Calculation of Fuel, Currency, and Inland Freight Price Adjustment Factors for Military Marine Shipping

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Final Report

Bunker Fuel Adjustment Factor (BAF), Currency Adjustment Factor (CAF) and Inland Intermodal Adjustment Factor (FAF)

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Acronyms, Abbreviations, and Selected Technical Terms

base rate	freight price per cargo unit for carriage from A to B, without any fuel adjustment factor or other price supplements
BAF	bunker adjustment factor, a supplemental charge for additional fuel cost due to sudden increases in fuel prices
base price	fuel price per metric ton immediately prior to the announcement of a new base rate
current price	weighted average of bunker fuel prices of different grades and locations applicable in the present or immediate past
cargo unit	basic unit of cargo that the base price applies to, either a container (TEU or FEU) or a measurement ton of breakbulk cargo (MT)
ECA	Emission Control Area
FEU	forty-foot equivalent length container
IBS	Integrated Booking System, TRANSCOM's freight management database
MT	Measurement ton, measure of volume of capacity taken up by breakbulk cargo
TEU	twenty-foot equivalent length container
RoRo	roll-on roll-off cargo, such as vehicles transported as breakbulk cargo

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1. EXECUTIVE SUMMARY

This report describes the refreshing of the USTRANSCOM Economic Price Adjustment (EPA) factors for use in the USC-7 contract. The three EPA factors developed by Volpe in 2009 are the starting point for this update, and these are the Bunker Fuel Adjustment Factor (BAF), Currency Adjustment Factor (CAF) and Inland Intermodal Adjustment Factor (FAF). [1]

The basis for the development of each factor in 2009 was re-examined as part of the current refresh. This was done through reviewing current industry practices, relevant EPA related literature or articles, and any changes in the general container shipping market (e.g., emission regulations), to determine whether the underlying methodology used to develop the EPA factors in 2009 would need to be revisited.

Based on the market review, the methodology used for the CAF and FAF factors was left unchanged. The introduction of the Emission Control Areas (ECAs) meant the BAF methodology had to be revised to incorporate this change in the container shipping market.

1.1. Bunker Fuel Adjustment Factor

1.1.1. Background

The introduction of ECAs since the 2009 EPA study represents a significant market change that requires an update of the BAF factor methodology. In particular, the BAF methodology needs to now include a mechanism to capture the effect of the ECAs on carrier fuel costs.

Under these emissions regulations carriers are required to burn cleaner, more expensive fuel in protected waters and near ports, but are allowed to burn the cheaper bunker fuel on the open ocean.

The US and Europe have imposed ECAs within 200 nautical miles of their shores, in which ships must burn low sulfur fuel. This means the BAF factor must include additional functionality to isolate carrier use of three types of fuel, IFO380 (bunkers), LS380 (low sulfur fuel for use inside an ECA), and MGO (which is typically burned when a container ship is in port), depending upon how much time spent at sea, within an ECA and in port. Additionally, prices may need to be taken from a broader set of worldwide ports to account for any regional price differences. In contrast, the 2009 version of the BAF only accommodated two fuel types from two U.S. ports and did not account for the presence of ECAs.

Outside of the adjustment to accommodate the ECAs, the basic structure of the BAF model remained broadly the same as the version developed in 2009, except for some modifications discussed below.

[1] US DOT/Volpe Center, *Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts*, (July 2009).

The BAF first appeared in 1974 after the oil price shocks, with the basic principal of a BAF being a mechanism through which carriers sought to minimize their exposure to unanticipated large fuel price increases. Initial versions were percent increases on the freight rate if the rise in fuel prices met the conditions set forth in the agreement. These evolved into a flat fee per unit of cargo, the method that is used in industry today.

By using a BAF, carriers are able to maintain their basic freight rates constant (allowing for shipper cost predictability), and pass large increases in fuel costs along to shippers. On the opposite of this position, shippers contend that fuel cost is the burden of the carrier and that these costs should be included in the basic freight rate. Even with a BAF, total costs are still uncertain and the mechanism for calculating the BAF is opaque, which could lead to carriers recovering more than the rise in fuel prices would justify. If fuel prices stay within a specified range over the contract period, then no BAF should be paid.

Uniquely among shippers, USTRANSCOM requires carriers to set base rates that remain in force for up to 17 months. If the primary justification for having a BAF is shifting fuel volatility risk, then it should operate to increase the shipper's price the longer the time between the date of the shipping price quote relative to the date of shipping. If the BAF is properly established with a new baseline at the time of each price quotation, then the frequency with which a BAF is paid will tend probabilistically to increase with the time lag.

1.1.2. USTRANSCOM BAF

The USTRANSCOM BAF incorporates a buffer zone around the baseline fuel price, beyond which fuel price volatility is compensated by a surcharge that is in addition to the base freight rate. If a change in the fuel price does not exceed the buffer then no surcharge is payable. An important federal requirement of the USTRANSCOM BAF is that the buffer is symmetrical around the baseline fuel price. A decline in the price of fuel below the buffer will result in a rebate.

The baseline fuel price is set as the current price at the time of the bid or contract, and the subsequent price is the price at the time of service delivery. The base rate for the service includes all costs, including fuel, other than the excess volatility component of fuel price.

The overall structure of the BAF takes the form

$$BAF = \Delta p_f \times Fuel_{CU} \times Risk\ Sharing\, Factor$$

where Δp_f = change in the price of bunker from the baseline to the current price, $Fuel_{CU}$ = quantity of fuel consumed per cargo unit carried (TEU or MT), and *Risk Sharing Factor* = share of risk that is borne by (transferred to) the shipper.

Thus a BAF has three types of elements:

1. A fuel price differential representing the change in the unit price of fuel from the baseline to the current period;
2. A fuel consumption amount for the transit of the vessel from load port to discharge port, allocated to units of cargo; and

3. A risk sharing multiplier whose value can range from zero to 1.0.

The base freight rate and the BAF are additive, and the magnitude of the BAF is not affected by the magnitude of the base freight rate. Together they make up the unit price (per TEU or MT) of the shipment. The BAF is specific to each USTRANSCOM shipping lane.

The fuel price volatility component of the BAF structure incorporates all three fuels (IFO 380, LS380 and MGO) and provides a reference fuel price for each lane and ECA factor. The share of fuel used for the port requirements is universally set at 5%.

An important aspect of the BAF is that the baseline fuel price must be updated to current prices whenever a new freight rate is bid. Subsequent price volatility within the contract period is then covered by the BAF, while longer-term (between price quotations) upward or downward trends in prices are incorporated into the base freight rate.

If the fuel price baseline is set arbitrarily and not updated when new rates are published, the BAF becomes a separate charge for fuel consumption, which can include a large but unknown share of all of fuel costs. This results in a multi-part price, which serves no useful economic purpose and can be manipulated by carriers to increase profit.

The second component of the BAF, fuel consumption is calculated for each lane based on a typical vessel operating on that lane. The IBS database was used to identify the vessels operating on USTRANSCOM lanes and vessel specific information (type, capacity, speed, and fuel consumption) was obtained through a shipping fleet database. From this information an average vessel for each lane was developed. Given USTRANSCOM preference for U.S. flagged ships, the average vessel developed used only U.S. flagged vessels. If insufficient U.S. vessels were available for a particular lane a "worldwide" vessel (U.S. flag included) was used. In the event that not enough vessels were available to construct a meaningful average ship, a general U.S. flagged average vessel was used.

Fuel consumption per cargo unit (either TEU's or measurement tons) is calculated by determining the number of steaming days for the particular lane (which was done through using a shipping distance software package to find the USTRANSCOM lane distance and the number of steaming days for each lane based on the speed of the typical ship) and multiplying this by the typical ship's fuel consumption per day.[2] Dividing this value by vessel capacity (which can be adjusted as appropriate to account for broken stowage) provides fuel per cargo unit.[3]

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[2] Due to better distance data, the circuity factor, which was used in the 2009 study, was removed from the updated BAF methodology.

[3] Vessel capacity is not dependent upon actual capacity utilization, such as due to trade imbalances or other market conditions, which is taken to be a business decision made by carriers based on supply and demand conditions.

A substitution factor is added to the BAF to capture the measures carriers take to adjust fuel use when its price increases. Through slow steaming (or other strategies such as hull cleaning and vessel performance monitoring) carriers substitute the use of other inputs for fuel. The recommended value for the substitution factor is 0.80, which means that for every $1.00 increase in fuel price, total shipper costs would increase by only $0.80.

The final component of the BAF addresses risk sharing. Since the BAF is a mechanism for shifting risk from one party to another, a determination needs to be made to how much of the risk each party should bear. It is recommended that the risk distribution factor be set at 0.75, meaning that 75% of the estimated cost of price volatility is absorbed by the shipper. The Risk Sharing Factor is a policy choice on the part of the shipper rather than an empirical technical factor.

