



Contamination Control Checklist for Critical Equipment



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Introduction to contamination causes.

Contamination is one of the leading causes of premature failure in industrial and mining equipment. Studies published by the OEMs (Bosch Rexroth, Parker, SKF) and confirmed by LPR site data show that between 70% and 80% of hydraulic, gearbox and bearing failures can be traced back to lubricant contamination - most of it introduced during storage, handling and top-up, not during operation.

Dust, water, wear debris and cross-contamination between lubricant grades degrade the oil, strip additives, damage load-carrying films and shorten component life. In modern equipment, where hydraulic servo valves and rolling-element bearings operate at clearances of 1–5 microns, contaminants smaller than a human hair ($\approx 70 \mu\text{m}$) are enough to cause catastrophic wear.

This document forms part of the LPR Knowledge Centre. It sets out the principles, practices and monitoring tools that LPR applies through its Total Fluid Management (TFM) programme - combining Castrol high-performance lubricants, One Eye Industries magnetic filtration and HPL specialty products to protect customer equipment and extend component life.



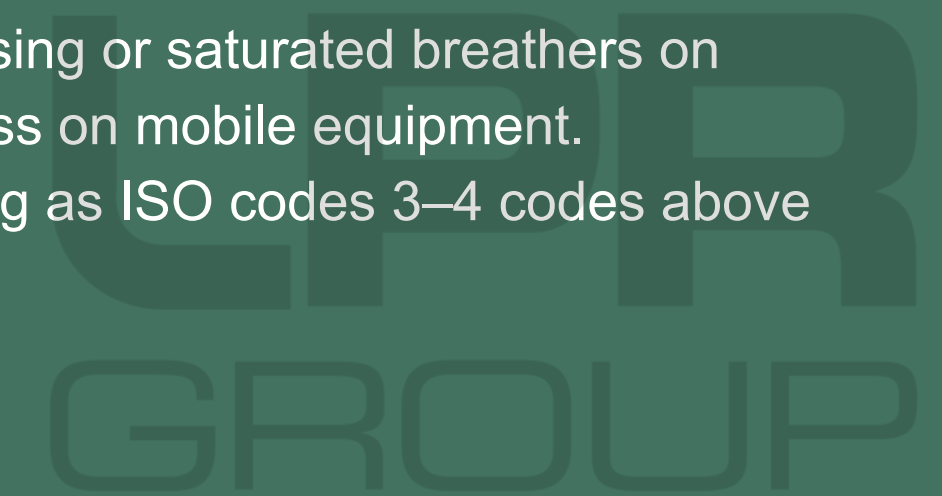
1. What are the biggest sources of contamination in industrial equipment?

The dominant contamination sources across LPR customer sites fall into four categories:

- **Airborne dust and silica ingress** - through failed or missing breathers, damaged shaft seals, worn gearbox vents and unsealed reservoir hatches. In South African mining and quarrying environments, silica dust is abrasive, angular and extremely destructive to hydraulic pumps and rolling-element bearings.
- **Water ingress** - from condensation (day/night temperature swings), high-pressure wash-down, rain, coolant leaks and poorly stored drums left outdoors. Free and emulsified water destroys the oil film, promotes rust, accelerates additive depletion and drives hydrogen-induced bearing spalling.
- Internally generated wear debris - ferrous and non-ferrous particles produced during normal operation. Standard depth or pleated filters do not effectively remove sub-10-micron wear particles, which then circulate and cause a cascade of secondary wear.
- **Cross-contamination and handling errors** - mixing incompatible lubricants (mineral with PAG, lithium with polyurea grease), using dirty transfer containers, sharing funnels between grades, and topping up from open drums. LPR routinely finds that top-up is the single largest source of new dirt entering a system.

Effective contamination control begins upstream of the equipment: sealed bulk storage, dedicated colour-coded transfer equipment, high-quality desiccant breathers, correct seal maintenance and disciplined handling procedures.

- **Site-specific sources we encounter most often:** top-up from open 210 L drums stored outdoors; missing or saturated breathers on gearboxes and hydraulic reservoirs; shared transfer pumps between grades; and wash-bay water ingress on mobile equipment.
- **Most common contamination issue:** particulate ingress combined with moisture — typically presenting as ISO codes 3–4 codes above the OEM target, elevated water content and rising iron/silicon in oil analysis.



