
# Delay and Environmental Costs of Truck Crashes

This report presents the Federal Motor Carrier Safety Administration (FMCSA) with a more complete estimate of the costs of truck crashes. This estimate is needed to determine the full benefits of reducing commercial motor vehicle (CMV) crashes.

## SCOPE OF COSTS

The primary components of crash costs are shown in Figure 1. Crash costs estimated as part of this study are the shaded cells, and include property damage, vehicle delay costs, emissions costs, and excess fuel consumption costs. The item "Lost Productivity" estimated in previous studies includes both lost work time from injuries and additional travel time resulting from crash-caused traffic backups, but the present study only addresses the latter. Quality-Adjusted Life Year (QALY) is a dollar amount assigned to the value of life for analytical purposes. Volatile organic compounds (VOC) are pollutants formed during complete and incomplete combustion of fuel. Additional emissions and additional fuel consumption from backups are also estimated, as well as spilled fuel and emissions from ruptured motor fuel tanks. This report also addresses estimated costs specific to crashes involving hazardous material (HM) releases.

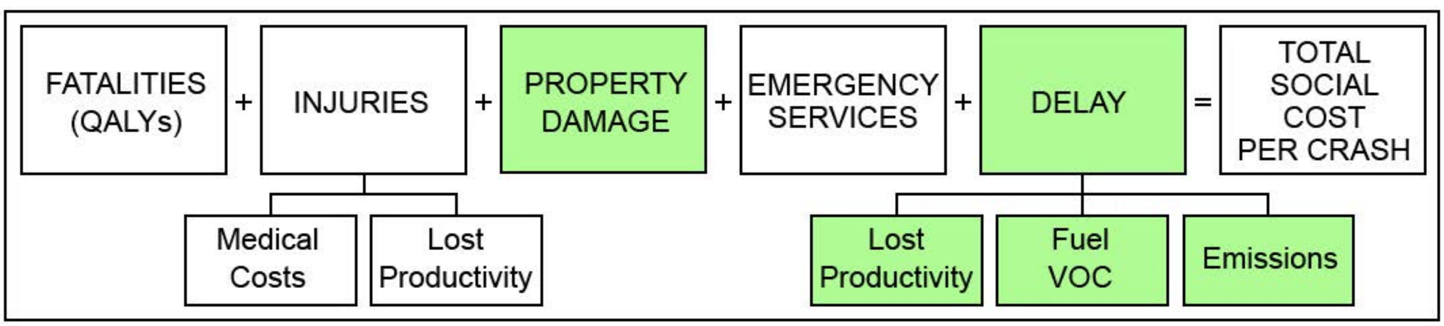


**Figure 1. Flow Chart. Crash Cost Components.**

## INCIDENT DELAY MICROSIMULATIONS

The study uses real-world data fed into the Traffic Software Integrated System Corridor Simulation (TSIS-CORSIM) traffic microsimulation model to determine delay time. TSIS-CORSIM requires the following inputs: 1) the characteristics of the roadway, 2) the volume of traffic on the roadway, and 3) the duration of the road closure due to the crash. The characteristics of the roadway are represented by five roadway types:

- Urban Interstate/Expressways.
- Urban Arterial.
- Urban Other.
- Rural Interstate/Principal Arterial.
- Rural.

To know how many vehicles will be affected, the traffic volume must be determined for each hour of the day. Using data from the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS), a curve representing the percent of total road volume per hour of day was developed to estimate the traffic impacts of a crash occurring throughout the day.

The distribution of CMV crashes per road type was developed using national vehicle crash records from the National Highway Traffic Safety Administration's (NHTSA) Fatality Analysis Reporting System (FARS) for fatal crashes and from NHTSA's General Estimates System (GES) for non-fatal crashes.

Scenarios for each roadway type involve traffic volumes and durations of road closures for different times of day and days of the week (e.g., weekday versus weekend). Crash duration is affected by severity. Estimates of delay costs are developed for various combinations of those attributes and the resulting cost estimates are weighted by the frequency with which each type of crash occurs to develop estimates of expected crash costs for various subcategories.