The key difference between the 2009 and 2013 BAF technical factors is a new method of estimating the distance of a lane by mapping real-world routings based on actual USTRANSCOM shipments obtained from IBS. Using the values recommended for the input substitution and risk distribution factors, the new trade technical factors (which drive the BAF calculation) are approximately 33% less than the previous values calculated in the 2009 study (Figure 1). A similar pattern is observed when looking at break-bulk, for which the new calculations result in an approximately 40% decrease in BAF amounts (Figure 2). Specific BAF technical factors can be found in the main BAF section of this report.

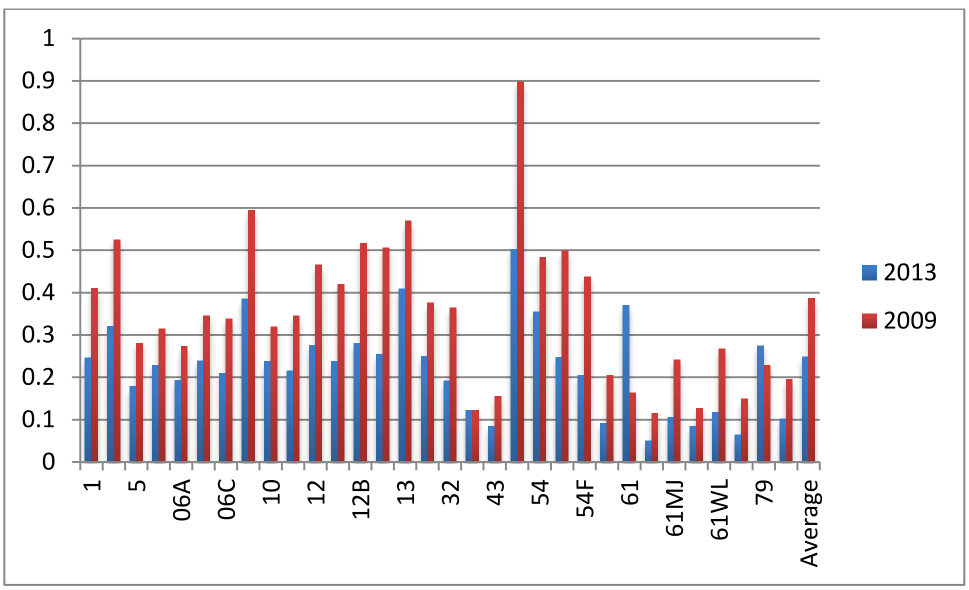

Figure 1. 2009 and 2013 Volpe TEU technical factor comparison for selected routes (0.8 for Input Substitution Factor, 0.75 for Risk Factor)

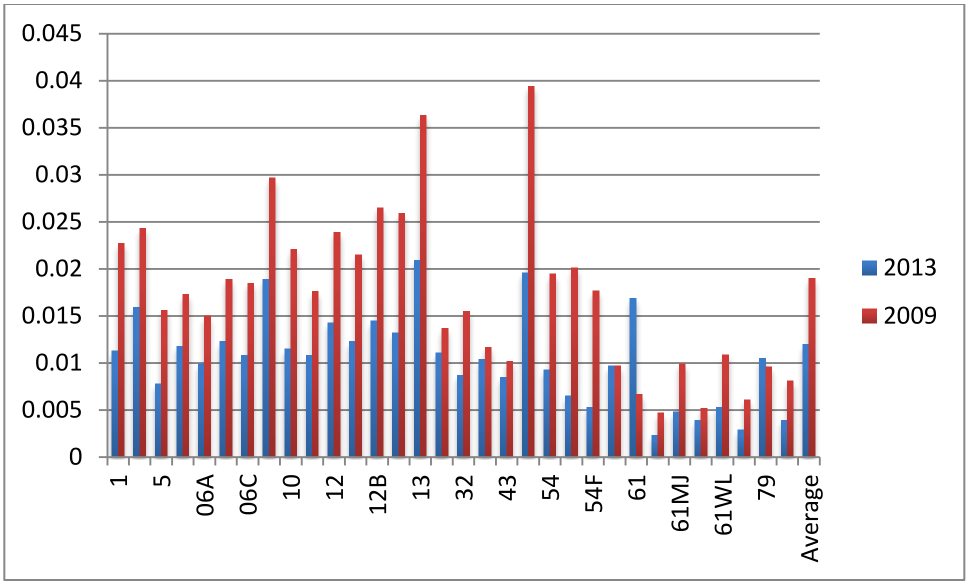

Figure 2. 2009 and 2013 Volpe Breakbulk technical factor comparison for selected routes (0.8 for Input Substitution Factor, 0.75 for Risk Factor)

Where they corresponded by lane, the updated USTRANSCOM BAF factors were compared with the BAF factors previously published by Maersk (Figure 3). This comparison revealed that overall fuel burn per TEU is generally aligned between the USTRANSCOM BAF and Maersk. On a lane specific basis some differences in fuel burn is apparent; for services operating largely in the Atlantic and Mediterranean, Maersk vessels consumed more fuel per TEU than the typical ships as estimated by the Volpe methodology, while Maersk vessels were relatively more efficient in Transpacific or Indian Ocean voyages, suggesting differences in fleet vessel composition by trade location.

When comparing Volpe BAFs to the commercial market, it is important to recognize that each carrier's BAF method is based on internal practices, which means differences in specific fuel consumption values may be explained by the operational differences between carriers and the average USTRANSCOM carrier. How these factors are combined in the final calculation is also different. For example, in its BAF, Maersk uses trade specific values for vessel utilization that may raise or lower the final BAF, while the methodology presented in this report assumes a full capacity utilization rate. Also, Maersk applies a BAF above a low fixed price-- their "Base Bunker Element,"[4] -- which is also trade specific, while the USTRANSCOM methodology applies a BAF to all trades at prices outside the 20% threshold around a base fuel price that is reset each year.

[4] Maersk has recently updated its formula that excludes the Base Bunker Element going forward (see section 2.2.3 on p. 17).

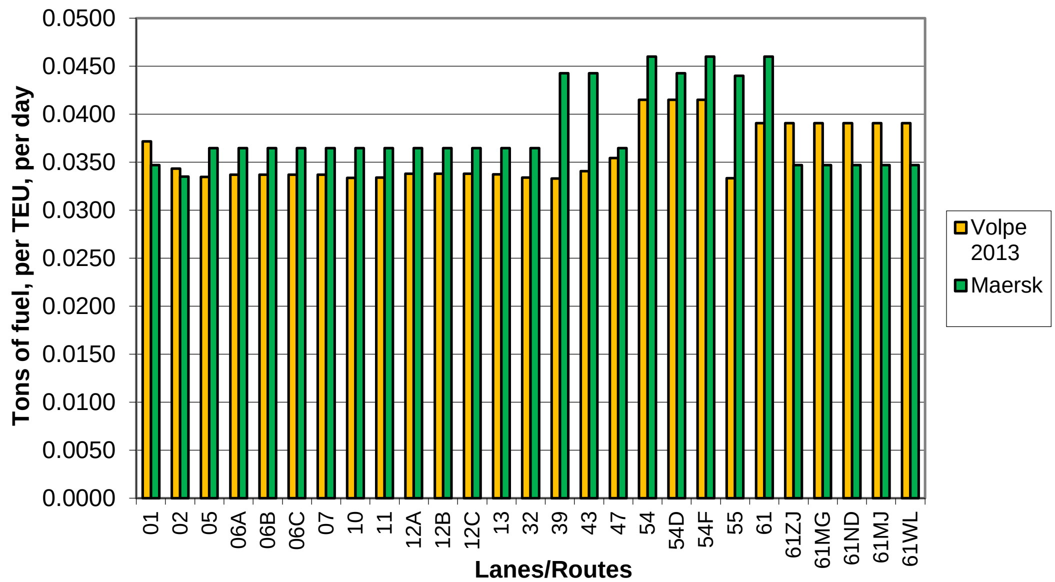

Figure 3. Daily fuel consumption factor, Maersk vs. 2013 methodology.

The revised BAF requires more supporting data items than were required for the 2009 version. In particular, additional fuel price data need to be collected each month and entered into the BAF calculator for the additional fuel type being monitored, for a set of regional ports. Also, any changes in ECA locations will require the generation of new lane-specific weighted fuel prices.

When implementing the BAF, and for it to serve its purpose as a mechanism to insulate carriers against large fuel price increases over a long lead time, each new base freight price quotation should be accompanied by an update of the baseline fuel price to the current level.

1.2. Currency Adjustment Factor (CAF)

The CAF methodology used for this update remains unchanged from the one developed in the 2009 EPA study. As such, the present report details the key elements of the CAF methods and the results of their updating. The background research and development of the technical elements are not documented here and can be found in the prior study.[5]

The CAF covers CONUS to OCONUS shipments only and applies to three superlanes. These superlanes represent 90% of USTRANSCOM's OCONUS trade and cover countries in the Eastern Asia, Western Indian Ocean and Europe/Mediterranean/Iceland/Greenland regions. Within these superlanes, 19 key currencies were identified (weighted by the extent of USTRANSCOM

[5] US DOT/Volpe Center (July 2009).

trade in each currency). Based on historical volatility and these trade weights, these key currencies are used to determine a buffer zone for each superlane, outside of which a CAF is applied (Table 1).