2. Which equipment is most vulnerable to contamination?

The most sensitive systems on any customer site are those with tight internal clearances and high operating pressures:

- **Hydraulic systems** - servo and proportional valves operate at clearances of 1–3 µm; piston pumps at 5–10 µm. Bosch Rexroth, Parker and Eaton typically specify ISO 4406 cleanliness of 18/16/13 or cleaner for reliable service.
- **Rolling-element bearings** - the elastohydrodynamic (EHD) oil film in a loaded bearing is only 0.1–1 µm thick. Particles larger than the film thickness cause surface indentation, which becomes the initiation site for spalling and premature failure.
- **Industrial gearboxes** - gear tooth contact films are 0.5–3 µm. Water content above 500 ppm reduces gear and bearing life significantly and drives additive depletion in EP oils such as Castrol Alpha SP and Optigear.
- **Compressors and vacuum pumps** - sensitive to moisture, oxidation and varnish. Small amounts of water and oxidation by-products cause valve sticking, deposit build-up and reduced efficiency.
- **Diesel engines** - soot, fuel dilution and coolant ingress rapidly degrade engine oil performance and drive bearing, ring and turbocharger wear.

A useful rule of thumb applied by LPR technical: the higher the pressure or the tighter the tolerance, the greater the impact of a single unit reduction in the ISO cleanliness code. Improving cleanliness by 2 codes typically doubles component life.

- **Most common failures across our customer base:** hydraulic pump wear (particularly on ADTs, dozers and drill rigs), premature gearbox bearing failures on conveyors and mills, and wheel-motor / final-drive contamination on mobile mining fleet.
- **Highest-risk industries: opencast mining, quarrying, cement, sugar and pulp & paper** - where dust, moisture and washdown environments combine with high-load hydraulics and gearing.

3. How can contamination be prevented?

Contamination control is a system, not a single product. LPR applies the following prevention hierarchy across every TFM site:

- **Exclude** - seal the system. Fit high-capacity desiccant breathers, replace worn shaft seals, close reservoir hatches, and use quick-connect couplings on top-up points.
- **Store correctly** - keep drums and IBCs indoors, on their side or under cover, with bungs down. Use dedicated bulk tanks with sealed fill points and breathers for high-volume products such as Castrol Hyspin AWS, Alpha SP and Tection.
- **Transfer cleanly** - colour-coded, dedicated transfer pumps and containers per grade. All new oil should be filtered on the way in — new oil from the refinery is typically ISO 21/19/16 or dirtier, well outside hydraulic OEM specification.
- **Filter continuously** - specify main-flow and off-line filtration to match the OEM cleanliness target. LPR installs One Eye Industries magnetic filtration alongside conventional pleated elements to capture ferrous and non-ferrous wear debris down to 1 µm at up to 99% efficiency — well below the range of standard depth filters.
- **Monitor** - routine oil analysis (particle count, water, viscosity, wear metals, additive levels) to verify that prevention is working and to trigger corrective action early.
- **Train** - the best filter cannot protect equipment from poor handling. LPR provides on-site contamination control training as part of every TFM roll-out.
- **Standard TFM contamination-control practices:** sealed bulk installations, colour-coded handling, desiccant breather retrofits, One Eye magnetic filter installations on hydraulic and gearbox systems, particle-count monitoring after every filter change and quarterly oil analysis reporting.
- **Additional recommendations:** flushing procedures during oil changes (equipment is often re-filled into a dirty system), and use of Castrol Techniclean or equivalent system cleaners before changing to a new lubricant technology.

4. How should contamination be monitored?

Effective monitoring combines laboratory oil analysis, on-site checks and trending over time. LPR recommends the following as a minimum:

- **ISO 4406 particle counting** - the primary cleanliness measure for hydraulic and circulating systems. Compare results to the OEM target, not to industry averages.
- **Water content** - Karl Fischer (ppm) for critical systems; crackle test on-site for a quick indicative check.
- **Viscosity at 40 °C and 100 °C** - confirms the correct grade is in the system and detects fuel dilution, oxidation and cross-contamination.
- **Wear metals and additives (ICP)** - iron, chromium, copper, tin, aluminium, silicon (dirt), sodium/potassium (coolant); plus zinc, phosphorus, calcium for additive health.
- **TAN / TBN** - oxidation and reserve alkalinity, particularly for engines, compressors and turbine oils.
- **Filter debris analysis** - cutting open used filters (including One Eye magnetic elements) provides direct visual evidence of the wear mode inside the system.

