Transport 2:
One-Time Truck Shipments

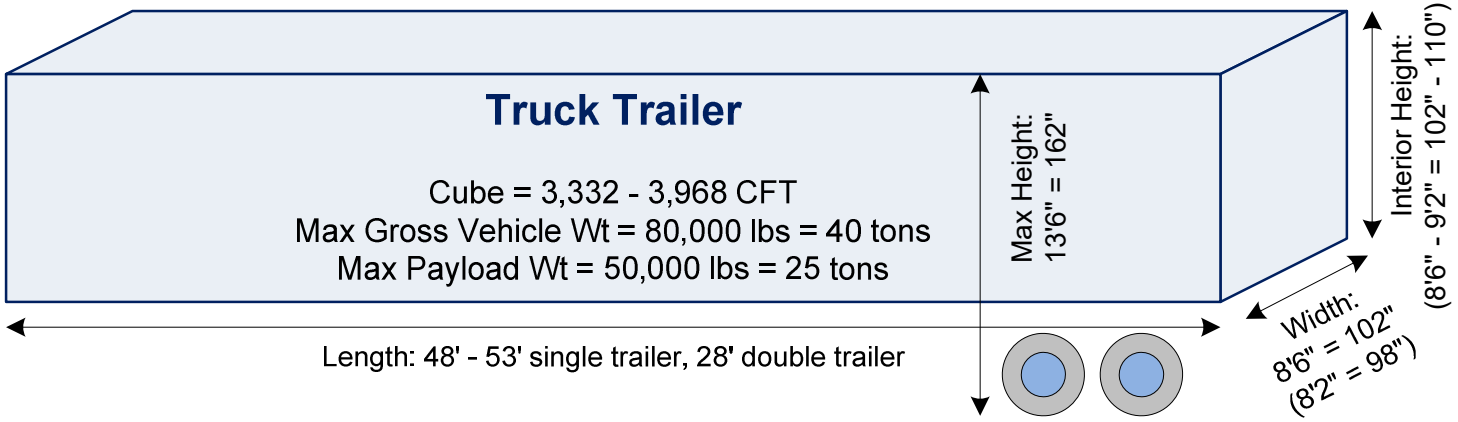
- **Load density:** freight capacity is determined by both the *weight* and *cube* of a load
- Trucking is the only transport mode that most shippers need to have detailed knowledge of
  - Only trucks used for shipping/receiving at most facilities
    - Trucks transport from facility to railhead, port, airport
  - Other modes handled by specialized freight brokers

Trucking

U.S. For-Hire Trucking Services

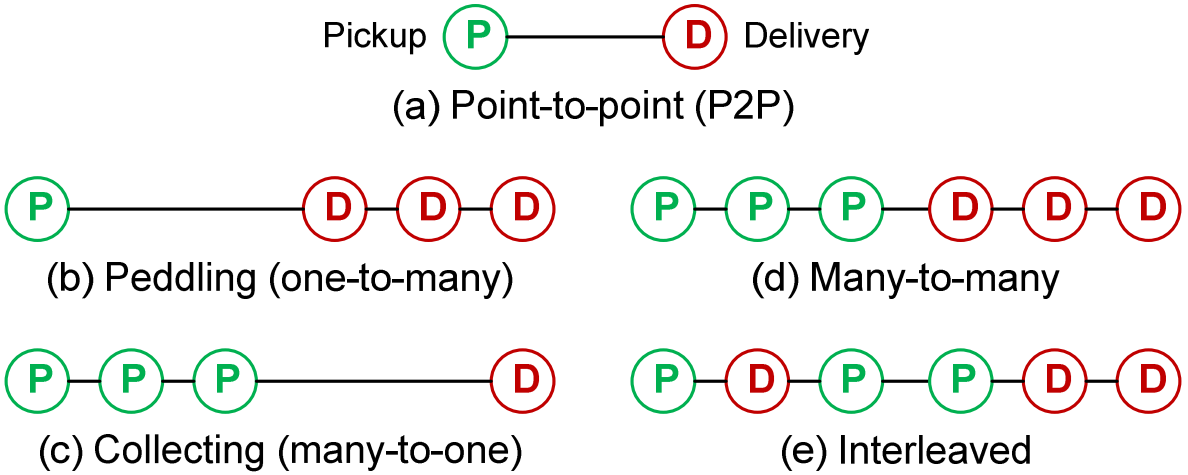
	TL	LTL	PX
Minimum payload	10,000 lb	150 lb	2 lb
Average payload[12]	30,000 lb	1000 lb	10 lb
Maximum payload	50,000 lb	10,000 lb	70 (UPS) – 150 lb
Average length of haul	294 mi	752 mi	894 mi
Average value	$775/ton	$7002/ton	$37,538/ton

Truck enclosed van semi-trailer (interior dimensions in parenthesis)