Table 1: Superlane Buffers

Superlane Name	2013 Buffer	2009 Buffer
Eastern Asia	5.950%	9.480%
Western Indian Ocean (inc. Persian Gulf)	*5.323%*[6]	*6.020%*
Europe/Mediterranean/Iceland/Greenland	7.158%	8.190%
Global Median	5.323%	6.020%

Along with a buffer zone, the CAF incorporates a technical factor of 7% to account for the portion of the base rate that would require payment in a foreign currency. In addition, a risk sharing factor is included, which can be adjusted to reflect the relative market position of USTRANSCOM and ocean carriers.

All of these elements are combined into the CAF equation as: *CAF* =

*(Current Monthly Average Exchange Rate/Base Exchange Rate)-1 * Technical Factor * Risk Sharing Factor*

It is assumed that the CAF will remain in place for a period of up to 17 months, and consistent with the previous study, the recommendation is to calculate the baseline rate as the average exchange rate from the month prior to the start of the bidding.

The current monthly currency rate is set as the monthly average rate from two months previously (as is the current practice). To be consistent the baseline rate should be set as a monthly average.

1.3. Inland Intermodal Adjustment Factor (FAF)

This report presents an update of the approach for determining a FAF for the CONUS inland portion of USTRANSCOM shipments. The FAF update focuses on data inputs rather than the methodology. The approach is based on a tradeoff between simplicity (administrative burden) and accuracy. It involves the calculation of a FAF for six “zones”. These zones are East Coast ports to East Coast states; East Coast ports to all other states; Gulf Coast ports to Gulf Coast

[6] The Western Indian Ocean buffer is set equal to the global median: see section 1.4.3.1.3 below for details on when the global median is applied.

states; Gulf Coast ports to all other states; West Coast ports to West Coast states; and West Coast ports to all other states.

The FAF methodology is based on the fuel price differential between a specified base period and the current time period, and the fuel used in moving a container or shipment unit an average distance within a given zone or between zones. The approach is similar to current industry practice on FAF for inland Continental United States (CONUS) container movements. However, the proposed approach is more transparent than the current industry practice on FAFs. The calculated FAFs are based on the widely available diesel fuel price data published by the Department of Energy's Energy Information Agency, typical fuel consumption factors for U.S. trucking and intermodal rail operations, and typical USTRANSCOM inland container movements as indicated in the IBS (Integrated Booking System) data for 2012.

2. BUNKER ADJUSTMENT FACTOR (BAF)

This chapter discusses the general concept behind a bunker fuel adjustment factor, the industry practices used in calculating a BAF, as well as the concepts utilized in building a new BAF for USTRANSCOM. The accompanying workbook “2013 BAF Calculation 092513” puts the concepts and assumptions described below into a working model for determining the new BAF.

2.1. General Principles of a BAF

Historically, the cost of bunker fuel used by carriers was built into the basic freight rate charged to shippers. These rates were fixed for a period of time usually not more than six months. As bunker fuel costs were both stable and a relatively small share of carriers' costs, price increases were reflected in the subsequent round of carrier freight rates. When fuel price volatility increased within the term of a contract, carriers sought to minimize their exposure to unanticipated large fuel price increases, and pass those costs on to their customers.

The first BAF appeared in 1974 after the oil shocks caused a significant rise in bunker prices. Initial versions of BAFs were percent increases on the freight rate if the rise in fuel prices met the conditions set forth in the agreement. These evolved into a flat fee per unit of cargo, the method that is used in industry today.

Carriers argue that fuel costs, as is any cost of production in competitive markets, are rightly passed along to shippers as part of the price of their service. Using a BAF surcharge keeps basic freight rates constant, allowing for shipper cost predictability. Shippers counter that fuel, as with any input, is the burden of the carrier, and shippers prefer that costs be added into the basic freight rate. With BAFs, shippers argue that total costs are still widely variable, preventing cost certainty. Furthermore, the mechanism for calculating the BAF is opaque and shippers are suspicious that carriers recover more than what the rise in bunker prices would justify.

Three strategies for setting container unit prices are summarized in Table 2. The normal commercial standard is for the seller to quote a fixed price, take it or leave it. The USTRANSCOM compromise is to include a factor that shifts the risk of fuel price volatility to the shipper rather than the carrier. The current industry standard is a 2-part price with the second limited to fuel costs, which is a structure that can only exist in a monopolistic market.

Table 2. Alternative Shipping Pricing Strategies

Rationale for Pricing Structure	Base Price per Container	Additional Factor
Commercial Norm	base price (all inclusive)	None
Fuel Price Volatility	base price (all inclusive)	fuel price volatility risk only
Industry Pricing	base price (unknown content)	fuel cost estimate

The rationale for the second structure is that USTRANSCOM requires that price quotations be exercisable up to 18 months from the time of quotation, and fuel prices are both relatively volatile and make up a large share of costs. The risk of cumulative fuel price changes – either up or down, which leave initial estimates of shipping cost far from accurate – increase over time. This effect is represented in Figure 4. Under a random walk (or a biased stochastic process), the actual fuel price can gradually deviate from the secular trend, with some probability that depends on the amount of incremental price changes and any serial correlation. Eventually the deviation is likely to exceed a buffer distance of any arbitrary amount, 20% in the present discussion.

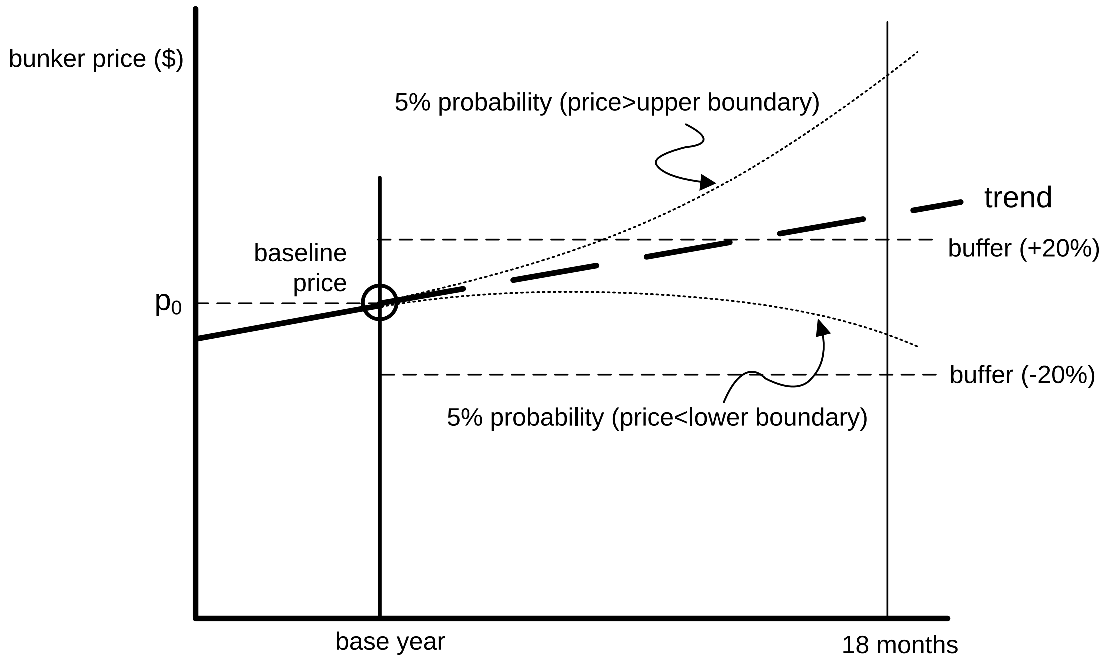

Figure 4. Cumulative pricing error with increasing time since quote.

In this concept, each time a new price quotation is entered, the baseline price is reset to the current average price per tonne of bunker. With fuel prices trending upward, the likelihood that prices will exceed the buffer on the low side (resulting in a refund to the shipper) is small but not zero.

2.1.1. Sharing of Fuel Price Volatility

While price volatility in inputs is an uncertainty and hence a risk factor, it is not obvious which party—buyer or seller—is the most efficient one to absorb the risk. If the carrier acquires the fuel, adjusts its input mix to optimize its production function and relevant prices, and has the opportunity to hedge on prices by advance purchases or other instruments, then that would suggest that the carrier is in a good position to control many of the risks. Even though the carrier may not have control over spot prices in world markets, it has more levers to deal with variations than the shipper, who has little or no control over the carrier's economic choices.

Nor is price volatility without cost to the shipper. Assuming there is some demand elasticity, the shipper has to estimate its preferred point on its own demand schedule without knowing the exact amount of the price. If demand is inelastic, and funds can be transferred into or out of other activities readily easily in the short run, then the volatility cost may be minimal to the shipper. If the shipper needs to plan more accurately, then volatility may be a substantial cost.

An argument in favor of passing fuel volatility costs on to the shipper is that the base price charged by the carrier will be lower if it doesn't have to include uncertainty within the base price. To what extent the expected value of total (shipper plus carrier) cost is less than what carriers would charge in the absence of a BAF is an empirical question, but there is no obvious reason why carriers should be abnormally risk averse in their pricing, i.e., charge very high base prices to cover the risk.