Recommended sampling intervals (guideline):

- Hydraulic systems (mobile & industrial): every 500 operating hours or 3 months, whichever comes first.
- Industrial gearboxes (critical): quarterly, or monthly for high-criticality applications.
- Diesel engines: every service interval (typically 250–500 hours).
- Turbines and compressors: quarterly, with continuous online particle-count monitoring where justified.

The value of monitoring lies in trending - a single result identifies a moment in time; a trend identifies a developing failure early enough to act.

- **LPR monitoring services provided:** sampling, laboratory oil analysis via accredited partners, ISO 4406 particle counting, trend reporting, on-site quick-check kits (crackle, patch test, viscosity comparator), and root-cause investigation on out-of-limit samples.
- **Reporting:** consolidated fleet-level dashboards under the TFM programme, with red/amber/green status and clear corrective actions per asset.

5. What are the warning signs of lubricant contamination?

Contamination almost always announces itself before the failure. The warning signs LPR looks for during site inspections and oil analysis review include:

- **Visual:** cloudy or hazy oil (water), darkened or blackened oil (oxidation, soot, thermal degradation), visible sediment at the bottom of the sample bottle, foaming or air entrainment.
- **Operational:** rising operating temperatures, unusual noise from pumps or bearings, sluggish or erratic hydraulic response, increased cycle times, and repeated filter blockages or short filter life.
- **Oil analysis:** ISO codes trending upward, rising silicon (dirt ingress), rising iron or copper (bearing / bushing wear), water above 500 ppm, viscosity shift outside $\pm 10\%$ of new-oil value, and additive depletion.
- **Filter and magnet evidence:** heavy loading on One Eye magnetic elements (fine ferrous fuzz vs. large chunks tells a different failure story), premature blockage of conventional filters, and metallic sheen on drain plugs and sump magnets.
- **Component symptoms:** unexplained repeat failures of the same component, shortened bearing life, sticking valves, seal leaks and pitting on gear teeth or bearing raceways.
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Where two or more of these signs appear together, the system should be sampled and inspected before the next planned service - the cost of investigation is a fraction of the cost of an unplanned failure.

- **Warning signs most commonly identified on site:** elevated silicon in mining hydraulics, rising water in gearboxes exposed to washdown, and premature filter blockage on retrofitted systems where the pre-existing contamination has never been flushed out.
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Customer case examples (to be developed for the final PDF): One Eye magnetic filter installation on a mining ADT hydraulic system - reduction in ISO cleanliness from 22/20/17 to 17/15/12 within two oil changes; Castrol Alpha SP + desiccant breather retrofit on a cement plant gearbox - bearing failure rate reduced by more than half over 12 months

The LPR Contamination Control Offer

LPR Group combines premium lubricants, specialist filtration and on-site technical services into a single Total Fluid Management (TFM) offer:

- **Castrol high-performance industrial lubricants** - Hyspin AWS/AWH hydraulics, Alpha SP and Optigear industrial gear oils, Tecton heavy-duty engine oils, Molub-Alloy specialty greases and Techniclean system cleaners, backed by Castrol OEM approvals.
- **HPL specialty products** - high-performance lubricants for niche and severe-duty applications not covered by standard Castrol range.
- **One Eye Industries magnetic filtration** - patented radial magnetic technology capturing ferrous and non-ferrous wear particles down to 1 µm at up to 99% efficiency, extending oil and component life well beyond conventional filtration alone.
- **On-site Total Fluid Management** - sealed storage design, colour-coded handling, filter cart services, oil sampling and analysis, contamination control training, and consolidated technical reporting.
- **Reliability outcomes** - measurably lower ISO cleanliness codes, extended drain intervals where appropriate, reduced unplanned downtime and lower total cost of lubrication.

Next Steps

For a contamination control assessment of your site, an ISO cleanliness baseline, or a TFM proposal that combines Castrol lubricants and One Eye Industries filtration, contact the LPR technical team.

LPR Group - National distributor for Castrol High Performance and Industrial Lubricants, HPL specialty products and One Eye Industries magnetic filtration. Total Fluid Management specialists.

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