Section 1
Introduction

1.1 Truck Idling[1]

The 1997 Vehicle Inventory and Use Survey[2] reports that 2.54 million trucks had a manufacturer's gross vehicle weight (GVW) rating of 26,001 lb or greater, and these trucks are classified as class 8 trucks (VIUS 2000). They may be single-unit trucks or combination trucks (single-unit trucks with a trailer or tractor-trucks with single, double, or triple trailers). Seventy percent of these trucks are operated within 200 mi from the home base, and 83% are operated within 500 mi of home base. However, about 458,000 combination trucks travel more than 500 mi from their home base each day. Most, but not all, of these trucks are equipped with sleepers. These are the trucks that are likely to be idling overnight during stopovers on long trips.

Drivers idle their truck engines to keep the cab and sleeper area warm when they are sleeping or resting in the truck (or away but likely to return soon); in extremely cold weather, drivers idle their truck engines to keep fuel from freezing and to keep the engine block warm to prevent difficult starting and smoke. They also idle the engines to run air-conditioning during hot weather and to provide power for appliances and other electrical devices. Sleepers can be quite comfortable and well equipped with modern conveniences, such as personal computers, stereos, and televisions. Figure 1.1 shows a typical sleeper compartment.

Figure 1.1 Typical sleeper compartment

One industry source estimates that a long-distance, freight-hauling, heavy-duty truck idles about 6 h/d on the average (TMC 1995). The actual extent of idling varies with the season and with the type of operation. A truck may idle for 10 h/d during winter and less than 5 h/d the rest of the year; the baseline entry in Table 1 reflects a 6-h/d average,[3] with a seasonal peak in the winter. Another source estimates that the average is higher 40% of the time is spent idling – on the basis of information provided by J.B. Hunt (Whiteside 1996). Most trucking organizations now offer incentives to reduce idling, and some large firms have succeeded in reducing truck idling time to 20% (Whiteside 1996). However, nearly 40% of the long-haul trucks are in fleets of less than 25 vehicles, and these small fleets are less likely to have such incentive programs. A recent study by Caterpillar and a survey by researchers at the University of California at Davis have also estimated typical idling time at 1800 h/y. More details on these results will be added here.

[1] Revised from Stodolsky *et al* 2000.

[2] The 2002 Survey has not been published at this writing.

[3] Eighty-five winter days at 10 h/d and 218 nonwinter days at 4.5 h/d.

We interviewed several truck operators and fleet owners and found a wide variation in actual behavior. At one extreme, one owner-operator of an older truck reported that he leaves his truck running all the time, even at home over the weekend, to make absolutely sure that it will start. On an annual basis, he idles his truck for more than 5,000 h. At the other extreme is another owner-operator, who lives in Minnesota, makes two round trips to Chicago each week, and only runs his truck when he is in it. He plugs in a small electric heater to keep the engine warm at home in the winter, but he still does occasionally have trouble starting the truck. He idles his truck for fewer than 1,000 h/yr. In between these extremes, an Iowa contract fleet owner reports that his drivers run their trucks all the time during the week, but the trucks are turned off for the weekend in his yard (Riemer 1999). These 40 trucks are idling for approximately 3,600 h annually. In the absence of actual statistical data, we present results as a function of number of hours idled per year.

The location and the availability of appropriate places to stop also influence truck idling patterns. Truck drivers stop to rest at public rest areas and private truck stops (TRI 1996). Most truck drivers use free public rest areas during the day and for short stops. Nearly 1,500 public rest areas are scattered throughout the contiguous 48 states and the District of Columbia, offering some 25,000 truck parking spaces for the nearly 480,000 long-distance trucks (including those that do not need to park overnight on the road). Accessibility is an important concern, which favors the public rest areas on interstate routes. Therefore, the public facilities along the busy interstate routes (such as I-5, I-10, I-40, I-80, I-90, and I-95) become full early (TRI 1996). Private truck stops provide approximately 184,000 additional parking spaces, and many truck drivers use these, with new construction projected to increase that number to 213,000 by the end of 1999 (TRI 1996). Although many trucker drivers prefer not to pay user fees, higher fuel taxes, or higher registration fees for parking, truck stops offer such services as showers, laundry, and restaurants (TRI 1996). The truck stops along the busy interstate routes report 90% occupancy levels. Drivers sometimes park at their customers' lots if the site is safe. Drivers must balance their concerns for safety and cost in selecting a place to rest. Several recent studies have addressed the question of parking space availability; additional information from these will be added here.