The importance of fuel price as a risk factor depends upon two criteria: (1) the magnitude of the component in total cost, and (2) the volatility of the component relative to the time between the price quote and the service consumption. Both conditions must be present, i.e., a volatile but minor component is not worth much attention (the price of fresh peaches), nor is a large but stable component (a containership).

2.1.2. Time Lag Between Purchase and Delivery of Service

For fuel costs, a key factor is the time horizon over which the cost must be estimated. If the price quote and the delivery date are relatively close—less than, say, two months—then the likely changes in fuel price are smaller in magnitude and more easily estimated. Price quotes that need to be valid for as much as a year in advance may be subject to substantial cost variability in fuel.

Thus the utility of a BAF is dependent upon and presumes a lag between purchase and delivery of a large enough elapsed time as to make price volatility a problem. Otherwise—as with charters—the price can be estimated and quoted at the time the service is to be provided.

If the primary justification for having a BAF is shifting the risk of fuel price variability, then the BAF should operate to increase the shipper's price the longer is the time between the date of the price quote versus the date of shipment. This could be built into the risk factor (see Section 2.4 below). If the BAF is properly established with a new baseline at the time of each price quotation, then the magnitude of the BAF will tend probabilistically to increase with the time lag.

2.1.3. Isolating Volatility in a BAF

The volatility component of pricing can be isolated from other cost factors by setting a base price and measuring deviations of subsequent prices from that baseline. Deviations beyond a given percentage amount (a "buffer") are then compensated by a surcharge (the BAF). The baseline price is the current price at the time of the bid or contract, and the subsequent price is the price at the time of service delivery. The base rate for the service includes all costs, including fuel, other than the volatility component of fuel price.

The overall structure of a price volatility compensation factor takes the form

$$[1] \qquad BAF = \Delta p_f \times Fuel_{CU} \times Risk\ Sharing\ Factor$$

where Δp_f = change in the price of bunker from the baseline to the current price, $Fuel_{CU}$ = quantity of fuel consumed per cargo unit carried (TEU or MT), and *Risk* = share of risk that is borne by (transferred to) the shipper.

Thus a BAF has three types of elements:

1. A fuel price differential representing the change in the unit price of fuel from the baseline to the current period;
2. A fuel consumption amount for the transit of the vessel from load port to discharge port, allocated to units of cargo; and
3. A risk sharing multiplier whose value can range from zero to 1.0.

The base freight rate and the BAF are additive, and the magnitude of the BAF is not affected by the magnitude of the base freight rate. Together they make up the unit price (per TEU or MT) of the shipping.

2.2. Change in Fuel Price

The change in fuel price is measured as the difference between two prices:

$$[2] \qquad \Delta_{price} = \ current\ price - base\ price$$

where current price = a weighted average of bunker prices immediately prior to shipment and where base price = a weighted average of bunker prices immediately prior to initial bidding or quoting of the base freight rate. Prices may be averaged over several months. The price index is typically a weighted average of the posted prices of applicable fuels in the relevant ports of call for a given route. It is thus a composite price, rather than an abstract index.

Price components may be different grades of fuel (IFO380, MGO, LS, etc.) at different locations (New York, Gibraltar, Singapore, etc.).

Weightings are in proportion to the shares of the various grades and locations that apply to a given lane or trade. The weightings by lane are affected by the extent of Emissions Control Areas (ECAs) the lanes pass through, including port zones. Most ports prohibit burning low-grade fuel in port, and may provide auxiliary power as a substitute.

2.2.1. Fuel Price Differential Buffer

The buffer is a percentage deviation from the base fuel price. If the deviation of the current price does not exceed the buffer range, no BAF is calculated and the variation is assumed to be within the normal range of variation that the carrier is expected to accommodate within it basic freight rate structure. Variations outside the buffer range are assumed to be abnormal volatility, and constitute a risk that is potentially sharable between shipper and carrier.

The USC-5/6 contract set the price threshold for bunker fuel at 20% in either direction from the baseline price. At prices 20% above the baseline price, the carriers are compensated by a BAF for the added costs of fuel that wasn't included in their base freight rates set at the time of bidding. The principle of mutuality (symmetry) required by the FAR/DFAR also enables USTRANSCOM to be compensated by carriers if the input price of fuel falls below the base price by more than the buffer threshold. This prevents a carrier from receiving windfall profits if the price of fuel fell significantly below the baseline price.

The current price should not be changed daily with each slight change in the price of bunker fuel. For planning purposes, the BAF needs to stay fixed for some reasonable period of time, say, at least a month.

With a buffer, then, the BAF functions as catastrophe insurance for carriers against potentially damaging price swings, a risk for which the shipper is offering to take primary but not sole responsibility.

2.2.2. Updating the Base Fuel Price

For a BAF to function in the way it is intended, the base prices must be updated to current prices whenever a new freight rate is bid. Subsequent price volatility is then covered by the BAF, while longer-term upward or downward trends in prices are incorporated into the base freight rate.

If the fuel price baseline is set arbitrarily and not updated when new rates are published, the BAF becomes a separate charge for fuel consumption, which can include a large but unknown share of all of fuel costs.[7] This does not mean that fuel costs are no longer included in the base freight rates, nor is it a cost-plus itemization of fuel. Instead, the price of the freight is made up of two separate estimates, one for everything and one for fuel only. This is a multi-part price, which serves no useful economic purpose and is easily manipulated by carriers to increase profit. For comparison, Figure 5 shows the effect of failure to reset the base fuel price at the time of the price quotation or bid.

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[7] Maersk has set the base price for its "Standard Bunker Factor" at zero, meaning that all estimated fuel costs are included in the BAF and some unknown amount of fuel and profit remain in the base freight rates. TSA currently assumes that the base fuel price is $250 per tonne, and subtracts out $80 per container from the full fuel cost BAF for an Asia to US West Coast run.

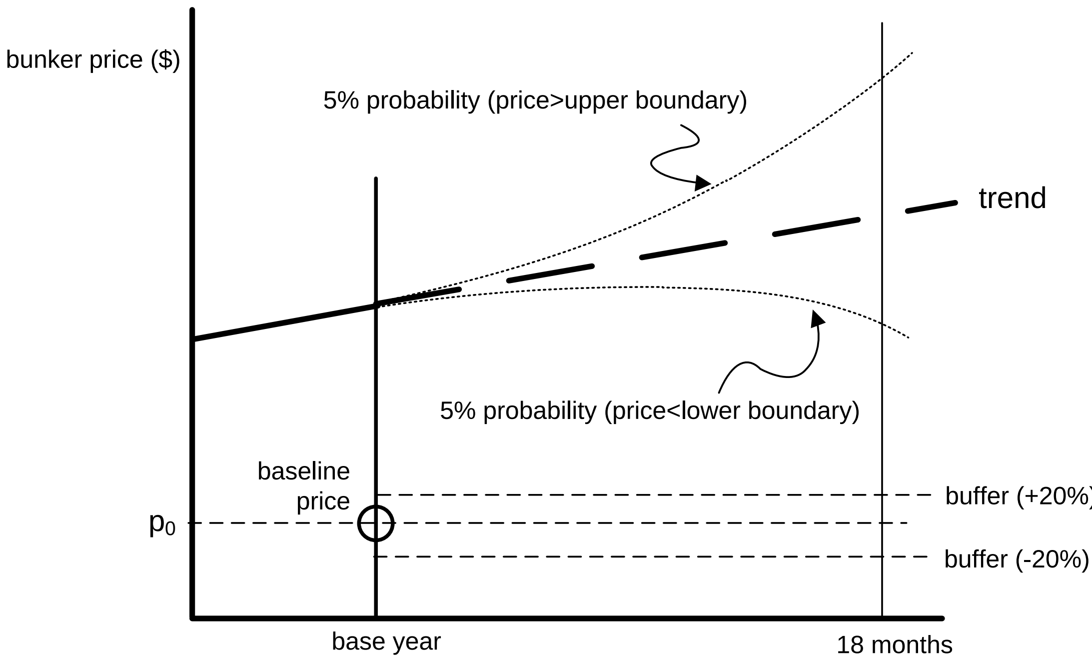

Figure 5. Incorrect or fixed fuel price baseline.

In these circumstances, the difference between the baseline price and the actual price is inevitably large from the day the price is posted, and the buffer is ignored. Failure to reset baseline price transforms the BAF from a volatility adjustment to a multi-priced service, both components of which are potential profit centers. This serves industry objectives in two ways that are not in USTRANSCOM's interest:

1. If the base price is set well below current prices, including a price of zero, the BAF only goes upward; if future prices of fuel fall below current prices, the carrier still extracts a fuel surcharge from the shipper and USTRANSCOM does not share in the favorable trend.
2. The basic BAF structure recommended here effectively isolates the volatility component of fuel costs, leaving the base freight rate as the single comprehensive price for the service, in the absence of price volatility. The carrier is in the best position to estimate all costs and, once the volatility component is removed, the carrier can perform its normal business function of offering a price for its service. In contrast, the multipart price creates the opportunity for making a profit on both fuel and basic freight service, without any assurance that the prices charged do not include some double-counting of fuel cost. The un-rebased BAF does serve to cover fuel price volatility, but also a lot more for which there is no reason to remove the supplier's/producer's/seller's responsibility.

