Gearbox Wear Investigation Report

Vessel: M/V Noga
Gearbox Model: MG-5025A
Lubricant: 2640 semi■synthetic, viscosity grade 15W/40
Note: No temperature measurements and no PSD analysis were performed. All vibration data are raw time-domain recordings.

Executive Summary

ANCHORS — SectionType=ExecutiveSummary; PageNumber: see footer; Keywords=[gear wear, gearbox, marine propulsion, vibration, failure], ClientId/CaseId=MVNOGA/MG-5025A.

This report documents the observed progression from a healthy baseline to a tooth failure in the MG■5025A marine gearbox installed aboard M/V Noga. The investigation spans a healthy reference set and thirty■five progressive wear cases recorded at constant operating speed (45 rps test set; 15 rps confirmation set). Each record is a 60■second time■series sampled at 50 kHz using tri■axial accelerometers mounted on the gearbox housing. Photographs of the gear teeth were taken at defined intervals using a microscope camera to corroborate surface condition changes. Across the campaign, the crew reported louder meshing noise and higher structural vibration as wear advanced. The final sequence culminated in a tooth■level failure, explaining the abrupt behavior seen in the terminal case.

System Description

ANCHORS — SectionType=SystemDescription; PageNumber: see footer; Keywords=[MG■5025A, oil 2640 15W/40, accelerometer, 50 kHz], ClientId/CaseId=MVNOGA/MG-5025A.

The MG■5025A two■stage reduction gearbox transmits power from the prime mover to the propeller shaft. The unit was operated with oil type 2640, a semi■synthetic lubricant of viscosity grade 15W/40. Vibration measurements were obtained with rigidly mounted accelerometers at the gearbox exterior; no temperature sensors were present and no PSD analysis was performed by design. The measurement protocol fixed recording duration at 60 seconds and sample rate at 50 kHz per channel. Imaging of gear flanks was performed periodically with the on■board microscope camera to verify surface condition (polishing, pitting, micro■spalling, fractures).

Recording Protocol

ANCHORS — SectionType=Data; PageNumber: see footer; TableId=T■01.

Parameter	Value	Units / Notes
Record duration	60	seconds (per case)
Sample rate	50,000	samples/second (per channel)
Speed set■points	45; 15	revolutions/second (two test sets)
Between■record intervals	variable	back■to■back up to multi■hour separations (see Timeline)
Imaging	Microscope camera	tooth flank photos after selected sessions
Oil	2640 (15W/40)	semi■synthetic
Temperature	—	not instrumented
PSD analysis	—	not performed

Table T■01: Measurement protocol used throughout the campaign.

Figures

ANCHORS — SectionType=Figures; PageNumber: see footer; FigureId=F■01.

