Crude Oil Tank Cars

Economics, Specification, Supply, Regulation, and Risk

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Agenda

- Help participants understand key dynamics in railcar supply for the crude market
  - Railcar Economics
  - Crude characteristics as they relate to car demand and specification
  - Tank car supply and production
- Regulatory Issues
  - Design history
  - Crashworthiness of flammable liquids tank cars
  - H2S
- Versatility, Flexibility, and Ownership Risk
  - EC/I vs. NC/NI tanks
  - Tankcar regulatory compliance
  - Pipeline impact
Railcar Economics

- Weight Capacity
- Volume Capacity
- Car Length
- Turn Times
Railroads are most profitable when they can “hook and haul”: provide power and crew to pick up a single trainload from a single origin to a single destination. This is the lowest cost way for them to move any commodity.

Railroads therefore incentivize shippers to move the largest amount of commodity in a single trainload that is physically possible. What limitations are at play in this calculation?

- Shipment size
- Train length
- Railcar dimensions
- Tare weight
- Axle loadings

Shippers also have the added incentive to maximize railcar utilization by shipping in a way that reduces turn times.
What does this imply for shippers?

- Maximize shipment size to allow for unit train shipping
  - Smaller shipments will travel in manifest service with higher rates and longer turns
- Utilize light weight cars with high axle loadings
  - 286K GRL vs. 263K GRL
  - NC/NI vs. EC/I
    - Flexibility of EC/I may be deliberate tradeoff
- Optimize volume for expected commodity density
  - Avoid substantial excess volume capacity due to weight penalty
  - Some excess volume may be an acceptable tradeoff of flexibility
- Select cars with minimum length characteristics
  - Larger barrel diameter designs
Crude Types

Impact on Car Specification and Demand
North American Crude Production and Distribution

- **U.S.**
  - Production growth continues in Bakken, Permian, and Eagle Ford formations; others to follow
  - Growth projected from 6.7 MMb/d in 2012 to 11.6 MMb/d in 2022

- **Canada**
  - Expected to provide more than 80% of U.S. crude imports by 2022
  - Growth projected from 3.5 MMb/d in 2011 to 5.6 MMb/d in 2025

- **Rail** is critical to accommodate this new growth, at least in the near term
  - If even half of this incremental 7MMb/d goes by rail, there will be a need for at least 70,000 railcars to move it
  - Pipeline infrastructure is not in place yet; future pipeline development is an open question

Sources: BENTEK, GATX
Lighter U. S. Crudes (Bakken, Eagle Ford, Permian)

• 6.2 to 7.0 LB/Gal
• <5 cSt viscosity at moderate temperature
• <0.5% sulfur
• Origin: North Dakota & Montana
• Destinations: Coastal US and Eastern Canadian refineries
• Turn times: 14-20 days
• Optimal Car: 31,800-gallon 286K NCNI tank
• Fleet requirement: 19-28 railcars per 1,000bbl/d

Sources: BENTEK, ND DMR, Crude Quality, Inc., GATX
Canadian Crudes

- 7.2 (synthetic) to 7.8 (dilbit) to 8.4 (unprocessed) LB/Gal
- 5-15 (synthetic) to 130-220 (dilbit) to >250 (unprocessed) cSt viscosity at moderate temperature
- >1% sulfur
- Origin: Alberta
- Current Destinations: US Gulf Coast
- Future Destinations: US MW, Pacific export
- Turn times: 10-20 days
- Optimal Car:
  - Dilbit: 25.5 or 28.3Kgal 286K EC/I tank
  - Synthetic: 28.3 or 29.2Kgal 286K EC/I tank
- H2S issue under study
- Fleet requirement: 15-32 railcars per 1,000bbl/d

Sources: BENTEK, ND DMR, Crude Quality, Inc., GATX
Tank Car Supply

Fleet Trends Since 2008
Current Production Backlogs
## Crude-Capable Railcar Fleet Overview

<table>
<thead>
<tr>
<th>Figures in Thousands</th>
<th>Pre-Recession (1/1/08)</th>
<th>Pre-Crude Boom (1/1/10)</th>
<th>One Year Ago (1/1/12)</th>
<th>Today (1/1/13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large NC/NI 263K</td>
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<td>53.4</td>
<td>54.2</td>
<td>56.0</td>
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<td>Large NC/NI 286K DOT111A100</td>
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<td>Large EC/I 286K DOT111A100</td>
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<td>0.2</td>
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<tr>
<td>Medium EC/I 263K</td>
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<td>26.0</td>
<td>27.1</td>
<td>27.8</td>
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<td>Medium EC/I 286K DOT111A100</td>
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<td>0.2</td>
<td>1.5</td>
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<tr>
<td>Total</td>
<td>70.8</td>
<td>81.0</td>
<td>83.5</td>
<td>93.1</td>
</tr>
</tbody>
</table>

~9.6K of ~17.7K tank cars produced in 2012 were crude-capable.