For a BAF to serve its purpose of insulating carriers against large fuel price increases over a long lead time, each base freight price quotation should be accompanied by an update of the base price to the current level.

Fuel prices used in BAF calculations are taken from 3rd party sources such as Bunkerworld, Platts Bunker Wire, or Bunker Index. These prices don't necessarily incorporate the actual prices paid as carriers may purchase fuel months in advance, but rather, the prevailing market price at the time. A carrier active in fuel hedging markets can mitigate its exposure to price fluctuation whether or not it also applies a BAF.

2.2.3. Emissions Control Areas (ECAs)

Carriers are subject to environmental regulations imposed by the IMO or the countries through whose waters they pass. Carriers may be required by local law to burn cleaner, more expensive MGO while in port or protected waters, but are allowed to burn the cheaper bunker fuel on the open ocean. The US and Europe have imposed ECAs within 200 nautical miles of their shores, in which ships must burn low sulfur fuel. A map of the current U.S. East Coast and European ECAs is shown in Figure 6.

Figure 6. East Cost and European ECAs, 2013.

These regulations change slowly (relative to prices), but consistently over time in the direction of higher fuel costs. Because not all fuels are equally available in all lanes, and prices vary by geographic location, each lane or trade will have different prices for each grade of fuel and different requirements for fuel type depending upon the regulations.

2.2.4. Mix of Fuel Types

Crude oil is refined by distillation, which separates petroleum into components by boiling point and viscosity. These components can be further transformed or broken apart chemically by other procedures sometimes referred to as "cracking." The residual from the distillation process is thick (viscous) and full of impurities. This residual, mixed with a modest amount of distillate, can be used to fuel diesel engines designed for this purpose. The most common grade, or standard, is IFO 180 or IFO 380, called bunkers in reference to the space where coal was originally stored aboard ship.

Because bunker fuel has limited application and is hard to use (it has to be heated), it is a relatively cheap fuel. Because of its impurities, however, it produces high emissions when burned in engines. These emissions have been accepted so far on the open ocean, but are increasingly being prohibited in ports and near coastlines.

To capture the impact of ECA regulations on each lane, the fuel mix is estimated as a composite of three fuel types: IFO 380, 1% LS 380 (low sulfur) and MGO.

$$PF_{lane} = PF_{IF0380} \times FS_{380} + PF_{LS380} \times FS_{LS} + PF_{MGO} \times Ports \quad [3]$$

where PF_{lane} = composite fuel price for a lane, PF_{IFO180} = price of IFO380 in the lane, and

$$FS_{380} = (1 - Ports) \times (1 - ECA_{lane}) \quad [4]$$

where FS_{380} = share of IFO380 among all fuels burned in the lane, *ports* = share of total fuel burned in port, ECA = share of travel in the lane that occurs within ECAs, and

$$FS_{LS} = (1 - Port) \times ECA_{lane} \quad [5]$$

where FS_{LS} = share of low sulfur fuel in total fuel consumed, and

$$FS_{MGO} = Ports \quad [6]$$

where FS_{MGO} = share of MGO fuel in total fuel consumed, and

$$Ports = 0.05 \quad [7]$$

and

$$ECA_{lane} = \frac{nautical\ miles\ within\ ECA_{lane}}{total\ nautical\ miles_{lane}} \quad [8]$$

Thus each lane has its own reference prices (at ports accessible to that lane) and ECA factor. The share of fuel used for port requirements is universally set at 5%.

2.3. Fuel Consumption per Cargo Unit

Fuel use depends on both the characteristics of the vessel as well as the operational constraints of the carrier and specific trade route. These characteristics include:

Vessel type and age
Vessel capacity

Vessel speeds
Vessel engine fuel consumption
Balance of trade
Voyage length

The daily burn rates are multiplied by the voyage length to determine the total fuel consumption for a vessel in a given trade. Dividing this by the average vessel TEU capacity gives the amount of fuel required to move a single container within a trade.

USC cargo is categorized as containerized or breakbulk. Further breakdowns of containers are 20-foot, 40-foot, over- and out-sized, and refrigerated. Over- and out-sized breakbulk cargo can be palletized or roll-on roll-off (RoRo). For BAF purposes, the primary units are 20-foot standard containers (TEU), 40-foot standard (FEU), and measurement tons for non-containerized breakbulk cargo. These three categories provide sufficient accuracy for adjusting shipping prices to changes in fuel price.

2.3.1. Fuel Consumption per Vessel Voyage

Calculating fuel consumption on a per-cargo-unit basis requires estimating the fuel consumption for the lane and the capacity of the typical vessel in the trade. Container ships are assumed to carry only or mostly containers, with a flexible mix of 20s and 40s. For RoRo or breakbulk ships, the capacity is approximated in measurement tons. Thus the fundamental formula is

[9] $$Fuel_{CU} = \frac{Fuel_{vessel}}{Capacity_{vessel}}$$

where CU = cargo units (in TEUs or measurement tons) for each lane or trade, and vessel fuel consumption is

[10] $$Fuel_{vessel} = Fuel_{day} \times Steaming\ days$$

where $Fuel_{day}$ = fuel consumed per day in metric tons by the average ship on that lane and *Steaming days* = time spent travelling on the average voyage on that lane.

Steaming days are obtained through the NETPAS Distance software package that calculates the nautical miles between each of a sequence of ports that are served by a particular lane. To find the steaming days for a lane, the top 3 ports (as determined by USTRANSCOM traffic) on each side of a lane were plotted in the NETPAS software, which broke the resulting distance down into shares within and outside an ECA. Nautical miles were then converted to steaming days using average ship speed data by lane.

Fuel consumption is calculated using distance and burn rate averaged for typical vessels in the trade under typical conditions. Because speed can be adjusted to meet schedules, distance and fuel consumption rates are commonly measured in days.

2.3.2. Speed

Speed is an average for the vessels typically serving a lane and port schedule. The fuel consumed per day per vessel is dependent upon speed and fuel efficiency, along with other operating characteristics such as hull cleaning and trim monitoring.

In the BAF, speed enters through a substitution factor, developed conceptually in more detail below under "Input Substitution Factor" on page 45. The reason for calculating steaming days in the BAF is because fuel consumption in the data source is given in days for the associated steaming speed.

2.3.3. Vessel Capacity

Vessel size or capacity allows for scale economies in fuel consumption per ton or TEU. Published (subscription) service data for fuel consumption and capacity are used for these measures, corroborated by means of Volpe internal estimates. Sensitivities of these estimates to vessel age, speed, weather, size, and other variables are reflected in empirical averages or are assumed to be unbiased errors around calculated quantities.

For various reasons, the nominal maximum capacity of the vessel may not be achievable in practice. In particular, the typical configurations of vessel cargo spaces and of military breakbulk and RoRo cargo may require broken stowage, meaning that some space is unavoidably left over as unusable.

$$[11] \qquad Capacity = effective\ capacity = Design\ Capacity \times utilization$$

where Design Capacity is taken from published sources and a weighted averaged for typical vessels in the trade, and the utilization is a Broken Stowage Factor to allow for unusable capacity. This factor may be specific to the cargo type and trade.

2.3.4. Utilization of Capacity

World trade occurs in many directions, but not necessarily equally. The U.S., especially, imports more than it exports. Thus there is a "peak" direction (toward the U.S.) where demand is usually higher than in the other direction. Most of this effect is reflected in base shipping rates, but there will still be some directional tendency in traffic, leaving fewer cargo units across which to spread fuel costs. Directionality also means that containers need to be "repositioned" (i.e., carried empty) so that they can be reused.

An imbalanced flow factor acknowledges that the utilization of capacity is bound to be unequal between eastbound and westbound routes. There are marketing efforts and operational strategies that carriers can take to reduce or mitigate the imbalance, and BAF components should not reduce the incentives for carriers to utilize excess capacity. Thus trade imbalance is a business factor that carriers adapt to in their pricing and marketing, and is reflected in their base freight rates. It is not included in the recommended BAF.

2.3.5. Input Substitution

In theory, the mix of inputs into a given production function is selected according to their relative prices. The price of labor, the opportunity cost of a vessel, and the price of fuel usually have some effect on the amounts and proportions of those inputs that produce a vessel voyage. As the prices change the mix changes. As the price of fuel rises, the vessel operator tries to produce the same output at the least cost by substituting other inputs for the more-expensive fuel. The primary means for saving on fuel on ocean vessels is to reduce speed, but other strategies such as hull cleaning, propeller design, vessel trim, and energy efficiency monitoring can yield fuel savings. The higher the price of fuel, the more worthwhile these activities become.

The result is that the mix of inputs (fuel, vessels, labor) is not independent of the price of fuel. As the price of one input goes up, the total cost (or unit cost) goes up, but by less than would be the case if the ratios of inputs were fixed. The amount of substitution that will efficiently take place in response to a change in the price of one input depends upon technology, the importance of the input in the production function, and the relative variation in price.

