# CHAPTER 7
# VEHICLE MAINTENANCE

Ski area vehicle maintenance shops generate a variety of solid wastes, hazardous wastes, and air emissions and have many opportunities to reduce these environmental hazards. For example, a typical vehicle maintenance shop that implements the environmental strategies discussed in this chapter can generate little or no hazardous waste. This chapter discusses pollution prevention opportunities for ski area vehicle maintenance shops in the topic areas listed below.

- Aqueous cleaning
- Chemical product selection
- Refillable spray bottles
- Used oil heaters
- Shop spill cleanup
- Oil bottle draining
- Re-refined oil
- Oil filter management
- Snowmobiles
- Oxygenated gasoline
- Snowcat hydraulic line preventive maintenance

Case studies are used to illustrate how ski areas have implemented the various strategies described in this chapter. Cost savings documented by the vehicle maintenance case studies from ski areas range from $500 to $80,000 per year. Information sources (vendors, documents, and web sites) for each topic discussed in this chapter can be found in Section 7.12.

## 7.1 AQUEOUS CLEANING

Mineral spirits is a petroleum distillate solvent commonly used for part cleaning because of its ability to quickly dissolve oil, grease, dirt, grime, burnt-on carbon, and heavy lubricants. Although it is effective for cleaning, mineral spirits use raises significant environmental and worker health concerns:

- Mineral spirits contains volatile organic compounds (VOC) that contribute to smog formation and that may be toxic when inhaled.
- Mineral spirits evaporates quickly, making worker exposure difficult to control.
- Solvent cleaning units are a significant source of hazardous waste in ski area vehicle maintenance (and lift operations) shops.

Using solvents creates unnecessary environmental and worker health issues for ski areas. In some metropolitan areas (for example, Los Angeles and San Francisco), using solvents for part cleaning has been banned or severely restricted, and this regulatory trend is likely to expand to other areas of the country. Switching to less toxic, water-based (aqueous) cleaning solutions can minimize regulatory compliance requirements, waste disposal, and labor costs.

Aqueous part cleaning systems feature a water-based solution that, unlike petroleum-based solvents, is typically nonflammable and contains less than 5 percent VOCs. Instead of dissolving grease and solids, water-based systems rely on heat, agitation, and soap action to clean parts. Although they clean differently, according to many vehicle maintenance shop supervisors and mechanics, aqueous cleaning units perform as well as or better than traditional solvents.

"We cleaned a transmission in the aqueous unit for 15 minutes and it came out sparkling clean."

*Don Mushet*
*ASC Vehicle Maintenance Manager*

Aqueous cleaning units are available in four basic designs: (1) microbial sink-top, (2) spray cabinet, (3) immersion, and (4) ultrasonic. The appropriate type for a vehicle maintenance shop depends on the size and specific cleaning needs of the shop; however, most vehicle maintenance (and lift operations) shops in ski areas can successfully convert from solvent to aqueous cleaning with a spray cabinet. Table 7.1 summarizes useful information about spray cabinets.

**TABLE 7.1 AQUEOUS SPRAY CABINETS**

| **Applications** | **Key Features** |
|---|---|
| • Parts with heavy or difficult-to-remove contamination<br>• Moderate to very large quantities of parts<br>• Medium- to large-size parts (but can accommodate small parts)<br>• Heavy-duty repairs and rebuilding | • Solution heated to 130 to 190 °F<br>• Spray pressure of 40 to 60 psi<br>• Flow rate of 50 to 250 gpm<br>• Oil skimming devices<br>• Solution concentration typically maintained between 10 and 15 percent<br>• Available in a range of sizes from small to extremely large |
| **Advantages** | **Disadvantages** |
| • Significant reduction (at least 80 percent) in cleaning labor<br>• High level of cleaning performance<br>• Large cleaning capacities available<br>• Potentially lower waste management costs | • Moderate to high cost ($1,700 to $11,500)<br>• Uses more electrical power than a solvent sink-top unit |
| **Unit Selection Considerations** | |
| • Pump power, spray pressure, flow rate, and number of nozzles (higher spray pressure and flow rate and greater coverage result in better cleaning performance)<br>• 220-volt outlet often required<br>• Stainless-steel units last longer<br>• Programmable thermostat reduces energy use<br>• Temperature adjuster helps optimize cleaning performance<br>• Insulated units more energy-efficient | |

**Notes**:
gpm = gallon per minute
psi = pound per square inch

Shop managers and mechanics like spray cabinets because they clean well and reduce cleaning labor. A conventional solvent "sink-on-a-drum" part cleaning unit requires mechanic "elbow grease" and time standing at the unit cleaning parts. In contrast, an aqueous spray cabinet only requires the mechanic to place the parts in the unit and turn the timer knob. As the parts are cleaned by nonhazardous soap and water, the mechanic can continue working on other jobs in the shop.

**Waste Management**

Aqueous spray cabinets can generate four types of waste streams: waste solution, used filters, skimmed oil, and sludge. Management practices for these waste streams are discussed below.

For more information about aqueous cleaning or other pollution prevention topics for fleet maintenance facilities, call (800) 490-9198 and ask for the Fleet Maintenance P2 Toolkit, EPA publication number EPA-909-E99-002.

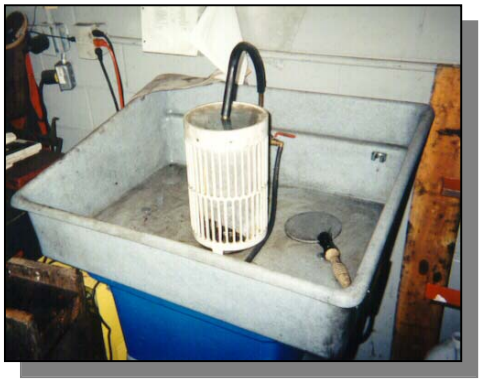
**Waste Solution**. Aqueous cleaning solutions may qualify as hazardous waste after extended use because concentrations of metals such as cadmium, copper, lead, and zinc may exceed state or federal limits. For this reason, there are two basic waste management approaches: (1) conservatively assume that the waste solution is hazardous and manage it accordingly, or (2) send a sample of the waste solution to a laboratory for analysis and manage the solution as hazardous or nonhazardous based on the analysis. The analysis is "valid" as long as the cleaning process (solution, parts, and so on) remains unchanged; however, many shops conservatively update their analysis annually. Always use a licensed waste disposal company to manage waste solution. Also, many waste disposal companies analyze waste solution to determine whether it is hazardous. The cost of disposal varies according to the characteristics of the waste and the volume generated but is generally $2 to $4 per gallon for hazardous waste and $1 to $2 per gallon for nonhazardous waste. Unless a shop obtains written permission from its local sewage treatment agency, the waste solution should not be discharged to a sewer or septic system.

By law, the waste generator is responsible for determining whether or not particular waste streams are hazardous.

**Used Filters**. If permitted by state regulations, used filters may be recycled along with spent engine oil filters with the permission of the recycler. Some filter haulers accept used filters only if they are encased in metal shells like engine oil filters, and some states prohibit recycling of used filters with engine oil filters. If they are not accepted with engine oil filters, used filters should be managed as hazardous waste and disposed of by a licensed waste disposal company. Contact your state or local environmental agency to learn whether any special rules apply to used filters from spray cabinets.

**Skimmed Oil**. Oil skimmed from an aqueous cleaning solution can be managed with used engine oil generated in the shop and recycled. Oil recyclers accept skimmed oil with used engine oil provided that the oil skimmed from the spray cabinet is not contaminated with solvent.

**Sludge**. Little or no sludge accumulates in aqueous cleaning units with filtration devices, but a unit without filtration may accumulate sludge at the bottom of the solution reservoir. This sludge may be disposed of along with waste solution. Most waste disposal companies remove a moderate amount of sludge when waste solution is pumped from a spray cabinet. If the sludge is managed separately from the solution, the sludge may not be disposed of as solid waste unless an analysis demonstrates that it is nonhazardous.



