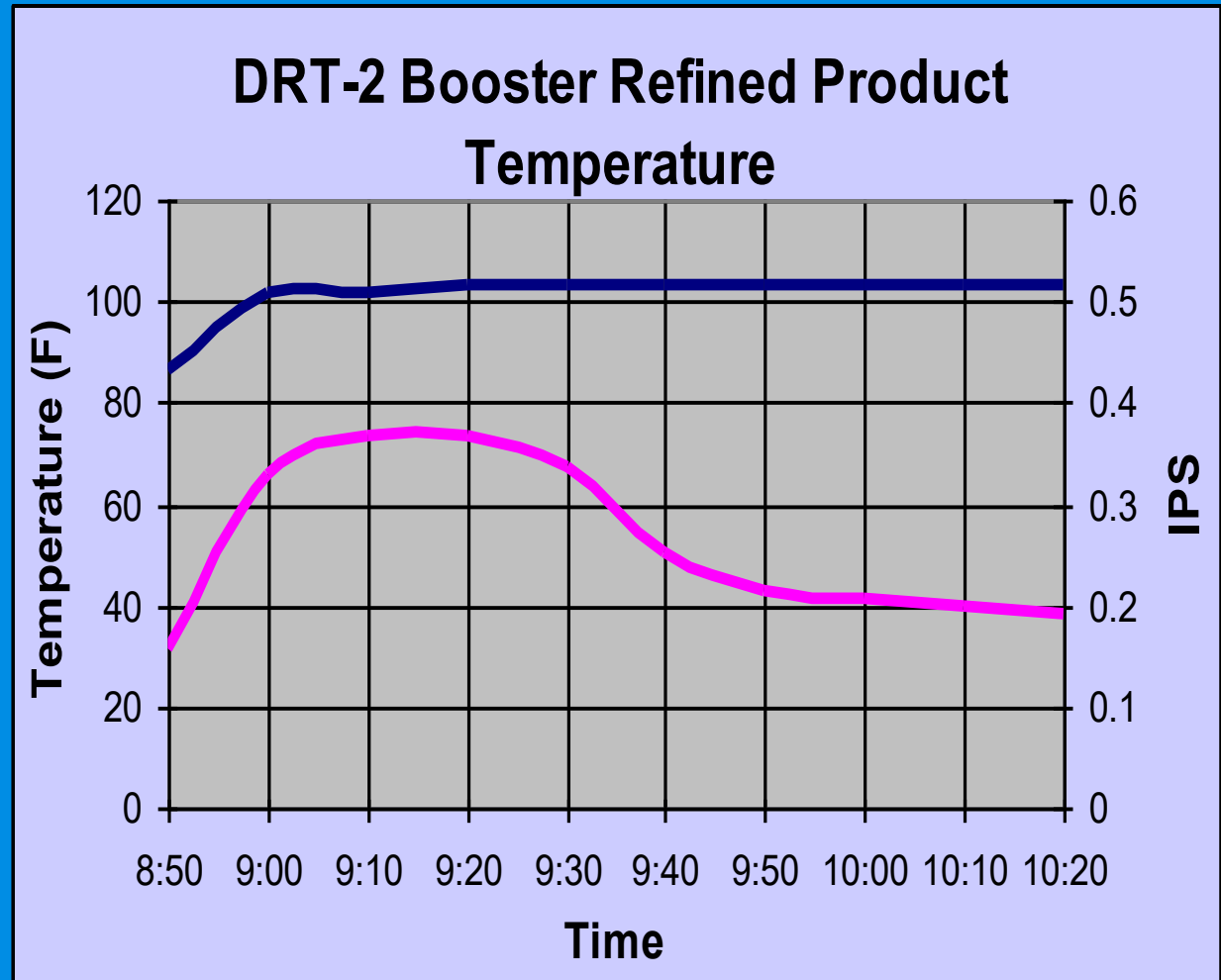


RCFA Logic Tree

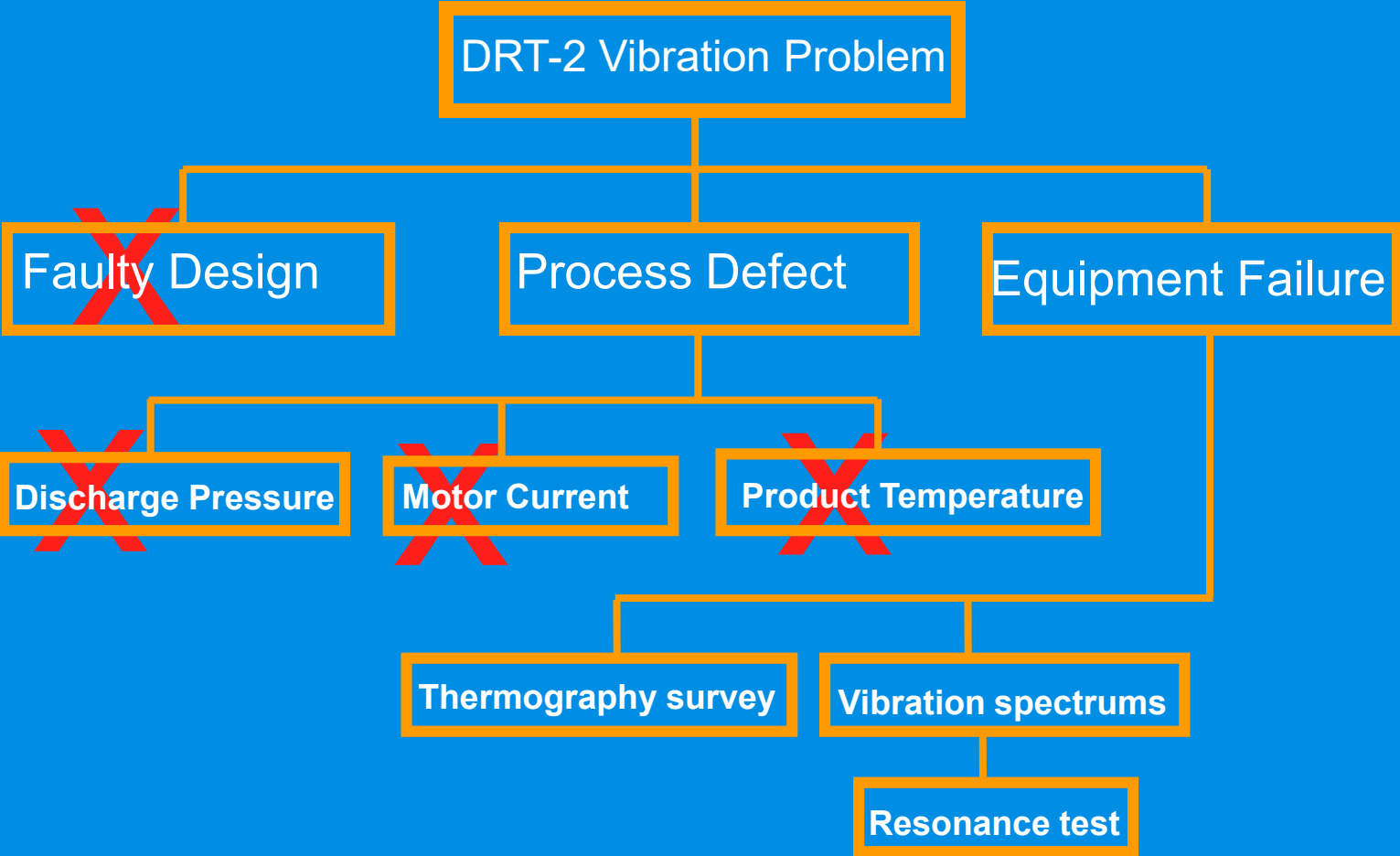


Possible Process Defect

- During DRT-2 high vibration problem, refined product temperature stay constant at 106F.



RCFA Logic Tree

