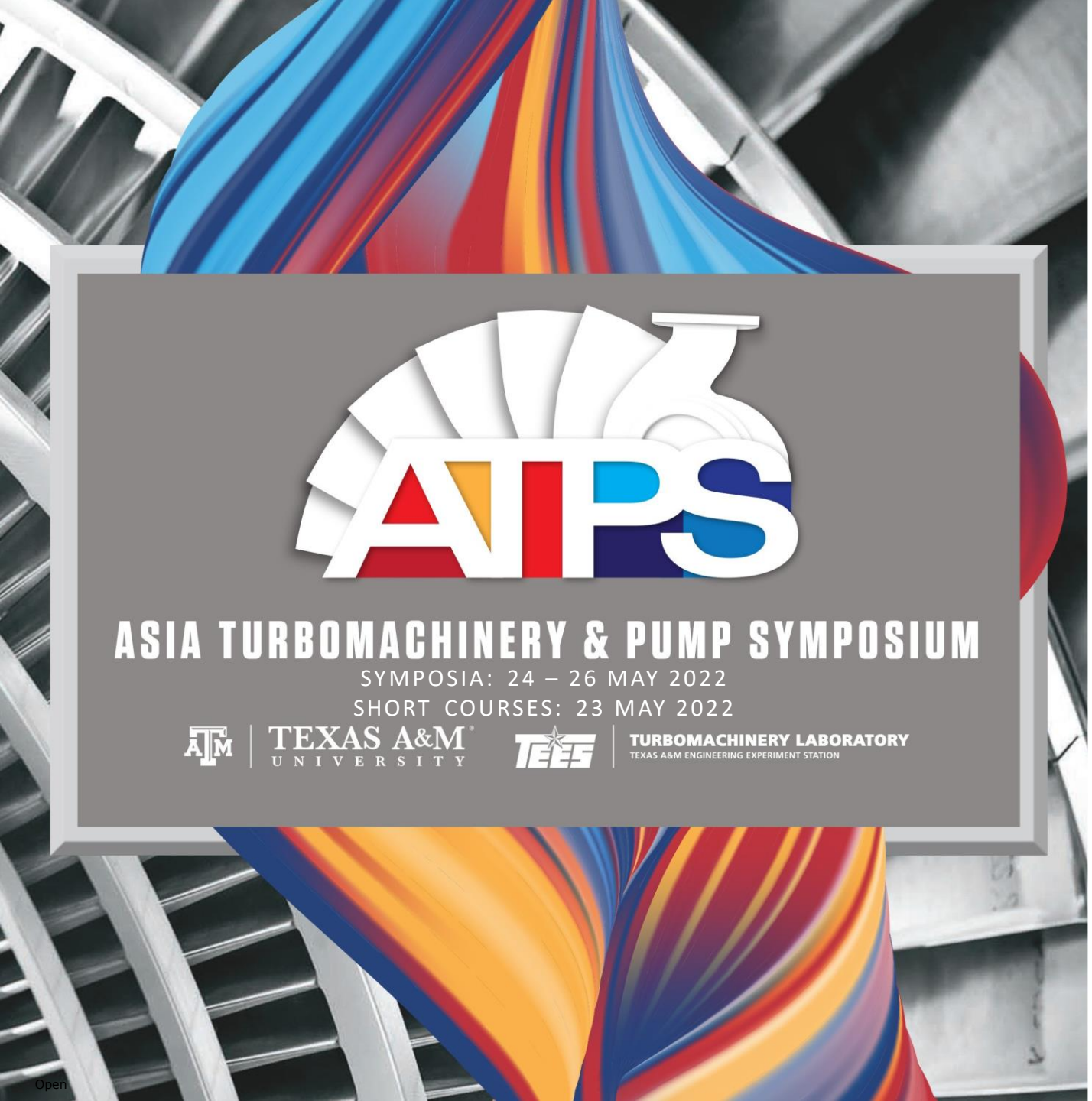

Case Study 39: Pump Vibration due to Reciprocating Engine Balance Gear Issue

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ABSTRACT

This paper presents the effect of balance gear on a reciprocating engine which drive the crude oil transfer pump that had experienced vibration at one of the offshore platform in Malaysia.