## CASE STUDY: AQUEOUS CLEANING AT ASPEN SKIING COMPANY (ASC) AND ARAPAHOE BASIN (A-BASIN)

In summer 2000, vehicle maintenance and lift operations shops at ASC and A-Basin tested and purchased aqueous spray cabinets to replace solvent part cleaning units. The shops involved in the aqueous spray cabinet testing included:

**Vehicle Maintenance Shops**
- Aspen Mountain
- Buttermilk Mountain
- Aspen Highlands
- Snowmass Mountain
- A-Basin

**Snowmobile Maintenance Shop**
- Snowmass Mountain

**Lift Operations Shops**
- Aspen Mountain
- Buttermilk Mountain
- Aspen Highlands

Each shop tested one or more aqueous spray cabinets for 1 to 2 weeks. After the testing period, each of the shops switched from solvent sink-top units to spray cabinets. In general, mechanics and managers found that the spray cabinets provided satisfactory to excellent cleaning performance for the types of parts cleaned, which included very greasy bearings, gear boxes, and hydraulic components. In addition, mechanics appreciated the reduction in cleaning labor and elimination of solvent exposure.

### Making the Switch at ASC and A-Basin

*Spray cabinet in Buttermilk Mountain vehicle maintenance shop*

The vehicle maintenance and lift operations shops at ASC and A-Basin each used between one and three solvent units, and each unit was serviced between three and six times per year. Combined, the shops at ASC generated 635 gallons per year of spent solvent, and the vehicle maintenance shop at A-Basin generated 180 gallons per year of spent solvent. Depending on the shop and the season, mechanics spent anywhere from 8 to 50 hours per week cleaning parts. Operation and maintenance costs (including cleaning labor costs) for the solvent units ranged from $23,000 to $65,000 per year per shop. After the switch to aqueous cleaning, operation and maintenance costs associated with part cleaning range from $15,600 to $19,800 per shop. Implementation details and a cost analysis for the Buttermilk Mountain vehicle maintenance shop are summarized below.

By switching to aqueous cleaning, ASC and A-Basin collectively reduced solvent use by 815 gallons per year and saved more than $80,000 per year.

### Lessons Learned

During the spray cabinet testing period and during the first month of operations after the purchase, ASC and A-Basin experienced some implementation issues. Table 7.2 summarizes the implementation issues and lessons learned as a result of switching from solvent cleaning to aqueous cleaning at ASC and A-Basin.

Do not contaminate aqueous solution with solvents from aerosol products. Doing so can make waste solution a hazardous waste.

| BUTTERMILK MOUNTAIN VEHICLE MAINTENANCE SHOP<br>Types of Parts Cleaned: bearings, gear boxes, and hydraulic components | |
|---|---|
| **SOLVENT CLEANING** | |
| **Number of Solvent Units**: | 1 |
| **Solvent Replacement Volume and Frequency**: | 17 gallons every 3 months |
| **Part Cleaning Labor Hours**: | 20 to 25 hours per week for 6 months and 8 hours per week for 6 months |
| **Solvent Unit Service Cost**: | $1,000/year ($250 x 4) |
| **Electricity Cost Per Year**: | 120 ($0.07/kWh) |
| **O&M Cost (including labor cost)**: | $23,000 per year (labor cost = $30 per hour) |
| **AQUEOUS CLEANING** | |
| **Number and Type of Aqueous Units**: | 1 Landa SJ 15 spray cabinet |
| **Solution Replacement Frequency**: | Every 45 days for 6 months (summer) and every 90 days for 6 months (winter) |
| **Part Cleaning Labor Hours**: | 4 to 5 hours per week for 6 months and 1.5 hours per week for 6 months |
| **Electricity Cost Per Year**: | $1,310 ($0.07/kWh) |
| **O&M Cost (including labor cost)**: | $7,440 per year (labor cost = $30 per hour) |
| **Capital Cost**: | $4,245 |
| **Annual Savings**: | $15,560 ($23,000 - $7,440) |
| **Payback Period**: | Less than 4 months |

**Notes**:
kWh = Kilowatt-hour
O&M = Operation and maintenance

**TABLE 7.2 AQUEOUS CLEANING IMPLEMENTATION ISSUES**

| Issue | Lesson Learned | Resolution |
|---|---|---|
| Voltage incompatibility | If the voltage of the unit is different than the voltage of the electrical outlet, the contacts on the unit will burn out. | The vendor should check the voltage of the outlet before plugging in the unit and install a transformer if necessary. |
| White residue on parts | Some cleaned parts have a white residue after drying that must be cleaned off manually. | The ratio of soap to water in the cleaning solution is too high. Dilute the solution with water. |
| Bearing cleanliness | Bearings still have grease on inner surfaces after cleaning. | Try some or all of the following:<br>(1) Work with the vendor to modify part placement, nozzle arrangement, solution temperature, and the amount of solution in order to achieve acceptable cleaning performance.<br>(2) Clean bearings for 10 minutes, spray them off with compressed air, and clean them for 10 more minutes.<br>(3) Wipe each bearing with a rag before placing it in the unit. |
| Waste disposal | Waste may be considered hazardous because of heavy metal or solvent contamination. | Have waste solution analyzed for heavy metals and likely solvents (such as solvents from brake cleaning products). Dispose of the waste solution accordingly. |

**Spray Cabinet Implementation**

To maximize the benefits of spray cabinets, be sure to

- ✓ Purchase a unit with an oil skimmer, but do not overskim. A thin layer of oil on top of the cleaning solution decreases evaporation, which saves heating energy and water, thereby lowering operating costs.
- ✓ Purchase a unit with an oil skimmer that is not open to the air (a weir type is preferred over a skimming wheel). Open-air oil skimmers increase evaporation in spray cabinets.
- ✓ Dispose of skimmed oil with other waste oil generated in the shop.
- ✓ Keep solvents out of the cleaning solution. One drop of hazardous solvent can render the cleaning solution hazardous.
- ✓ Check the Material Safety Data Sheet (MSDS) of the cleaning solution for VOC concentrations. A solution should not be considered aqueous if it has more than 5 percent (50 grams per liter) VOCs.
- ✓ Work with the vendor to select a detergent that suits the shop's cleaning needs. For example, special soaps may be required for cleaning aluminum parts.
- ✓ Remove parts from the unit soon after cleaning to prevent rusting.
- ✓ Consider purchasing a stainless-steel unit to avoid unit rusting.
- ✓ Have the vendor test the electrical outlet that the unit will be plugged into with a volt meter.
- ✓ Work with various vendors to select the best unit for the shop's cleaning needs.
- ✓ Test the unit in the shop before purchasing it.
- ✓ Use filtration to extend solution life.
- ✓ Have the waste solution analyzed to determine proper management and disposal methods.

The South Coast Air Quality Management District in southern California maintains a list of aqueous solutions that are certified to contain less than 5 percent VOCs at: www.aqmd.gov/tao/cas/prolist.html.

## 7.2 CHEMICAL PRODUCT SELECTION

Ski area vehicle maintenance shops use a variety of chemical products, including brake cleaners, carburetor cleaners, engine degreasers, and lubricants, that contain mixtures of toxic and hazardous substances. Frequent, long-term exposure to some of these substances by inhalation or skin contact can cause liver and kidney damage. Products that contain cancer-causing chemicals (carcinogens), reproductive toxins, or chlorinated solvents should be eliminated or used in a restricted manner.

Different methods may be used to determine whether an chemical product is environment- and worker-friendly. Many organizations use selection criteria to choose products that do not contain toxic or hazardous substances. Examples of how selection criteria are being used in practice can be found in purchasing programs initiated by various city, state, and federal organizations. Chemical purchasing program information can be found at the following web sites:

Many chlorinated solvents damage the ozone layer, and all are toxic to some degree. Chemical products with chlorinated compounds should be avoided.

- EPA www.epa.gov/opptintr/epp
- State of Massachusetts www.state.ma.us/ota/.support/epp.htm
- State of Minnesota www.moea.state.mn.us/lc/cleaning.cfm
- State of Washington www.metrokc.gov/procure/green
- City of San Francisco www.sfrecycles.org/
  (look under "City Government" and then the "EP3 project")
- City of Santa Monica www.ci.santa-monica.ca.us/environment/

Chapter 6, "Purchasing," covers chemical product selection in greater detail than this chapter. Refer to Section 6.2 for a discussion of product characteristics to be avoided when selecting chemicals, a four-step procedure for selecting chemical products, and a relevant case study.

