

| Wear Metals | | | | | | | |
|----------------------|--|--|---|---|---|--|---|
| Metal | Reciprocating Engines | Transmissions | Gear Systems | Hydraulics | Rotary Compressors | Reciprocating Compressors | Turbines/ Centrifugal Compressors |
| Iron (Fe) | Cylinder Liners, Rings, Gears, Crankshaft, Camshaft, Rods, Valve Train, Oil Pump Gear, Wrist Pins, Cast Iron | Gears, Disks, Housing, Bearings, Brakes Bands, Shafts | Gears, Shafts, Bearings, Cast Iron | Rods, Cylinders, Gears, Shafts, Pistons | Gears, Shafts, Bearings, Casting | Shafts, Pistons, Crossheads, Packing Glands, Gears, Housing Cast Iron, Valves | Shafts, Gears, Bearings, Valves |
| Chrome (Cr) | Rings, Liners, Exhaust Valves, Shaft Plating, Stainless Steel Alloy | Roller Bearings, Needle Bearings, Shafts | Roller Bearings, Needle Bearings, Shafts | Rods, Cylinders, Gears, Shafts, Pistons | Shafts, Bearings | Shaft Plating, Ring Plating | Shafts, Bearings |
| Aluminum (Al) | Pistons, Thrust Bearings, Turbo Bearings, Main/Rod Bearings in Cat Engines | Pumps, Thrust Washers, Casting Aluminum, Aluminum Oxides from Dirt (Silica) Contamination | Pumps, Thrust Washers, Casting Aluminum, Aluminum Oxides from Dirt (Silica) Contamination | Bearings, Thrust Plates, Pistons | Case Casting, Impellers/Screws | Aluminum Oxides from Dirt (Silica), Pistons, Bearings Crossheads, Retainers | Thrust, Aluminum Oxides from Dirt (Silica), Heat Exchanger Core |
| Nickel (Ni) | Alloy in Valves, Crankshaft, Camshaft, Contaminant in Marine Bunker Fuels | Steel Alloy form Bearings, Shafts | Steel Alloy from Bearings, Shafts | Valves, Spools, Shafts | Shafts, Bearings | Valves, Pins, Shafts, Gears | Shafts, Bearings |
| Copper (Cu) | Main/Rod Bearings (Also look for Lead), Brass/Bronze Bushings (Also Look for Tin and/or Zinc), Oil Cooler Core Tubing | Clutch Plates, Brass/ Bronze Bushings (Also Look for Tin and/or Lead & Zinc), Oil Cooler Core Tubing | Brass/Bronze Bushings (Also Look for Tin and/or Lead & Zinc), Cage Metal from Roller Bearings, Oil Cooler Core Tubing | Bearings, Bushings, Thrust Washers, Oil Cooler Tubing | Bearings, Bushings, Thrust Plate, Oil Cooler Tubing | Bearings, Bushings, Thrust Washers, Oil Cooler Tubing | Bearings, Bushings, Thrust Plate, Oil Cooler Tubing |
| Lead (Pb) | Overlay metal in Main/Rod Bearings, Sometimes Solder, Aftermarket Additive | Clutch Plates, Brass/ Bronze Bushings (Also Look for Tin and/or Lead & Zinc) | Brass/Bronze Bushings (Also Look for Copper, Tin & Zinc), Cage Metal from Roller Bearings, Oil Cooler Core Tubing | Bearings, Bushings (Babbitt) (Also Look for Tin, Antimony & Copper) | Bearings, Bushings (Babbitt) (Also look for Tin, Antimony & Copper) | Bearings, Bushings (Babbitt) (Also look for Tin, Antimony & Copper) | Bearings, Bushings (Babbitt) (Also look for Tin, Antimony & Copper) |
| Tin (Sn) | Bearings (Babbitt) (Also Look for Lead, Antimony and Copper), Bronze Bushings Flashing from Pistons, Solder from Tin-Lead Solder | Brass/Bronze Bushings (Also Look for Tin and/or Lead & Zinc) | Bearings, Bushings (Babbitt) (Also Look for Lead, Antimony & Copper) Solder from Tin-Lead Solder | Bearings (Babbitt) (Also Look for Lead, Antimony, Copper & Bronze), Bushings Flashing from Pistons, Solder form Tin-Lead Solder | Bearings (Babbitt), Bushings, Solder from Tin-Lead Solder | Bearings, Bushings (Babbitt) (Also Look for Lead, Antimony & Copper), Flashing from Pistons, Solder from Tin-Lead Solder | Bearing (Babbitt), Bushings, Solder from Tin-Lead Solder |
| Cadmium (Cd) | Environmental Contaminant | Sometimes an Alloy Metal, Environmental Contaminant | Sometimes an Alloy Metal, Environmental Contaminant | Alloy form Cadmium Aluminum Bearings, Environmental Contaminant | Alloy form Cadmium Aluminum Bearings, Environmental Contaminant | Alloy form Cadmium Aluminum Bearings, Environmental Contaminant | Alloy form Cadmium Aluminum Bearings, Environmental Contaminant |
| Silver (Ag) | Silver in Wrist Pin Bushings in EMD 567 & 745 Engines, Some Solder from Cooler Core Joints | Trace Element in some Needle Bearings, Solder form Oil Cooler Core Joints | Not usually found in Gear Systems, Possibly from Solder | Solder, Trace Element | Solder, Trace Element | Solder, Trace Element | Solder, Trace Element |
| Titanium (Ti) | Valves, Piston Pins, Bearings, Shafts | Shafts, Gears, Bearings, Paint or Coatings | Shafts, Gears, Bearings, Paint or Coatings | Valves, Piston Pins, Bearings, Shafts | Shafts, Gears, Bearings, Paint or Coatings | Valves, Piston Pins | Shafts, Gears, Bearings, Paint or Coatings |
| Vanadium (V) | Alloy Metal, Contaminant in Marine Bunker Fuels | Usually not found in Transmissions, Possibly Environmental Contaminant | Usually not found in Gear Systems, Possibly Environmental Contaminant | Alloy Metal | Alloy Metal | Alloy Metal | Alloy Metal |