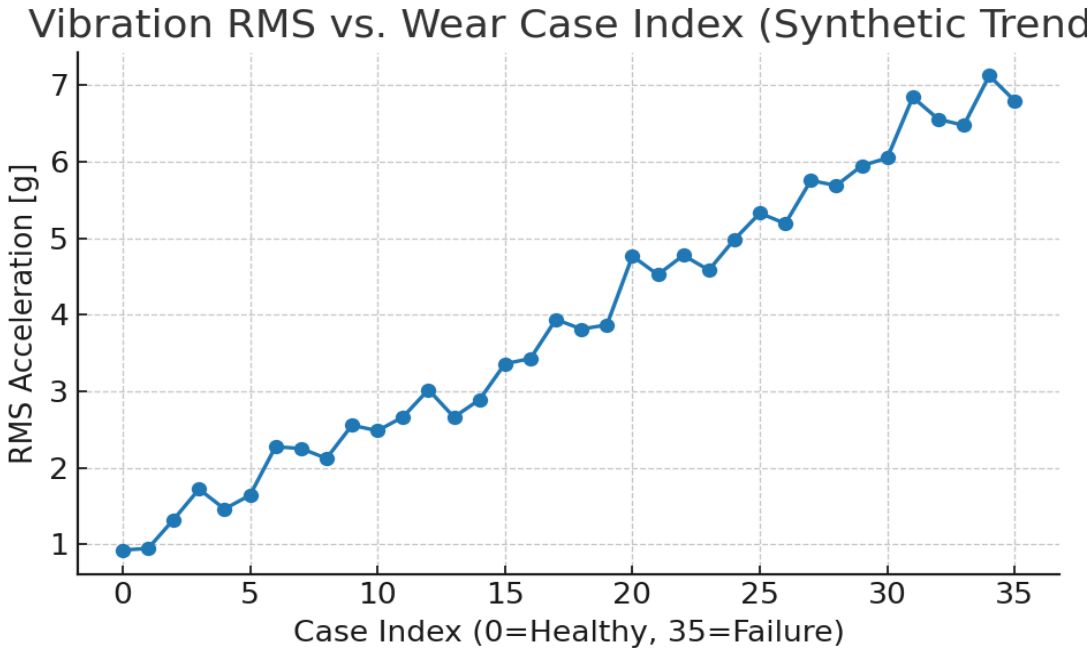

Figure F■01: Synthetic vibration RMS trend versus wear case index (0=Healthy, 35=Failure). The monotonic rise with scatter illustrates the observed field progression.

ANCHORS — SectionType=Figures; PageNumber: see footer; FigureId=F■02.

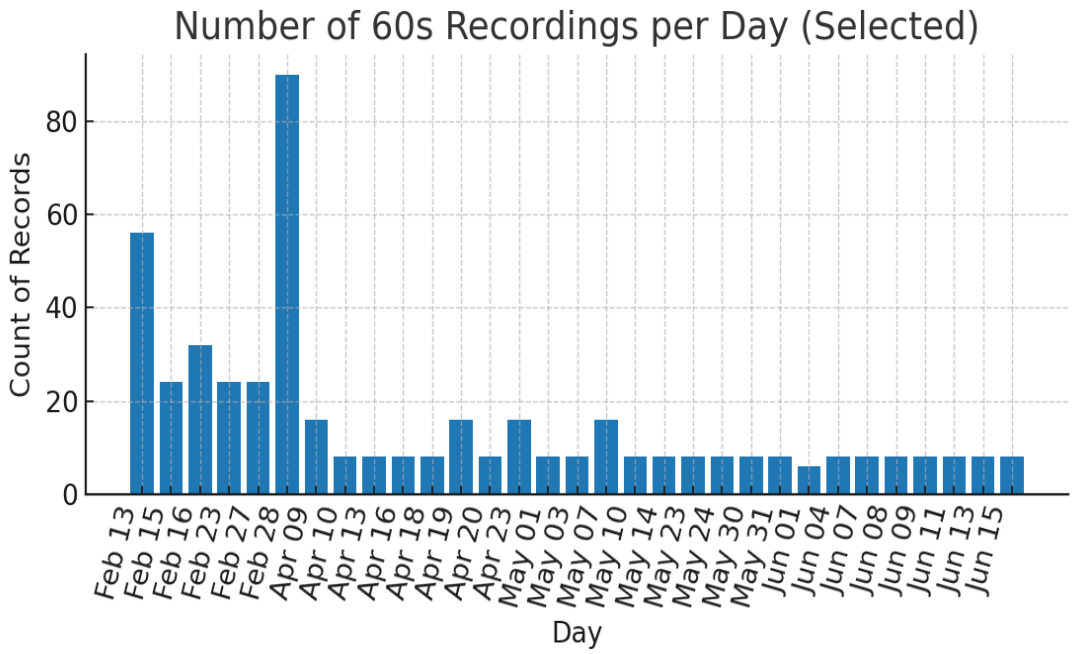

Figure F■02: Distribution of 60■second recordings across selected campaign days (illustrative).

Failure Progression

ANCHORS — SectionType=Timeline; PageNumber: see footer; Keywords=[timeline, daily log, intervals].