In economic terms, this is represented by a substitution elasticity. A high elasticity would maintain a constant *ratio* of input costs (to each other) while quantities of inputs varied in relation to price. This results in a substitution factor of approximately 0.75, meaning that for every dollar increase in the price of fuel, total costs would increase by $0.75. In contrast, completely inelastic inputs (called fixed factors, e.g., one bus and one driver) result in a substitution factor of 1.0: every dollar of fuel price yields $1.00 increase in cost.

For ocean shipping, substitution elasticity is moderately high and is likely to lie in the range of 0.80-0.85.

$$[12] \qquad Subfac = 0.80$$

where $Subfac$ = substitution factor, which is applied to the fuel consumption rate per CU from equation [9] to obtain the fuel consumption factor in equation [1]. A list of some practical means for reducing fuel consumption by increasing related inputs is shown in Table 3.

2.4. Risk Sharing

Because the BAF is a mechanism for shifting the risk of fuel price volatility, the decision should be explicitly made as to how much of the risk each party should bear. That allocation will then be reflected in the bid or offered basic freight rates. The more that the risk is borne by carriers, the lower will be the BAF and the higher will be the base freight rates in order to absorb the risk, assuming rates are set in competitive markets.

Table 3. Short and Long Term Methods for Reducing Fuel Consumption

Input Factor	Estimated Savings	Citation	Remarks
speed/slow steaming	20-30%	Macqueen BW (3/18/13), BWOI (4/25/13); Currie BWOI (4/8/13); Jameson BW (3/11/13); Einemo BWSS (5/15/13)	industry regards as primary concern; “Maersk to stick with slow steaming” with Triple-E newbuilds
scrap/replace vessel	30%	Ng BWOI (3/25/13); Macqueen (BW 3/18/13); Einemo BW (9/27/13); BWOI (4/15/13)	existing overcapacity shortens effective vessel life from 25 to 15 years; older smaller less-efficient ships devalued
LNG fuel, dual fuel		Ng BWNews (3/15/13)	only under stringent emissions constraints <.01%
engine monitoring, air-fuel mix	3-10%	Tan BWOI (4/12/13)	
vessel performance monitoring	“excellent”	Macqueen BWOI (4/12/13); Warris BW (1/9/13); Cacnio BWSS (4/16/13); Ng BW (3/15/13)	simultaneously balance wind, waves, weather, trim, heel, draft, load, hull cleanliness, routing, crew, cargo handling, propeller
rudder control technology	1-3%	Ng BW (3/20/13)	
electric propulsion		Tan BWOI (3/19/13)	allows for wide variety of fuels
hull maintenance	3-5%	Cacnio BBSS (3/25/13)	cleaning reduces drag
anti-fouling coatings	1-3%	Macqueen BWSS (5/8/13); Chew BWSS (3/29/13)	reduce frequency of cleaning
optimize and derate engines	10-15%	Tan BWSS (7/23/13)	re-optimize for slow steaming
propeller design, ducts, boss cap fins	2-5%	Tan BWSS (7/23/13); Jameson BWOI (4/9/13)	
bow design modifications	1-3%	Jameson BWSS (4/16/13)	front bulb reshaped and repositioned for slow steaming
SEEMP		Jelsma BW (9/13/12)	comprehensive plan for energy efficiency management
sail-shaped hull		Jameson BW (923/13)	speculative design for utilizing wind on the hull
citations: BW = Bunker World News or blog BWOI = Bunker World Ocean Intelligence BWSS = Bunker World Sustainable Shipping some categories may overlap			

It is fundamental to any hedging or risk-reducing measure that it allow for both positive and negative outcomes. If the BAF is positive for price increases but not negative with price decreases, the carrier is relieved of any downside risk but gets to keep the upside gains. This is having your cake and eating it too. It costs the carriers nothing, transfers all the risk to the shipper, and offers the potential to augment the basic price. While in a competitive market these advantages should be reflected in lower base freight rates, the market is only partially competitive and, like complex financial derivatives, the true costs and risks are obscured. If there is a BAF at all, it should at least be symmetrical upward and downward.

2.4.1. Hedging

A strategy for reducing the impacts of uncertainty and volatility is generically referred to as hedging. Hedging amounts to placing a bet against yourself such that you win if things go badly. This allows a buyer to suppress the volatility of future price changes, both up and down. The fundamental concept of hedging is that you give away some of the upside potential in order to limit the downside.

Fuel price hedging can be accomplished by purchasing futures contracts on the commodities market. The buyer agrees to pay a given price at a future date for a given quantity. Futures trading in petroleum products began in 1978 on the New York Mercantile Exchange.

The buyer can hedge all or some portion of future fuel purchases, and buy the rest at the time of consumption or on the spot market. If the market price is higher at the time of consumption, the buyer has received a windfall; if the market price is lower, the buyer has paid a higher price.

An option is a form of hedging in which the buyer agrees to pay a certain future price, but is not obligated to take the commodity if the cash/spot price is lower. In that case, the option expires without any transaction. The buyer has paid some amount up front for the option to buy at a certain price, but does not exercise the option if the market price turns out to be lower.

Although the inclusion of a BAF in purchasing transportation services is a form of hedging, the one does not obviate the other, nor are they exact substitutes. Inclusion of a BAF does, however, reduce the need for hedging. Without a BAF, carriers are likely to hedge or pre-purchase a larger share of their fuel than with the BAF.

Since there is no inherent need for a BAF in order to accomplish hedging, the question of whether and how much to use a BAF then depends on risk allocation.

2.4.2. Transparency

The nature of the industry and its customers has a lot to do with how transparent the generation of the amount is and the verifiability of the data sources. BAFs arose during the oil shock of the 1970s, but became pegged to published statistics somewhat later. A lack of transparency leads shippers to suspect that BAFs are monopoly-imposed rents rather than neutral cost adjustments. While the calculation of commercial BAFs is somewhat transparent, there are always some factors that are not verifiable.

The BAF should not be based on actual costs or actual load factor, but constitutes a partially compensating adjustment for unanticipated unit input price changes. Hence the technical factors should be based on a stylized set of conditions, not actual conditions. Carriers that use fuel-efficient vessels will profit from the BAF adjustment when prices rise; inefficient ships will benefit more when prices drop (fuel efficiency then has less value).

2.4.3. Flagging and the Maritime Security Program

Ocean-going ships are registered in some nation, whose rules it must abide by. To be flagged in the U.S. requires that the vessel meet certain safety standards and be crewed by unionized U.S. seamen. Foreign vessels can load and unload in U.S. ports, but cannot carry cargo between U.S. ports (cabotage). Congress requires all military cargo to be carried on U.S. flag vessels (with some exceptions), which is a 'Buy America' trade and labor protection measure primarily for the benefit of domestic U.S. seamen.

A justification for these policies as applied to ocean carriers is to ensure the availability of a fleet of commercial ships and operators in case of national emergency, so the nation would not have to depend upon foreign carriers that might be inaccessible or hostile. Because foreign carriers can carry U.S. domestic cargo by reflagging their vessels, they can bid on USTRANSCOM cargo, but such ships are not in any practical sense part of the U.S. merchant marine fleet. In practice, international shipowners may flag a portion of their fleet in the U.S. so they can carry the preferred cargo at a higher rate. The portion of the vessel capacity not needed for the restricted cargo is sold to whoever will buy it, at market rates.

Carriers can offer vessels to the Maritime Security Program (MSP), and receive an annual rent for making their vessels available to the US government in time of national emergency.

2.5. Industry BAF Practices

Carriers impose BAFs on commercial customers, who have little ability to negotiate the terms unless they are very large shippers. Perhaps as a consequence of their monopoly leverage, BAFs imposed by carriers on their shippers are not especially favorable to shippers.

2.5.1. The Transpacific Stabilization Agreement (TSA)

TSA is a conference of carriers serving the Asia to the U.S. West Coast market. The member carriers of the TSA are: APL, CMA CGM, Coscon, Evergreen, Hanjin, Hapag-Lloyd, Hyundai, “K” Line, Maersk, MSC, NYK, OOCL, Yang Ming, and ZIM. Carrier members of the TSA can use the conference-recommended formula:

$$[13] \qquad BAF = \frac{p_{fuel} \times F_{vessel} \times D_{sailing}}{C_{vessel}}$$

where

BAF = bunker adjustment factor ($/cargo unit)

p_{fuel} = average price of bunker fuel ($/metric ton)

F_{vessel} = fuel consumption rate for the vessel (mt/day)

$D_{sailing}$ = sailing days from origin port to destination port (days)

C_{vessel} = capacity of the ship (cargo units)

For containerships, the cargo unit is *FEUs* (forty foot equivalent units). The above formula is then adjusted for:

1. Repositioning empty containers
2. Fuel cost "historically embedded" in base freight rates

The first of these is elsewhere referred to as a directional factor or imbalance factor or empty deadweight factor; this is effectively also a utilization factor for total capacity that is unused on the backhaul. The second is intended to remove the share of the basic freight price that covered fuel, at a time when fuel prices were much lower than the present.