Source: UMLER, ARCI
• 80% of current railcar backlogs are tank cars (48.2K out of 60.2K)
• Tank car backlog equals 19.3% of total tank car fleet
• Estimated 2013 production of 19K-24K is 2.4x to 3.1x natural tank car replacement rate
• Crude-capable fleet up 22.3K since 1/1/08
  o If non-crude tank car demand is down roughly 10%, this suggests the crude fleet is at roughly 30K cars.
  o This would imply a current crude-by-rail capability in North America of roughly 1 to 1.5 MMbbl/d depending upon turn times, car types, and crude types

Source: ARCI, FTR, EPA, AAR
Tank Car Regulations

* * *

Design History
Crashworthiness of Flammable Liquids Tank Cars
Hydrogen Sulfide
Evolution of Crude Oil Tank Car Specifications

- Factors affecting crude oil tank car configurations and capacity
  - Density drives car capacity
  - Viscosity affects flow and need for heater coils & insulation
  - Sulfur content will affect need for lining and stainless fittings
  - Water content could cause corrosion
Evolution of Crude Oil Tank Car Specifications

• Tank car specs 1970 – 1995
  o Capacity limited to 25K gallons
  o Shell Material A-515-70 Steel
  o 263K GRL
  o Interior heater phased to exterior coils
  o Visual outage gage scale

• Tank car specs 1996 – 2010
  o Higher grade steel
  o Improved crashworthiness
  o Million Mile underframes applied
  o Electronic gage device
  o Still 263K GRL
Current State of Crude Oil Tank Specifications

- AAR issues Circular letter CPC-1232 for crude oil and ethanol service
  - 286K GRL takes precedence
  - Larger Volume Capacity
  - Affects cars ordered after October 10, 2011
  - Half-Height Head shield protection
  - Tank & Head Material must be normalized TC-128 Gr. B or A-516-70
    - 1/2” shell thickness for TC128 non-jacketed cars
      (5/8” for A-516-70)
  - Top fitting protection required
  - PRD must be reclosing type
Current Crude Oil Tank Car Specifications

- Single cars - capacity 29K & 31.8K gallons at 286L GRL
  - 29.2K car with insulation & heater coils for all climates
  - 31.8K car is multipurpose for crude, gasoline or ethanol
    - Un-insulated & no coils allows more shipping capacity
    - Product payload dependent on product density
    - Optimal for use in moderate climates
Future Crude Oil Tank Car Specifications

- Derailments of ethanol unit trains cause extensive damage, clean-up costs, fatality
- DOT not satisfied with AAR responsive actions to date
Future Crude Oil Tank Car Specifications

• **Regulatory Activity**
  - Shippers / FRA feel CPC-1232 oversteps AAR authority
  - DOT / PHMSA accept AAR petition to adopt CPC-1232 specification
  - DOT / PHMSA asks industry for more than CPC-1232, including consideration of thermal protection
  - NTSB exerting pressure on DOT to address BOTH new and existing fleet

• **Industry Advocacy (AAR, Private Car Owners, Shippers)**
  - Continued support of CPC-1232 recommendations
  - Alternate pressure relief device for thermal protection
  - Modifications to bottom outlet valves

• **Status**
  - DOT / PHMSA has submitted to OST / OMB
  - ANPRM expected any day
  - Final rule making at least 2 years out
Future Crude Oil Tank Car Specifications

- Thermal Protection Systems
  - **Option 1 – Modified PRD Design**
    - Goal – Fully exhaust tank contents at low pressure to prevent explosion
    - Most practical and economical for both new and existing fleet
    - Challenge – new valve designs required
    - Likely that DOT would adopt
  - **Option 2 – Fire rated Insulation Blanket**
    - Goal – Control tank temperature during fire conditions
    - Practical for new, NOT for existing
    - Challenge – Reduced tank capacity, no reliable retrofit options
• **Enhanced Bottom Outlet Valve Protection**
  
  o Goal – Eliminate potential BOV “catch points” during derailments
  
  o AAR tank car committee has proposed a rule that includes:
    
    • No handles in transit, or stow handles in transit
    
    • Visual indication of open/closed position
  
  o Both new car and retrofit of existing fleet is likely
Improved Crash Worthiness

- Better / Thicker Tank Steel
  - New steels under review, but current steel is tough to beat
  - Retrofit of existing fleet impossible, but obsolescence risk offset by other more effective options
  - DOT likely to incorporate AAR requirements into final rule for crude oil service

- Head Protection
  - Practical retrofit option based on past precedence
  - Most efficient crash worthiness option
  - DOT likely to incorporate AAR requirements into final rule for crude oil service
• **Enhanced Train Control**
  - DOT wants to stop trains faster at the first sign of an accident
  - Electronically Controlled Pneumatic (ECP) and Distributed Power (DP) under consideration
  - Both options are very effective in normal operation, questionable in emergency situation
  - Implementation costly and complex for mixed freight service
  - DOT will NOT likely incorporate into final rule
Hydrogen Sulfide

- Transport Canada concerned about H2S building up in the vapor space of cars carrying sour crude
- Issue under study
- Industry view has generally been that volume, pressure, and concentration make hazard level low
- Some concern about possible corrosive effect on tank shell and fittings
Versatility, Flexibility and Ownership Risk

- NC/NI vs. EC/I tank cars
- Tank car regulatory compliance
- Market Risk
NC/NI vs. EC/I

• NC/NI cars are the lightest-weight, highest-capacity cars for light crude shippers

• 2.6K Gal/load (62 bbl) is a major advantage
  o Savings can be $100s/carload

• However
  o NC/NI cars can’t move heavy crude
  o NC/NI cars may be more likely to attract new rules
  o NC/NI cars have seen a greater run-up in fleet size due to the sequential booms in ethanol and crude
Tank Car Regulatory Compliance and Market Risks

- HM-216b places expanded burdens on car owners for developing and overseeing compliance processes
- New car owners face daunting “build it or buy it” choice on compliance capability
  - Scale may be increasingly important to efficient and effective compliance practices
  - Access to shop capacity may become extremely valuable
- Market risks remain
  - Overbuilding
  - Pipelines
  - External risks (environmental, economic, political)
Questions?

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