Based on this case, it is imperative to understand more on the reciprocating engine vibration behavior especially those related to the balance gear positioning. The balance gear is a critical component that must be fitted right at the first installation. Due to the rarity of requirement for balance gear adjustments, there are gaps in term of experience and exposure of the operators with regards to the maintenance of this component. Hence, this paper addresses the gap.

OUTLINE

1. Introduction
2. Problem Statement
3. Data Review
4. Failure Analysis Chart
5. Inspection and Findings
6. Resolution and Final Vibration Results
7. Lessons Learned

INTRODUCTION

Pump

Horizontal Multistage Centrifugal Pump

3560 RPM rated speed

Crude Oil Pumping, 220 GPM

Drive Shaft

Flexible Coupling

Gearbox

3.028:1 ratio

Input Speed 1200 RPM

Engine

8-cylinder, Natural Aspirated Gas Engine

1200 RPM

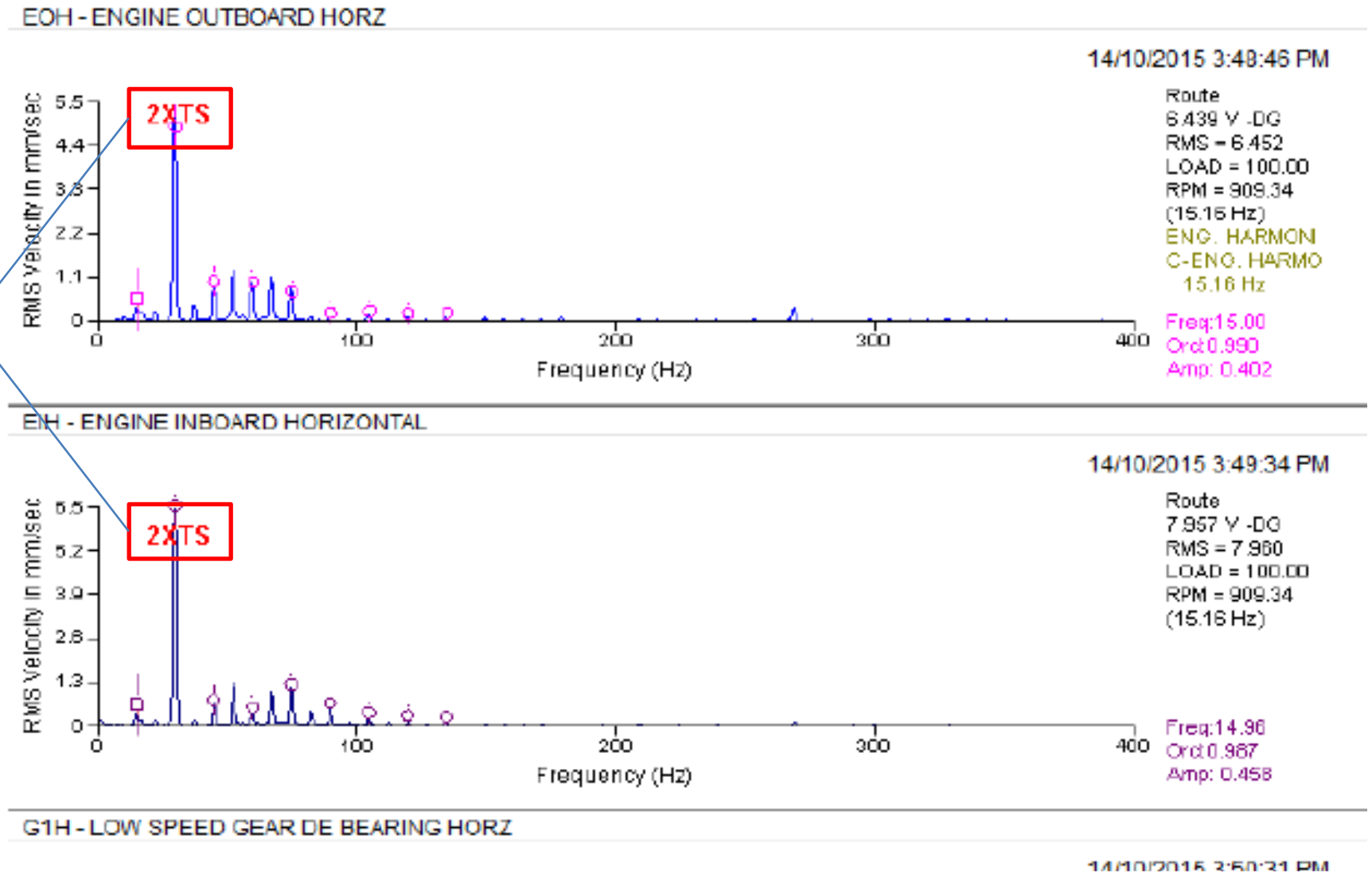
PROBLEM STATEMENT

Point Description	Point ID	14/10/15	Unit
Engine Outboard	Hori	6.43	mm/s RMS
	Vert.	10.73	mm/s RMS
	Axial	2.87	mm/s RMS
Engine Inboard	Hori	7.95	mm/s RMS
	Vert.	11.90	mm/s RMS
	Axial	3.65	mm/s RMS
Low Speed Gear DE	Hori	6.65	mm/s RMS
	Vert.	7.30	mm/s RMS
	Axial	7.47	mm/s RMS
Low Speed Gear NDE	Hori	8.06	mm/s RMS
	Vert.	6.53	mm/s RMS
	Axial	10.8	mm/s RMS
High Speed Gear NDE	Hori	7.61	mm/s RMS
	Vert.	7.63	mm/s RMS
	Axial	7.04	mm/s RMS
High Speed Gear DE	Hori	7.68	mm/s RMS
	Vert.	6.68	mm/s RMS
	Axial	8.04	mm/s RMS
Pump DE	Hori	3.29	mm/s RMS
	Vert.	4.12	mm/s RMS
	Axial	3.31	mm/s RMS
Pump NDE	Hori	5.99	mm/s RMS
	Vert.	2.28	mm/s RMS
	Axial	5.58	mm/s RMS
Engine Speed		900	RPM

- Significant high vibration across engine, GB and pump assembly post engine major overhaul and radiator fan replacement