## 7.3 REFILLABLE SPRAY BOTTLES

***Clean up messy lockers by decreasing aerosol can use***

Each year, ski area vehicle maintenance shops generate hundreds of used aerosol cans of brake cleaner, carburetor cleaner, lubricant, and other products. An alternative to aerosol cans is a refillable spray bottle. There are two basic types of refillable spray bottles: (1) metal bottles that spray product using compressed air and (2) plastic bottles that use a hand pump to spray product. Refillable metal bottles more closely resemble aerosol cans in terms of their design and performance. These bottles are filled with products such as brake cleaner from bulk containers and expel products at pressures ranging from 80 to 200 pounds per square inch (psi) of shop-compressed air (80 psi is the minimum pressure needed to expel product, and 200 psi is the upper pressure limit of the bottles). Plastic bottles are also filled from bulk containers but do not require compressed air; rather, they are operated by pumping a trigger to create a mist or stream of product. Compared to refillable spray bottles, aerosol cans are more expensive and have greater environmental impacts:

- Ounce for ounce, spray-on product sold in aerosol cans is more expensive than bulk product.
- Most aerosol cans contain 10 to 15 percent propellant by weight. Shops incur the cost of this propellant with every aerosol can purchased.
- Carbon dioxide, propane, and butane are commonly used aerosol propellants. These are also greenhouse gases that contribute to global warming and smog formation.
- Used aerosol cans take up valuable landfill space.

Refillable spray bottle purchase and operation considerations are listed below.

**Capacity**. The capacity of air-pressurized, refillable spray bottles varies from 7 fluid ounces to 1 quart. Smaller bottles are useful for spraying hard-to-reach areas. Larger bottles are more convenient because they require less frequent filling and therefore less mechanic time.

**Construction Material**. Refillable spray bottles are available in different materials (aluminum, stainless steel, brass, and steel) and with different finishes for use with different types of bulk product. Steel is the most common construction material for spray bottles used in vehicle maintenance shops. Ask the spray bottle manufacturer for a bottle compatible with the product to be used in it.


***Refillable spray bottles***

**Nozzle Type**. One-quart, refillable spray bottles have either spray or stream nozzles. A nozzle that can be adjusted from spray to stream is also available. Smaller bottles (16- and 8-fluid ounce) are available that closely resemble aerosol cans in size and shape and have a spray pattern similar to an aerosol can's.

**Nozzle Extensions**. Nozzle extensions up to 12 inches long are available for use in spray areas that are otherwise difficult or impossible to reach.

"You can teach an old dog new tricks. We are switching to refillable spray bottles permanently."

*Don Popish*
*ASC Vehicle Maintenance Manager*

**Cost**. Air-pressurized, refillable spray bottles cost from $25 to $60 each, depending on their capacity and construction material. However, many bulk product vendors will supply free refillable spray bottles in exchange for product purchases. Chemically resistant plastic bottles and hand pumps cost from $1 to $6 each. Be sure to check with the product vendor about plastics that are compatible with various chemical products.

**Economy**. Ounce for ounce, bulk product is about 17 to 57 percent cheaper than product in aerosol cans. Most common spray-on products are available in containers ranging from 1 to 55 gallons in size.

**Make sure that aerosol cans are empty before throwing them in a dumpster.**

Used aerosol cans with hazardous constituents that are not empty are considered to be hazardous waste by EPA, the State of Colorado, and many other states. Disposing of them improperly can result in fines of up to $1,000 per can.

**What is empty?** The regulatory definition of "empty" is that all the can's contents have been emptied through the nozzle during normal use (in other words, no product comes out if you push the nozzle and the can has not been punctured).

**When is it hazardous?** If the can is not empty and the contents are hazardous, the can is considered to be hazardous waste. See Chapter 4 for a general discussion of hazardous waste.

## CASE STUDY: REFILLABLE SPRAY BOTTLES AT ASC AND A-BASIN

In summer 2000, Snowmass Mountain lift operations, Snowmass Mountain vehicle maintenance, and A-Basin vehicle maintenance switched from using brake cleaner in aerosol cans to using bulk brake cleaner and metal refillable spray bottles. The Buttermilk Mountain vehicle maintenance shop began using refillable spray bottles in 1998. Table 7.3 summarizes details and cost factors associated with Snowmass Mountain's and A-Basin's switch to refillable spray bottle use.

The Buttermilk Mountain vehicle maintenance shop began using refillable spray bottles for brake cleaning in 1998.

**TABLE 7.3 AEROSOL CAN VERSUS REFILLABLE SPRAY BOTTLE USE FOR BRAKE CLEANER AT SNOWMASS MOUNTAIN AND A-BASIN**

| Item | Snowmass Mountain Lift Operations | Snowmass Mountain Vehicle Maintenance | A-Basin Vehicle Maintenance |
|---|---|---|---|
| **BEFORE** | | | |
| Aerosol cans per year | 48 | 216 | 120 |
| Aerosol can product cost per gallon (per can) | $26.36 ($3.19) | $30.63 ($3.35) | $17.98 ($1.96) |
| **AFTER** | | | |
| Number and size of refillable spray bottles | 6<br>16-ounce | 4<br>1-quart | 1<br>1-quart |
| Total purchase cost of refillable spray bottles | $0<br>(provided by bulk product supplier) | $160 | $40 |
| Average refilling time | 5 minutes | 3 minutes | 2 minutes |
| Bulk product cost per gallon | $15.00 | $13.00 | $14.91 |
| Annual savings | $70 | $416 | $40 |
| Payback period | Immediate | 6 months | 1 year |

Before purchasing refillable spray bottles, each shop tried the bottles for 2 months to evaluate their performance. During the trial period and after the purchase of the bottles, Snowmass Mountain and A-Basin shop personnel experienced some implementation issues. Table 7.4 summarizes the implementation issues and lessons learned as a result of switching from aerosol cans to refillable spray bottles at Snowmass Mountain and A-Basin.


**TABLE 7.4 REFILLABLE SPRAY BOTTLE IMPLEMENTATION ISSUES**

| Issue | Lesson Learned | Resolution |
|---|---|---|
| Broken nozzles | Nozzles sometimes break when refillable spray bottles are dropped or bumped. | Inexpensive replacement parts are available from automobile part stores, from W.W. Grainger, or directly from the manufacturer in any quantity. A packet of common replacement parts is available from the manufacturer for $5.41. |
| Bottle pressure | Aerosol cans blow dirt off parts, and refillable spray bottles do not. | Use a compressed air hose to blow dirt off parts. |

**Refillable Spray Bottle Implementation Tips**

To maximize the benefits of refillable spray bottles, be sure to:

- Avoid product loss from spills during refilling. Use funnels and pumps to minimize spills.
- Keep replacement parts on hand. Small, inexpensive parts such as nozzle seals, filler caps, valves, and nozzles may deteriorate with repeated use and pressurization.
- Refillable spray bottles are used only if they are as convenient for mechanics as aerosol cans. Therefore, provide every mechanic with a refillable spray bottle for each type of frequently used aerosol product.
- Water in shop air lines may cause corrosion in some steel refillable spray bottles. Ensure that the shop air supply has a water removal device.

## 7.4 USED OIL HEATERS

Ski area vehicle maintenance shops generate used oil that is commonly re-refined or burned off site. Disposing of used oil off site incurs a waste management cost and impacts the environment in various ways. Environmental impacts include fuel use and emissions associated with transporting the used oil, incineration emissions, and recycling process residuals. An alternative to off-site disposal is a used oil heater that can safely combust used oil on site to provide space heating. Properly installed oil-fired equipment that has a design rate of less than 500,000 British thermal units (BTU) per hour and consumes less than 10,000 gallons of used oil per year is exempt from state Air Pollutant Emission Notice (APEN) requirements. According to EPA guidelines (40 *Code of Federal Regulations* (CFR) Section 279.23, September 10, 1992), used oil is not considered to be hazardous waste and may be burned for energy recovery provided that

Every gallon of used oil contains 140,000 BTUs of energy. Depending on the size of a shop, this gallon of used oil could heat the shop for an hour.

1. The heater burns only oil generated by the shop.
2. The heater has a maximum capacity of 500,000 BTUs per hour.
3. The combustion gases from the heater are vented to ambient air.

Used oil heaters burn all grades of used oil, creating a low-maintenance alternative to off-site disposal or recycling while providing heat that will lower energy use and costs.