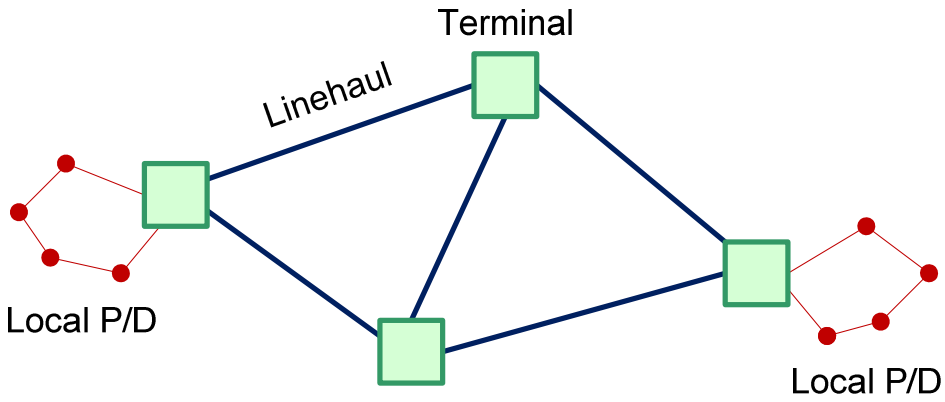


Trucking Operations

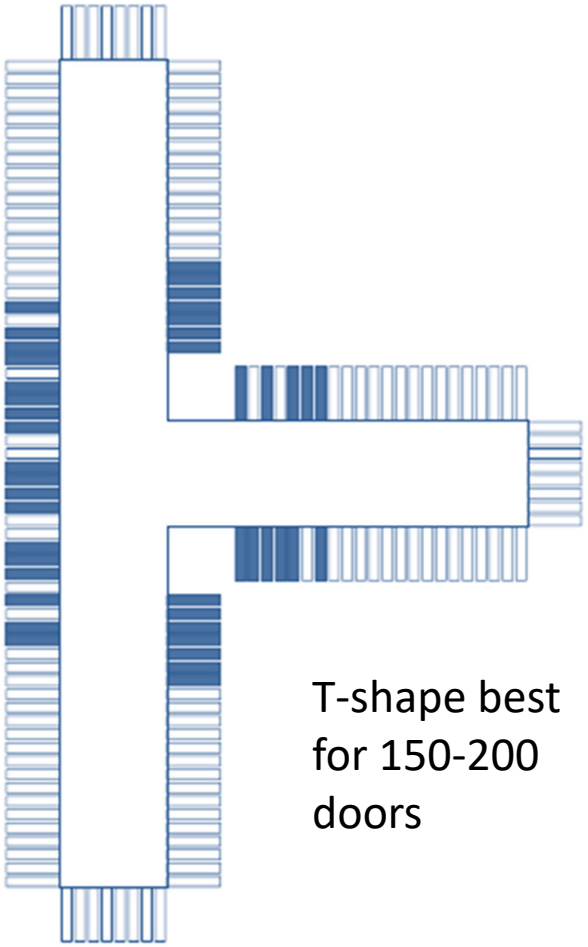
TL routing alternatives



Logistics network used for LTL and PX



LTL Terminal



T-shape best for 150-200 doors

One-Time vs Periodic Shipments

- **One-Time Shipments** (*operational* decision): know shipment size q
  - Know when and how much to ship, need to determine if TL and/or LTL to be used
  - Must contact carrier or have agreement to know charge
    - Can/should estimate charge before contacting carrier
- **Periodic Shipments** (*tactical* decision): know demand rate f, must determine size q
  - Need to determine how often and how much to ship
  - Analytical transport charge formula allow "optimal" size (and shipment frequency) to be estimated
    - U.S. Bureau of Labor Statistic's *Producer Price Index* (PPI) for TL and LTL used to estimate transport charges

Transport Charges

- **Spot price:** current no-contract charge
- **Contract price:** negotiated multi-shipment charge
  - Charge for each single origin and destination (*lane*)
  - Charge for any origin/destination (OD) based discount off of *tariff*
- **Estimated price:** based on analytical formula
  - Only used for planning purposes (e.g., prior to negotiation)
  - Gives estimate of average charge across all OD pairs
    - Mix of spot and contract
    - Why are spot prices usually higher than contract? Are they always?
  - *Design constants* used for missing data
  - Can determine “optimal” shipment size/frequency

Logistics Engineering Design Constants

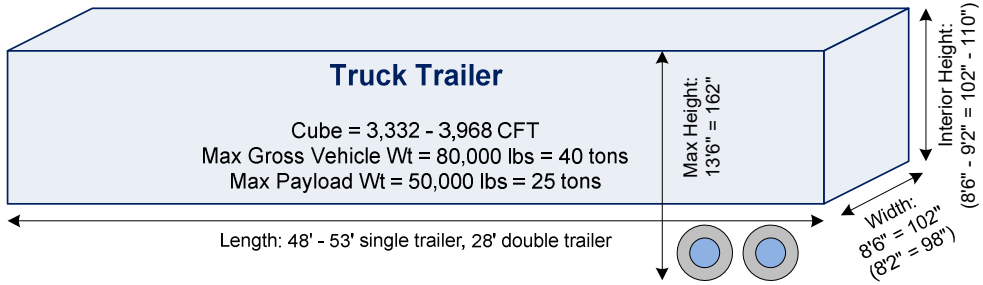
1. Circuity Factor: 1.2 (g)
   - 1.2 × GC distance ≈ actual road distance
2. Local vs. Intercity Transport:
   - Local: < 50 mi ⇒ use actual road distances
   - Intercity: > 50 mi ⇒ can estimate road distances
     - 50-250 mi ⇒ return possible (11 HOS)
     - > 250 mi ⇒ always one-way transport
     - > 500-750 mi ⇒ intermodal rail possible
3. Inventory Carrying Cost (h) = funds + storage + obsolescence
   - 16% average (no product information, per U.S. Total Logistics Costs)
     - (16% ≈ 5% funds + 6% storage + 5% obsolescence)
   - 5-10% low-value product (construction)
   - 25-30% general durable manufactured goods
   - 50+% computer/electronic equipment
   - >> 100% perishable goods (produce)

Logistics Engineering Design Constants

4. $\dfrac{\text{Value}}{\text{Transport Cost}} \gg 1$: $\$1\ \text{ft}^3 \approx \dfrac{\$2{,}620\ \text{Shanghai-LA/LB shipping cost}}{2{,}400\ \text{ft}^3\ 40\text{'}\ \text{ISO container capacity}}$

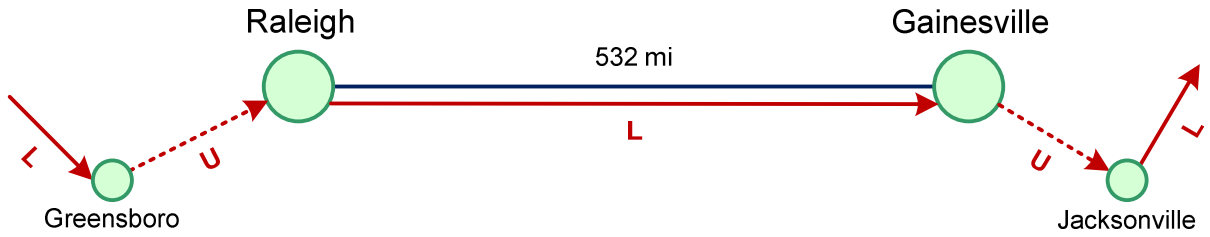
5. TL Weight Capacity: 25 tons (K_{wt})
   - (40 ton max per regulation) – (15 ton tare for tractor-trailer) = 25 ton max payload
   - Weight capacity = 100% of physical capacity

6. TL Cube Capacity: 2,750 ft³ (K_{cu})
   - Trailer physical capacity = 3,332 ft³
   - Effective capacity = $3{,}332 \times 0.80 \approx 2{,}750\ \text{ft}^3$
   - Cube capacity = 80% of physical capacity