For ships in the TSA serving US West Coast ports, the measured current prices for IFO380 and IFO180 are taken at Los Angeles and Hong Kong; for the US East Coast/Gulf, the reference ports are Hong Kong and New York. The source for prices is Bunkerworld.

The TSA BAF is adjusted quarterly "based on a 13-week reporting period that ends 30 days before the effective date of the next adjustment."[8] Thus the BAF remains fixed for three months at a time, but the base price is never recalculated. The current price is from Bunkerworld data averaged over thirteen weeks, and is a weighted average of fuel grades based on ECA requirements for the trade.

Table 4. TSA BAF Formula Factors

Component	US West Coast - Asia	US East Coast/Gulf - Europe
Average Vessel Capacity[a]	2,744 FEU	1,928 FEU
Utilization[b]	88.19% to WC	91.56% to EC/Gulf
Average Vessel Fuel Consumption	158.45 mt/day to WC	127 mt/day to EC/Gulf
Average One-Way Steaming Time	13.94 days to WC	24.0 days to EC/Gulf
Empty Repositioning Share of Westbound Vessel Deadweight[c]	7.714% from WC	8.84% from EC/Gulf

[a] Vessel Capacity is adjusted for broken stowage and other constraints on using all space potentially available.
[b] Utilization is a factor applied to Effective Capacity to derive an "actual" capacity, and constitutes a load factor.
[c] Empty Repositioning is an additive fuel cost for carrying empty containers, applied to total cost before subtracting embedded fuel costs.

As applied to an example set of prices, the results are shown in Table 5. Yellow-shaded cells are data or parameter inputs, while unshaded cells with number are calculated from the data.

[8] http://www.tsacarriers.org/fs_bunker.html.

Table 5. Example Calculation of TSA BAF

	WC	EC/Gulf
Capacity (FEU)	2,744	1,928
Utilization	88.19%	91.56%
Actual Effective Capacity	2,420	1,765
Fuel per Vessel Day (mt)	158.45	127.00
Steaming Days	13.94	24.00
Fuel per Trip	2,208.79	3,048.00
Fuel Cost/Price	$ 740.65	$ 735.00
Fuel Cost/Trip	$ 1,635,942.54	$ 2,240,280.00
Repositioning Factor (%)	7.714%	8.840%
Repositioniong Cost	$ 126,196.61	$ 198,040.75
Total Fuel Cost	$ 1,762,139.14	$ 2,438,320.75
Cost per FEU	$ 728.18	$ 1,381.27
Rounded to nearest dollar	$ 728.00	$ 1,381.00
Fuel price buffer	$ 20.00	2.7%
Embedded Fuel Cost/FEU	$ 80.00	$ 160.00
Final Adjust BAF (per FEU)	$ 648.00	$ 1,221.00

For trades that pass through ECAs, the BAF is supplemented by a Low Sulfur Component (LSC) to adjust for the need to burn low sulfur fuel in areas within 200 miles of the coast. An example of this supplement is shown in Table 6.

Table 6. Calculation of Low Sulfur Supplement

Low-Sulphur Component (LSC)	WC	EC/Gulf
Inside ECA sailing time (days)	2.698	4.22
Fuel consumption (mt/day)	110.42	101.93
IFO380	623.5	583.0
LS380	810.0	641.0
MGO	1022.0	951.0
Additional Fuel Cost	$ 55,560.80	$ 24,948.39
Cost per FEU	$ 22.96	$ 14.13
	Los Angeles	Houston

This formula estimates the amount of fuel that is required to pass through the ECA and calculates the additional cost of that fuel over and above the cost of the lower grade fuel. The fuel consumption rate for the ECA is much lower than the average rate shown in Table 5, suggesting that the higher grade has a higher energy content, speed is lower in the ECA, or weather is better.

2.5.2. The Westbound Transpacific Stabilization Agreement (WTSA)

WTSA formerly was a conference of carriers serving the U.S. (both East and West Coasts) to Asia market. The conference has since merged with the TSA.

The WTSA previously had a suggested BAF calculator structured in much the same way as the TSA's structure, but with differences in a few of the components. An example is shown in Table 7.

Table 7. WTSA BAF Formula

	WC	EC
Capacity (FEU)	2,744	1,928
Utilization	67.38%	66.44%
Actual Effective Capacity	1,849	1,281
Fuel per Vessel Day (mt)	158.45	127.00
Steaming Days	13.94	24.00
Fuel per Trip	2,208.79	3,048.00
Fuel Cost/Price	$ 740.65	$ 735.00
Fuel Cost/Trip	$ 1,635,942.54	$ 2,240,280.00
Repositioning Factor (%)	92.29%	91.16%
Repositioniong Cost		
Total Fuel Cost	$ 1,509,811.37	$ 2,042,239.25
Cost per FEU	$ 816.56	$ 1,594.25

The nominal vessel capacities are the same as the TSA values in Table 5, but the actual capacities are much less; the WTSA text states that the utilization factor is 1.0, but the implicit utilization is around 0.67. These numbers are not provided in the documentation. Fuel consumption and steaming are the same as for the TSA formula. Similar numbers for fuel prices were given for the WTSA formula (indicating the prices are the full bunker prices and not deviations from a base price), but Table 7 uses those from the previous table for comparison. The repositioning factor has the effect of *lowering* the BAF cost, but the net result is BAF prices higher than those from TSA.

WTSA says “the overall aim” of its bunker charge “is full cost recovery.” This is a misconception. As a private supplier of services, the carrier seeks to earn enough revenues from customers to cover ALL its costs. Normally the seller offers a price, which the buyer accepts or rejects (or negotiates). Rarely does the seller say the price depends upon the future price of inputs, unless the buyer is entering a cost-plus contract (in that case, the quantities and prices are audited actual amounts, not *a priori* estimates). If carriers were to extend this concept, each input would be priced – labor, other materials, purchased services, vessel ownership or rental, etc. – with actual charges based on future prices and estimated quantities. Price volatility would be eliminated for all inputs, and all price risk transferred to shippers. This could only be applied in markets in which the sellers constituted a strong monopoly.

2.5.3. Maersk Line

Maersk is a worldwide carrier with its own BAF (separate from the TSA or WTSC formula). After the EU banned carrier conferences on all shipping in and out of European ports, effectively banning conference BAFs, Maersk created its own BAF for its European markets and for its worldwide operations. For any given trade, Maersk has established a technical constant based on the fuel consumption per day per container of its vessels, multiplied by the average transit time as well as an additional adjustment to reflect the imbalance of trade. This factor is multiplied by the change in price for that route. Within any given trade, Maersk has established a base bunker price under which it will assume all fuel costs. When the average price is above that trade-specific price level (either one or three month averages, again trade-specific), a BAF is calculated.

Table 8. Maersk BAF Example Calculation

Trade: US West Coast to Hong Kong	Existing BAF Calculation:	New "Standard" Bunker Factor:
Vessel Bunker Consumption (mt/TEU/day)	0.02728	0.02491
Transit Time (days)	28.0	29.1
Imbalance Factor	1.00	1.09
Bunker Price Base Element	$ 115.00	$ -
Current Bunker Price	$ 663.00	$ 663.00
Bunker Price Change	$ 548.00	$ 663.00
BAF (per TEU)	$ 418.58	$ 523.85

The current or historical Maersk BAF calculation assumes an arbitrary base price of $115 per metric ton, and compensates Maersk for all estimated fuel costs above that floor. Thus most fuel costs incurred by the carrier are paid by the shipper. The new "Standard" BAF takes a zero price for fuel as the baseline, so the shipper is making a payment for 100% of estimated fuel costs (and perhaps more).[9] The imbalance factor accounts for the partially-empty backhaul and the repositioning of empty containers, both of which are affected by trade imbalance.

2.5.4. Mitsui O.S.K. Lines (MOL)

Mitsui O.S.K. Lines is a worldwide carrier with its own BAF in some trades. After the EU banned carrier conferences on all shipping in and out of European ports, effectively banning conference BAFs, MOL created its own BAF for its Trans-Atlantic markets. MOL created a "Trade Sensitivity Factor" to estimate average consumption per container, incorporating vessel size, service speed, vessel voyage days, cargo weight, vessel utilization level, trade imbalance and bunker consumption rate. When the three-month average bunker price exceeds $200 per metric ton, the difference is multiplied by the trade sensitivity factor to determine a resulting BAF. For all prices below $200 per metric ton, MOL assumes all fuel costs.

2.5.5. Defects of the Commercial BAFs

To the extent that USTRANSCOM can utilize concepts and data that are now in use in commercial ocean shipping markets, then implementation of TRANSCOM contract provisions is made easier and unnecessary extra work minimized. While existing commercial BAFs are designed to provide protection to the carriers in the face of potential fuel price volatility, these

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[9] Notteboom and Carriou (2009) have compared actual BAFs with calculated estimates of fuel costs and concluded that ocean shipping BAFs typically overrecover fuel costs by as much as a factor of two.

commercial BAFs have defects that make them unusable in their stated form for TRANSCOM shipping purposes.