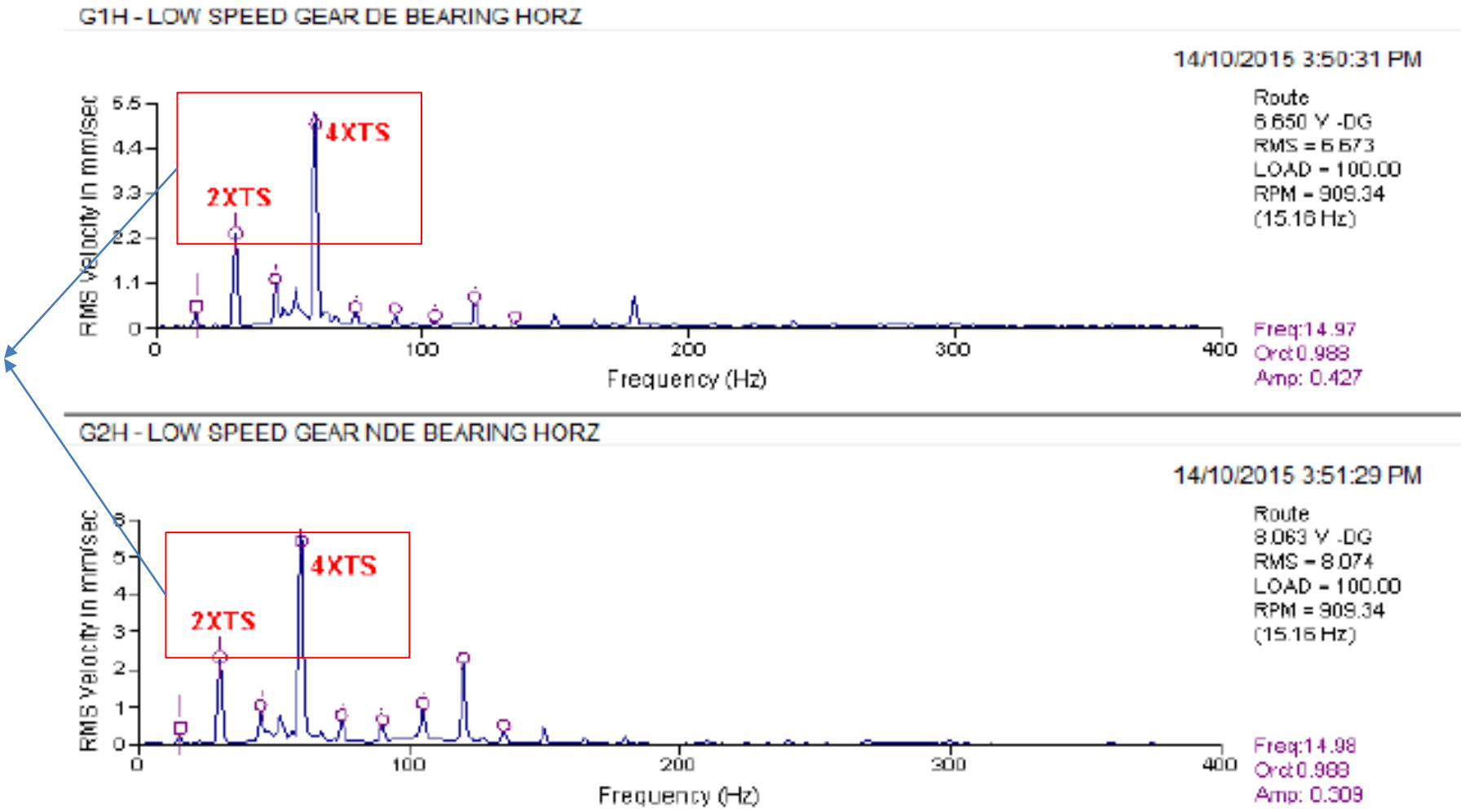
DATA REVIEW

Spectrum observed high amplitude of 2XTS at both direction DE and NDE points



DATA REVIEW

Spectrum observed 2X and 4X dominant peaks correspond to Engine running speed