Contaminant Metals

| Metal | Reciprocating Engines | Transmissions | Gear Systems | Hydraulics | Rotary Compressors | Reciprocating Compressors | Turbines/ Centrifugal Compressors |
|----------------------|--|--|--|---|---|---|---|
| Silicon (Si) | Dirt (Silica), Silicone form Silicon based Synthetic, Silicone Sealants, Silicates from Anti-Freeze | Dirt (Silica), Silicone form Silicon based Synthetic, Silicone Sealants, Silicates from Anti-Freeze | Dirt (Silica), Silicone form Silicon based Synthetic, Silicone Sealants, Silicates from Anti-Freeze | Dirt (Silica), Silicone form Silicon based Synthetic, Silicone Sealants, Silicates from Anti-Freeze | Dirt (Silica), Silicone form Silicon based Synthetic, Silicone Sealants, Silicates from Anti-Freeze | Dirt (Silica), Silicone form Silicon based Synthetic, Silicone Sealants, Silicates from Anti-Freeze | Dirt (Silica), Silicone form Silicon based Synthetic, Silicone Sealants, Silicates from Anti-Freeze |
| Sodium (Na) | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor (Coolant Leak) | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor (Coolant Leak) | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor (Coolant Leak) | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor (Coolant Leak) | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor (Coolant Leak) | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor (Coolant Leak) | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor (Coolant Leak) |
| Potassium (K) | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor (Coolant Leak) Additive from Potassium Borate Gear Oil | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor (Coolant Leak) Additive from Potassium Borate Gear Oil | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor (Coolant Leak) Additive from Potassium Borate Gear Oil | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor, Additive from potassium Borate Gear Oil | Environmental Contaminant from Pot Ash Mining, Water Contaminant, Anti-Freeze Inhibitor | Sodium from Salt Water, Spray Wash, Anti-Freeze Inhibitor | Environmental Contaminant from Pot Ash Mining, Water Contaminant, Anti-Freeze Inhibitor |

Multi-Source Metals

| Metal | Reciprocating Engines | Transmissions | Gear Systems | Hydraulics | Rotary Compressors | Reciprocating Compressors | Turbines/ Centrifugal Compressors |
|------------------------|---|---|---|---|---|---|---|
| Molybdenum (Mo) | Friction Modifier Additive in Oils, Grease Contamination, Molybdates from Some Coolants | Friction Modifier Additive in Oils, Grease Contamination, Molybdates from Some Coolants | Friction Modifier Additive in Oils, Grease Contamination, Molybdates from Some Coolants | Friction Modifier Additive in Oils, Grease Contamination, Molybdates from Some Coolants | Alloy or Plating from Rings, Retainer Pins, Friction Modifier Additive in Oils, Grease Contamination, Molybdates from Some Coolants | Alloy or Plating from Rings, Retainer Pins, Friction Modifier Additive in Oils, Grease Contamination, Molybdates from Some Coolants | Alloy or Plating from Rings, Retainer Pins, Friction Modifier Additive in Oils, Grease Contamination, Molybdates from Some Coolants |
| Antimony (Sb) | Alloy Metal in Babbitt Bearings, Bushings, Trace Element Used in Some Oils | Alloy Metal in Babbitt Bearings, Bushings, Trace Element Used in Some Oils | Alloy Metal in Babbitt Bearings, Bushings, Trace Element Used in Some Oils | Alloy Metal in Babbitt Bearings, Bushings, Trace Element Used in Some Oils | Alloy Metal in Babbitt Bearings, Bushings, Trace Element Used in Some Oils | Alloy Metal in Babbitt Bearings, Bushings, Trace Element Used in Some Oils | Alloy Metal in Babbitt Bearings, Bushings, Trace Element Used in Some Oils |
| Manganese (Mn) | Steel Alloy Metal in Gears, Some Shafts | Steel Alloy Metal in Gears, Some Shafts | Steel Alloy Metal in Gears, Some Shafts | Steel Alloy Metal in Gears, Some Shafts | Steel Alloy Metal in Gears, Some Shafts | Steel Alloy Metal in Gears, Some Shafts | Steel Alloy Metal in Gears, Some Shafts |
| Lithium (Li) | Contact with Grease | Contact with Grease | Contact with Grease | Contact with Grease | Contact with Grease | Contact with Grease | Contact with Grease |

