Rail Safety Staff Activities: Train Securement

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Presentation Overview*

- Oil-train derailment tragedy, Lac-Mégantic, Canada, July 6, 2013.
- Northern oil field shipments.
- A primer on train brakes.
- California uncontrolled train movements.
- Canadian and U.S. train securement regulations.
- Transportation Safety Board of Canada safety advisories.
- SED staff inspections, activities.

* *Disclaimer: Much of the information in this presentation is preliminary and should be independently verified before further use. This is only intended to be a briefing, a primer, and material for further research and investigation.*

Lac-Mégantic, Canada, July 6, 2013, Oil-train Derailment and Fire

- Unattended oil train.
  - 72 loaded tank cars.
  - 5 locomotives.
  - 10,287 tons.
  - 0.9 mile long.
- Parked on 1.2 percent grade at Nantes.
- Ran uncontrolled 8 miles down-grade to downtown Lac-Mégantic .
- 63 tank cars derailed.
- 1.5 million gallons light crude spilled, ignited.
- 47 fatalities from explosion and fire.

Lac-Mégantic Oil-train Derailment (cont.)

Lac-Mégantic town damage

Lac-Mégantic Oil-train Derailment (cont.)

Destroyed tank cars

Car type: USDOT Class DOT-111

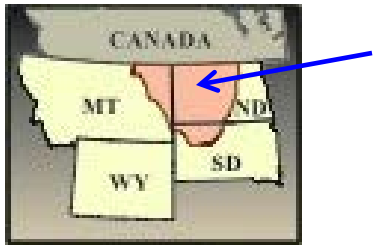
Lac-Mégantic Oil-train Derailment (cont.)

Some events, issues relevant to the investigation:

- How were brakes set?
- Did fire and locomotive shut-down affect:
  - Locomotive air brakes?
  - Locomotive handbrakes?
  - Train air brakes?
  - Train handbrakes?
- What operating rules? Reasonably executable? Ambiguity? Sufficient? Expectations of consequences? Compliance?
- Similar issues for regulations?
- Was sufficient training provided?
- Compliance assurance, competing demands?
- One-person crews?
- Mechanical defects, peculiarities in any of the three brake securement systems?
- Leaving train on main line?
- Use of derails?
- Integrity of tank cars?

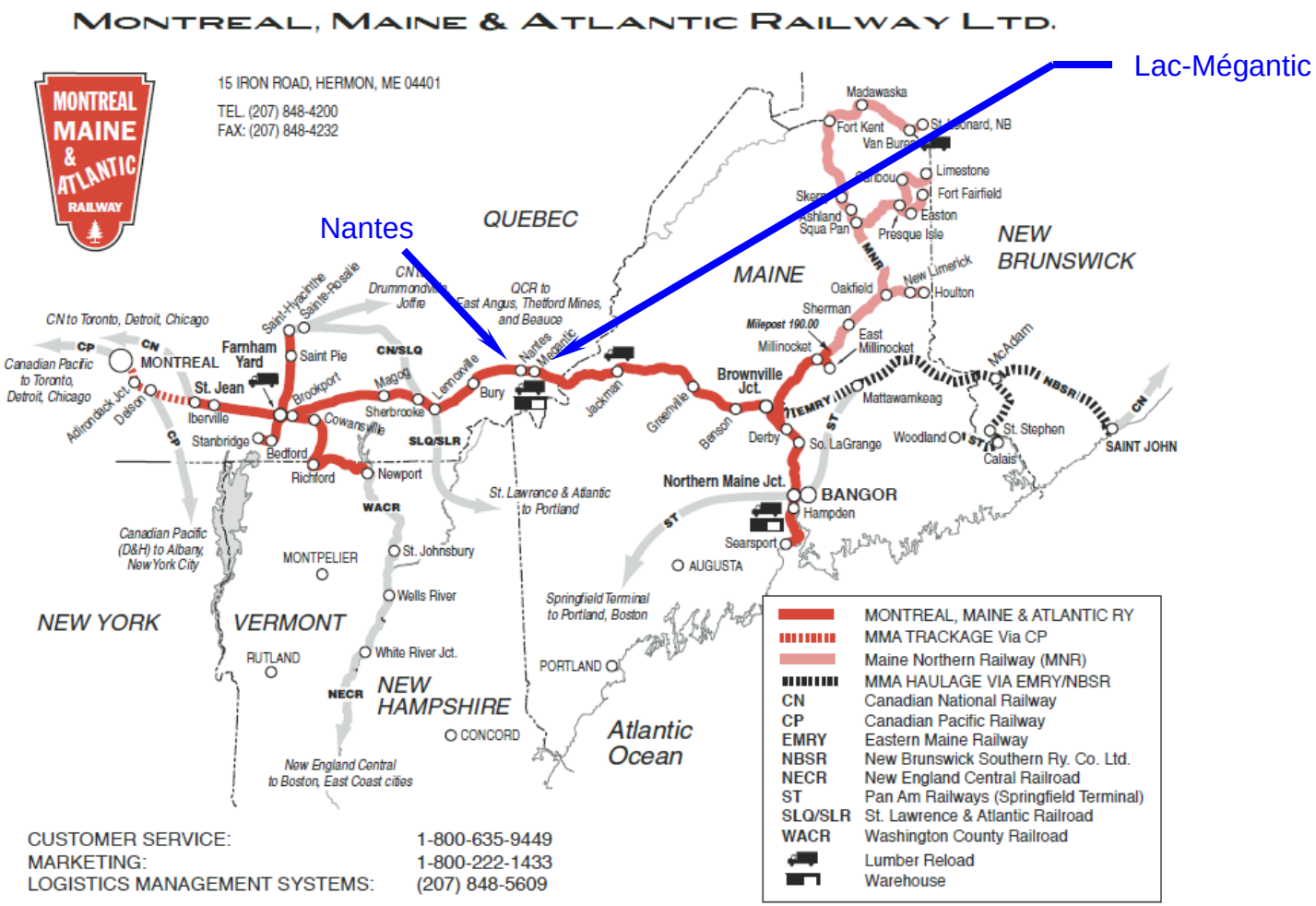
Lac-Mégantic Oil-train Derailment (cont.)