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If there are 458,000 truck drivers who are likely to need to stop and sleep, and there are only about 210,000 parking spaces at rest areas and truck stops, then a maximum of 46% of the heavy long-haul trucks can be using them at any one time. Although trucks are out of service part of the time for maintenance, there is peak utilization on weekdays, which increases the overcrowding. Many truckers drive at night and sleep during the day.

1.2 Locomotive Idling

Locomotives idle for slightly different reasons than do trucks. They also idle to keep the engine and fluids warm to ensure that it starts. Note that antifreeze is generally not used in locomotive engines because it can damage the bearings in large diesels. Idling protects against both freezing water and cold oil that's too stiff for cranking. Antifreeze would reduce the horsepower output because water is a better heat transfer fluid than antifreeze, so it allows for 20% smaller radiators. With no antifreeze, there are no potential environmental impacts of its leaking.

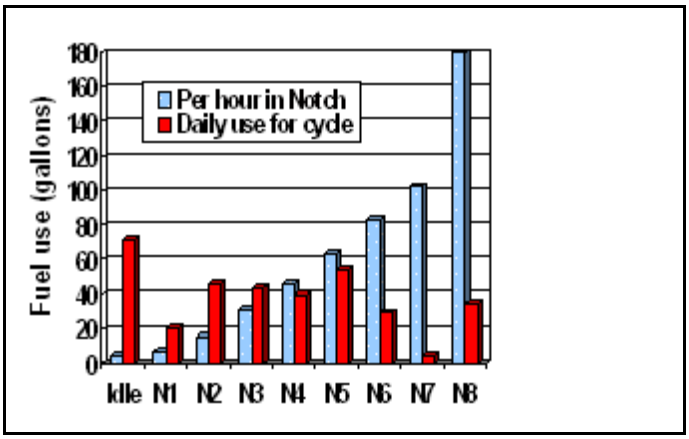

Figure 1.2 Switcher energy use by throttle notch

Although the operator does not sleep in the cab, locomotives still have hotel loads while they are waiting on sidings for higher-priority trains to pass, and at terminals. They also idle to keep the battery charged, and to heat the toilet water; frozen toilets can cause costly service loss. In addition, locomotives idle to keep the brake air pressure up and avoid the time-consuming Terminal Brake Test. Similar to trucks, there is a perceived futility of shutdown, and operators' ingrained habits.

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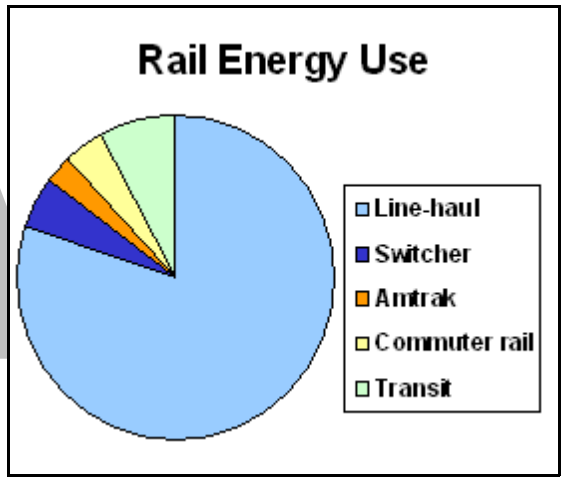

Figure 1.3 Energy use by train type

Different types of trains also have different idling characteristics. Idle commuter and transit trains cluster at fixed locations and are run on rigid schedules. Their loads are relatively light. Freight rail includes road units (linehaul), which carry heavy loads and may idle in remote locations. This type of service dominates rail energy use (see graph), but yard units (switchers) idle up to 75% of the time at fixed locations. These are an obvious source of noise and pollution in populated areas.