The last data point required by the model is the average

**Table 1. Estimated Delay Time Cost per Crash (2010 Dollars)**

| Roadway Type | Fatal | Injury Only | Property Damage Only | Average for Road Type |
|---|---|---|---|---|
| Urban Interstate/Expressway | $163,792 | $61,395 | $52,175 | $55,121 |
| Urban Arterial | $11,760 | $3,328 | $2,649 | $2,876 |
| Urban Other | $11,303 | $3,860 | $3,258 | $3,458 |
| Rural Interstate/Principal Arterials | $7,086 | $2,628 | $2,222 | $2,351 |
| Rural Other | $2,421 | $821 | $684 | $729 |
| Average for All Roadway Types | $39,602 | $14,508 | $12,280 | $12,996 |

time length of a CMV crash. The distributions of roadway closure times were based on real-world CMV crash data from the Pennsylvania and Kentucky Departments of Transportation.

## NETWORK DELAY

Some severe crashes with a long duration may also cause delay for drivers using alternate routes to avoid the crash. Alternate route delay stems from main route drivers voluntarily diverting, or being diverted around the crash site, thereby interacting with drivers on secondary streets. To calculate delay stemming from these types of severe crashes (determined by duration, volume, and degree of lane closure), a secondary diversion delay model was developed. The diversion delay model is based on deterministic queuing (traffic backup) theory and its delay estimates are combined with the primary traffic delay simulation model estimates to provide total delay for each volume. Rubbernecking delays are also included.

When crashes are placed into a developed roadway network in TSIS-CORSIM the model is able to simulate different traffic patterns under different situations by varying the characteristics of the roadway, traffic volume, traffic speed, driver aggressiveness, and other parameters. Crashes are simulated by introducing blockages on the roadway that close certain lanes for predefined sets of time to represent the time needed to clear a crash site. The simulation traces the effects of traffic as a backup builds after a crash that has completely or partially blocked a roadway.

The simulation continues after the blockage is removed, to capture dissipation of the backup as traffic flow returns to normal. The simulation is run both with an incident and for conditions without an incident to measure the incremental delay from the crash. Also, each scenario is run multiple times to allow for random variation in driver behaviors. The delay estimates use the median value from those multiple runs.

## DELAY COSTS ESTIMATES

Dollar values can be placed on the time lost by drivers on the roadway for each roadway type using established valuation of time estimations. Across roadway types, the estimated cost of delay increases with crash severity. Generally, fatal crashes have delay costs almost three times higher than injury only crashes. This result is driven by the finding that fatal crashes result in road closures of longer duration. Injury-only crashes have delay costs only 20 percent higher than property damage only crashes (see Table 1).

## EMISSIONS, EXCESS FUEL CONSUMPTION

The data created by TSIS-CORSIM must be modified for the Environmental Protection Agency (EPA) Motor Vehicle Emission Simulator (MOVES) model to calculate vehicle emissions. The animation data file from TSIS-CORSIM is used to generate descriptions of vehicle starts, stops, acceleration, and deceleration. Incorporating this vehicle drive cycle information provides more accurate estimates of emissions and fuel consumption than simply using the TSIS-CORSIM or MOVES models alone. This method appears to be the first to combine the two models in this way. Thus, emissions per crash, as well as fuel burned per crash, can be calculated and the associated costs estimated (Table 2). Emissions are valued at their societal costs including damage to infrastructure and health impacts. Fuel consumption is valued at retail prices of gas and diesel reported by the Energy Information Administration as of April 2011.

**Table 2. Estimates of Cost of Emissions and Excess Fuel Burn per Crash (2010 Dollars)**

| Cost Type | Fatal | Injury Only | Property Damage Only | Average for All Crashes* |
|---|---|---|---|---|
| **Excess Fuel Burn** | $2,147 | $757 | $636 | $675 |
| **Emissions** | $951 | $338 | $285 | $302 |

* Across all road types.

For further information, see the full report at: http://www.fmcsa.dot.gov/facts-research/art-public-reports.aspx.