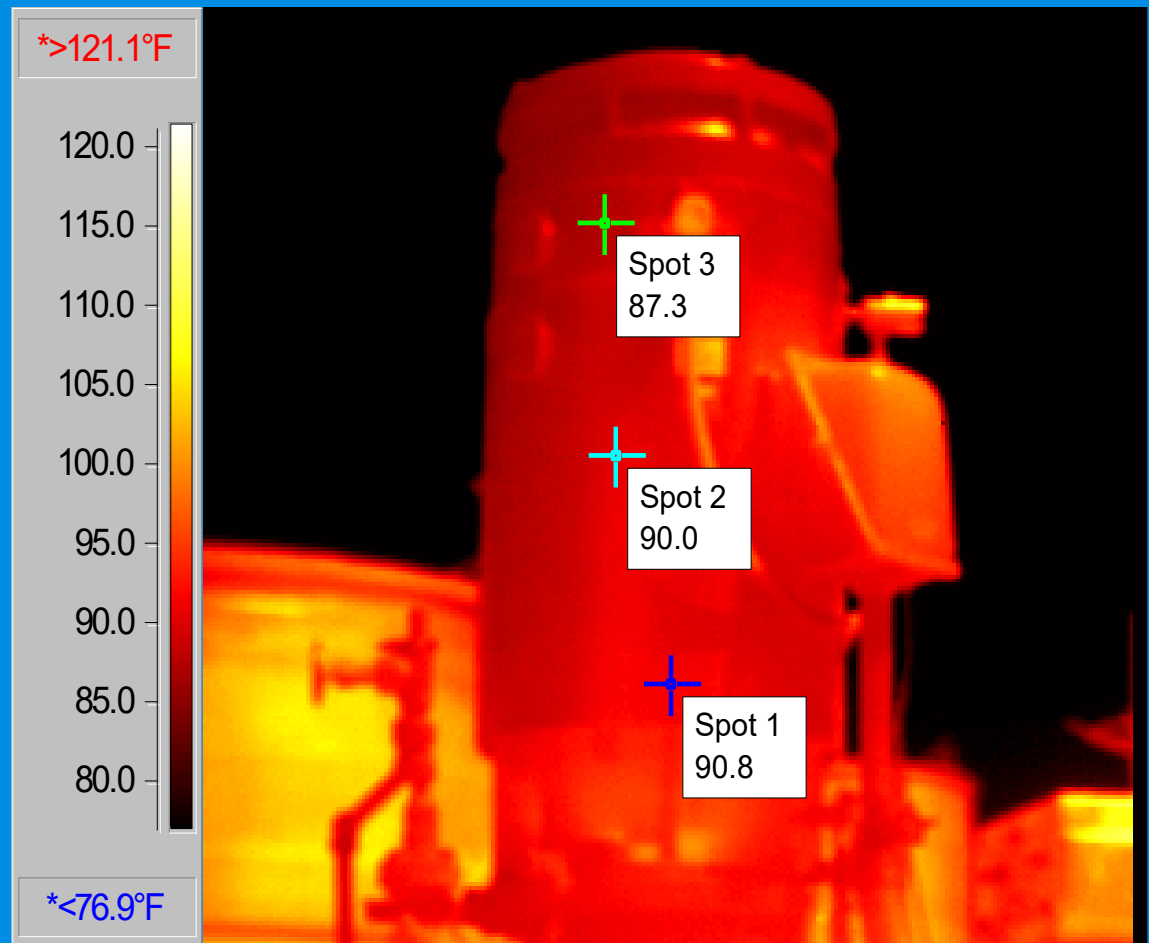


Equipment Failure

Thermography Readings of DRT-2 Running at High Vibration

Thermography survey is to see the temperature distribution on the DRT motor. motor top bearing temperature and bottom bearing.

