Appendix E

Rail Accident Rates

Accident Rates

For the analysis described in Chapter 3, Section 3.2, *Rail Operations Safety*, OEA used both qualitative and quantitative methods to estimate rail accident rates and potential consequences. OEA estimated the number of train accidents (primarily collisions and derailments) that could occur during rail operation based on accidents rates from the Federal Railroad Administration (FRA) (2020). OEA analyzed the rates in combination with the specifics of the proposed rail line operation (e.g., number of trains, route length, track class) to estimate the number of accidents per year. The analysis used predicted rates based on data for all railroads, informed by rates for BNSF Railway Company (BNSF) and Union Pacific (UP) rail traffic as both are likely to connect the Uinta Basin (the Basin) to other national destinations, using accidents per million train miles (Table E-1).

Table E-1. Nationwide Train Accident Rates

Year	All Railroads (Passenger and Freight Trains)	All Railroads (Main Line and Sidings)	BNSF (Freight Trains)	UP (Freight Trains)
2016	2.50	0.89	2.07	3.24
2017	2.53	0.91	2.01	3.35
2018	2.73	0.94	2.10	3.71
2019	2.74	1.00	2.11	4.47

Train accident rates are generally distinguished only by freight versus passenger service, not by specific cargoes. In estimating accident rates, OEA considered both loaded and unloaded crude oil trains. Given that the rail line would primarily operate unit trains that would travel from the Basin to the end markets with only a few manifest cars being separated out, trains would generally pass around or straight through most yards on their travel. Thus, OEA focused the analysis for the project study area on accidents on the alignments of the Action Alternatives (main lines and sidings). Similarly, the downline analysis focused on the main lines and sidings, rather than rail yards. OEA calculated the predicted number of accidents per year by multiplying segment lengths by the number of trains per year by the appropriate accident rate for the track class on that segment.

Accident rates have shown to vary considerably by track class, with higher accident rates occurring on lower track classes that require lower train speeds due to the standards to which they are built and maintained.[1] Liu et al. (2011) derived derailment rates by track class, starting with baseline rates provided by Anderson and Barkan (2004). They found that the derailment rates for Track Class 3 were twice the overall average and derailment rates for Track Class 2 were six times the overall average (accident rates increase with lower track classes due to lower track standards/quality). Conversely, derailment rates for Track Class 5 were roughly a third of the overall average rates (accident rates decrease with higher track classes due to higher track standards/quality and other factors). Anderson and Barkan (2004) found that the overall accident rate (collisions, derailments, and other types) on Track Class 3 was roughly twice the total rate for all track classes, and the overall rate on Track Classes 4 and higher was roughly half the total rate for all track classes.

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[1] Train accidents are more likely to occur on lower track classes (which have lower allowable speeds) because lower track classes are not designed and maintained to the same standards as higher track classes.

OEA used data on accident rates by track class to generate a base accident rate for all of the Action Alternatives, which would operate on Track Class 3 in the Basin at an average of 15 miles per hour (mph) based on information provided by the Coalition. The allowable operating speeds are up to 40 mph on Track Class 3, but lower anticipated speeds reflect the geometry, tunnels, bridges, and steep grades on the proposed rail line. OEA started with the nationwide rates over the last 2 years of about 2.7 accidents per million train miles for all railroads and types of track (Table E-1) as the basis for predicting accident rates. OEA also reviewed the combined total for main lines and sidings (i.e., not including yards and industry track) for all railroads, which gave an average of 0.97 accident per million train miles for 2018 and 2019. This was rounded to 1 accident per million train miles (the same as the value for 2019). Using the multiplier of two for Track Class 3, as indicated by Anderson and Barkan (2004) and Liu et al. (2011), OEA predicted a rate of 2.0 accidents per million train miles for the Action Alternatives.

For the downline analysis, OEA reviewed the maximum allowable speeds on the different segments and found that the likely track classes involved were primarily Track Classes 3, 4, and 5. OEA used Track Class 3 in the analysis for Kyune to Grand Junction and used Track Class 4 or higher for the other downline segments. For the Action Alternatives, Track Class 3 had a rate of 2.0 accidents per million train miles. Using the findings of Anderson and Barkan (2004), OEA estimated the rate for the other downline segments as 0.5 per million train miles, or one-half that for the average across all track classes.

Spill Sizes and Release Probabilities

To understand the potential severity of train accidents during rail operations, OEA reviewed accidents that have occurred on existing rail lines in Utah. Based on FRA data (2020), eight main line accidents occurred in Utah in 2019, five involving derailments; there were no collisions. One of the derailments involved 25 cars with releases from two propane cars. There were two accidents on siding track, both derailments, one due to a broken flange and one attributed to the roadbed being soft or having settled.

In the past, rail accidents involving crude oil or other hazardous materials typically resulted in small releases. However, recent accidents in Lac-Mégantic, Québec; Casselton, North Dakota; Aliceville, Alabama; Lynchburg, Virginia; and Ontario, Canada, among others, have been more significant and generated additional attention on crude by rail transportation.

Lac-Mégantic, Québec, July 6, 2013

After hand and air brakes on a parked train failed, the train rolled downhill reaching a speed of 65 mph before derailing. Almost all of the 63 derailed tank cars were damaged in some way; many had large failures. Roughly 1.6 million gallons (38,000 barrels) of oil were released. Fires and explosions caused 47 fatalities and massive property damage. All cars were DOT-111s. (Transportation Safety Board of Canada 2013; NTSB 2014a)

Casselton, North Dakota, December 30, 2013

A crude oil train collided with a previously derailed grain car on an adjacent main line track at roughly 42 mph. Twenty tank cars derailed and 18 were punctured, releasing more than 420,000 gallons (10,000 barrels) of crude oil. No injuries were reported (NTSB 2014b).