**CASE STUDY: USED OIL HEATER AT ASPEN HIGHLANDS**

**Cost Analysis Assumptions**

- Used oil is burned at a rate of 1 gallon per hour in the used oil heater.
- The cost of natural gas is $4.50 per MMBTU.
- Used oil would be disposed of twice per year at a cost of $75 per disposal (630 gallons).

In 1997, the Aspen Highlands vehicle maintenance shop purchased and installed a Shenandoah Model 235 used oil heater for $6,150. The heater generates 140,000 BTUs and supplements heat provided by a natural gas heater. Details and benefits associated with the used oil heater are summarized below.

- Volume of used oil burned annually: 1,260 gallons
- Used oil disposal cost savings: $150 per year
- Capital and installation costs: $6,350
- Natural gas use savings: 90 million BTUs (MMBTU) per year
- Natural gas cost savings: $400 per year
- Total annual cost savings: $550
- Payback period: 11.5 years

Although payback period of 11.5 years is rather high, natural gas prices fluctuate and tripled since the time that ASC purchased the waste oil heater. The cost efficiency of a used oil heater therefore depends on the market conditions. In general, the cost of nonrenewable resources is likely to only increase as supply decreases.

## 7.5 SHOP SPILL CLEANUP

From time to time, liquid spills occur in ski area vehicle maintenance shops. For large spills (over 5 gallons), absorbent pigs and blankets should be kept on hand for emergency response and containment. However, cleaning up smaller spills of liquids, such as solvent, oil, and antifreeze, containing toxic substances is in some ways more problematic.

Small spills can be tracked around a shop, spreading contamination or causing slips and falls. Furthermore, various environmental issues can arise, depending on how the shop manages spills and floor wash water containing toxic substances. For instance,


- Discharges to septic systems can cause soil, groundwater, and drinking water contamination, creating site cleanup liabilities.
- Discharges to storm drains flow directly to surface water, causing water pollution and aquatic ecosystem damage.
- Discharges to sanitary sewers result in metal accumulation in sludge at the sewage treatment plant, preventing beneficial use of the sludge. Also, some contaminants may pass through the treatment plant and be discharged to lakes and rivers.
- Discharges to oil-water separators can contaminate sludge in the separators, causing the sludge to become hazardous waste and thus increasing disposal costs.

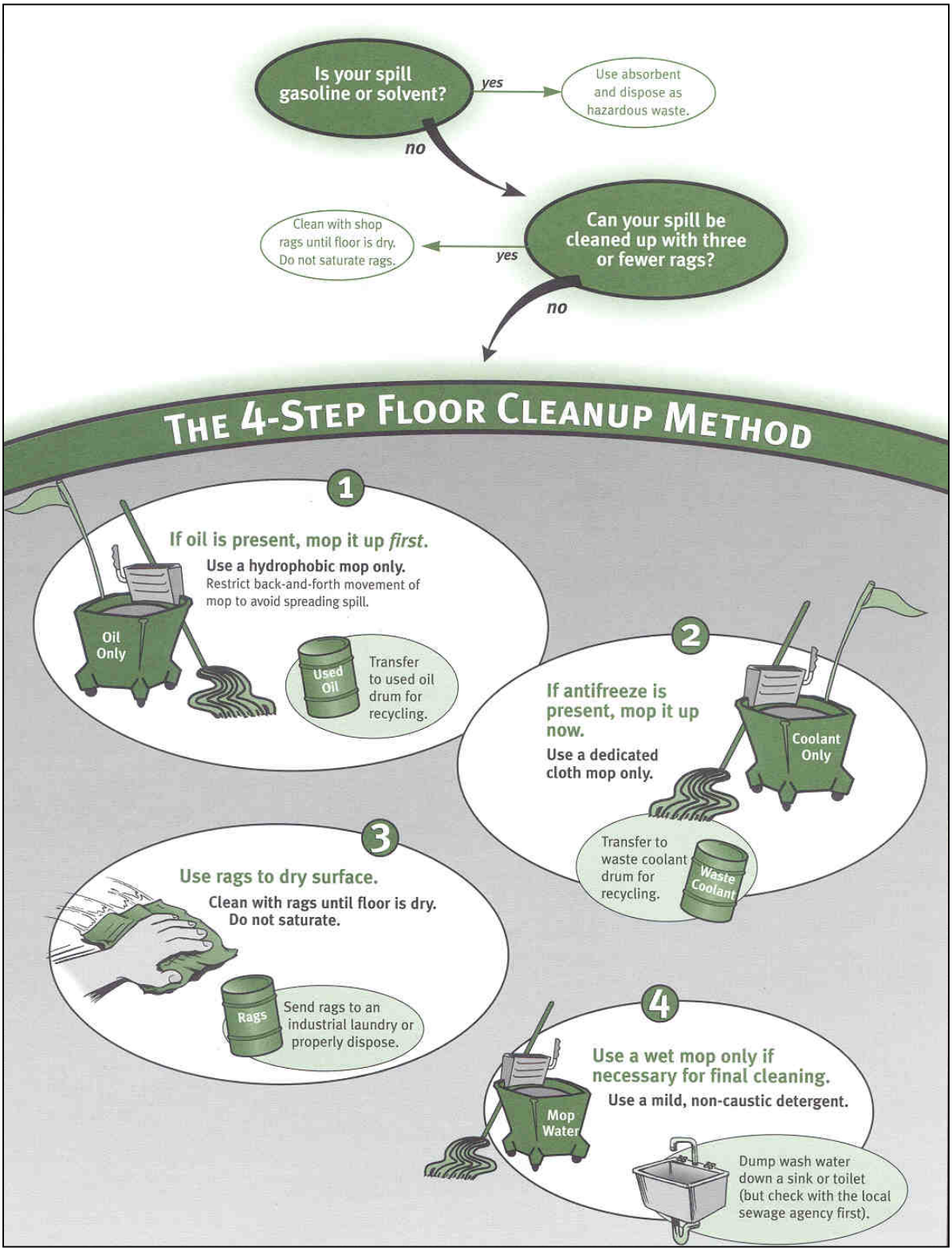
In many cases, shop mechanics clean up small spills with granular absorbent (floor sweep, grease sweep, "kitty litter," rice hull, and so on). Spent granular absorbent is commonly disposed of in trash dumpsters without analysis to determine whether it is hazardous. Because the characteristics of the spilled liquid and the saturated absorbent are difficult to predict, disposing of the absorbent as trash is risky business – the waste absorbent may introduce contaminants to landfills, and improper disposal of hazardous waste is illegal. Furthermore, using granular absorbent is time-consuming and expensive. Absorbent should be used only under the following circumstances:

Discharges of spills and floor wash water containing toxic substances to a drain connected to any system (septic, storm sewer, sanitary sewer, or oil-water separator) have negative environmental implications.

- A spill cannot be cleaned up with shop rags or dedicated mops (see below).
- The spill contains gasoline, solvent, or other hazardous chemicals.

Use the decision tree on the following page to select the proper cleanup procedure.

**SPILL CLEANUP DECISION TREE**



## 7.6 OIL BOTTLE DRAINING

> "[BOB] gets the prize for the most innovative ecology-minded money-saving product we've seen in a long time.… When you dump the bottle, you don't throw out any oil. We really like this one!"
>
> *Dick Berggren*
> *Stock Car Racing Magazine*
> *Editor*

Although it's preferable to use bulk oil delivery systems to decrease solid waste (empty oil bottles), save time, and reduce spills, some ski area vehicle maintenance shops maintain a stock of 1-quart oil bottles. "Empty" quart oil bottles contain oil residue, which not only represents wasted oil, but can prevent recycling of the bottles. In the U.S., 3.34 billion quart bottles of oil are produced every year. Each of those 32-ounce bottles contains about 4 percent (1.25 ounces or 2.5 tablespoons) of oil when disposed of. That is equivalent to 3.5 Exxon Valdez spills per year. [1] Plastic Oil Products manufactures the Bottom of the Bottle Oil Recovery System, or BOB. BOB is a small, plastic device designed to conveniently drain and recover oil residue from oil bottles. After draining overnight on BOB, plastic oil bottles (which are usually #2 plastic) are recyclable, and the drained oil may be used or recycled. One BOB device costs $9.99.