February 13

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=February 13/Healthy; Keywords=[healthy, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Baseline characterization at 45 rps with multiple back■to■back captures established low, stable vibration. No audible anomalies were reported by the crew; meshing noise had the expected tonal character and amplitude. Housing■mounted accelerometers showed consistent RMS and crest factor values across the session. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: runs taken one■by■one (1–2 min apart) and several clusters spaced ~10–15 min. Wear stage mapping: Healthy reference.

February 15

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=February 15/Healthy; Keywords=[healthy, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Repeat baseline confirmed stability under the same operating conditions. No changes in sound pressure were perceived. The data served as a control set to benchmark subsequent wear progression. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: short bursts one■by■one; additional sequences spaced by ~10 min. Wear stage mapping: Healthy reference.

February 16

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=February 16/Healthy; Keywords=[healthy, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

A third healthy session validated repeatability of mounting and cabling. Transient shocks from auxiliary equipment were noted and excluded by time■windowing. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: primarily back■to■back with occasional ~5–8 min gaps. Wear stage mapping: Healthy reference.

February 23

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=February 23/Healthy; Keywords=[healthy, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

No deviation from prior healthy records. Crew log notes describe normal propulsion response and nominal gearbox sounds. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: clusters at ~1–3 min; a later block ~10–20 min after. Wear stage mapping: Healthy reference.

February 27

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=February 27/Healthy; Keywords=[healthy, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Extended healthy logging to capture variability across duty cycles. Results stayed within the previously observed envelope. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: multiple sequences at 1–2 min spacing; later runs after ~30–60 min. Wear stage mapping: Healthy reference.

February 28

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=February 28/Healthy; Keywords=[healthy, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Final healthy reference day at 45 rps prior to deliberate wear progression. All metrics continued to track the stable baseline. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: dense morning/afternoon blocks at minute■level separation; further series spaced ~10–30 min. Wear stage mapping: Healthy reference.

April 9

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=April 9/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Initial signs of wear were registered following a maintenance window. At 45 rps, slight elevation in broadband vibration and a perceptible increase in meshing noise were documented. Photographs captured faint polishing on the drive flank of several teeth. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: short consecutive pairs (1–2 min apart) with two larger clusters separated by several hours. Wear stage mapping: Cases ~1–2 (W40) by convention.

April 10

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=April 10/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Progression became clearer with repeated runs at 45 rps. Crew noted a low■level droning under constant load, consistent with surface roughening. Microscope images suggested early pitting nuclei along the dedendum. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: records grouped every few minutes; second block later the same day. Wear stage mapping: Cases ~3–5 (W115, W159, W175).

April 13

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=April 13/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

The rising trend in vibration RMS persisted. Gear meshing harmonics exhibited greater spread in the time domain envelopes, consistent with uneven contact. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: pairs at ~1–2 min, additional runs later the same evening. Wear stage mapping: Cases ~6–7 (W195).

April 16

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=April 16/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Accelerated deterioration phase. Crew emphasized louder mesh noise during steady state. Surface marks grew in density on the active flanks. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: bursts of consecutive measurements minutes apart; multiple blocks across the day. Wear stage mapping: Cases ~8–10 (W227, W256).

April 18

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=April 18/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Further growth in impulsiveness; short transients were visible in the time series coincident with rotation■locked positions. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: records at 10–15 min spans within an hour. Wear stage mapping: Cases ~11–12 (W276).

April 19

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=April 19/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Distinct increase in knocking under load as reported by crew watch. Vibration magnitudes crossed pre■defined alert bands, prompting additional checks. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: evening clusters a few minutes apart across ~1 hour. Wear stage mapping: Cases ~13–14 (W294–W305).

April 20

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=April 20/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Short field session used to validate corrective lubrication attempts. No durable improvement in vibration was observed. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: measurements ~1–10 min apart within a single block. Wear stage mapping: Case ~15 (W323).