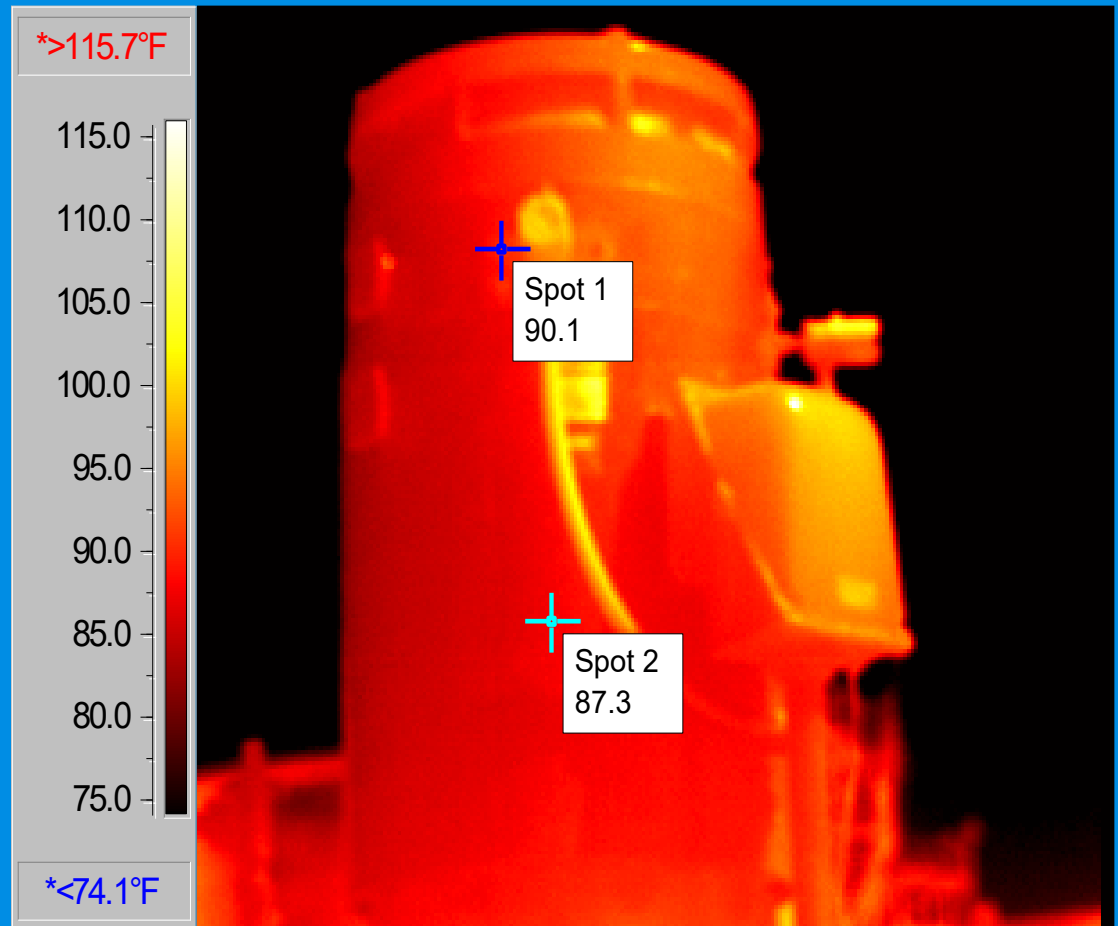
Temperature distribution of DRT#2 booster at different operating conditions: The thermal images were recorded on DRT#2 booster when it was stopped, running at low vibration and running at high vibration.