Logistics Engineering Design Constants

7. TL Revenue per Loaded Truck-Mile: $2/mi in 2004 (r)
   - TL revenue for the carrier is your TL cost as a shipper



$$15\%, \quad \text{average deadhead travel}$$

$$\$1.60, \quad \text{cost per mile in 2004}$$

$$\frac{\$1.60}{1-0.15} = \$1.88, \quad \text{cost per loaded-mile}$$

$$6.35\%, \quad \text{average operating margin for trucking}$$

$$\frac{\$1.88}{1-0.0635} \approx \$2.00, \quad \text{revenue per loaded-mile}$$

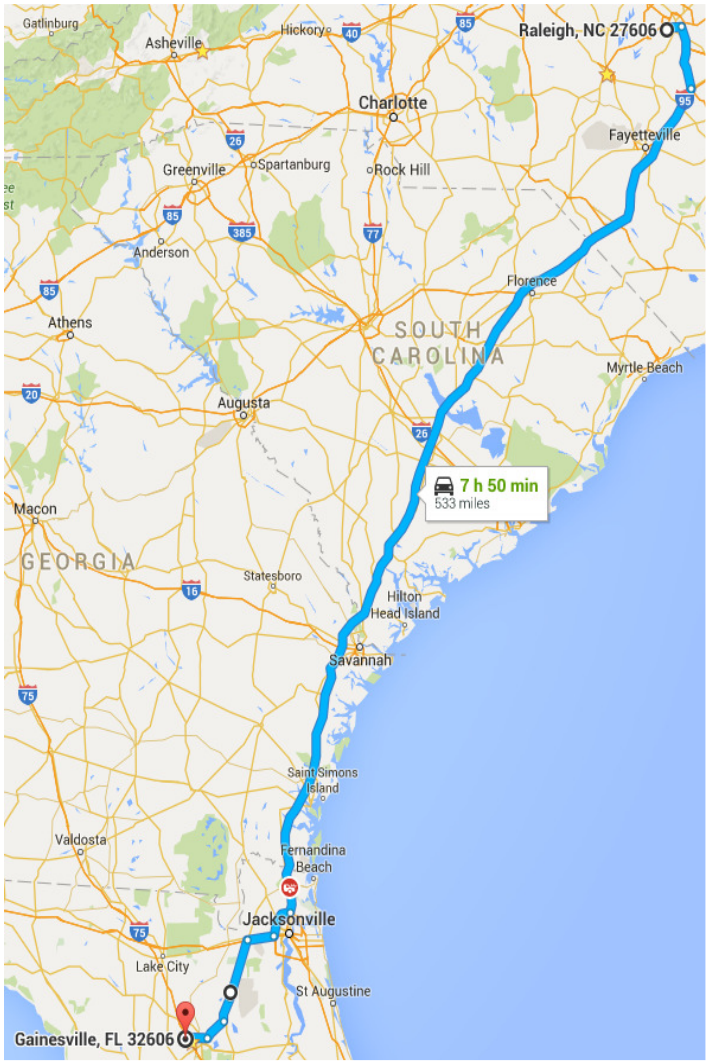
TL Cost per Mile in 2004

- Bottom-up estimate of TL cost per mile in 2004:

Interest Rate		Annual	Source
Prime Rate		4.75%	(http://www.forecasts.org/prime.htm)
Increase over Prime		2.00%	
Nominal Interest Rate		6.75%	
Current Inflation Rate		2.70%	(http://www.forecasts.org/inflation.htm)
Real Interest Rate	(i)	4.05%	
Lease			
Economic Life	(N, yr)	7.25	= 754,000/103,945, Avg mi until replace/Avg mi [1]
Investment Cost	(IV, $)	132,576	[2]
Salvage Percentage		20%	
Salvage Value	(SV, $)	26,515	
Effective Investment Cost	(IV^{eff}, $)	112,695	
Cost Cap Recovery	(K, $/yr)	18,240	
Costing			
Annual Mileage	(mi/yr)	103,945	[1]
Fuel Efficiency	(mi/gal)	4.5	p. 10 in [3]
Fuel Cost per Gallon	($/gal)	1.780	(https://www.eia.gov/petroleum/gasdiesel/)
Fuel Cost	($/mi)	0.39555556	
Annual Fuel Cost	($/yr)	41,116	
Tire,Repair,Insurance	($/yr)	58,367	$0.34/mi in 1988 [3] * 103945 * (2.18/1) [4]
Driver Salary with Benefits	($/yr)	49,058	$34,343 mean wage/(1 - 0.3) [5]
Operating Cost	($/yr)	148,541	
Operating Cost per Unit	($/mi)	1.43	
Annual Investment Cost	($/yr)	18,240	
Cost per Mile	($/mi)	0.18	
Total Annual Cost	($/yr)	166,781	
Cost per Mile	($/mi)	1.60	

Truck Shipment Example

- Product shipped in cartons from Raleigh, NC (27606) to Gainesville, FL (32606)
- Each identical carton weighs 40 lb and occupies 9 ft^3 (its *cube*)
  - Don't know linear dimensions of each unit for TL and LTL
- Cartons can be stacked on top of each other in a trailer
- Additional info/data is presented only when it is needed to determine answer



Truck Shipment Example: One-Time

1. Assuming that the product is to be shipped P2P TL, what is the maximum payload for each trailer used for the shipment?

$$q_{\max}^{wt} = K_{wt} = 25 \text{ ton}$$

$$K_{cu} = 2750 \text{ ft}^3$$

$$s = \frac{40 \text{ lb/unit}}{9 \text{ ft}^3/\text{unit}} = 4.4444 \text{ lb/ft}^3$$

$$K_{cu} = \frac{q_{\max}^{cu}}{\left(\frac{s}{2000}\right)} \Rightarrow q_{\max}^{cu} = \frac{s K_{cu}}{2000}$$

$$q_{\max} = \min\left\{q_{\max}^{wt}, q_{\max}^{cu}\right\} = \min\left\{K_{wt}, \frac{s K_{cu}}{2000}\right\}$$

$$= \min\left\{25, \frac{4.4444(2750)}{2000}\right\} = 6.1111 \text{ ton}$$

Truck Shipment Example: One-Time

2. On Jan 10, 2018, 300 cartons of the product were shipped. How many truckloads were required for this shipment?

$$q = 300\frac{40}{2000} = 6 \text{ ton}, \quad \left\lceil \frac{q}{q_{\max}} \right\rceil = \left\lceil \frac{6}{6.1111} \right\rceil = 1 \text{ truckload}$$

3. Before contacting the carrier to negotiate (and using Jan 2018 PPI), what would have been the estimated TL transport charge for this shipment?

$$d = 532 \text{ mi}$$

$$r_{TL} = \frac{PPI_{TL}^{\text{Jan 2018}}}{PPI_{TL}^{2004}} \times r_{2004} = \frac{PPI_{TL}}{102.7} \times \$2.00/\text{mi}$$

$$= \frac{131.0}{102.7} \times \$2.00/\text{mi} = \$2.5511/\text{mi}$$

$$c_{TL} = \left\lceil \frac{q}{q_{\max}} \right\rceil r_{TL} d = \left\lceil \frac{6}{6.1111} \right\rceil (2.5511)(532) = \$1,357.20$$

Truck Shipment Example: One-Time

Series Id: PCU484121484121
Series Title: PPI industry data for General freight trucking, long-distance TL, not seasonally adjusted
Industry: General freight trucking, long-distance TL
Product: General freight trucking, long-distance TL
Base Date: 200312