*BOB at A-Basin vehicle maintenance shop*

## 7.7 RE-REFINED OIL

Used motor oil may be contaminated with lead, arsenic, cadmium, chromium, polychlorinated biphenyls (PCB), and solvents. According to the Buy Recycled Business Alliance, in the United States, 1.3 billion gallons of used oil is generated each year, but only 150 million gallons (8.7 percent) is collected and sold as re-refined oil. Re-refined oil is used motor oil that undergoes an extensive re-refining process to remove contaminants and produce a good-as-new base oil. This base oil is sold to blenders that blend in additive packages to produce lubricants such as motor oil, transmission fluid, and grease.

Re-refined oil is subject to the same refining, compounding, and performance standards as virgin oil products and may be used in place of virgin oil in any type of vehicle or equipment that uses oil. However, not all re-refined oils are certified. The American Petroleum Institute (API) has established standards for engine oil quality (http://api-ec.api.org/intro/index_noflash.htm). API operates a voluntary Engine Oil Licensing and Certification System (EOLCS). EOLCS licenses and certifies engine lubricants made from crude oil and re-refined oil. All API-certified oil sold bears either a double circle or starburst symbol. In addition, vehicle and engine manufacturers such as Mercedes Benz, Ford, General Motors, Chrysler, and Detroit Diesel have issued warranty statements that permit use of re-refined oil that meets API standards. Finally, the Magnuson-Moss Act of 1975 prevents warranties from being voided if a comparable, recycled product is used in place of a virgin product. Other facts and benefits associated with re-refined oil are listed below.



- Re-refining rather than burning used oil reduces air pollution.

[1] www.bob2000.com

- It takes just 1 gallon of used oil, compared with 42 gallons of crude oil, to produce 2.5 quarts of lubricating oil.
- Three times more energy is used to process crude oil than to re-refine used oil.
- Today's re-refined oil products meet or exceed the same stringent performance standards that apply to virgin products.
- The price of re-refined oil fluctuates according to the market, but generally it is less expensive than virgin oil.
- The life (change cycle) of re-refined oil is the same as that of virgin oil.
- Fleets have been using re-refined oil for years with no problems.
- There are no compatibility concerns associated with switching from virgin to re-refined oil.
- Oil can be recycled indefinitely–the oil never wears out, only the additives.

For more information about re-refined oil, visit the California Integrated Waste Management Board's introduction to re-refined oil at www.ciwmb.ca.gov/UsedOil/Rerefined/.

**CASE STUDY: ASC SWITCHES TO RE-REFINED OIL**

Until July 2001, ASC vehicle maintenance shops purchased about 7,500 gallons per year of virgin 15-40 engine lubricating oil and hydraulic tractor oil from Texaco. In spring 2000, ASC began researching the possibility of switching to re-refined oil. The following table compares costs for two re-refined oil product lines to the costs of the oil used by ASC vehicle maintenance shops at the time of the evaluation.

"If all the waste oil in the U.S. were re-refined we'd displace half the estimated oil supply in the Arctic National Wildlife Refuge. We're drilling for oil in our waste stream instead of where the caribou live."

*Jim Ward*
*ASC Purchasing Director*

| | **Re-refined Oil** | **Virgin Oil** | |
|---|---|---|---|
| **Type of Oil** | **America's Choice Bulk Cost ($/gallon)** | **Texaco Current Cost ($/gallon)** | **Cost Savings ($/gallon)** |
| 15-40 Engine Oil | $3.32 | $4.44 | $1.12 |
| Hydraulic Tractor Oil | $3.48 | $4.84 | $1.36 |
| **Type of Oil** | **Firebird Bulk Cost ($/gallon)** | **Texaco Current Cost ($/gallon)** | **Cost Savings ($/gallon)** |
| 15-40 Engine Oil | $3.14 | $4.44 | $1.30 |
| Hydraulic Tractor Oil | $3.05 | $4.84 | $1.79 |

Because of delivery constraints associated with the Firebird oil, ASC chose America's Choice oil. The annual cost savings that ASC realized by switching to re-refined oil for its vehicle maintenance shops are summarized below.

| Brand and Type of Oil | Cost Savings per Gallon | Number of Gallons Replaced Each Year | Total Cost Savings per Year ($/year) |
|---|---|---|---|
| **America's Choice**: | | | |
| 15-40 Engine Oil | $1.12 | 850 | $952 |
| Hydraulic Tractor Oil | $1.36 | 1,030 | $1,401 |
| | **Total Savings** | 1,880 | $2,353 |

In July 2001, ASC began using re-refined oil in its vehicle fleet. According to one ASC vehicle maintenance manager, no issues were observed with the re-refined oil in the vehicle fleet during summer 2001 operation.

## 7.8 OIL FILTER MANAGEMENT

According to the Filter Manufacturers Council, over 450 million used oil filters are disposed of every year. Even after crushing, these filters contain about 3 million gallons of oil. Instead of disposing of used oil filters, ski area vehicle maintenance shops should consider recycling the filters. About 30 percent of the 450 million used oil filters annually generated in the U.S. are recycled; the rest, about 315 million, are disposed of in landfills. State regulations governing disposal of used oil filters vary. However, federal regulations (40 CFR Section 261.4) require that, at a minimum, filters be either

- Punctured through the dome or anti-drain back valve and then hot-drained (for 12 or more hours preferably at or near engine operating temperature but definitely above 60 °F)
- Hot-drained (same requirements as above) and crushed
- Dismantled and hot-drained (same requirements as above)

Did you know that after a filter is hot-drained, it can still contain 3.5 to 8 ounces of oil?

The Filter Manufacturers Council maintains a web site at www.filtercouncil.org that contains filter disposal regulations for all states and a list of filter management companies.

### CASE STUDY: OIL FILTER RECYCLING AT ASC

Three mountains at ASC, Buttermilk Mountain, Aspen Mountain, and Aspen Highlands, generate about 500 used oil filters per year from snowcats and trucks maintained in the vehicle maintenance shop. Twice per year the maintenance staff remove the filters from the snowcats and trucks using the following 6-step procedure:

1. Remove filter at operating temperature (a technique called hot draining)
2. Puncture the dome of the filter
3. Place the oil filter on a screen that drains in a waste oil drum (oil is later recycled)
4. Let filter sit for up to one week
5. Place drained filters in a 55-gallon drum
6. Transport full 55-gallon drum to recycling facility (ASC's local landfill accepts segregated oil filters and recycles them for scrap metal.)

## 7.9 SNOWMOBILES

Snowmobiles are integral to ski area operations, but they can be noisy and foul smelling; emit a visible haze; and present environmental and health concerns, especially for children, pregnant women, and people with cardiovascular disease and impaired lung function such as asthma (Montana Department of Environmental Quality, Pollution Prevention Bureau). These negative aspects of conventional snowmobile use are due to engine design. Most snowmobiles are powered by lightweight, high-power, two-cycle engines tuned to "run rich" for cold starts and better throttle response. These two-cycle engines emit 20 to 33 percent of the fuel and lubricant (because lubricant is mixed with the fuel) unburned. The rich fuel mixture and fuel bypass used for lubrication result in high amounts of emissions, including carbon monoxide (CO), unburned hydrocarbons (HC), particulate material (PM), and a variety of gases classified as "air toxics." Ski areas have two alternatives to address these concerns: (1) implement emission reduction techniques for two-cycle snowmobile engines and (2) consider purchasing four-cycle engine snowmobiles. These alternatives are discussed below.

### 7.9.1 Two-Cycle Engine Emission Reduction Opportunities

Two practices for reducing emissions from two-cycle snowmobile engines involve engine tuning and lubricant selection. Emissions are lower from engines that are properly tuned for the elevation at which they operate. At higher elevations (above 3,000 feet), decreasing the orifice size in carburetor jets results in more complete fuel combustion. Thus, proper jetting decreases emissions and improves engine performance. In addition, snowmobile clutches should be adjusted to match the improved performance resulting from proper jetting, which will also reduce fuel use and emissions.

Emissions can also be reduced through use of oxygenated gasoline (see Section 7.10) and alternative lube oils. Shops can use alternative lubricants, typically a special grade of motor oil (synthetic low particulate and synthetic biodegradable) in snowmobiles to reduce toxic emissions. Extensive testing of two-cycle engine snowmobiles indicates that use of alternative lubricants reduces visible smoke, increases mileage, and prevents spark plug fouling and carburetor freeze-up. Estimated emission reductions that can be expected to result from using alternative lube oils are shown below.