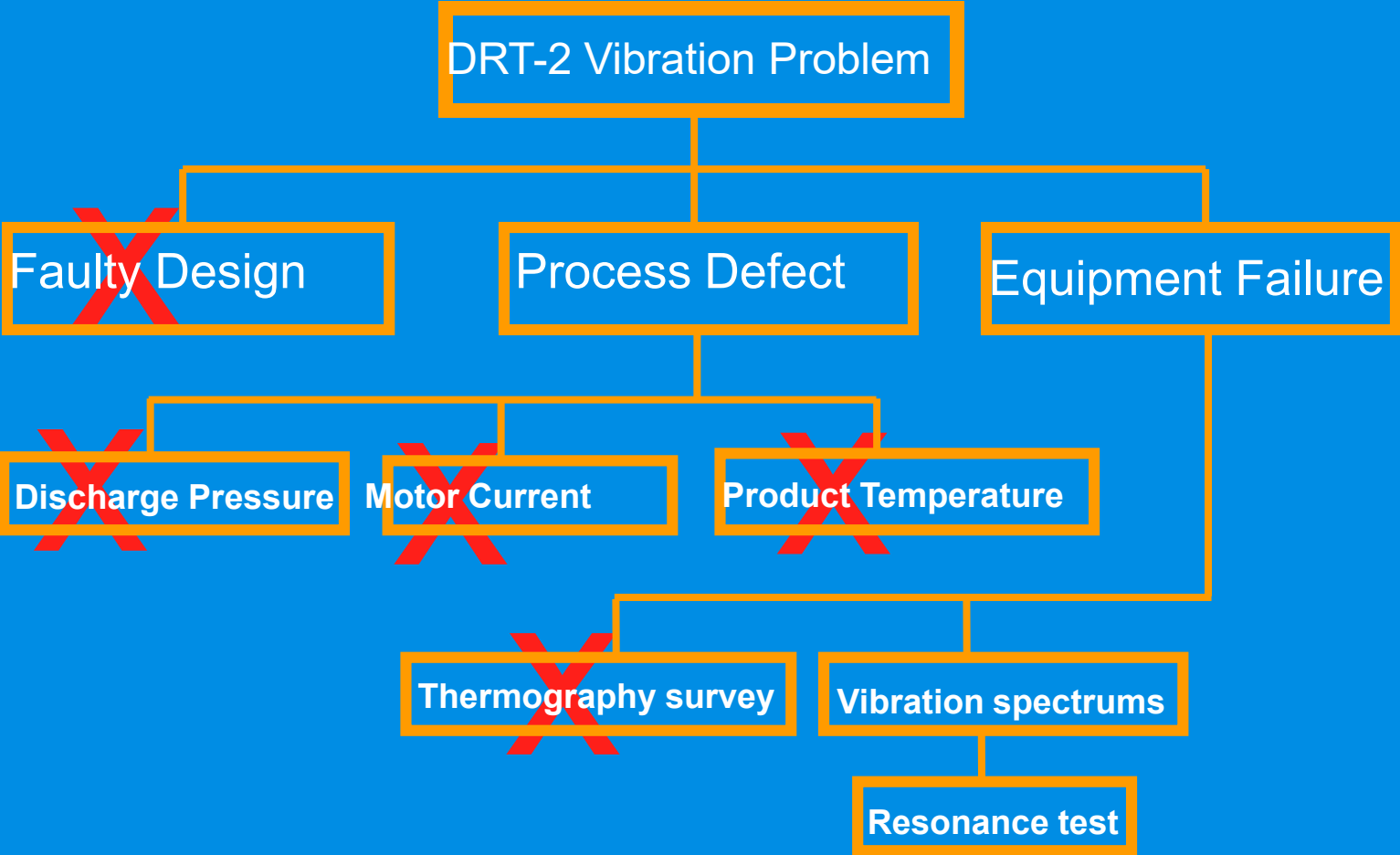
Equipment Failure

Thermography Readings of DRT-2 at Reduced Vibration

As you can see and compare between those imagers, the thermography images didn't indicate a significant change on DRT#2 booster temperatures at different operating conditions that can be related to the high vibration problem.