- Montreal, Maine, and Atlantic Railroad (MMA)
  - Canadian short-line railroad
  - One of two Canadian railroads that operate with only one crewmember.
- Oil shipment from the North Dakota Bakken Total Petroleum System (TPS).
- Via MMA train from Montreal to Saint John, New Brunswick, refineries.
- Implications for California.
  - Four 50-car trains per day to Benicia?
  - Other large hazardous materials shipments?



Bakken TPS

Lac-Mégantic Oil-train Derailment (cont.)

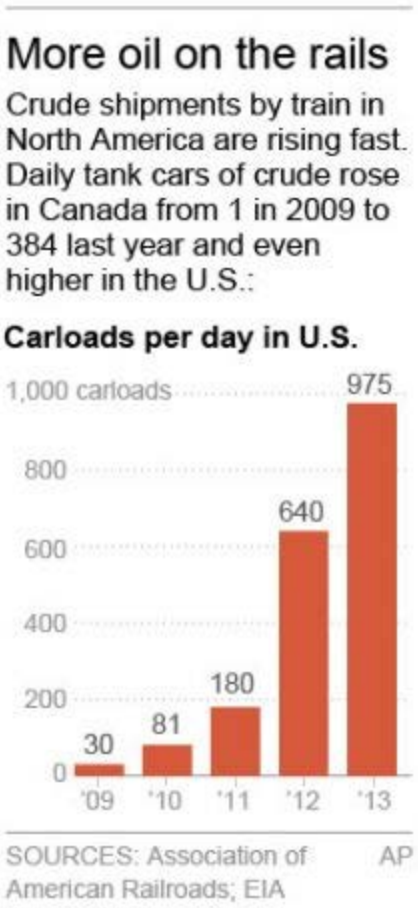


Lac-Mégantic Oil-train Derailment (cont.)

Tank car integrity

- U.S. Department of Transportation (DOT) car integrity requirements.
  - DOT-111
    - Car in Lac-Mégantic tragedy.
    - 2012 NTSB recommendations for retrofit integrity improvements.
      - Enhance head (end) and shell (side) puncture resistance.
      - Improve pressure relief valve and top fittings.
  - DOT-111S
    - New class, new standards.
    - Enhanced head (end) and shell (side) puncture resistance.
    - Improved pressure relief valve and top fittings.

