# Laboratory Oil Analysis Summary

Prepared by Endurance Marine Diesel Inc.

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| **Client** | Jeffrey Labowski |
| **Vessel Name** | Bunny's Toe |
| **Location** | Huntington Beach, CA |
| **Samples Drawn** | July 13, 2026 — during survey & sea trial |
| **Laboratory** | Hawthorne Machinery Co. (CAT S·O·S) — Received July 17, 2026 |
| **Analysis Method** | Spectrographic elemental analysis, viscosity, infrared condition, water/fuel/antifreeze screening |
| **Units Sampled** | Port & Starboard Main Engines · Port & Starboard Transmissions · Generator |
| **Reference** | Marine Engine, Transmission & Generator Survey Report — Bunny's Toe |

## PURPOSE & HOW TO READ THIS SUMMARY

During the July 13 survey, oil samples were drawn from both main engines, both transmissions, and the generator and submitted for laboratory spectrographic analysis, as noted in the survey report's scope of inspection. The laboratory results have now been received. This summary presents each unit's result with the lab's finding and our interpretation in plain terms.

Spectrographic analysis measures microscopic metal particles suspended in the oil — the "fingerprint" of internal wear — along with oil viscosity, contamination (water, fuel, coolant), and the condition of the oil itself. It is one of the best early-warning tools available for machinery health, because internal problems typically show up in the oil before they can be seen, heard, or felt.

Prior laboratory samples from March 2024 are on file for four of the five units (the starboard transmission is sampled here for the first time), and each unit's prior result is noted in its section below. Even so, the laboratory notes throughout that more sample history is needed to establish reliable wear trends — the real diagnostic power comes from comparing samples over time. Continued sampling at each service is recommended for every unit.

## PORT MAIN ENGINE — VOLVO PENTA D12D-MP

✓ LAB RESULT — NO ACTION REQUIRED

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| **Wear metals** | **Low** | Iron 3 ppm, copper 2 ppm — excellent for a D12; no abnormal internal wear indicated |
| **Water / antifreeze** | **Negative** | No coolant intrusion into the oil despite the external coolant leaks noted in the survey |
| **Viscosity @ 100°C** | **13.8 cSt** | Within grade and unchanged from the prior sample |
| **Fuel content** | **2.4%** | Elevated versus 0.88% in the 2024 sample — see comment below |
| **Additive package** | **Low** | Calcium, zinc & phosphorus well below the prior sample — see comment below |

**PRIOR SAMPLE ON FILE** March 26, 2024 · ID H190-54092-4001 · 593.2 hrs · Lab verdict: all tests normal, unknown hours on oil. Then: iron 10 ppm, fuel 0.88%, viscosity 13.80 cSt, full additive package (Ca 1,820 / Zn 1,254 / B 402). Approximately 17 hours accumulated between samples.

**Our comments.** Internal wear indicators are excellent. Two items are worth attention, both consistent with conditions already documented in the survey. First, fuel content in the oil has risen to 2.4% — this aligns with the substantial active fuel leak found at the aftercooler and reinforces the recommendation to correct that leak before extended operation; fuel dilution thins the oil and reduces its protective ability if allowed to continue. Second, the additive levels are far lower than the previous sample, which suggests the current fill may not match the previous oil specification. We recommend confirming the correct Volvo Penta-approved oil (VDS-3 15W-40) at the upcoming oil service, then resampling to establish a clean baseline.

## STARBOARD MAIN ENGINE — VOLVO PENTA D12D-MP

✓ LAB RESULT — NO ACTION REQUIRED

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| **Wear metals** | **Low** | Iron 5 ppm, copper 4 ppm — normal for the hours; no abnormal internal wear indicated |
| **Water / antifreeze** | **Negative** | No coolant intrusion into the oil |
| **Viscosity @ 100°C** | **14.5 cSt** | Within grade; consistent with the prior sample |
| **Fuel content** | **1.4%** | Up from 0.74% in 2024 — mild; worth watching at the next sample |

**PRIOR SAMPLE ON FILE** March 26, 2024 · ID H190-54092-4003 · 596.4 hrs · Lab verdict: all tests normal. Then: iron 7 ppm, fuel 0.74%, viscosity 14.30 cSt. Approximately 18 hours accumulated between samples.

**Our comments.** A clean report. Internal wear is low and the oil is holding its grade. Fuel content has crept up modestly and should simply be watched on the next sample after the recommended fuel-system and injector-related service items are completed.