RCFA Logic Tree

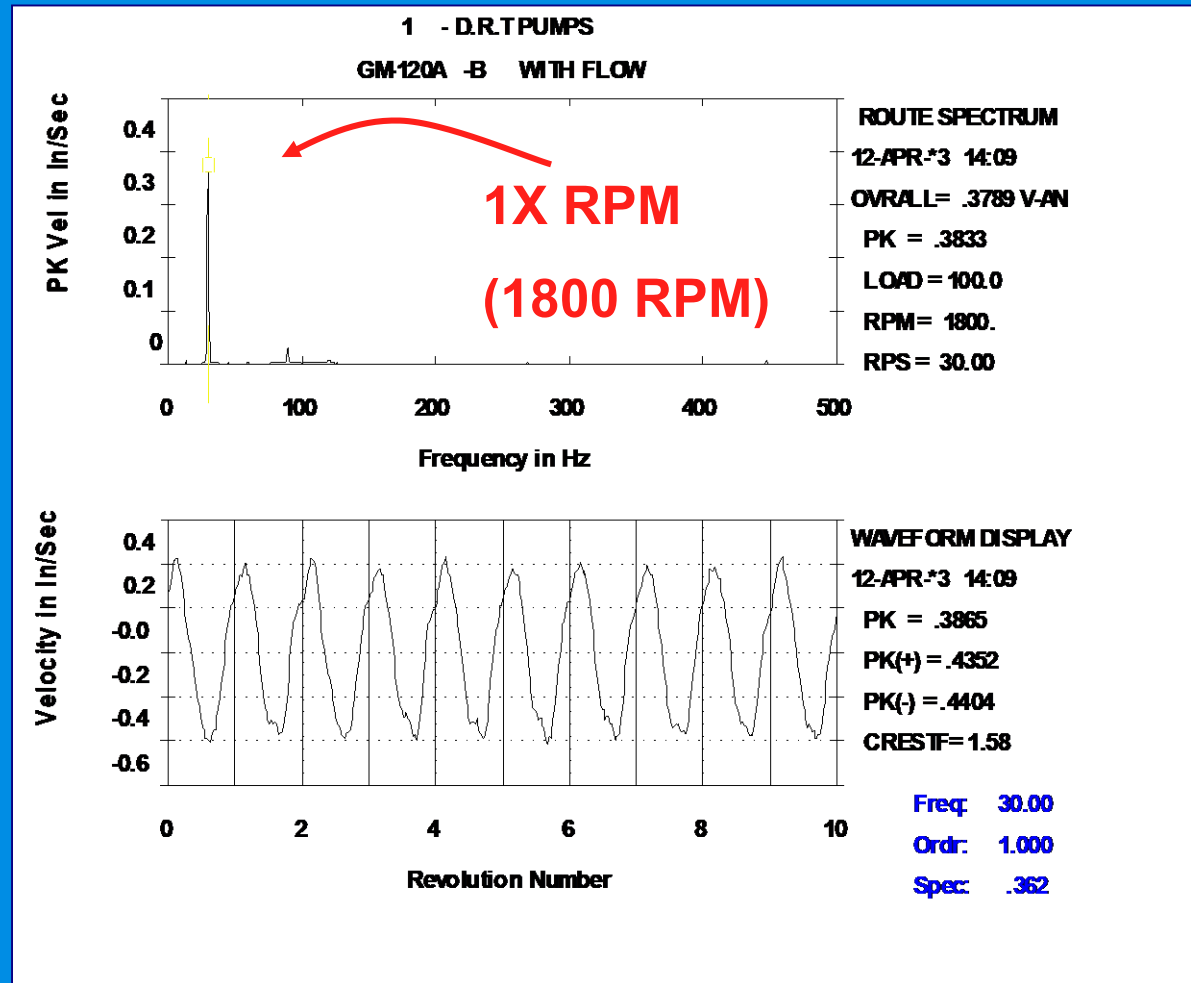


Equipment Failure

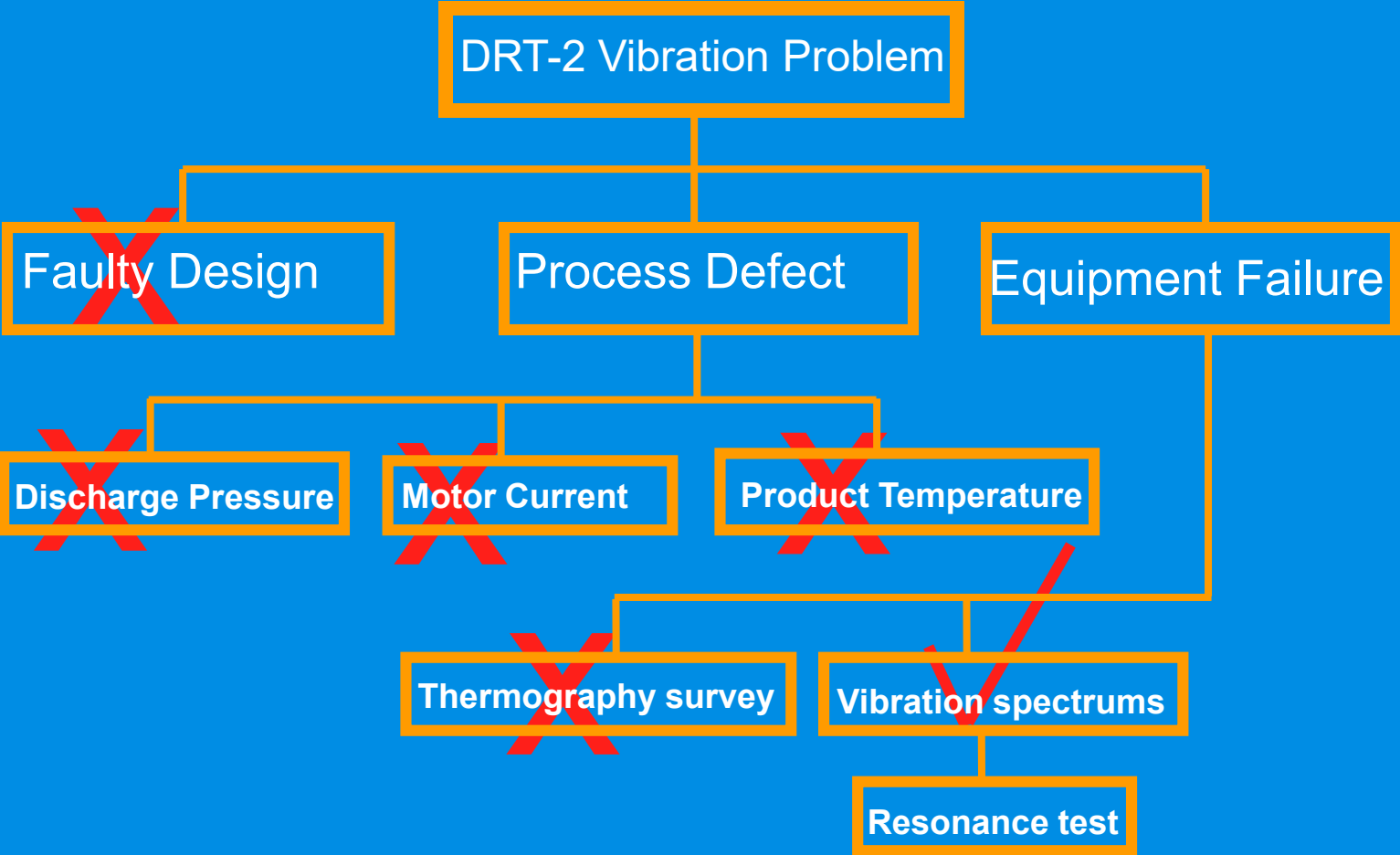
High Vibration Reading For DRT-2

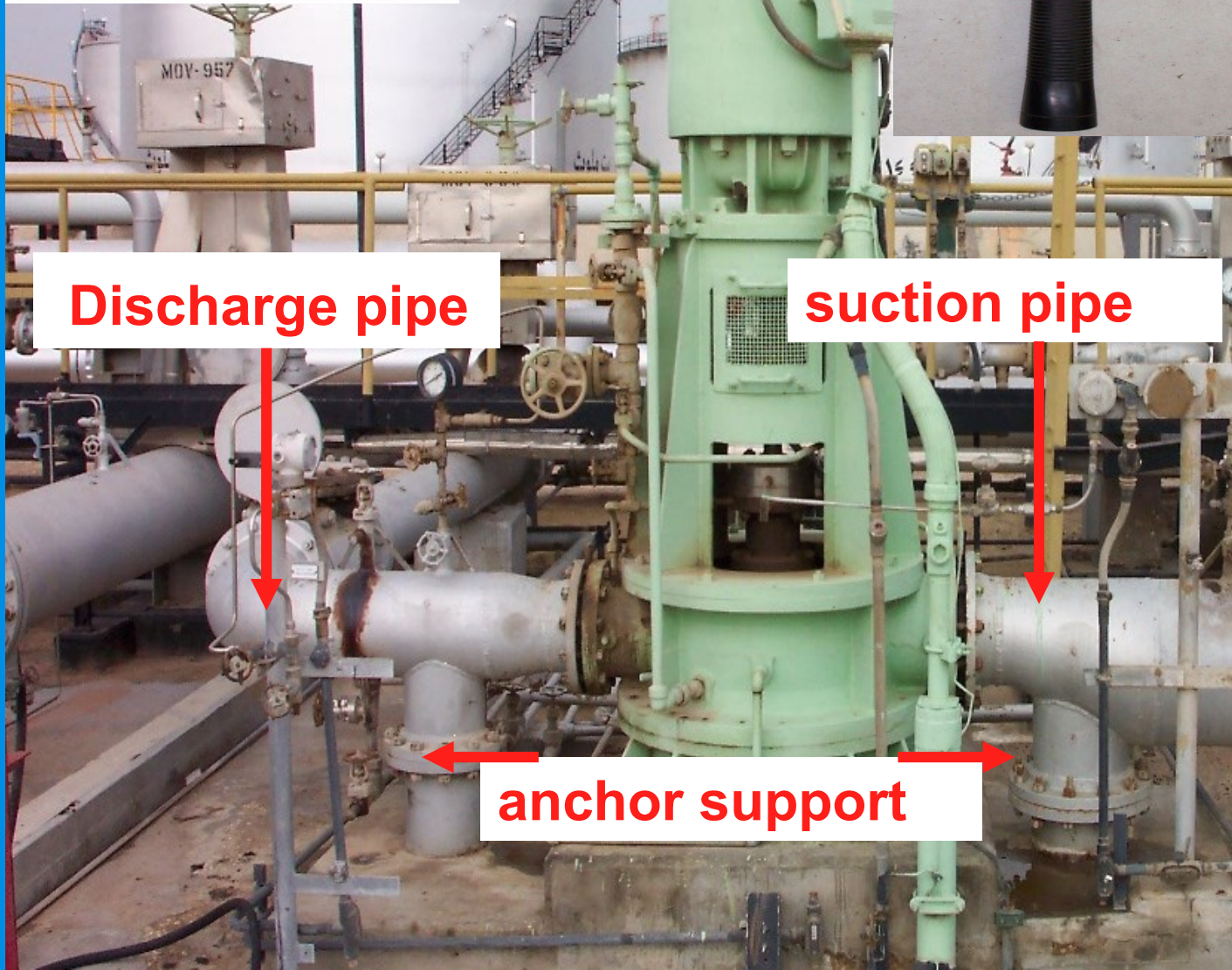
The vibration data spectrum recorded indicated a real vibration and most of the overall vibration is fallen at one-time running speed.

There are no predominant frequencies on the vibration spectrum other than 1X RPM.