https://data.bls.gov/multi-screen?survey=pc

Download: xlsx

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003												100.0
2004	100.3	101.1	101.2	101.5	101.9	102.5	102.6	103.0	104.0	104.7	105.4	104.8
2005	105.5	106.2	106.9	107.5	108.3	108.4	108.3	108.6	110.0	111.3	111.9	111.0
2006	110.3	110.4	110.4	110.8	112.1	112.4	112.5	113.2	113.4	113.0	112.5	112.3
2007	113.0	112.5	112.4	112.9	113.1	112.8	113.0	113.3	113.8	114.0	115.1	115.8
2008	116.0	115.9	116.5	117.8	120.5	123.0	124.0	124.0	121.8	121.3	117.8	115.1
2009	113.2	112.1	110.4	109.7	109.8	110.1	111.4	111.0	111.7	110.8	111.5	110.9
2010	110.8	111.0	111.9	112.2	113.2	113.5	113.4	113.7	113.8	114.4	115.8	116.1
2011	116.5	117.4	119.3	121.0	121.7	121.4	121.3	121.2	122.0	122.0	123.2	123.3
2012	124.0	124.6	126.2	126.7	127.0	125.8	125.6	126.8	127.4	127.2	126.9	127.0
2013	126.7	127.2	128.0	127.5	127.8	127.6	127.6	127.6	127.1	127.2	127.6	127.4
2014	127.9	128.2	128.7	129.5	130.6	130.8	130.3	130.4	130.4	129.7	129.8	128.9
2015	126.7	126.0	126.0	126.2	126.3	127.1	126.9	126.2	125.9	125.5	125.8	124.8
2016	124.6	123.4	123.2	123.6	122.8	122.7	123.0	123.0	123.3	124.1	124.1	124.2
2017	124.4	124.7	124.2	124.3	124.0	124.2	124.2	125.9	126.6	126.6	128.5	130.3
2018	131.0	132.0	132.0	132.3	133.6	135.4	136.8	137.5	138.6	139.8	140.3	140.4
2019	139.9	138.6	138.2	136.7	137.3	137.7	136.8	136.1	136.6	136.6	140.1	141.0
2020	136.3	136.1	134.3	131.8	128.2	132.0	134.0	135.6	139.0	142.2	146.6	147.6
2021	146.1	151.3	154.7	159.3	162.1	159.3	159.929	164.691	169.568	173.847	182.629	187.738
2022	198.275	208.028	211.126	209.823	210.733	203.350	204.018	200.068	197.526	197.549	195.947	200.778
2023	187.156	194.459	202.307	184.407	192.615	190.471	178.666	173.268	182.025	184.002	187.206	177.712
2024	178.925	178.320	172.822	172.961	181.573(P)	182.584(P)	188.840(P)	189.015(P)				

P : Preliminary. All indexes are subject to monthly revisions up to four months after original publication.

Truck Shipment Example: One-Time

4. Using the Jan 2018 PPI LTL rate estimate, what was the transport charge to ship 15 cartons LTL?

$$q = 15\frac{40}{2000} = 0.3 \text{ ton}$$

$$r_{LTL} = PPI_{LTL}\left[\frac{\frac{s^2}{8}+14}{\left(q^{\frac{1}{7}}d^{\frac{15}{29}}-\frac{7}{2}\right)\left(s^2+2s+14\right)}\right]$$

$$= 177.4\left[\frac{\frac{4.44^2}{8}+14}{\left(0.3^{\frac{1}{7}}532^{\frac{15}{29}}-\frac{7}{2}\right)\left(4.44^2+2(4.44)+14\right)}\right] = \$3.7770 / \text{ton-mi}$$

$$c_{LTL} = r_{LTL}\,q\,d = 3.7770(0.3)(532) = \$602.81$$

Truck Shipment Example: One-Time

Series Id: PCU484122484122
Series Title: PPI industry data for General freight trucking, long-distance LTL, not seasonally adjusted
Industry: General freight trucking, long-distance LTL
Product: General freight trucking, long-distance LTL
Base Date: 200312

https://data.bls.gov/multi-screen?survey=pc

Download: xlsx

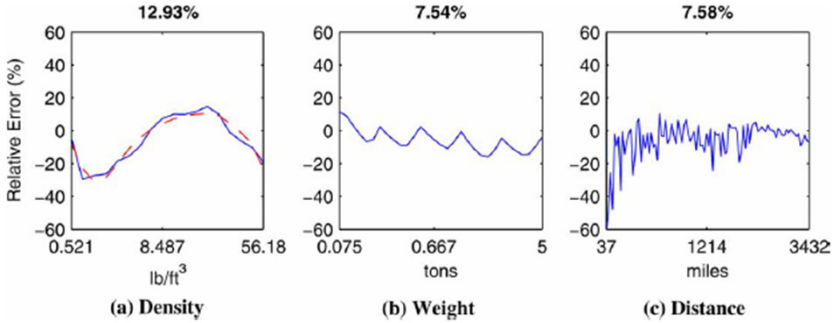
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003												100.0
2004	101.1	101.5	101.9	101.4	102.2	103.4	104.8	105.1	106.3	107.1	108.1	108.0
2005	108.1	107.5	108.6	109.3	110.5	111.8	113.3	113.2	114.6	116.1	115.3	113.7
2006	114.7	114.3	115.4	116.6	119.2	119.2	119.5	120.3	119.7	117.5	117.6	117.9
2007	117.1	116.5	117.8	121.5	122.4	122.7	121.7	121.2	120.9	122.0	123.7	124.0
2008	123.5	124.9	127.8	130.1	131.0	133.3	132.2	130.7	129.4	126.8	123.5	121.2
2009	126.3	126.6	125.4	125.7	126.0	125.3	125.9	126.1	125.4	125.0	125.4	123.4
2010	122.2	123.5	125.9	127.0	127.1	126.4	126.3	126.4	126.8	127.8	131.5	131.0
2011	131.8	134.1	134.1	137.1	139.1	137.3	137.5	138.3	140.1	140.9	141.0	140.6
2012	141.4	141.7	144.9	145.5	144.2	143.7	145.0	147.4	149.9	150.1	149.5	150.3
2013	148.7	149.9	151.0	148.8	148.1	151.2	150.7	151.7	152.4	153.0	152.3	154.4
2014	153.8	153.4	154.5	158.5	158.9	158.8	160.5	160.9	158.0	157.3	156.8	158.8
2015	157.0	154.5	156.1	153.8	156.5	155.1	154.8	153.4	153.2	152.1	156.2	156.6
2016	156.1	158.7	158.3	160.3	160.2	160.7	161.2	161.1	159.5	163.1	164.3	165.6
2017	166.4	166.8	166.7	167.0	168.0	167.9	169.7	169.9	173.3	173.5	175.1	175.5
2018	177.4	178.5	178.4	178.9	181.0	183.1	183.2	183.3	184.0	185.3	184.8	183.9
2019	188.5	188.8	187.8	186.2	189.9	190.3	188.1	190.1	187.8	188.7	189.3	185.2
2020	193.6	191.1	189.7	188.4	187.7	186.1	190.3	189.9	185.5	189.6	187.7	187.1
2021	196.7	196.8	202.5	203.4	203.7	210.7	208.302	207.759	209.299	211.703	217.984	218.148
2022	222.856	220.690	239.535	243.598	251.869	258.802	248.576	242.100	242.930	237.312	242.376	233.568
2023	240.539	236.298	233.331	228.176	231.510	230.664	230.773	240.812	242.879	244.315	240.901	236.187
2024	242.245	244.230	245.484	246.943	244.791(P)	241.732(P)	247.454(P)	243.762(P)				

P : Preliminary. All indexes are subject to monthly revisions up to four months after original publication.