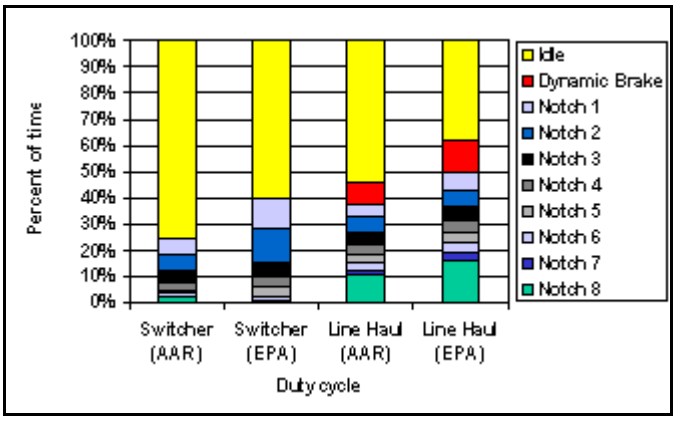

Figure 1.4 Freight train duty cycles

Since they dominate rail energy use, we examine freight locomotives in more detail. Both yard and road locomotives idle a significant fraction of the time. Typical duty cycles have been published by both the Association of American Railroads and the Environmental

Protection Agency for road and yard locomotives. These are shown in Figure –. Note that locomotives operate in distinct throttle settings, called notches, with Notch 8 being the highest horsepower. It can be seen (next figure) that switcher (yard) locomotives use more of their fuel idling than in any other notch. Reduction of idling thus provides significant potential for fuel savings, as well as emission reduction. 'The time of maximum carbon accumulation is when they (locomotives) are idling or operating at minimum power output. The time of maximum carbon ejection is when power is applied after a period of idling.'(Source: Railroad Fire Prevention Guide)

1.3 Buses

Although total energy use by buses is rather small (about 0.2 Q/y), and the corresponding emissions are proportionately small, bus idling has received considerable public interest. That is because of the high visibility of many of these vehicles. First and foremost are school buses, which idle in lines outside of school buildings while they wait for students to board and exit. There has been much written on this subject, including a lengthy report by a Yale professor[4]. The exhaust from a bus idling in front of another affects both students on line to board and those who have already boarded. Because children are an especially sensitive population, many localities have passed ordinances restricting school bus idling.

The second particularly visible type of bus idling is tour buses at parks and monuments. These buses generally bring passengers to a point of interest and park nearby to await their return. While they wait, they idle their engines, primarily to keep the bus at a comfortable temperature. The result is lines of buses at popular tourist sites, obstructing the view, making noise, and polluting the air. Several municipalities have ordinances that limit idling time, but enforcement is uneven. Inter-city buses and transit buses may also idle when stopped for long periods. And all types of buses are idled, sometimes for hours, to warm them up before starting their runs for the day.