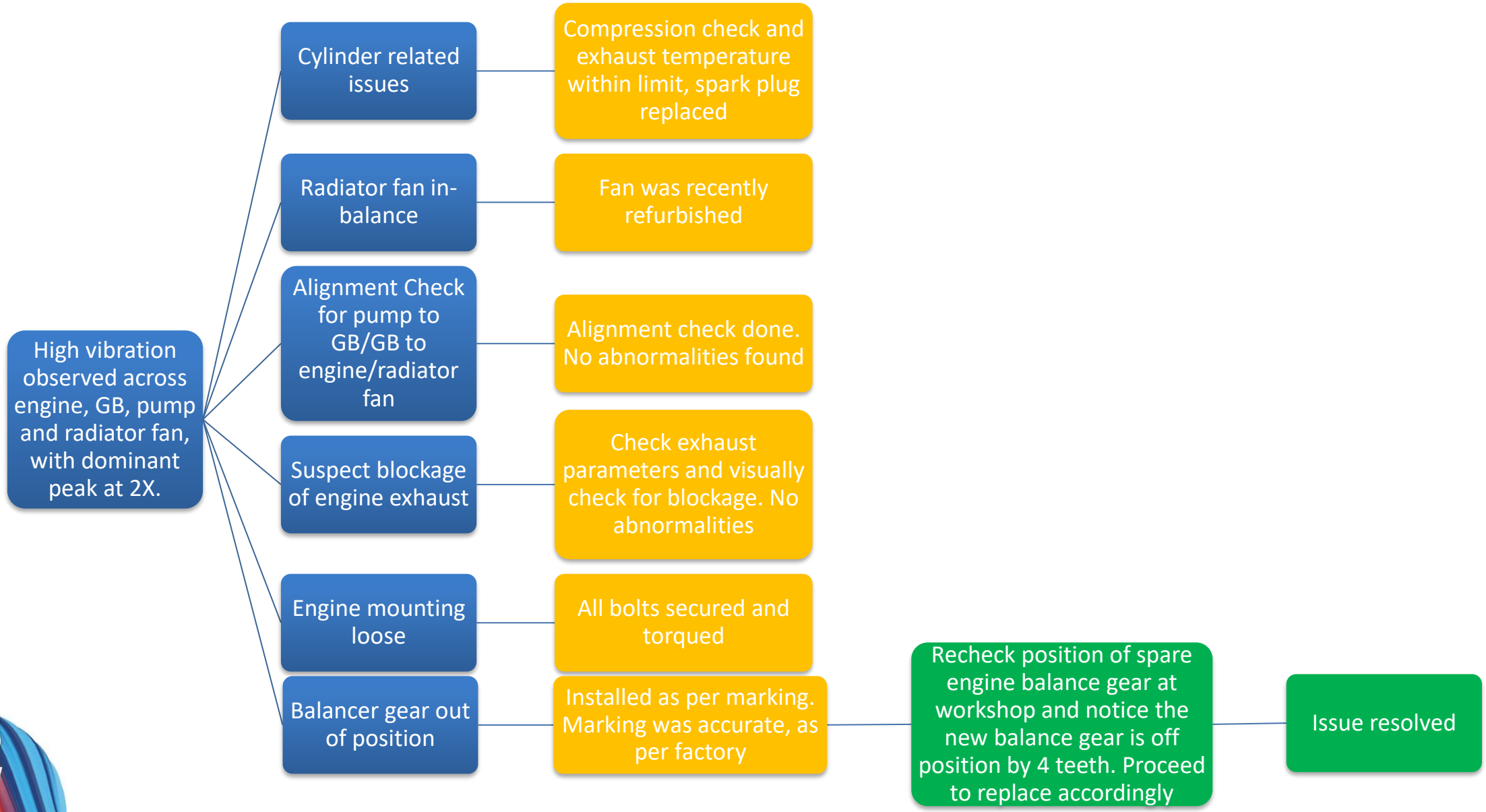


DATA REVIEW

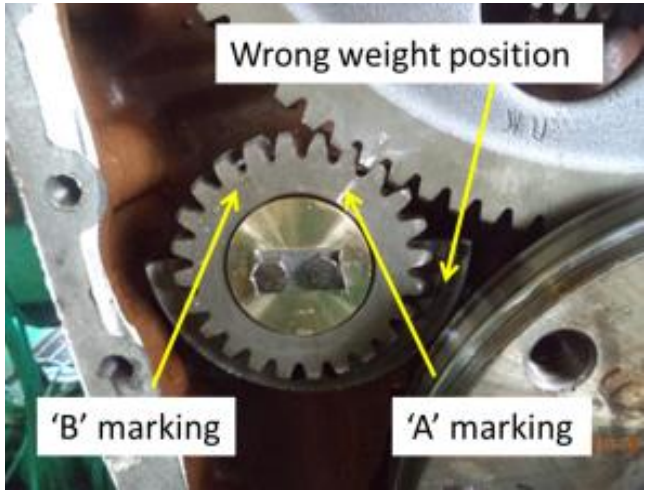
- Based on data acquisition, vibration increase significantly when speed reached 850rpm and above. Amplitude difference show more than twice increment.