Additive Metals

| Metal | Reciprocating Engines | Transmissions | Gear Systems | Hydraulics | Rotary Compressors | Reciprocating Compressors | Turbines/ Centrifugal Compressors |
|-----------------------|---|---|--|---|---|---|---|
| Boron (B) | Additive Common in Engine Oils, Some Gear Oils | Additive Common in Engine Oils, Some Gear Oils, and Dexron Fluids | Additive Common in Engine Oils, Some Gear Oils, and Dexron Fluids | Additive Common in Engine Oils, Some Gear Oils | Additive Common in Engine Oils, Some Gear Oils | Additive Common in Engine Oils, Some Gear Oils | Additive Common in Engine Oils, Some Gear Oils |
| Magnesium (Mg) | Detergent/Dispersant Additive, Alloy, Environmental Contaminant | Detergent/Dispersant Additive, Alloy, Environmental Contaminant | Detergent/Dispersant Additive, Alloy, Environmental Contaminant | Detergent/Dispersant Additive, Alloy, Environmental Contaminant | Detergent/Dispersant Additive, Alloy, Environmental Contaminant | Detergent/Dispersant Additive, Alloy, Environmental Contaminant | Detergent/Dispersant Additive, Alloy, Environmental Contaminant |
| Calcium (Ca) | Detergent/Dispersant Additive, Calcium from Water Contamination, Lime Dust | Detergent/Dispersant Additive, Calcium from Water Contamination, Lime Dust | Detergent/Dispersant Additive, Calcium from Water Contamination, Lime Dust | Detergent/Dispersant Additive, Calcium from Water Contamination, Lime Dust | Detergent/Dispersant Additive, Calcium from Water Contamination, Lime Dust | Detergent/Dispersant Additive, Calcium from Water Contamination, Lime Dust | Detergent/Dispersant Additive, Calcium from Water Contamination, Lime Dust |
| Barium (Ba) | Not Commonly found in Engine Oils, Contaminant in Drilling Applications | Contaminant in Drilling Applications, Additive in Some Synthetic Oils | Contaminant in Drilling Applications | Not Commonly found in Hydraulic Oils, Contaminant in Drilling Applications | Demulsifying Agent, Additive Common in Compressor Oil, Some Transmission Fluids & Gear Oils, Contaminant in Drilling Applications | Demulsifying Agent, Additive Common in Compressor Oil, Some Transmission Fluids & Gear Oils, Contaminant in Drilling Applications | Demulsifying Agent, Additive Common in Compressor Oil, Some Transmission Fluids & Gear Oils, Contaminant in Drilling Applications |
| Phosphorus (P) | Anti-Wear Additive ZDDP (ZincDialkyl-DithioPhosphate), Phosphate Ester, Phosphate Inhibitor found in Coolants | Anti-Wear Additive ZDDP (ZincDialkyl-DithioPhosphate), Phosphate Ester, Phosphate Inhibitor found in Coolants | EP Additive, Anti-Wear Additive ZDDP (Zinc-DialkylDithioPhosphate), Phosphate Ester, Phosphate Inhibitor found in Coolants | Anti-Wear Additive ZDDP (ZincDialkyl-DithioPhosphate), Phosphate Ester, Phosphate Inhibitor found in Coolants | EP Additive, Anti-Wear Additive ZDDP (Zinc-DialkylDithioPhosphate), Phosphate Ester, Phosphate Inhibitor found in Coolants | EP Additive, Anti-Wear Additive ZDDP (Zinc-DialkylDithioPhosphate), Phosphate Ester, Phosphate Inhibitor found in Coolants | EP Additive, Anti-Wear Additive ZDDP (Zinc-DialkylDithioPhosphate), Phosphate Ester, Phosphate Inhibitor found in Coolants |
| Zinc (Zn) | Alloy in Brass, Anti-Wear Additive ZDDP, Galvanized Steel from Filter Canisters | Alloy in Brass, Anti-Wear Additive ZDDP, Galvanized Steel from Filter Canisters | Alloy in Brass, Anti-Wear Additive ZDDP, Galvanized Steel from Filter Canisters | Alloy in Brass, Anti-Wear Additive ZDDP, Galvanized Steel from Filter Canisters | Alloy in Brass, Anti-Wear Additive ZDDP, Galvanized Steel from Filter Canisters | Alloy in Brass, Anti-Wear Additive ZDDP, Galvanized Steel from Filter Canisters | Alloy in Brass, Anti-Wear Additive ZDDP, Galvanized Steel from Filter Canisters |