RCFA Logic Tree





Discharge pipe

suction pipe

anchor support

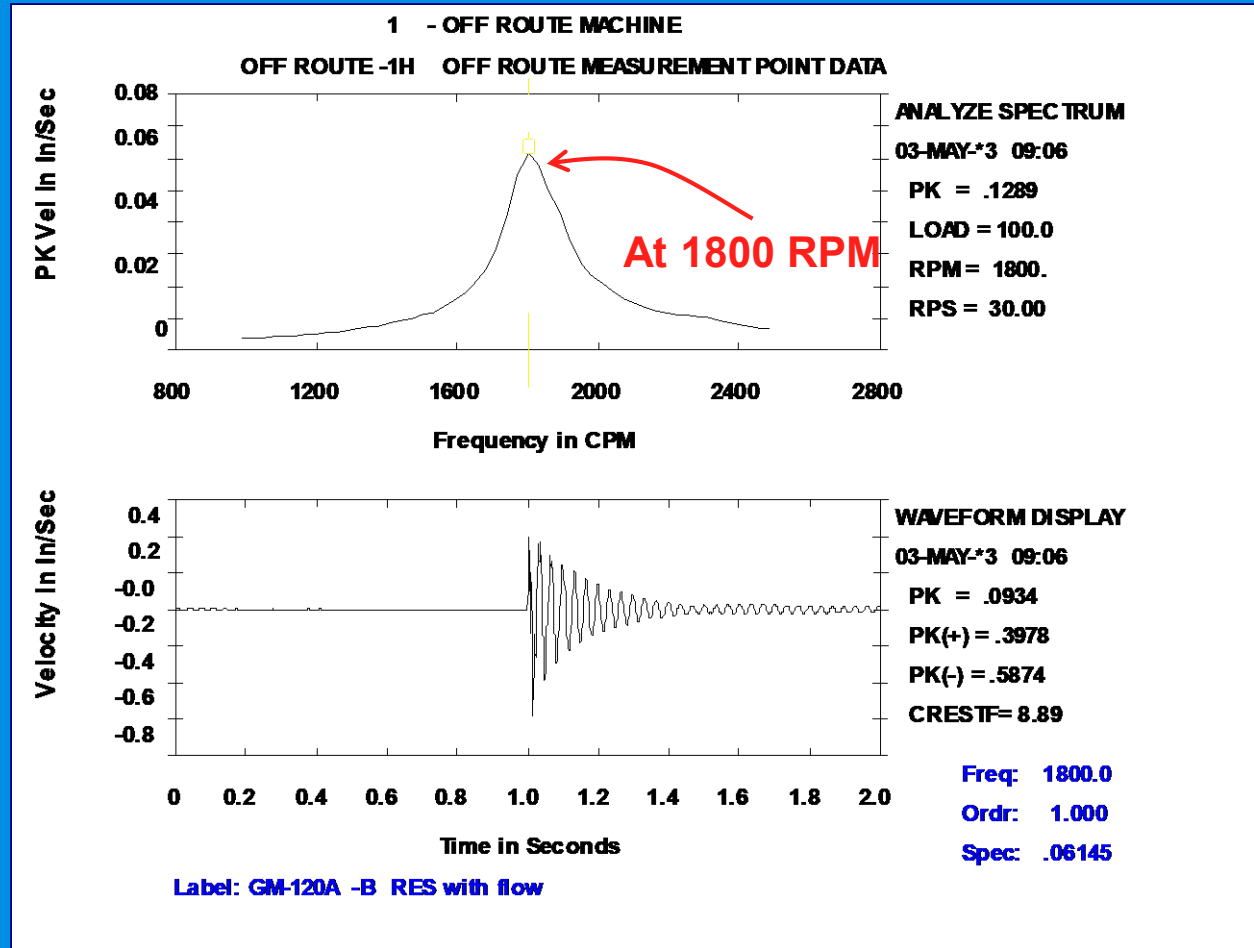
Resonance
Impact test
carried out to
obtain
information
about the
dynamic
characteristics
of DRT#2
booster and
its structural
support and
piping.

Equipment Failure

Resonance Test For DRT-2

The results of the test indicated that the natural frequency of DRT#2 booster pump structural occurs at 1800 rpm, which is the same as the rotating speed of the motor.

Operating any machine close to its natural frequency will amplify the vibration operating speed.



Repair Action

- **Changing DRT-2 Pump-Motor system stiffness by shifting the natural frequency away from motor speed.**

The changing of system stiffness was conducted by disconnecting the suction and discharge pipe anchor support. After changing the system stiffness the natural frequency of the pump-piping system changed to 1710 rpm which is less than induction motor speed 1800 rpm [actually 1780 RPM.