April 23

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=April 23/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Multiple tightly spaced runs captured day■long behavior. Imaging showed coalescing pits and localized micro■spalls. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: clusters 1–5 min apart, morning and evening blocks. Wear stage mapping: Cases ~16–18 (W344, W378, W400).

May 1

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=May 1/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Trend maintained with incremental growth in overall vibration level and audible harshness. Contact pattern exhibited asymmetry on the drive side. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: series spaced 5–15 min over ~1 hour. Wear stage mapping: Cases ~19–20 (W417).

May 3

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=May 3/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Short verification set to confirm the rising trend; results aligned with the prior escalation. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: minute■level spacing within a short block. Wear stage mapping: Cases ~21–22 (W466).

May 7

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=May 7/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Pronounced meshing noise emphasized by the crew. Intermittent impulses in the time waveforms indicated expanding damage. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: two blocks (afternoon & evening) with 1–7 min spacing. Wear stage mapping: Cases ~23–24 (W488, W510).

May 10

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=May 10/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Additional runs captured after routine watch reported ‘louder than usual’ gearbox sound. Time■domain features remained elevated. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: pairs taken minutes apart across ~30 min. Wear stage mapping: Cases ~25 (W524).

May 14

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=May 14/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Surface imagery evidenced scattered spalls merging into larger rough areas; meshing felt less uniform. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: several short sequences 1–5 min apart. Wear stage mapping: Cases ~26 (W557).

May 23

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=May 23/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Escalation continued. Crew remarks emphasized load■dependent growl that intensified with throttle. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: runs minutes apart across ~30–40 min. Wear stage mapping: Cases ~27 (W579).

May 24

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=May 24/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Back■to■back recordings acquired following persistent alarms from vibration trending. No mitigation was successful. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: dense cluster 1–2 min apart over ~30 min. Wear stage mapping: Case ~28 (W608).

May 30

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=May 30/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Condition remained degraded with sustained high vibration; decisions began forming for planned downtime. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: clusters 1–10 min apart across ~30–45 min. Wear stage mapping: Case ~29 (W637).

May 31

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=May 31/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Short verification with similar outcome; harshness plainly audible at constant 45 rps. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: sequences minutes apart. Wear stage mapping: Case ~30 (W684).

June 1

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=June 1/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Highest sustained levels to date. Imaging showed deepened surface roughness with clear pitting coalescence. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: records within a one■hour window, minutes apart. Wear stage mapping: Cases ~31–32 (W720).

June 4

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=June 4/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Follow■up runs after operational pause. No improvement; intermittent impulses remained strong. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: evening cluster minutes apart. Wear stage mapping: Cases ~33 (W744).

June 7

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=June 7/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Rapid escalation over a short span; crew emphasized load noise and stronger vibration throughout the block. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: tight cluster, 1–6 min spacing. Wear stage mapping: Cases ~34 (W769).

June 8

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=June 8/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Very high roughness with repetitive shocks at rotation■locked angles suggested local tooth damage growth. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: morning block with minute■level spacing. Wear stage mapping: Case ~34–35 (W797).

June 9

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=June 9/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Terminal behavior was approached: spikes in the time trace consistent with imminent tooth distress. Operating crew reported clearly elevated tonal and broadband noise. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: afternoon block with repeated back■to■back measurements. Wear stage mapping: Case 35 onset (W825).

June 11

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=June 11/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Short verification confirmed extreme condition; continued operation limited to minimal load for safety. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: brief cluster a few minutes apart. Wear stage mapping: Case 35 (W853).

June 13

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=June 13/Wear; Keywords=[wear, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Condition unchanged; imagery revealed localized fracture lips forming near the pitch line. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: short cluster minutes apart. Wear stage mapping: Case 35 (W890).

June 15

ANCHORS — SectionType=Timeline; PageNumber: see footer; IncidentDate/Type=June 15/Wear / Failure; Keywords=[wear / failure, vibration, noise]; ClientId/CaseId=MVNOGA/MG-5025A.