Crude Oil Shipments from Northern Oil Field

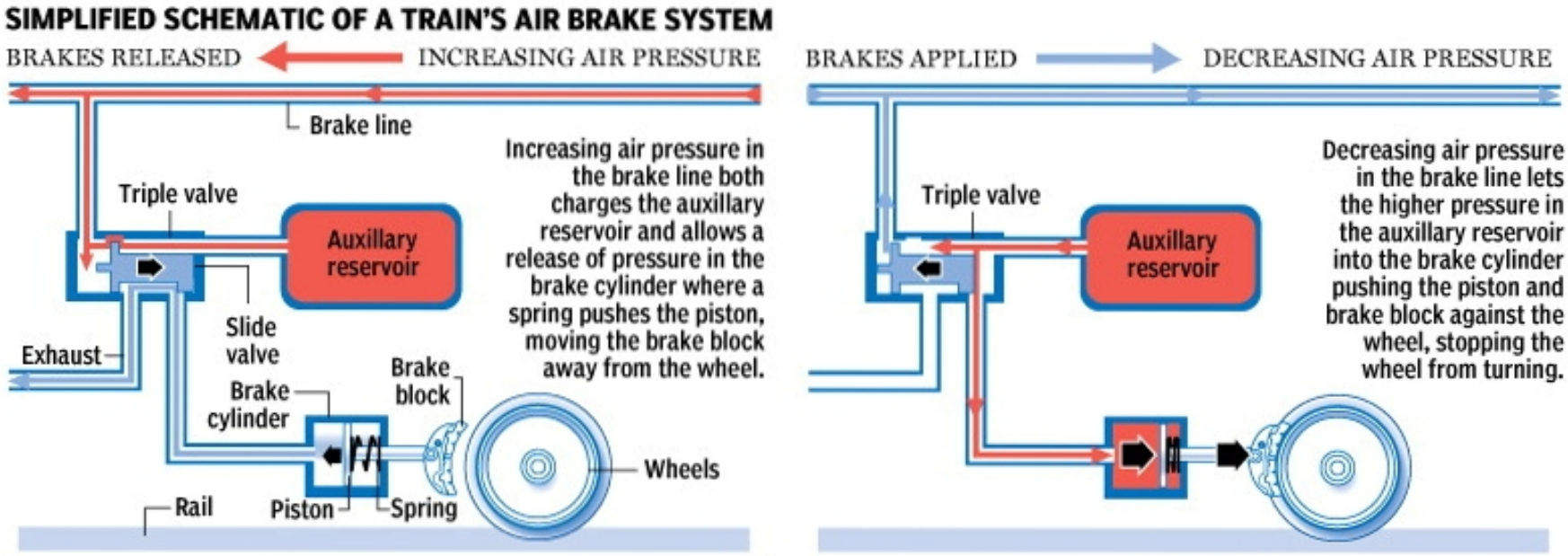


- Canada
  - 2009: 500 carloads/year.
  - 2013: 140,000 carloads/year (est).
- U.S.
  - 2009 1st half: 5,400 carloads/year.
  - 2013 1st half: 178,000 carloads/year.
- Bakken Formation
  - USGS estimates (recoverable):
    - 7.4 billion barrels crude oil.
    - 6.7 trillion cu. ft. natural gas.
    - 530 million barrels natural gas liquid.
  - Output outstrips shipping capacity.
  - Pipelines at capacity.
  - Heavy rail demand.

Train Brake Primer

- Handbrakes
  - On each car, secure standing car(s).
  - Moving trains:
    - Original 19th century system.
    - Speed controlled by brakemen walking on top of cars to set brakes on each car as train was moving.
- Air brake (train) – “Westinghouse Air Brake”
  - First invention simply applied air pressure to a brake cylinder on each car.
    - Increased air pressure in train air line applied brakes.
    - Decreased air pressure reduced brake force.
    - Complete air pressure loss released brakes.
    - Failed to unsafe.
  - “Triple valve” (control valve) invented as a more fail-safe brake.
    - Increased pressure releases brakes, decreased pressure applies brakes.
    - Air pressure loss initiates emergency brake application.
    - Fails to safe.*

Train Brake Primer (cont.)



Functional diagram of train air brake equipment on each car.
With brakes released, and with brakes applied.

Train Brake Primer (cont.)

- Modern control-valve air brake not completely fail-safe.
  - Speed and mass can exceed braking capacity.
  - Car air-brake reservoirs can be depleted with successive sets and releases without time to recharge.
  - Current FRA regulation requires trains to be stopped if exceeding authorized speed by 5 mph.

– Electronically controlled pneumatic (ECP) air brakes.
  - On some single-purpose “unit trains,” such as coal trains.
  - Electric cable runs length of train.
  - Brakes set and released electronically.
  - Air constantly charges air-brake reservoir.

– Locomotive dynamic brakes (not an issue in Lac-Megantic).