LTL Rate Estimation Formula

- Top-down regression using representation LTL tariff rates:

Residuals of Initial Model (Step 1)



$$\min \sum_{q \in Q} \sum_{s \in S} \sum_{d \in D} w_q w_s w_d \left| \frac{r_{LTL}(q, s, d)}{r_{\text{tariff}}(q, s, d)} - 1 \right|$$

$w_i =$ weighting factors represent relative likelihood of shipment weights, densities, and distances

$$r_{LTL}^{(N)}(q, s, d) = \left(\frac{\beta_1}{\beta_2 + q^{\beta_3} s^{\beta_4} d^{\beta_5}} \right) \left(\frac{\beta_6 s^3 + \beta_7 s^2 + \beta_8 s + \beta_9}{s^2 + \beta_{10} s + \beta_{11}} \right)$$

$$r_{LTL}(q, s, d) = PPI_{LTL} \left[\frac{(s^2/8) + 14}{(q^{1/7} d^{15/29} - (7/2))(s^2 + 2s + 14)} \right]$$

Residuals of Full Model (Step 3)

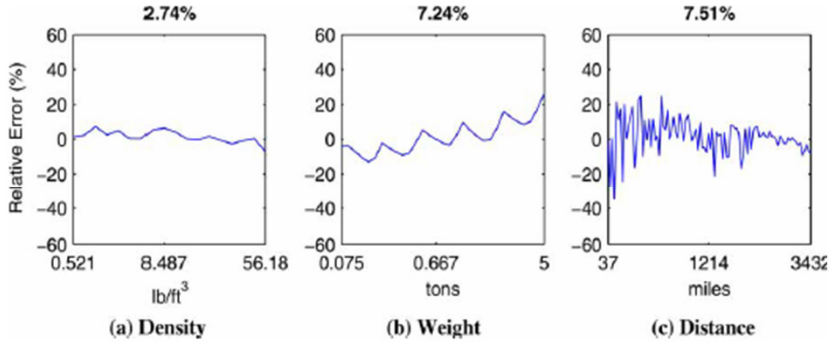


Table 2. Analysis steps with associated parameter values and weighted absolute relative errors (WAREs).

	Initial	Residual fit	Full	Simplify	Normalise	Simplify	Round
Step	1	2	3	4	5	6	7
WARE	20.49%	–	11.37%	11.66%	11.66%	11.66%	11.93%
1	100.1316	–	–	–	–	–	–
2	−1.6073	–	−3.0846	−3.5254	−3.5254	−3.5257	−7/2
3	0.2749	–	0.1567	0.1538	0.1538	0.1537	1/7
4	0.4575	–	−0.0644	–	–	–	–
5	0.4859	–	0.5044	0.5176	0.5176	0.5175	15/29
6	–	−0.0101	−0.2557	–	–	–	–
7	–	0.3859	33.7447	23.5443	0.1214	0.1208	1/8
8	–	−2.2739	−286.5365	−3.0893	−0.0159	–	–
9	–	−0.0294	5579.0010	2763.8200	14.2564	14.0210	14
10	–	−4.0998	6.9150	1.7135	1.7135	1.6699	2
11	–	15.2667	27.4923	14.5298	14.5298	14.3123	14

β_i

Truck Shipment Example: One-Time

5. What would the shipment size have to be so that the TL and LTL charges are equal?

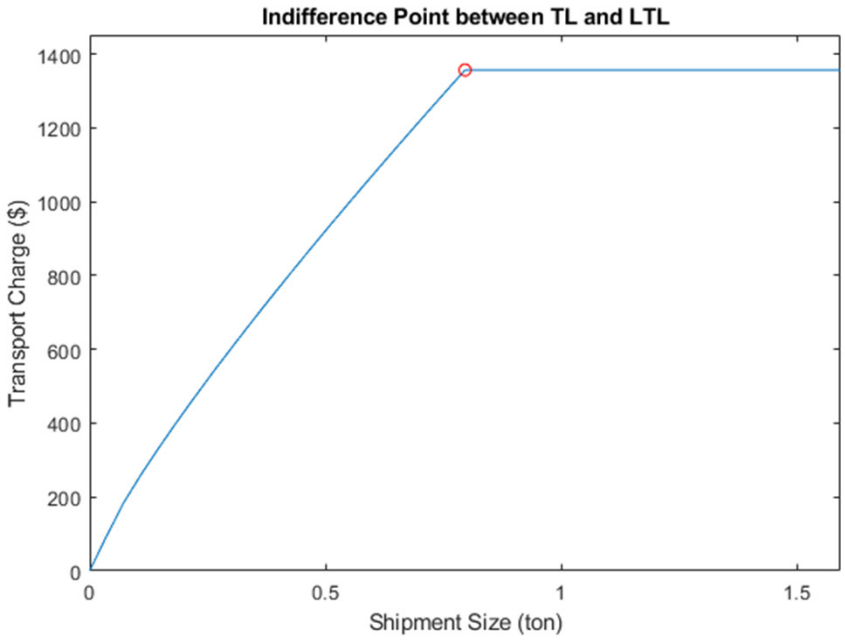
$$c_{TL}(q) = \left\lceil \frac{q}{q_{\max}} \right\rceil r_{TL} d$$

$$r_{LTL}(q) = PPI_{LTL} \left[\frac{\frac{s^2}{8} + 14}{\left(q^{\frac{1}{7}} d^{\frac{15}{29}} - \frac{7}{2} \right)\left(s^2 + 2s + 14 \right)} \right]$$

$$c_{LTL}(q) = r_{LTL}(q)\, qd$$

$$q_I = \arg\min_q \left(\left| c_{TL}(q) - c_{LTL}(q) \right| \right)$$

$$= 0.7960 \text{ ton}$$



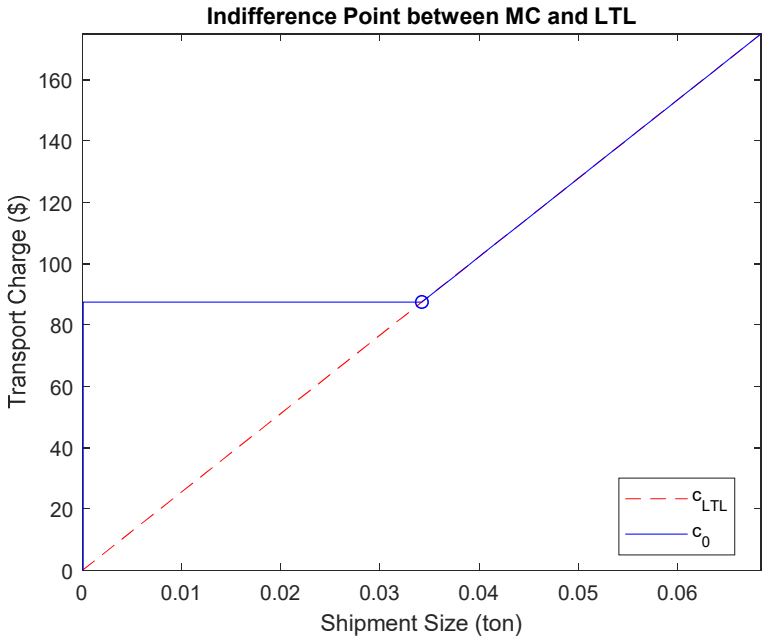
Truck Shipment Example: One-Time

6. What are the TL and LTL minimum charges?

$$MC_{TL} = \left(\frac{r_{TL}}{2}\right) 45 = \$57.40$$

$$MC_{LTL} = \left(\frac{PPI_{LTL}}{104.2}\right)\left(45 + \frac{d^{\frac{28}{19}}}{1625}\right)$$

$$= \left(\frac{177.4}{104.2}\right)\left(45 + \frac{532^{\frac{28}{19}}}{1625}\right) = \$87.51$$



$$q_I = 0.0342 \times 2000 = 68.43 \text{ lb}$$

- Why do these charges not depend on size of the shipment?
- Why does only the LTL minimum charge depend of the distance of the shipment?