Aliceville, Alabama, November 7, 2013

Derailment of this accident occurred at 38 mph, with 26 cars derailed. The accident caused a loss of 630,000 gallons (15,000 barrels) of crude oil, which contaminated some wetlands (NTSB no date).

Lynchburg, Virginia, April 30, 2014

This accident involved the derailment of 17 cars, with one car failing, which led to a fire. Three of the derailed crude oil cars ended up in the James River, spilling up to 30,000 gallons (714 barrels) of crude oil into the river. Later clarification noted that the fire involved a CPC-1232 rail car (NTSB 2016).

Gogama, Ontario, March 7, 2015

This accident involved a derailment of 39 cars following a train-initiated emergency brake application. About 690,000 gallons of crude oil were released (from 33 cars). Some of the product ignited and caused explosions and some entered the Makami River. A rail bridge over the Makami River and about 1,000 feet of track were destroyed. This accident occurred only 3 weeks after another major derailment in the nearby town of Gladwick. (Transportation Safety Board of Canada 2017)

Many of these accidents involved tank cars that do not meet present-day standards. Additionally, the Uinta Basin crude oil does not have the same volatility as the crude oil involved in the accidents cited above, such that explosions are much less likely even in the event of large spills. Even more rigorous standards will be fully implemented by May 2025. For the most part, the activities in the Basin are expected to use the 117 or 117R (retrofit) tank cars, with a limited number of CPC-1232 cars until May 2025. The DOT 117 standard included a jacketed thermal protection system, full-height head shields, and other protective features. These are all designed to reduce the chance of rail cars breaching in an accident or from exposure to a fire if nearby cars are breached. Additional safety precautions, including reduced speeds, are also in place for crude oil (and other flammable cargo) trains.

A detailed hazardous materials rail transportation model develop by Arthur D. Little, Inc. for the American Association of Railroads (AAR), the Railway Progress Institute (RPI), and the then Chemical Manufacturers Association considered a range of release sizes to try and bracket the potential range of consequences and allow for the frequencies of different-sized releases to be determined (Arthur D. Little 1996). That model used data from the RPI-AAR Railroad Tank Car Safety Research and Test Project on the relative frequencies of various release sizes from individual cars as a function of the number of cars derailed in an incident. It then considered the possible combination of releases from multiple cars to select representative spill sizes for the model. In particular, the following spill sizes were used, eliminating the very small releases, as they do not contribute much to overall risk.

- 30 gallons per minute for 10 minutes (300 gallons)
- 300 gallons per minute for 10 minutes (3,000 gallons)
- Single rail car volume spilled instantaneously
- Three rail cars spilled instantaneously

- Five rail cars spilled instantaneously

Given the uncertainty over the likely spill size, OEA considered in this analysis a range of potential release sizes and their associated chance of occurrence using the same ranges of spill sizes listed above; however, the first two categories were combined into one spill size of 1,000 gallons. Additionally, OEA added an extreme case of 450,000 to 900,000 gallons, to put such extreme spills in perspective.

In terms of the number of cars derailed, the *Washington State 2014 Marine and Rail Oil Transportation Study* (Washington State Department of Ecology 2015) reported the number of derailed tank cars per major crude oil accident in 2013 and 2014 ranged from 6 to 30 in the United States and 4 to 63 in Canada. The number of cars that spilled their contents was 1 to 20 in the United States and 0 to 5 in Canada; however, the two spills in Ontario in 2015 discussed previously involved releases from more rail cars. When looking at derailments, a larger set of accidents involving a variety of hazardous materials can be examined to understand the outcomes because the specific cargo type does not generally affect the chance of a train accident. Also, in general, slower speeds result in fewer cars derailed (Liu et al. 2012, 2014).

Data from the RPI-AAR Railroad Tank Car Safety Research and Test Project also provided information on the probabilities of release for rail cars of different designs and the detailed analysis to determine the chance of different numbers of cars derailing and releasing different quantities of the product carried. Liu et al. (2014) provides an updated description of this approach and gives some representative results. For Class I railroads, 24 percent of derailments involved one car, 50 percent involved five or fewer cars, and the overall average was about nine cars. As a group, the Class I railroads operate largely on Track Class 4 or 5, with the associated higher speeds.

More recently, analyses from the Railway Supply Institute (the former RPI) suggest that the chance of a release per car for CPC-1232 cars is roughly half that for the old 111 cars (at about 0.05 to 0.10), DOT 117 cars would be 0.03, and the 117R would be 0.04 to 0.08 (RSI 2019). These are for certain configurations of cars in trains and show the decreasing chances of releases in the better-protected rail cars.

OEA used a combination of these and other data to determine representative distributions of release sizes for the types of rail cars addressed in the assessment of the Action Alternatives, given that a derailment or collision has occurred on the proposed rail line.

- Minor spill from collision/derailment (1,000 gallons): 7 percent
- Collision/derailment release of 30,000 gallons: 17 percent
- Collision/derailment release of 90,000 gallons: 2 percent
- Collision/derailment release of 150,000 gallons: 0.07 percent
- Extreme collision/derailment release of 450,000 to 900,000 gallons: 0.005 percent

Taken together, this distribution suggests that 26 percent or roughly one in four accidents, most of which would be derailments, would have some sort of release, and most of the time the release would be equivalent to one car or less.

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