California Uncontrolled Train Movements

- Feather River Canyon, circa 1980.
  - Two “runaway” events, one fatality.
- 1989 Cajon Grade, San Bernardino.
  - Failure to control train speed with brake system. four fatalities.
  - Subsequent pipeline rupture and fire, two more fatalities.
- 1996 Cajon Grade, Cajon.
  - Failure to control train speed with brake system.
  - Two fatalities, hazardous materials release and fire.
- 2006 Beaumont Grade, Redlands (San Timoteo).
  - Failure to control with locomotive brake system.
  - Locomotive set derailed at high speed, no injuries.

Redlands 2006 locomotive derailment

Canadian and U.S. Train Securement Regulations

- Canadian Railroad Operating Rules, Rule 112 excerpts:
  - "When equipment is left at any point a sufficient number of hand brakes must be applied to prevent it from moving. Special instructions will indicate the minimum hand brake requirements for all locations where equipment is left."
  - "Before relying on the retarding force of the hand brake(s), whether leaving equipment or riding equipment to rest, the effectiveness of the hand brake(s) must be tested by fully applying the hand brake(s) and moving the cut of cars slightly to ensure sufficient retarding force is present to prevent the equipment from moving."
  - Railroad special instructions may provide guidance on "sufficient" and "minimum."
  - May be a Transport Canada compliance manual which may provide further guidance on the word "sufficient."

Regulations (cont.)

- U.S., Title 49, Code of Federal Regulations, Part 232.103(n) excerpts:
  - "A sufficient number of hand brakes shall be applied to hold the equipment."
  - "Railroads shall develop and implement a process or procedure to verify that the applied hand brakes will sufficiently hold the equipment with the air brakes released."
  - FRA Operating Practices Compliance Manual provides additional guidance on determining compliance with this section.
    - Excerpt: "A railroad simply stating in their operating rules or in their operational testing program that there will be a "sufficient" number of hand brakes, is not acceptable."
    - Excerpt: [Determine] "the precise number of handbrakes found to be fully applied, the precise number of handbrakes not fully applied, and the precise number of handbrakes required at that location."
  - Railroad special instructions should provide explicit guidance.

Number of Handbrakes to be Applied*					
	Railroad Grade				
Tons	0.25	1.00	1.25	2.00	3.00
< 1000	2	3	3	5	9
1000 +	3	5	6	10	20
3000 +	5	8	10	16	30
5000 +	6	12	15	24	39
7000 +	7	16	21	32	53
9000 +	9	20	25	40	65
10000 +	10	22	25	44	100%
11000 +	11	24	30	48	100%
13000 +	15	28	35	56	100%

Grade (%) columns apply until you reach the next higher Grade (%) shown.

* Minimum number of hand brakes required if unable to verify that sufficient hand brakes have been applied by release of the air brakes.

22 If applicable and applied to Lac-Megantic train, with 1.2% grade, 10,287 tons. Assumes available information on total tonnage includes approx. 1,000 tons for locomotives.

Transportation Safety Board of Canada Safety Advisories

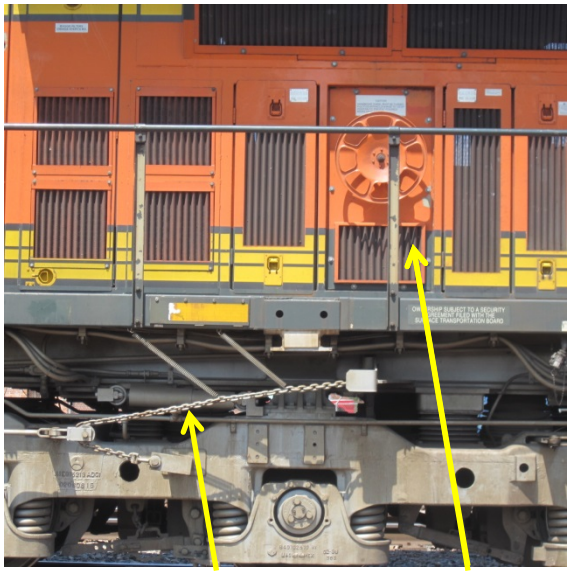
- CROR Rule 112 ensures that hand brakes are applied to prevent unwanted movement of the train while providing flexibility for a railway's operating needs. However, CROR Rule 112 is not specific enough in that it does not indicate the number of hand brakes necessary to hold a given train tonnage on various grades and it continues to be left up to the operating employee to determine the number of handbrakes to apply.
- It has been demonstrated that the push-pull test is not always a good indicator of whether an adequate number of hand brakes have been applied and not all handbrakes are effective even when properly applied.
- Considering all these risks, Transport Canada may wish to review CROR Rule 112 and all related railway special instructions to ensure that equipment and trains left unattended are properly secured to prevent unintended movements.
- Transport Canada may wish to consider reviewing all railway operating procedures to ensure that trains carrying dangerous goods are not left unattended on the main track.