## PORT TRANSMISSION — ZF 325-1A

✓ LAB RESULT — NO ACTION REQUIRED

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| **Water** | **Negative** | Significant improvement — the March 2024 sample tested positive for water |
| **Copper** | **345 ppm** | Typical of ZF gears — copper leaches from the oil-cooler core and clutch materials |
| **Lead** | **88 ppm** | Consistent with bushing/thrust-washer material; stable versus the 2024 sample |
| **Iron** | **6 ppm** | Low — gear and bearing wear normal |
| **Viscosity @ 100°C** | **11.6 cSt** | Acceptable |

**PRIOR SAMPLE ON FILE** March 26, 2024 · ID H190-54092-4024 · 593.2 hrs · Lab verdict: **positive water in sample** — lab directed inspection for water-entry source, oil & filter change, and a 10-hour resample. Then: copper 261 ppm, lead 98 ppm, viscosity 13.60 cSt.

**Our comments.** The most encouraging result of the set. The previous 2024 sample flagged positive water contamination in this gearbox; the current sample is clean — no water present. Elevated copper and lead readings are characteristic of ZF marine gears (cooler-core leaching and clutch/bushing material) rather than a sign of active failure, and the lab agrees no action is required. This pairs with the survey's recommendation to repair the pressure-sensor area leak and service the transmission cooler as part of the cooling package — after which a follow-up sample will confirm the trend.

## STARBOARD TRANSMISSION — ZF 325-1A

✓ LAB RESULT — NO ACTION REQUIRED

| | | |
|---|---|---|
| **Water** | **Negative** | Clean |
| **Copper** | **85 ppm** | Well below the port unit; normal cooler/clutch signature |
| **Lead** | **43 ppm** | Normal range for this gear |
| **Iron** | **3 ppm** | Low — gear and bearing wear normal |
| **Viscosity @ 100°C** | **10.8 cSt** | Acceptable |

**PRIOR SAMPLE** None on file — this is the first laboratory sample recorded for this unit.

**Our comments.** A clean first sample with low wear metals across the board. With no prior history on file for this gear, this result becomes the baseline; continue sampling at each service to build the trend line.

## GENERATOR — KOHLER 23EOZD

◆ LAB RESULT — NO ACTION REQUIRED · ONE ITEM NOTED

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| **Viscosity @ 100°C** | **10.9 cSt** | Flagged by the lab as low for a 15W-40 (typical range ≈12.5–16.3) |
| **Fuel content** | **0.6%** | Lab: fuel test acceptable |
| **Water / antifreeze** | **Negative** | Clean |
| **Wear metals** | **Low** | Iron 9 ppm, copper 2 ppm — normal at 42 hours |

**PRIOR SAMPLE ON FILE** March 26, 2024 · ID H190-54092-4002 · 36.9 hrs · Lab verdict: all tests normal, unknown hours on oil. Then: viscosity 10.30 cSt, fuel 0.54%. Approximately 5 hours accumulated between samples.

**Our comments.** The lab noted the viscosity is low for a 15W-40 while all other readings appear normal. Notably, the 2024 sample measured essentially the same low viscosity (10.30 cSt), which points toward the fill itself — a lighter-grade or mixed oil — rather than active dilution developing between samples. This dovetails with the survey's open item on the persistent rainbow sheen: at the recommended generator service, the oil should be changed to a confirmed 15W-40 fill, and the sheen diagnosis completed. A resample after the change will verify the viscosity corrects and establish the baseline.

## OVERALL SUMMARY

All five units returned **"No Action Required"** laboratory verdicts. Internally, this machinery is healthy — wear-metal levels are low across both engines and both transmissions, and no water or coolant contamination is present in any unit. The port transmission's previous water contamination from 2024 has cleared, which is a meaningful improvement.

The items the analysis does surface — elevated fuel content in the port engine oil, low additive levels in the port engine fill, and low viscosity in the generator oil — all align with and reinforce conditions already identified in the survey report rather than revealing new problems. In plain terms: the machinery is sound on the inside; the work needed is the external corrective maintenance already documented.

- Correct the port-engine fuel leak (survey recommendation) — the 2.4% fuel-in-oil reading confirms fuel is finding its way where it shouldn't.
- Perform oil and filter services on all five units using confirmed correct specifications (Volvo Penta VDS-approved 15W-40 for the mains; 15W-40 for the generator; ZF-approved fluid for the gears).
- Resample every unit at the completion of the recommended repairs to establish clean baselines, then sample at each regular service interval to build wear trends.

Laboratory analysis performed by Hawthorne Machinery Co. (CAT S·O·S program), interpreted by the laboratory and summarized here by Endurance Marine Diesel Inc. Laboratory reports are available in full upon request. Oil analysis is a predictive maintenance aid; no guarantee against component failure is expressed or implied.

Respectfully Submitted,

Todd Hockensmith

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