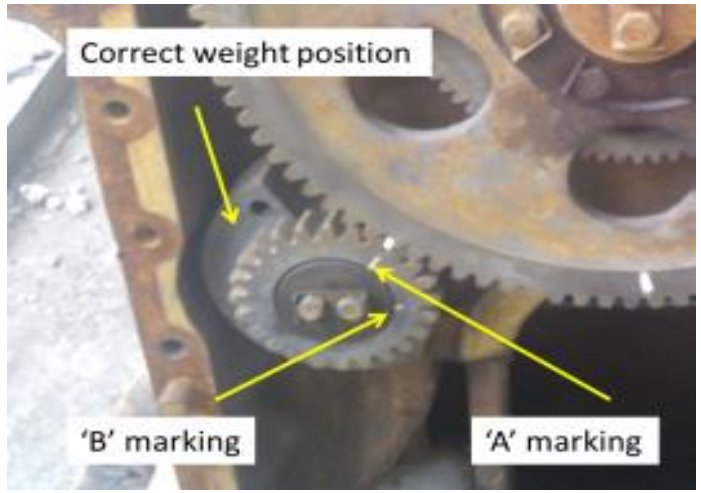
- Suspected engine unbalance which create high vibration on engine and transmitted to all related component including radiator fan, gearbox and pump

FAILURE ANALYSIS CHART



INSPECTION AND FINDINGS





The balance gear act as a counter-force to the unbalance forces produce by engine during rotation, which results in balanced engine. The balance gear is installed as per marking, in this case, as per factory marking. Failure to take note on the as found position of the gear lead to this common mistake, especially on work seldom done, since replacement of balance gear only happens during major overhaul.

Resolution and Final Vibration Results

Point Description	Point ID	14/10/15	24/05/2016	Unit
Engine Outboard	Hori	6.43	2.10	**mm/s RMS**
	Vert.	10.73	1.16	**mm/s RMS**
	Axial	2.87	1.32	**mm/s RMS**
Engine Inboard	Hori	7.95	1.89	**mm/s RMS**
	Vert.	11.90	1.41	**mm/s RMS**
	Axial	3.65	1.17	**mm/s RMS**
Low Speed Gear DE	Hori	6.65	4.43	**mm/s RMS**
	Vert.	7.30	2.34	**mm/s RMS**
	Axial	7.47	3.54	**mm/s RMS**
Low Speed Gear NDE	Hori	8.06	4.06	**mm/s RMS**
	Vert.	6.53	1.23	**mm/s RMS**
	Axial	10.8	2.80	**mm/s RMS**
High Speed Gear NDE	Hori	7.61	3.89	**mm/s RMS**
	Vert.	7.63	2.21	**mm/s RMS**
	Axial	7.04	2.95	**mm/s RMS**
High Speed Gear DE	Hori	7.68	4.09	**mm/s RMS**
	Vert.	6.68	1.47	**mm/s RMS**
	Axial	8.04	2.22	**mm/s RMS**
Pump DE	Hori	3.29	1.51	**mm/s RMS**
	Vert.	4.12	1.19	**mm/s RMS**
	Axial	3.31	0.74	**mm/s RMS**
Pump NDE	Hori	5.99	2.43	**mm/s RMS**
	Vert.	2.28	1.20	**mm/s RMS**
	Axial	5.58	0.92	**mm/s RMS**
Engine Speed		**900**	**850**	**RPM**

The balance gear was replaced and installed as per the correct position

Significant reduction in vibration observed across the engine, GB and pump assemblies.

Lessons Learned

- Initial spectrum analysis does indicate unbalance force, introduced by the engine which in turn affect the whole assembly. This has narrow down the scope of troubleshooting
- As found position of the balancer gear is important to be noted during disassembly process. Factory marking might be inaccurate and might induce vibration post engine overhaul.

THANK YOU!