Truck Shipment Example: One-Time

- Independent Transport Charge ($):

$$c_0(q) = \min\left\{\max\left\{c_{TL}(q), MC_{TL}\right\}, \max\left\{c_{LTL}(q), MC_{LTL}\right\}\right\}$$

Truck Shipment Example: One-Time

7. What is the most likely freight class for this LTL shipment?

- Load density is the main factor in determining the class:

$$s = \frac{40 \text{ lb/unit}}{9 \text{ ft}^3/\text{unit}} = 4.4444 \text{ lb/ft}^3$$

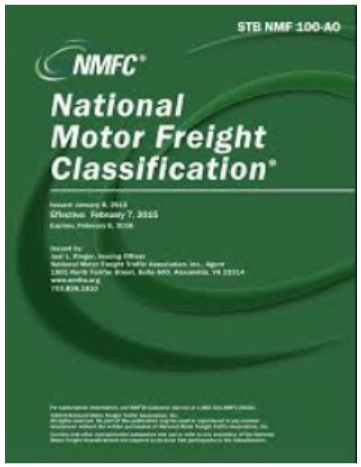
$\Rightarrow$ Class 200

Class-Density Relationship

Class	Load Density (lb/ft^3) Minimum	Load Density (lb/ft^3) Average	Max Physical Weight (tons)	Max Effective Cube (ft^3)
500	–	0.52	0.72	*2,750*
400	1	1.49	2.06	*2,750*
300	2	2.49	3.43	*2,750*
250	3	3.49	4.80	*2,750*
200	4	4.49	6.17	*2,750*
175	5	5.49	7.55	*2,750*
150	6	6.49	8.92	*2,750*
125	7	7.49	10.30	*2,750*
110	8	8.49	11.67	*2,750*
100	9	9.72	13.37	*2,750*
92.5	10.5	11.22	15.43	*2,750*
85	12	12.72	17.49	*2,750*
77.5	13.5	14.22	19.55	*2,750*
70	15	18.01	24.76	*2,750*
65	22.5	25.50	*25*	1,961
60	30	32.16	*25*	1,555
55	35	39.68	*25*	1,260
50	50	56.18	*25*	890

Truck Shipment Example: One-Time

- The *National Motor Freight Classification* (NMFC) can be used to determine the product class
- Based on:
  1. Load density
  2. Special handling
  3. Stowability
  4. Liability



Item	Description	Class	NMFC	Sub
Abietic Acid	Abietic Acid, in drums	55	42605	-
Accordions	Accordions, in boxes	125	138820	-
Acetonitrile	Acetonitrile, in boxes or drums. See item 60000 for class dependent upon released value	85	42645	-
Acetylene	in steel cylinders	70	85520	-
Acid Fish Scrap	Fish Scrap, NOI, dry, not ground, pulverized nor screened, or Acid Fish Scrap, in bags	77.5	69980	-
Aircraft Parts	metal, struts, skins, panels	200	11790	01
Aluminum Channel	U channel	60	13340	-
Aluminum Table Set	aluminum table SU	200	82105	01
Ambulance Stretcher	stretcher	200	56920	06
Arches Support	Iron Steel	60	52460	-
Architectural Details	6 - 8 lbs per cubic foot	125	56290	05
Architectural Details	2 - 4 lbs per cubic ft	250	56290	03
Assembled Furniture	Bathroom cabinet set up	300	39220	01
Assembled Furniture	Highboys, dressers, wooden set up	125	80120	01
Assembled Furniture	Wood furniture 4-6 Lbs per cu ft	150	82270	04
Assembled Furniture	Chairs wooden setup w/out upholstery	300	80770	01
Assembled Furniture	Chairs wooden setup w/out upholstery KD	125	80770	03
Assembled Furniture	Couch w/ back & arms put together	175	80865	03
Assembled Furniture	Chairs put together w/ upholstery	200	79255	01
Assembled Furniture	Metal cabinets in boxes	110	39270	06
Assembled Furniture	18 gauge steel cabinet	70	39340	-
Assembled Furniture	Benches, cabinets, tables for workstations	125	23410	-
Assembled Furniture	Buffets, china cabinets put together	125	80080	-
Assembled Furniture	Cabinets of metal or plastic for storage	92.5	39235	-
Assembled Furniture	Tanning bed	150	109050	-
Assembled Furniture	Mattresses, in packages or boxes	200	79550	-
Athletic / Sporting Goods	Gym equipment, playground, sports items. Density Item			
Attachments: Backhoe	NOI: Attachments, backhoe (Backhoes), tractor or truck, on lift truck skids or pallets:	175	114217	01
Attachments: Backhoe	Attachments, backhoe (Backhoes), tractor or truck, on lift truck skids or pallets: Each shipped with all components secured to a single pallet, platform or skid, weighing 1100 pounds or more and having a density of 8 pounds or greater per cubic foot	100	114217	02

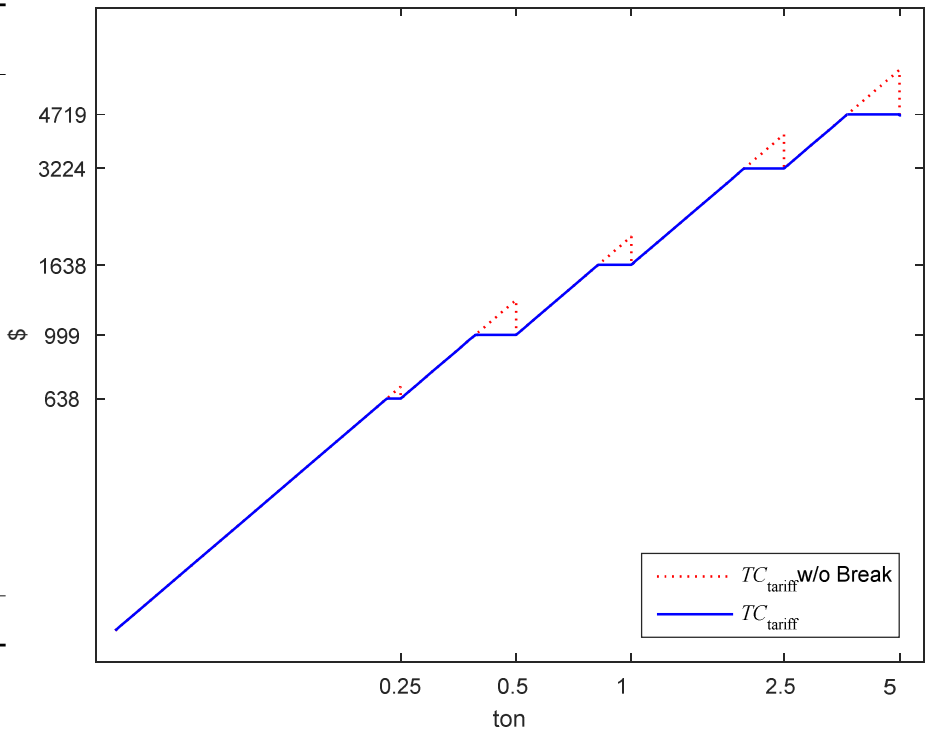
Truck Shipment Example: One-Time

- CzarLite tariff table for O-D pair 27606-32606

$$cwt = \text{hundredweight} = 100\ \text{lb} = \frac{100}{2000} = \frac{1}{20}\ \text{ton}$$