Before

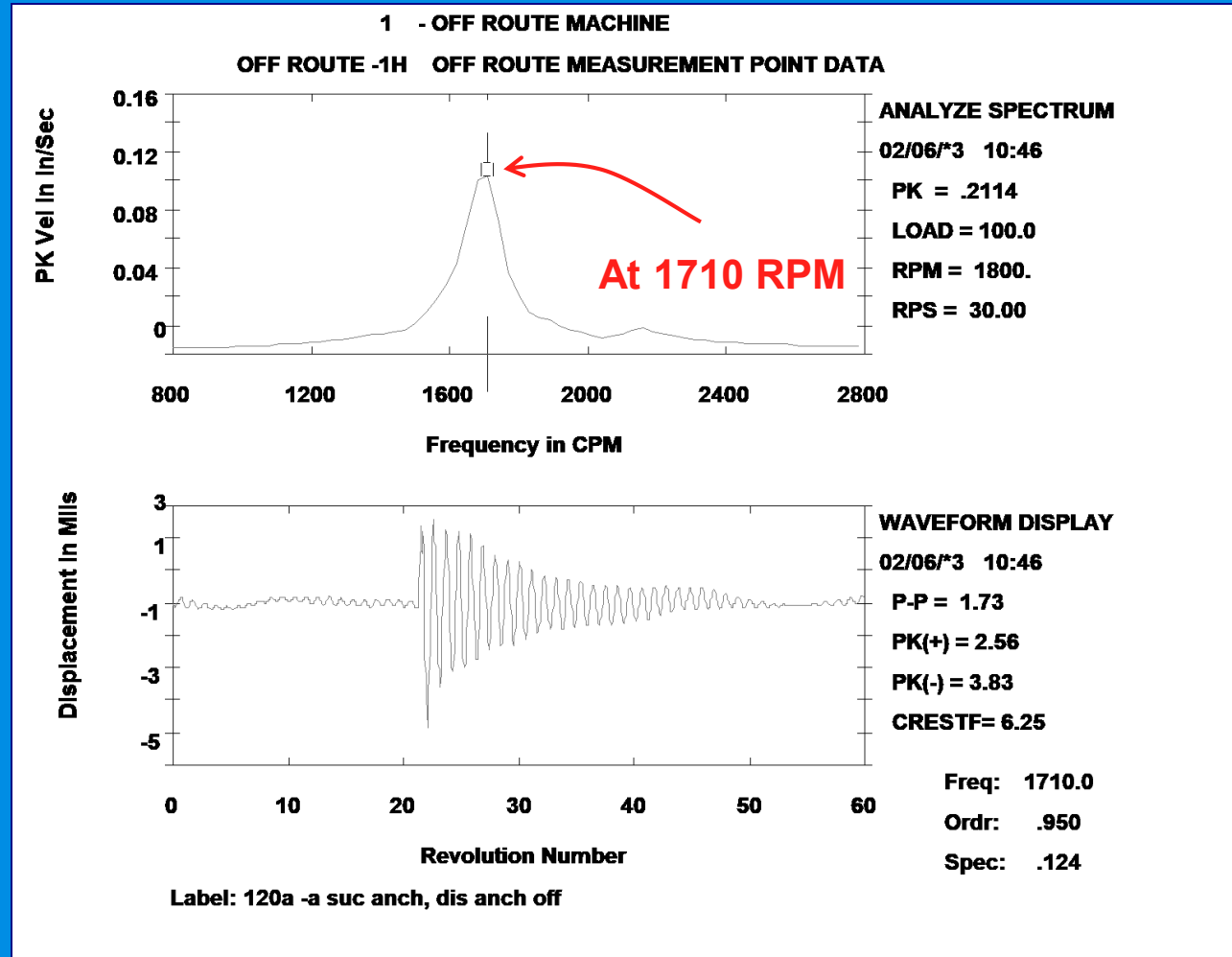
After



Equipment Failure

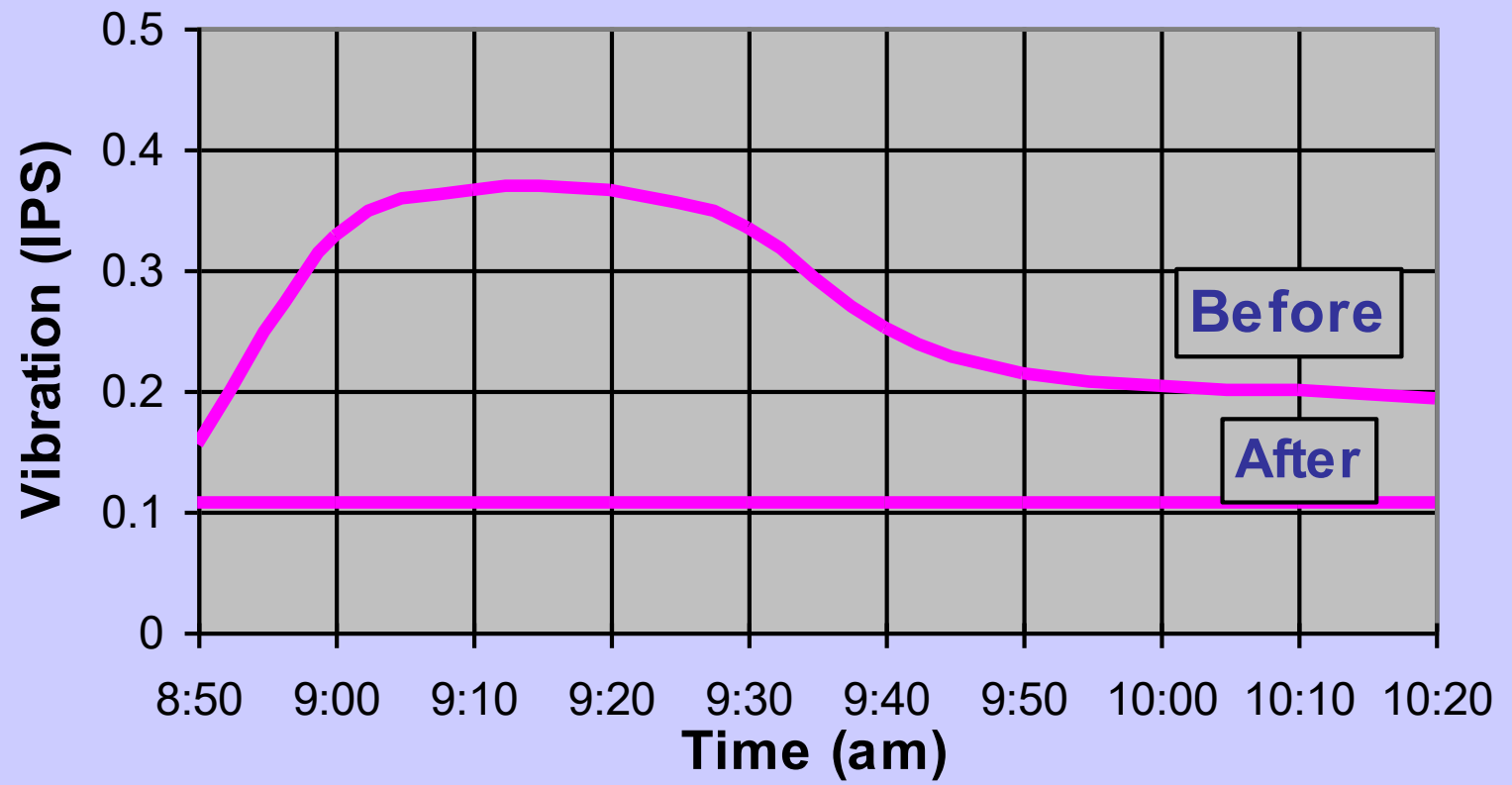
Resonance Test For DRT-2 After Repair

After changing the system stiffness
The natural frequency of the system occur at 1710 rpm which is less than motor speed (1800rpm).



Vibration Trend Before & After Repair

DRT-2 Booster Vibration Reading Trend Before and After Repair



Summary

- **Problem identified in early stage**
- **Correct diagnosing and analysis save motor & pump from repair cost.**
- **Vibration went back to acceptable level of 0.10 in/s RMS.**

Recommendations

□ Using the RCFA techniques will :

➤ Save Time

➤ Enhance Reliability

➤ Reduce risk of encountering repeat failures

Thank you