**EMISSION REDUCTION RANGES WITH USE OF ALTERNATIVE LUBRICANTS**

| Alternative Product | Emission Type | Emission Reduction Range |
|---|---|---|
| Bio-based lubricant | CO | 25 to 38 percent |
| Bio-based lubricant | HC | 16 to 38 percent |
| Synthetic lube oil and oxygenated fuel | PM | 25 to 70 percent |

Source: Montana Department of Environmental Quality

All major manufacturers of snowmobiles (and snowcats) such as Polaris, Arctic Cat, and Ski Doo have developed alternative lubricants suitable for use in snowmobile engines.

**CASE STUDY: ASC SNOWMOBILE SHOP REDUCES EMISSIONS**

The ASC snowmobile shop maintains 85 two-cycle engine snowmobiles. These snowmobiles are run between 20 and 60 miles per day and from 5,000 to 10,000 miles per season. Until 1997, the ASC snowmobile shop used Polaris Premium Bio-based oil. In 1999, the shop switched to Polaris Synthetic Injector and chain case oil because it burned more cleanly and completely; however, it was $8 per gallon more expensive than the oil that the shop used previously. In the 2000/2001 ski season, ASC switched to BG Snowmobile Oil, an environmentally preferable, smoke-free oil that provides good engine protection. Another benefit of the synthetic lube oil is that it cleans the exhaust ports of the snowmobiles. The following table summarizes the costs associated with changing lubricating oils in the ASC snowmobile shop.

**ALTERNATIVE LUBRICANT USE IN ASC SNOWMOBILES**

| Type of Lube Oil | Cost per Gallon | Amount Used Annually | Annual Cost |
|---|---|---|---|
| Polaris Premium | $10.51 | 660 gallons | $6,930 |
| Polaris Synthetic Injector | $18.75 | 660 gallons | $12,375 |
| BG Snowmobile | $13.00 | 660 gallons | $8,580 |

### 7.9.2 Four-Cycle Engine Snowmobiles

Another option for reducing emissions is using four-cycle engine snowmobiles. In 2000, Arctic Cat, Polaris, and Redline Performance Products (Redline) introduced four-cycle snowmobiles to the market. Four-cycle snowmobiles not only get better gas mileage and generate less emissions than two-cycle snowmobiles, but they are also quieter and less odorous.

The disadvantages of four-cycle snowmobiles compared to two-cycle snowmobiles include their cost (higher), weight (heavier), and power (less). Snowmobile manufacturers suggest that four-cycle snowmobile development will mature by 2003, producing less expensive, lighter-weight, more powerful snowmobiles. Although the cost, weight, and power issues will probably not be resolved for a few years, switching to four-cycle snowmobiles may be feasible today. Advantages and disadvantages of four-cycle snowmobiles are summarized below. Note that most of the 4-cycle snowmobiles on the market were developed for trail use. Snowmobile manufacturers suggest that research of 4-cycle snowmobiles intended for use at ski areas is ongoing.

**4-cylce Snowmobile Advantages**

- Emissions significantly reduced (up to 95 percent)
- Quieter
- Less odor
- Reduced maintenance time
- Positive public perception

**4-cycle Snowmobile Disadvantages**

- More expensive (2001 retail models cost about $1,000 more than two-cycle snowmobiles)
- Heavier (2002 retail models are 35 to 55 pounds heavier than two-cycle snowmobiles)
- Less powerful (2001 retail models have about half the horsepower of most two-cycle snowmobiles)

## CASE STUDY: ASC TESTS 4-CYCLE SNOWMOBILE

In February 2001, ASC tested the Arctic Cat 660 4-cycle touring snowmobile. The snowmobile gets 22 miles per gallon of gasoline and weighs about 610 pounds. ASC vehicle maintenance, lift maintenance, and ski patrol personnel tested the snowmobile for 2 weeks. Each time an individual tested the snowmobile, they completed a log sheet with the following information:

- Date
- Initials
- Riding Time (minutes)
- Riding Distance (miles)
- Handling Performance (exceptional, satisfactory, or unsatisfactory)
- Power Performance (exceptional, satisfactory, or unsatisfactory)
- Speed Performance (exceptional, satisfactory, or unsatisfactory)
- Noise (exceptional, satisfactory, or unsatisfactory)
- Odor (exceptional, satisfactory, or unsatisfactory)
- Comments (including the intended use of the snowmobile; e.g., towing injured skier, place snow gun, etc)

The overall reaction after the demonstration was that the snowmobile was quiet, had low odor, and was comfortable, but that it did not have enough power for the ski area needs and was too heavy to maneuver in the shop. Responses of individuals that tested the snowmobile are summarized in the following table:

***Arctic Cat 4-cycle engine snowmobile demonstration at ASC***

| Factor | Rating Summary |
|---|---|
| Riding Time | 5 minutes to 3.5 hours |
| Riding Distance | 1 to 30 miles |
| Handling Performance | Satisfactory |
| Power Performance | Unsatisfactory |
| Speed Performance | Unsatisfactory |
| Noise | Exceptional |
| Odor | Exceptional |

Based upon the snowmobiles power and speed performance as well as the increased capital investment (about $1,000 more than the price ASC paid for 2-cycle snowmobiles at the time of the trial), ASC decided not to purchase 4-cycle snowmobiles for the 2001/2002 ski season. However, the ASC snowmobile maintenance supervisor indicated that ASC would continue stay informed about 4-cycle snowmobiles, particularly in regard to technology advancements related to weight and power.

For more information about the Arctic Cat 4-cycle snowmobiles, visit www.arctic-cat.com/snowmobiles/index.asp.

**CASE STUDY: VAIL RESORTS PURCHASES 4-STROKE SNOWMOBILES AND OTHER ENERGY SAVING AND ENVIRONMENT FRIENDLY VEHICLES**

To meet Vail Resorts' company-wide goal of 5 percent energy reduction for the 2001/2002 ski season, Keystone Vehicle efforts include:

**4-Stroke Snowmobiles**: For the 2001/2002 ski season, Keystone purchased eight new 4-stroke snowmobiles. Traditional 2-stroke snowmobiles are inefficient, losing nearly 30 percent of used fuel as exhaust. At about $1,000 more per machine, the new 4-stroke snowmobiles are cleaner burning, more fuel efficient, quieter, and have a running life that is over twice that of conventional 2-stroke sleds.

**Snowcat Upgrades**: For the 2000/2001 ski season, Keystone purchased four new Bombardier BR 2000 snowcats. These snowcats use a "one pass tiller" with electric motor for grooming, which allows the vehicle to groom 25 percent more terrain and uses 1 gallon less of fuel per hour than older models. For the 2001/2002 ski season, Keystone purchased six more these efficient snowcats, and estimates a fuel savings of over 15,000 gallons per year.

**Argo**: In 2000, Keystone purchased an Argo, an 8-wheeled vehicle that can be used in both summer and winter. The vehicle leaves almost no footprint because its 8-wheel design allows its weight to be dispersed over a large surface area. The weight is so well dispersed that it can run over a person's hand without causing pain. The vehicle is useful for driving in sensitive areas.

**Mule™:** Keystone purchases multi-use lightweight equipment (Mule™) from Kawasaki instead of additional flat bed trucks for on-mountain and around-ski area use. The Mules are less expensive, more fuel efficient, and more useful than flatbed trucks, while still accommodating the ski area needs. As a result, Keystone has been able to keep the fleet size constant over the last 5 years even through constant resort growth.

**Saving Water Too**

For washing vehicles, Keystone installed a water recycling wash bay that uses 5,000 gallons of water per year. The system, made by Hydrodynamics corporation cleans soiled water, allowing the same water to be reused all season long.

**Part Rebuilding**

Instead of replacing used or worn parts in its vehicle fleet, Keystone implemented a policy to rebuild its parts and purchase reconditioned parts when available. This policy helps reduce machine waste and has proven to be extremely cost-efficient. Keystone saved $70,000 in service expenses in the 2001/2002 ski season as a result of this program.