Tariff (in $/cwt) from Raleigh, NC (27606) to Gainesville, FL (32606)
(532 mi, CzarLite DEMOCZ02 04-01-2000, minimum charge = $95.23)

Freight Class	Rate Breaks (i) 1	2	3	4	5	6	7	8	9&10
500	341.42	314.14	245.80	201.48	158.60	112.37	55.66	55.66	55.66
400	273.88	251.99	197.19	161.61	127.22	91.12	45.10	45.10	45.10
300	206.34	189.85	148.56	121.76	95.85	69.47	34.43	34.43	34.43
250	172.56	158.77	124.23	101.83	80.15	58.03	28.79	28.79	28.79
200	138.78	127.69	99.92	81.89	64.47	47.19	23.40	23.40	23.40
175	121.37	111.68	87.39	71.62	56.38	41.27	20.39	20.39	20.39
150	104.49	96.13	75.22	61.66	48.53	35.96	17.75	17.75	17.75
125	87.59	80.60	63.07	51.69	40.69	30.24	15.00	15.00	15.00
110	77.57	71.37	55.85	45.77	36.04	28.61	14.40	14.40	14.40
100	71.23	65.55	51.29	42.04	33.09	27.58	14.03	10.80	9.90
92	66.48	61.18	47.88	39.24	30.89	25.75	13.68	10.52	9.66
85	61.74	56.80	44.45	36.43	28.68	23.91	13.20	10.15	9.32
77	56.99	52.44	41.04	33.63	26.48	22.07	12.60	9.68	8.89
70	52.77	48.55	37.99	31.14	24.51	20.43	12.00	9.23	8.47
65	50.07	46.08	36.05	29.56	23.04	19.39	11.87	9.14	8.39
60	47.44	43.64	34.15	28.00	21.82	18.37	11.76	9.04	8.30
55	44.75	41.17	32.22	26.40	20.59	17.32	11.64	8.96	8.22
50	41.57	38.26	29.94	24.54	19.12	16.10	11.52	8.85	8.14
Tons (q_i^B)	0.25	0.5	1	2.5	5	10	15	20	∞



Truck Shipment Example: One-Time

8. Using the same LTL shipment, what is the transport cost found using the undiscounted CzarLite tariff?

$$q = 0.3, \quad class = 200$$

$$disc = 0, \quad MC = 95.23$$

Freight Class	Rate Breaks (i) 1	2	3	4	5	6	7	8	9&10
500	341.42	314.14	245.80	201.48	158.60	112.37	55.66	55.66	55.66
400	273.88	251.99	197.19	161.61	127.22	91.12	45.10	45.10	45.10
300	206.34	189.85	148.56	121.76	95.85	69.47	34.43	34.43	34.43
250	172.56	158.77	124.23	101.83	80.15	58.03	28.79	28.79	28.79
200	138.78	127.69	99.92	81.89	64.47	47.19	23.40	23.40	23.40
175	121.37	111.68	87.39	71.62	56.38	41.27	20.39	20.39	20.39
50	41.57	38.26	29.94	24.54	19.12	16.10	11.52	8.85	8.14
Tons (q_i^B)	0.25	0.5	1	2.5	5	10	15	20	∞

$$i = \arg\left\{ q_i^B \mid q_{i-1}^B \le q < q_i^B \right\}$$

$$= \arg\left\{ q_2^B \mid q_1^B \le q < q_2^B \right\}$$

$$= \arg\left\{ q_2^B \mid 0.25 \le 0.3 < 0.5 \right\} = 2$$

$$c_{\text{tariff}} = (1 - disc) \max\left\{ MC, \min\left\{ OD(class, i)\, 20q, OD(class, i+1)\, 20q_i^B \right\} \right\}$$

$$= (1 - 0) \max\left\{ 95.23, \min\left\{ OD(200, 2)\, 20(0.3), OD(200, 3)\, 20(0.5) \right\} \right\}$$

$$= \max\left\{ 95.23, \min\left\{ (127.69)\, 20(0.3), (99.92) 20(0.5) \right\} \right\}$$

$$= \max\left\{ 95.23, \min\left\{ 766.14, 999.20 \right\} \right\} = \$766.14$$

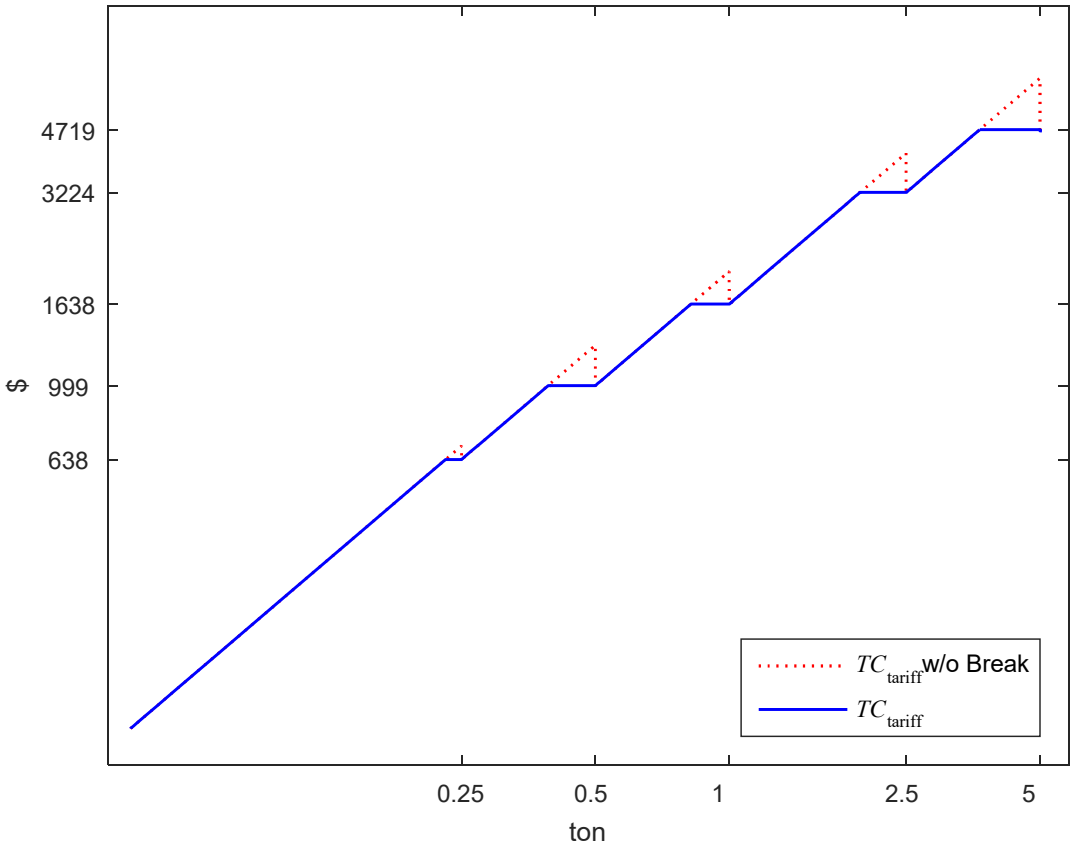
Truck Shipment Example: One-Time

- What is the weight break between the rate breaks at 0.25 and 0.5 tons?