SED Staff Inspections and Activities

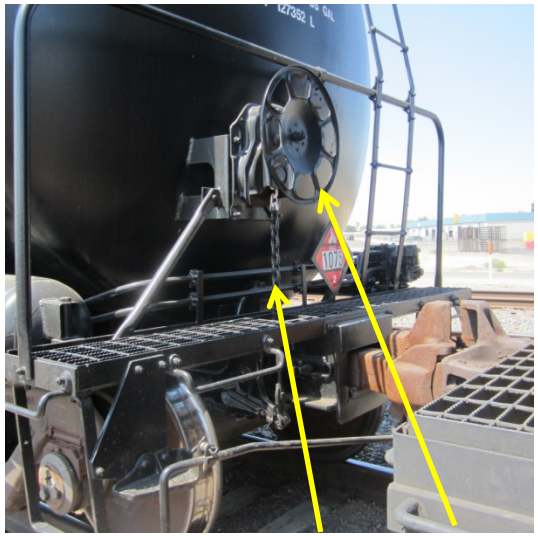
SED staff inspections of unattended equipment.

- Motive Power & Equipment inspectors.
  - Primarily inspect for handbrake condition, function, proper use.
- Operating Practices inspectors
  - Primarily determine compliance with railroad rules.
    - Determine applicable securement rules.
    - Determine appropriate number of handbrakes to be set.
    - Determine number of handbrakes set.
    - Derails set?

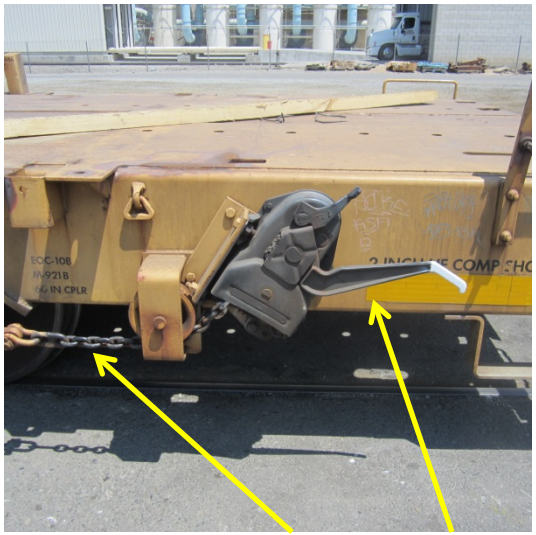
Locomotive handbrake chain Locomotive handbrake wheel



Handbrake chain Handbrake wheel



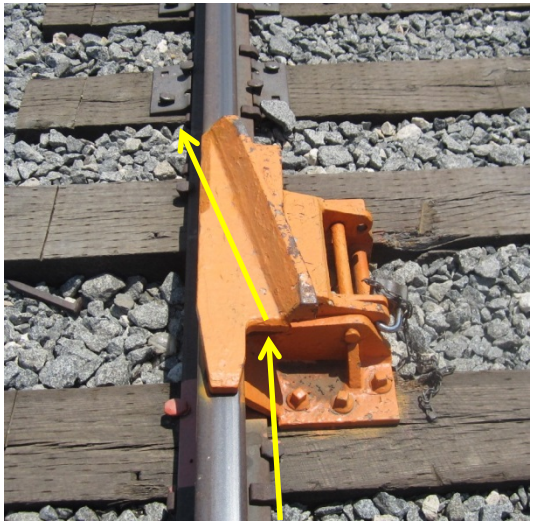
Tank car handbrake chain and wheel



Flat car handbrake, loose chain, lever

Checking handbrake

Derail



Derail showing wheel flange path

Wheel chock or block or “skate”

SED Staff Inspections and Activities

SED activities post-Lac-Mégantic derailment.

- SED staff staying informed re Lac-Mégantic investigation.
  - Unfolding facts, insights.
  - Safety advisories.
- Informal discussions with other agencies.
- Informal discussions with railroads, unions.
- Review of current railroad rules for securement.
  - Clarity, adequacy, possible weaknesses.
- Review of FRA compliance assessment practices.