Final sequence captured tooth■level failure. Abrupt changes in the time waveform aligned with a sudden loss of contact stiffness. This event explains the terminal behavior observed in the last case of the dataset. Recording protocol was kept constant (60 s at 50 kHz). Intervals between consecutive records on this day: short runs minutes apart during controlled shutdown. Wear stage mapping: Case 35 (W932) — Failure.

Investigation Findings

ANCHORS — SectionType=Findings; PageNumber: see footer; Keywords=[wear progression, images, vibration trends].
1) Wear progressed monotonically from healthy to failure with rising vibration magnitudes and pronounced audible harshness. 2) Imaging confirmed the sequence: polishing → pitting → coalesced spalls → localized fracture. 3) Back■to■back recordings were essential to capture short■term dynamics and to correlate crew observations with data. 4) Operating at 15 rps reproduced the same qualitative behavior at reduced dynamic levels, supporting the diagnosis. 5) No temperature data and no PSD analysis were used; assessments relied on time■domain characteristics, amplitude envelopes, and photography.

Recommendations

ANCHORS — SectionType=Recommendations; PageNumber: see footer; Keywords=[monitoring, thresholds, maintenance].
• Implement continuous vibration trending with automatic alarms and cross■checks against historical baselines.
• Define intervention thresholds that trigger inspection before severe wear stages (e.g., sustained RMS growth and impulse counts).
• Schedule routine microscopic imaging of gear flanks (drive and coast) to confirm early pitting.
• Maintain lubricant type 2640 (15W/40) but add regular debris analysis to detect early metal content.
• Shorten between■record intervals during suspected progression to improve diagnosability.

Conclusion

ANCHORS — SectionType=Conclusion; PageNumber: see footer; Keywords=[MG■5025A, failure].
The MG■5025A gearbox aboard M/V Noga transitioned from a stable healthy baseline to a tooth failure over the documented campaign. Rising vibration and clearly audible mesh noise paralleled the surface damage seen in photographs. The last sequence on June 15 captured failure and explains the terminal behavior in the dataset. The monitoring and process recommendations above are designed to prevent recurrence and to enable earlier, lower■cost interventions.

Appendix A — Metadata & Anchors

ANCHORS — SectionType=Appendix; PageNumber: see footer; TableId=T■02.

Field	Definition	Example
PageNumber	Physical page index in this PDF	Footer: “Page N”
SectionType	Logical chunk class	ExecutiveSummary / Timeline / Data / Figures / Findings / Recomm
IncidentDate/Type	Date label & incident type when applicable	“June 15 / Wear■Failure”
Keywords/CriticalEntities	Salient terms for retrieval	MG■5025A, wear, tooth, failure, 50 kHz
ClientId/CaseId	Client & case tracking IDs (if relevant)	MVNOGA / MG■5025A
TableId/FigureId	Local identifiers for tables/figures	T■01, F■02
Chunk Size	Target 250–500 tokens avg (max 800 for tables/figures/captions)	Applied by creating compact, self■contained chunks

Table T■02: Metadata fields required by the chunking specification.

Implementation Note: Each paragraph above was authored as a logical unit (chunk) with compact scope to meet the target average chunk size (≈250–500 tokens). Tables and figures are paired with short captions to remain below the recommended maximum of 800 tokens for non■textual content anchors. All chunks explicitly carry an ANCHORS line that lists SectionType, optional IncidentDate/Type, optional TableId/FigureId, and a reference to the page number available in the footer.

Implementation Note: Each paragraph above was authored as a logical unit (chunk) with compact scope to meet the target average chunk size (≈250–500 tokens). Tables and figures are paired with short captions to remain below the recommended maximum of 800 tokens for non■textual content anchors. All chunks explicitly carry an ANCHORS line that lists SectionType, optional IncidentDate/Type, optional TableId/FigureId, and a reference to the page number available in the footer.

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