## 7.10 OXYGENATED GASOLINE

The Clean Air Act Amendments of 1990 mandated use of oxygenated gasoline in areas that did not meet the federal ambient air standard for carbon monoxide (CO). Oxygenated gasoline is made by mixing an oxygenate such as ethanol with unleaded gasoline. In most areas, motor vehicles are the primary source of ambient CO, which contributes to smog and is a greenhouse gas. Oxygenated gasoline is designed to increase the combustion efficiency of gasoline, reducing CO emissions.

Vehicles that operate using unleaded gasoline release a variety of other emissions, including hydrocarbons (HC), particulate matter (PM), and air toxics. Using oxygenated gasoline reduces all such emissions. Laboratory and field tests conducted by the Montana Department of Environmental Quality, the University of Denver, the U.S. Department of Energy (DOE), EPA, and the Southwest Research Institute showed that compared to the emissions associated with regular unleaded gasoline, use of oxygenated gasoline in conventional snowmobiles and other vehicles reduced air emissions as shown below.

**EMISSION REDUCTION RANGES WITH USE OF OXYGENATED GASOLINE**

| Emission Type | Emission Reduction Range |
|---|---|
| CO | 9 to 38 percent |
| HC | 13 to 38 percent |
| PM | 25 to 55 percent |
| Air toxics | 22 percent |

Source: Montana Department of Environmental Quality

Unleaded gasoline can be oxygenated by adding a variety of oxygenates. In the past, EPA recommended using either methyl tertiary butyl ether (MTBE) or ethanol. However, according to a June 1997 interagency assessment of oxygenated fuels, experimental studies indicate that MTBE is carcinogenic for rats and mice. Because of air emissions and the threat of gasoline releases from leaking underground storage tanks, MTBE should not be used as an oxygenate.

When you purchase oxygenated gasoline, you should know that MTBE is a potential human carcinogen. Therefore, select fuel oxygenated with ethanol instead of MTBE.

**CASE STUDY: ASC CHANGES TO OXYGENATED GASOLINE**

ASC uses about 109,000 gallons of unleaded gasoline per year in its cars, trucks, snowmobiles, and other pieces of equipment. Because of the negative effects of emissions associated with regular unleaded gasoline on human health and the environment, in July 2001, ASC mandated that all unleaded gasoline purchased must be oxygenated. ASC began using an 87 octane unleaded gasoline oxygenated with ethanol (90 percent unleaded gasoline and 10 percent ethanol). ASC was able to work with its fuel supplier to obtain the oxygenated gasoline. Historically, ASC used 89 octane unleaded gasoline. At the same octane rating, oxygenated gasoline may cost about $0.05 per gallon more than non-oxygenated gasoline. However, adding an oxygenate enhances the octane rating of gasoline by 2 points. Therefore, unleaded gasoline rated at 87 octane becomes 89 octane gasoline when an oxygenate such as ethanol is added. ASC worked with its fuel supplier to source oxygenated gasoline at a nominal cost increase of 1 cent per gallon. The increase is almost completely offset by a lower tax rate on ethanol fuel.

The estimated emission reductions resulting from ASC's switch to oxygenated gasoline are presented in Table 7.6.

**TABLE 7.6 ESTIMATED EMISSION REDUCTIONS AT ASC**

| Emission Type | Estimated Reduction * |
|---|---|
| CO | 7.3 to 9.25 tons per year |
| HC | 5.9 to 8.5 tons per year |

*Note: The emission reduction values are estimated based on the types of vehicles and equipment using oxygenated gasoline and average reduction rates from tests conducted by the University of Denver.

**Implementation Issues**

Table 7.7 summarizes some common misconceptions about switching from regular unleaded gasoline to oxygenated gasoline, or "gasohol".

**TABLE 7.7 MYTHS ABOUT GASOHOL**

| Myth | Fact |
|---|---|
| Using gasohol will violate the vehicle warranty. | Manufacturers are required by the Clean Air Act Amendments of 1990 to warranty vehicles for use with any legally oxygenated fuel, such as 10 percent ethanol blend oxygenated gasoline (gasohol). Switching to gasohol does not require retrofitting for most snowmobiles built after 1988. Furthermore, gasohol can be used in any vehicle that operates with regular unleaded fuel (for example, cars, trucks, and snowmobiles). |
| Gasohol causes fuel line clogs. | Oxygenates (such as ethanol) in gasoline act like detergents. If an engine previously used regular unleaded gasoline that was improperly stored, gasohol may dissolve old contaminants in the tank and fuel lines, which may clog the fuel filter. If this happens, it usually occurs within the first few minutes of engine operation and may require fuel filter replacement. |
| Gasohol costs more. | Adding 10 percent ethanol raises the octane rating of gasoline by about 2 points (for example, 87 octane gasoline becomes 89 octane gasoline when 10 percent ethanol is added), and 87 octane gasoline with 10 percent ethanol (now an 89 octane gasoline) costs about the same as regular unleaded 89 octane gasoline. |

Another concern associated with switching to gasohol is phase separation. Phase separation occurs in regular unleaded gasoline when about 50 percent water is present, but it occurs when there is 5 to 12 percent water in gasohol. When phase separation occurs, a water phase forms on the bottom of the fuel tank, and a fuel phase forms at the top. Because the fuel pump is located at the bottom of the fuel tank, the fuel pump takes up the water phase first, which will not burn. However, during the past four winters, Yellowstone National Park used gasohol in its snowmobiles and reported no problems with phase separation in fuel tanks.

To avoid phase separation, fuel distribution and storage tanks in shops may need to be properly cleaned of all water and sludge before gasohol is added. Fuel storage tanks should be cleaned periodically even if fuel types are not being switched. Also, each hose used to dispense gasohol

should have a water filter. Public service stations have a water filter on each fuel dispensing hose, but private stations may not.

## 7.11 SNOWCAT HYDRAULIC LINE PREVENTIVE MAINTENANCE

Hydraulic oil lines on snowcats used to maintain ski trails operate under high pressure: 2,800 to 3,000 psi for auxiliary hoses and 6,000 to 6,500 psi for drive hoses. Because of the high pressure, when a hydraulic line breaks, a large spill of hydraulic oil flows from the snowcat in seconds, often before the operator notices a pressure drop on the snowcat's gauges. An auxiliary hose break usually results in an approximately 5-gallon oil spill, and a drive hose break can quickly release 40 gallons of oil.

During a July 1999 telephone survey of ski areas nationwide, environmental managers reported an average range of three to five on-mountain hydraulic line breaks per year. Based on the survey, ski areas respond to on-mountain oil spills in various ways. Responses range from no response at all (leaving the spilled oil where it is) to pushing contaminated snow off trails to drumming contaminated snow, transporting the drums off mountain, and melting the snow over an oil-water separator. Taking no action or pushing contaminated snow off trails has environmental consequences because the oil will either run off into surface water or soak into soil as the snow melts. However, cleaning up on-mountain hydraulic line breaks is time-consuming, labor-intensive, and generally undesirable because they typically occur in the middle of the night while trails are being groomed.

Ski areas should consider two alternatives to alleviate the hassles and environmental issues associated with on-mountain hydraulic line breaks: (1) hydraulic line preventive maintenance and (2) use of biodegradable hydraulic oil. Although hydraulic line maintenance can dramatically decrease the occurrence of line breaks, such breaks may still occur. Thus, ski areas should consider implementing both alternatives together. These alternatives are discussed below.

### 7.11.1 Hydraulic Line Preventive Maintenance

Ski area vehicle maintenance staff can reduce or eliminate the occurrence of hydraulic line breaks through use of good maintenance practices. ASC and A-Basin have implemented hydraulic line maintenance program that includes the following:

> "After being woken up in the middle of the night to deal with an on-mountain line break a few times, I decided to find an alternative."
>
> *Mike Lucas*
> *A-Basin Vehicle Maintenance Manger*

1. Replace all drive hoses every 2 years (after every 3,000 to 4,000 hours of operation) regardless of their appearance.
2. Inspect all auxiliary and drive hoses on the snowcat before every season. Replace all hoses that appear to be worn or chafed.
3. Wrap hoses with hard, plastic-like rubber to prevent wear and chafing.
4. Inspect and tighten all hydraulic line fittings.
5. Check hose routing to ensure that no hoses rub against each other during equipment operation.
6. When replacing hoses, be careful to properly place o-rings so that the hoses are not pinched, which can lead to a line break under pressure.

The following case study provides more detail about the snowcat hydraulic line preventive maintenance program at ASC.