$$q_i^W = \frac{OD(class, i+1)}{OD(class, i)} q_i^B$$

$$= \frac{99.92}{127.69}(0.5)$$

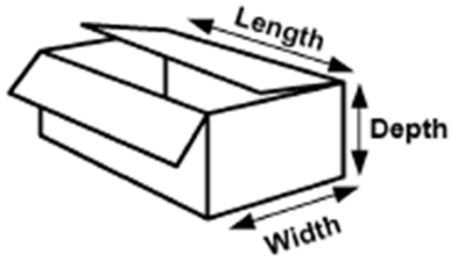
$$= 0.3913 \text{ ton}$$



Truck Shipment Example: One-Time

- Additional information needed for online one-time (spot) LTL rate quotes using Coyote.com website
  - Shipment weight in pounds:

$$2000\, q_{LTL} = 2000\,(0.3) = 600 \text{ lb}$$

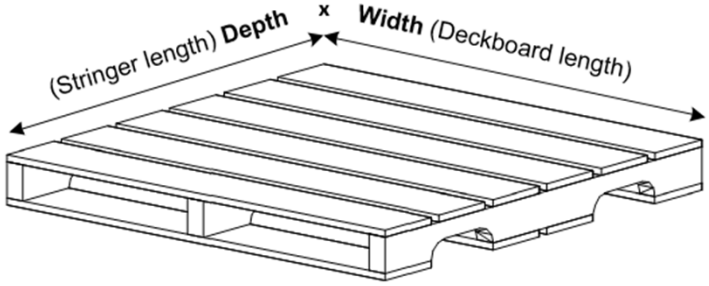


  - Carton dimensions:

$$cu = 9 \text{ ft}^3 = 9 \times 12^3 \text{ in}^3 \Rightarrow l \times w \times d = 15{,}552 \text{ in}^3 = 24 \times 24 \times 27 \text{ in}^3$$

  - Stack cartons on pallet to make it easier to transload: (Why was this not as necessary for TL?)

$$48 \text{ in.} \times 48 \text{ in. pallet} \Rightarrow 8 \text{ carton/pallet} \Rightarrow \left\lceil \frac{15}{8} \right\rceil = 2 \text{ pallets}$$



$$\Rightarrow \text{height} = 2 \times 27 + 5 = 59 \text{ in.}$$

(5 in. height of unloaded pallet)

Misc.

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Top Story

ATA Leader Chris Spear Presses Congress for AV Framework

WASHINGTON — Automated vehicles would gain greater adoption with a nationwide policy framework, Chris Spear, president of American Trucking Associations, told members of Congress on Sept. 13.

Trending

1. Nearshoring Boom Faces Growing Pains
2. Updated Ford F-150 Gets New Grille, Other Features
3. Utility Trailer Teams Up With Germany's Schmitz Cargobull
4. Diesel Issues Could Worsen Due to Lack of Crude From OPEC+
5. Suit Dismissed Over Old Dominion's Retirement Plan

Fuel Prices

Week of Sep 11

DIESEL $4.540 ↑4.8¢

GAS $3.822 ↑1.5¢

SEE ALL FUEL PRICE DATA

Misc.

Yellow's Shutdown Opens Up LTL Market for Competitors

'There's Enough Capacity in the LTL Space to Absorb the Yellow Business'

Yellow's freight volumes have already started shifting to competitors, with assets expected to follow. (David Paul Morris/Bloomberg News)

Top 100 For Hire Rankings

1	UPS Inc.
2	FedEx Corp.
3	J.B. Hunt Transport Services
4	TFI International
5	XPO
6	Landstar System
7	Knight-Swift Transportation
8	Schneider
9	Ryder Supply Chain Solutions
10	Old Dominion Freight Line
11	Hub Group
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13	Yellow Corp.
14	Estes Express Lines
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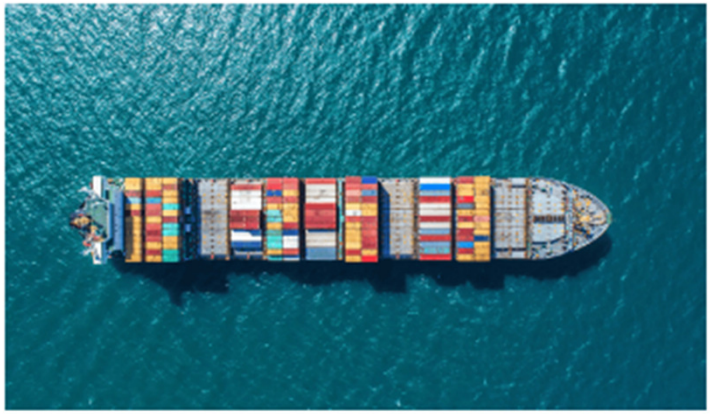

Today's News

As freight bill audit and payment expands to transportation spend management, these leading companies deploy advanced technology tools and offer services that transcend traditional freight audit and payment.

Amazon, IKEA, Patagonia, and Major Brands Launch Initiative to Accelerate Transition to Zero-Emission Fuels

Amazon and more than 20 other major global companies launched a tender to accelerate zero-emission shipping. Shipping lines are invited to submit bids for zero-emission shipping services that enable members of the Zero Emission Maritime Buyers Alliance (ZEMBA) to reduce supply chain emissions.

Misc.

September 27, 2023

12:00pm Central

90-minute Virtual Workshop

TLC TRANSPORTATION & LOGISTICS COUNCIL

Promoting & Representing the Interest of the Entire Shipping Community

Freight charges may be "buried" in your cost of sales, but they can make a significant difference in your bottom line. Many large and sophisticated shippers negotiate formal contracts with their rates and discounts, but others usually get a rate – over the phone or in an email – from a carrier or broker. Unfortunately, few people really understand the basics of carrier pricing.

In this Virtual Workshop subject matter experts will explain:

- LTL (Less than truckload) Class rates, NMFC (National Motor Freight Classification) classes and base rate tariffs
- Proprietary products, CzarLite
- Recent changes to the NMFC
- FAK (freight all kinds) rates
- Dimensional pricing, dynamic pricing for LTL shipments
- Truck Load rates – point to point, mileage
- Spot or quoted rates-is there a catch to watch out for?
- Accessorial charges and surcharges—their impact on total cost
- The relationship of rates to carrier liability—does a low rate have a hidden cost?

Moderator

Jace Martin - Sr. Manager LTL Carrier Development - GEODIS

Panelists

Christopher Adkins - VP Yield Strategy & Management - ArcBest

Carrie Deaver - LTL Freight Bill & Audit Payment Manager - Dillard's

Paul Dugent - Executive Director Digital LTL Council - NMFTA