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1.4 Off-Road Vehicles

1.4.1 Heavy Construction and Maintenance Vehicles

Heavy construction equipment is either owned by or leased to the construction contractor. It is generally delivered to and removed from the job site by highway-legal haulage truck-trailers. Due to cost considerations, units remain at the site only so long as used productively, and are removed thereafter. If a piece of equipment is deployed for a multi-day period at a worksite, its ignition controls are secured by lockdown after working hours to prevent misuse or theft, so there is little or no overnight idling. When powered up, virtually all equipment is being employed in excavation, earth moving, tamping, grading, paving, or related heavy activity. As a rule, operators do not remain idle in equipment cabs; if a unit will not be needed for some time, it may idle, but its operator will relocate to another piece of equipment whose services are required at once. Full engine shutdown of any unit

[4] Children's Exposure to Diesel Exhaust on School Buses, John Wargo, Ph.D., Yale University, Environment & Human Health, Inc.(2002)

that will be employed at the site at some point during the remainder of the workday is rare (and many sites run work shifts around the clock), but urban areas such as New York and Boston with pressing air pollution problems related to particulate matter now require engines not in use to be turned off to control idling emissions. Public works authorities in many areas also require contractors to commit to use of only either low-emission units or equipment with retrofitted emissions after-treatment devices as a pre-qualification for job bidding.

Municipally-owned or –leased equipment used in the maintenance of public works such as roads, bridges, parking facilities and landfills, and for snow clearance, follows a similar regimen to that described above, with equipment in multi-day service at a location locked out (and sometimes tagged out) for security after working hours. However, some of such equipment is likely to see longer slack periods between uses and therefore experiences comparably fewer operating hours per year than private-sector counterparts. Consequently, these units can remain in fleets for long periods. For examples, as of October 2002, over 20 percent of the diesel-powered off-road equipment in the City of Dallas, TX fleet was over 12 years old, and included several relatively inefficient indirect injection engines (information courtesy David Miller, City of Dallas Vehicle Fleet Coordinator). Idling fuel consumption of older units can be well above the average for their class/category.

1.4.2 Airport Ground Service Equipment

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A cooperative nationwide initiative among private air carriers and local airport authorities to replace antiquated diesel-powered aircraft tugs, jet A fuel tankers, and baggage transport power with either electric or clean-burning units has been underway for several years. Airside ground service vehicle electrification has the dual advantage of eliminating both on-site emissions and vehicle idling. New alternative fuel and "clean diesel" units are more fuel-efficient than their predecessors, and are already subject to air quality-driven idling restrictions at most major airports. Virtually all of this equipment can be stored indoors at airports, and thus shut down when not in use.

1.4.3 Agricultural Equipment

Farm tractors, combines, gleaners, and other agricultural equipment are highly seasonal in use and increasingly owned by specialized operations that "follow the harvest." Few private farmers can afford to idle their heavy equipment for long periods, and in-cab time for operators is coincident with productive equipment operation.

1.4.4 Mining and Other On-Site Industrial Mobile Rigs

Mining rigs span the range from huge earthmoving trucks to subterranean long wall load-haul-dump units. Operational efficiency of mining units is usually based on a 50-minute hour, implying about 17% non-working time per shift (it is not known whether this represents time with engines actually running at idle—in an underground environment with limited ventilation, for example, this seems unlikely).

Industrial properties utilize mobile task equipment on site throughout a workday. While much industrial equipment is as small as forklifts, there can also be large cranes and material moving equipment, such as payloaders, in regular service at a fixed site. In recent years, much smaller industrial equipment (especially forklifts) has been electrified as both a cost-saving and air quality measure.

Because 100% of the operating cost of mining and industrial units is absorbed by the operating entity, expense due to excess idling would be recognized and measures taken to reduce it should it prove a notable detriment to the company's bottom line.

1.5. Marine Vessels

Ships in port require power for various reasons, depending on the vessel's function. Passenger ships require hotel power for lighting, heating and air-conditioning, and appliances. Even when no passengers are on board, minimal atmospheric conditions must be maintained, and food in refrigerators and freezers must be kept cold. Cargo ships might need power for pumps or cranes to move the cargo, as well as refrigeration for some containers. And some lighting and space conditioning would also be needed. In fact, power requirements in port can be greater than those at sea, and are typically on the order of 4 MW for refrigerated container ships and up to 10 MW for cruise ships. (Daniel Gore, MARAD, personal communication 1/04)

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