**CASE STUDY: SNOWCAT HYDRAULIC LINE PREVENTIVE MAINTENANCE AT ASC**

ASC implemented a hydraulic line preventive maintenance program to reduce on-mountain hydraulic line breaks in snowcats. To assess the hydraulic line inspection and replacement practices of mechanics while this program was being implemented, a data collection log was used.

**HYDRAULIC LINE TESTING DATA COLLECTION LOG**

Mechanic Name: _____ Date: _____
Vehicle Description: _____
Vehicle Identification: _____
What items on the vehicle were inspected?
Hydraulic lines ☐ Fittings ☐ Pumps ☐ High pressure o-rings ☐ Motors
Please complete the section below for each fault found:

**Hydrostatic Hoses**

Are any hoses faulty? ☐ Yes ☐ No
If yes, describe the fault: ☐ Worn ☐ Bubbled Skin ☐ Other _____
Was faulty hose replaced? ☐ Yes ☐ No
If yes, describe where on the vehicle on the vehicle the hose was located:
_____
If no, why not? _____
Did the hose replacement require any unusual work to replace it? ☐ Yes ☐ No
If yes, please describe: _____

**Auxiliary Hydraulic System Hoses**

Are any hoses faulty? ☐ Yes ☐ No
If yes, describe the fault: ☐ Worn ☐ Bubbled Skin ☐ Other _____
Was faulty hose replaced? ☐ Yes ☐ No
If yes, describe where on the vehicle on the vehicle the hose was located:
_____
If no, why not? _____
Did the hose replacement require any unusual work to replace it? ☐ Yes ☐ No
If yes, please describe: _____
Were any other leaks found? ☐ Fittings ☐ O-rings ☐ Pumps ☐ Motors
If yes, please explain the leak and how it was fixed: _____

The data collection log was created to collect information regarding hydraulic line maintenance, but the shop manager noted that the log served an additional purpose. He found that mechanics' use of the log led to more consistent and thorough hydraulic line maintenance for snowcats because it included a checklist of items to inspect.

Because of the hydraulic line preventive maintenance program at ASC, the vehicle maintenance shop saves $1,145 per year. Results of ASC's cost analysis of the program are presented in Table 7.8.

**TABLE 7.8 RESULTS OF HYDRAULIC LINE PREVENTIVE MAINTENANCE AT ASC**

| Item | Before Preventive Maintenance | After Preventive Maintenance |
|---|---|---|
| Number of line breaks per season (drive and auxiliary) | 2 to 4 major breaks (3 mountains) per month; 3 breaks/month x 4 months per season = 12 breaks per season | 0 breaks per year per mountain after 1 year of preventive maintenance; 3 minor breaks after 2 years |
| Average size of hydraulic oil spill | 5 to 35 gallons per spill (average of 20 gallons per spill) | < 5 gallons |
| Labor cost to repair a broken hydraulic line | 2 people x 5 hours per person x $22.50/hour (time+1/2) x 12 breaks = $2,700 | 2 people x 5 hours per person x $22.50/hour (time+1/2) x 3 breaks = $675 |
| Labor cost for preventive maintenance (unloaded labor rate) | $0 | 1 person x 2 hours x $15/hour x 31 snowcats = $930 |
| Cost of materials to replace hydraulic lines | $150 (drive) x 7 = $1,050<br>$50 (auxiliary) x 5 = $250 | $150 (drive) x 6 = $900<br>$50 (auxiliary) x 3 = $150 |
| Total annual cost | $4,000 | $2,655 |
| **ANNUAL SAVINGS = $1,345** | | |

The cost comparison does not include the labor costs to clean up spills because of the variability in spill size and cleanup practices. The benefits of hydraulic line preventive maintenance would be even more apparent if the labor costs of cleaning up spills were factored in.

### 7.11.2 Use of Biodegradable Hydraulic Oil

"For years the cost of [biodegradable] has kind of deterred people form switching from a mineral oil, but now what we're seeing is that people are looking at the bottom line: overall cost, longer life, less wear, better oxidation capabilities."

*Mike Dormandy*
*Director of Industrial Products,*
*AMSOIL Inc*

Using biodegradable hydraulic oil in snowcats is another opportunity for ski areas to address environmental concerns associated with on-mountain hydraulic line breaks if they do occur. Although spills of hydraulic oil should be cleaned up regardless of whether the oil spilled is biodegradable or conventional, if any biodegradable hydraulic oil is not collected, the potential environmental hazard will be significantly less serious. One good source of information about biodegradable hydraulic oil is an article titled "Going Green: Biodegradable Products for Your Hydraulic System" by Janice Kaspersen; this article is available at www.forester.net/msw_0005_going.html.

Biodegradable hydraulic oil costs more than conventional hydraulic oil; however, some users of biodegradable hydraulic oil find that it performs better under severe conditions and lasts longer.[2] Most major oil companies have developed a line of biodegradable hydraulic oils, and some equipment manufacturers have as well.[2] Many ski areas are hesitant to use biodegradable hydraulic oil in equipment engines for fear of violating equipment warranties and degrading equipment performance.

[2] Janice Kaspersen. "Going Green: Biodegradable Products for Your Hydraulic System." Obtained from Internet on April 17, 2001. www.forester.net/msw_0005_going.html.

## 7.12 ADDITIONAL INFORMATION SOURCES

The following table provides contact information for organizations that can supply additional information on topics discussed in this chapter.

| Organization | Contact Information |
|---|---|
| **Aqueous Cleaning** | |
| Better Engineering | Matt Kelly<br>(800) 229-3380 ext. 309<br>www.betterengineering.com |
| EcoClean Corporation | Jim Andrews<br>(800) 797-4050 |
| Clayton Associates Inc. | Jim Clayton<br>(800) 248-8650<br>www.jclayton.com |
| Equipment Manufacturing Company | Larry Rhodes<br>(888) 833-900<br>www.equipmentmanufacturing.com |
| Graymills | (312) 248-6825 |
| Kleer Flo | (800) 328-7942<br>www.kleer-flo.com<br>info@kleer-flo.com |
| Landa | (800) 547-8672<br>www.landa-inc.com |
| Mirachem | Bob Boyle<br>(800) 847-3527<br>www.mirachem.com |
| **Refillable Spray Bottles** | |
| Milwaukee Sprayer Manufacturing Company Inc. | Ron Nielsen<br>(800) 558-7035 |
| **Used Oil Heaters** | |
| Lanair | (800) 753-1601<br>www.usedoilheater.com |
| Shenandoah Manufacturing Company Inc. | www.usedoilheaters.com |
| Reznor | (800) 635-1901<br>www.reznorwasteoil.com |
| Auto Repair Shop Equipment Buyers Group | (800)466-5488<br>www.buyersgroup.com<br>pkitt@buyersgroup.com |
| **Programmable Shop Thermostats** | |
| Grasslin Controls Corporation | (800) 272-1115<br>www.grasslin.com |
| **Hydrophobic Mops** | |
| CCP Industries | (800) 321-1050 |

| Organization | Contact Information |
|---|---|
| Hy-Tec Environmental | Tony Armas<br>(800) 336-4499 |
| **Oil Draining Device** | |
| Plastic Oil Products | Gerard Forgnone<br>(805) 937-3050<br>g-whiz@ix.netcom.com<br>www.bob2000.com |
| **Re-refined Oil** | |
| Evergreen Oil | (800) 972-5284<br>www.evergreenoil.com/ |
| Safety-Kleen Corporation (America's Choice) | (800) 525-5739 |
| **Recycling Oil Filters** | |
| Filter Manufacturers Council | (800) 993-4583<br>www.filtercouncil.org |
| **Oxygenated Gasoline** | |
| Contact your unleaded gasoline supplier. | |
| **Four-Cycle Engine Snowmobiles** | |
| Arctic Cat | (218) 681-8558<br>www.arcticcat.com |
| Redline Performance Products | Chris Rodewald<br>(760) 598-0167 |
| **Biodegradable Hydraulic Oil** | |
| AMSOIL Inc. | (715) 392-7101<br>www.amsoil.com |
| Diamond Oil Company | (800) 422-7563<br>www.lubricants-oil.com/diamondoil/index.shtml |
| Petro Canada | Dan Gabriel<br>(888) 284-4572<br>www.htlubricants.com |