1. Not Focused on Fuel Price Volatility

By setting the base price at something other than the applicable world or trade price immediately prior to the contract for services, the carriers achieve several features in their own self-interest: the BAF always goes up, the trigger or buffer is always exceeded, and base fuel costs are comingled with price volatility that makes the two factors harder to separate.

Estimating the fuel share of carrying ocean freight is the responsibility of the carriers, as they are most knowledgeable about their needs and performance tradeoffs, and best able to optimize fuel costs. The BAF should focus solely on the volatility of fuel prices, so that specific risk is removed from their calculation of freight rates.

A multi-part price in which a major cost component – fuel – appears in both parts is intended to confuse shippers. The price to the shipper is the sum of both parts, but the second part is not known in advance. The quoted shipping price should be the base freight rate, with all fuel costs included, plus a risk component that effectively insures the carrier against large price increases (it should also include a rebate if fuel prices drop substantially after the start of the contract).

2. Creates Multiple Profit Centers

The lack of transparency in multi-part pricing that charges for the same thing in more than one part creates the opportunity to make a profit on both components.[10] Rebasing the current price at the beginning of a new contract ensures that the BAF responds to price volatility and not to other considerations. All cost components should be included in the basic freight price. If some portion of the risk of wide swings in fuel prices is shifted to the shipper, then the BAF should only appear (be non-zero) if prices have shifted by a relatively large amount from their levels at the beginning of the contract.

Although these formulas are in part a response to shipper’s complaints about lack of transparency, it is clear that the calculations still contain factors that are arbitrary and not verifiable.

2.5.1. Positive/Negative Symmetry

In practice, commercial BAFs never go below zero, while U.S. government price adjustment factors (EPAs, or economic price adjustments) are required to be symmetrical with respect to increases or decreases in the exogenous commodity price.

When using an economic price adjustment, the FAR/DFAR acquisition regulations require “mutuality” to protect both parties. The concept behind mutuality is that when contract inputs

[10] Bottom and Cariou (2009).

are volatile enough to make cost projections and thus contracting difficult, a price range is identified outside of which either party is compensated by the other. A contract is created assuming an input's market price and an index is used to track the price. If the price stays constant, the input price at the time of bidding is assumed to be the full responsibility of the contractor and their bid reflects that amount.

2.6. Details and Results for 2013 USTRANSCOM BAFs

For each lane, a set of ports is identified that define the ends of the lane. The ports are selected by weighting the ports in the lane by their TRANSCOM traffic volumes. Up to 6 ports per lane are selected, for approximately 100 lanes.

Prices for 3 grades of fuel are extracted from Bunker World data for a given day. The available fuel grades are shown in Table 9. IFO380 is the most viscous of the bunker fuels, and low sulfur marine gas oil is the lightest; these approximately span the price range from least to most expensive.

Table 9. Fuel Grades Used in International Shipping

Grade	Description
IFO380	intermediate Fuel Oil 380
IFO180	intermediate Fuel Oil 180
MGO	marine gas oil
MDO	marine diesel oil
LS380 1%	low sulphur 380
LS180 1%	low sulphur 180
LSMGO 0.1%	low sulphur MGO

Bunkerworld (BW) prices pertain to approximately 300 ports. The primary ports in all USTRANSCOM lanes number about 135, as extracted from IBS. Of the IBS ports, fewer than half are on the BW list. Thus for each IBS port, the most likely substitute port on or near the lane needed to be selected. Few ports quote daily prices for all of the fuel grades, and in some cases there were no ports on a given lane that quoted a given grade, low sulfur grades in particular. To assist with identifying top ports by traffic by lane and to find key fueling ports, IBS ports were grouped into the regions shown in Table 10. For five of these regions no prices were quoted in BW: Alaska, Azores, Black Sea, Greenland, and Hawaii. To provide simplicity and ease of updating for TRANSCOM staff, eight ports were selected for the 19 regions in Table 10. Each region was assigned the port either within its bounds or along a likely route.

Table 10. TRANSCOM Shipping Regions.

Region	Name
AF	Africa
AL	Alaska
AS	Asia
AZ	Azores
BS	Black Sea
CB	Caribbean
CM	Central America
EC	US East Coast
EU	Europe
GC	US Gulf Coast
GR	Greenland
HI	Hawaii
IC	Iceland
MD	Mediterranean
ME	Middle East
OC	Oceania
SA	South America
SB	Baltic Sea
WC	US West Coast

With IBS regions matched to BW ports, fuel prices specific to each lane could be extracted as an average of the prices for the regions on either end of the lane. Interport lanes were based on a single port. Three fuel grades were selected: IFO 380, 1% LS 380, and MGO. The average price for the lane is a weighted average of the prices for the three grades in the ports on either end. Averages were calculated from the data that were available for the lane, ignoring missing observations.

2.6.1. ECA factors

Vessels are required to use MDO or lighter fuels while in most ports, or hook up to auxiliary berthside power connections. As with the previous studies, the base amount of the light fuel is estimated to be 5% of the average vessel journey in all lanes. The share of low sulfur (LS) fuel required is estimated on the basis of the amount of distance at sea during which the vessel is traveling in an ECA, relative to the total amount of steaming time for the average voyage. The residual of these two components is the share of travel under fuels not meeting the LS standard. (see 2.2.4 “Mix of Fuel Types” on p.16)

This calculation accounts for the amounts of the three fuel grades that can be expected to be used on each lane, and their prices at points of sale on the lane. The indirect impacts on fuel markets and the market for ocean shipping are more complex.

Four categories of emissions are currently regulated or anticipated, as shown in Table 11. These are in addition to port-specific restrictions.

Table 11. Emissions Restrictions on Ocean Shipping

Pollutant	Current in ECAs	Current outside ECAs	Future
Sulfur (S)	1% low sulfur fuel starting 2010	up to 3.5% sulfur	0.1% LS inside ECAs starting 2015; global limit outside ECAs may drop to 0.5% in 2020.
Particulate Matter (PM)			to be reduced by 85% from current levels in 2016; black carbon from HFOs may be banned near arctic to reduce warming impacts on snow.
Nitrogen Oxides (NOx)			to be reduced by 80% in 2016
Carbon Dioxide (CO2)			to be reduced by 20% by some uncertain date

The major significance of the restrictions is that they are becoming more restrictive and more widespread over time, this trend is very likely to continue, and it will increase the cost of moving ships over the oceans. Given that fuel is a major and increasing share of shipping costs, the market for shipping services is likely to shrink, other things being equal. Offsetting market factors, such is increased trade imbalances, are unlikely and seem to be trending away from greater demand for freight shipping. Because there is already an overcapacity in container fleets, further pressures to reduce costs are likely to cause weaker carriers to shed capacity.

Environmental restrictions can be implemented in a variety of ways, as outlined in Table 12. The policies progress from indirect to direct, in both the ordering in the table and in the development and adoption of new regulations.

Table 12. Policy Strategies for Controlling Emissions

Policy	Strategy	Advantages
Regulate Fuel Quality	restrict inputs so as to control outputs or emissions	relatively easy to monitor and enforce
Regulate Emissions	control output directly	use cheap dirty fuel with stack scrubbers
Cap and Trade	create market for tradeable pollution rights	economic incentive to find and apply cheapest emissions reduction technology
Emissions Pricing	carbon tax	finds cheapest technologies and optimal emissions level

The uncertainty about future regulations and the time frame for their implementation leave carriers with a wide range of possible responses and considerable risk as to which responses will pay off. Some of the possible carrier responses are shown in Table 13. Shipowners are testing these strategies on a small scale, and some larger carriers are investing heavily in large Tripe-E (fuel efficiency, environmental sustainability, scale economies) vessel newbuilds.

Table 13. Shipowner Response Strategies to Emission Regulations

Carrier Strategy	Advantages	Disadvantages
use IFO where permitted, LS in ECAs, MGO in port, modify route	current default, ok in short run until requirements become more stringent	will become unprofitable
use IFO everywhere, stack scrubbers in ECAs	avoids expensive fuels	capital cost of equipment, plus operating cots and disposal of waste
use LNG everywhere	meets emissions requirements	more expensive where not needed; little port infrastructure in place
use dual fuel engines	optimize fuel quality for specific lane; more flexibility	capital cost of engines and on-board fuel storage infrastructure
replace vessels	fuel efficiency and design optimized for speed, fuel, and capacity	large initial cost

Other IMO policy actions could add to cost pressures, such as a proposed tax on all vessels to provide for environmentally benign and non-hazardous methods for ship salvage. Larger carriers are investing now to position themselves to be on the cost-efficient frontier when the industry shakeout works its way through the industry. If they are successful, they may emerge with enhanced pricing power.

2.6.2. Price Indexing Factors

The price baseline scenario in the Volpe BAF is driven by the length and terms of the USTRANSCOM contract. At the time of bidding, the baseline is set using the spot price on the first of the month immediately preceding the issue date of the solicitation. Bidding for the USTRANSCOM contract takes place five months prior to the start date of the contract which itself lasts a full year. The baseline price quoted at the time of bidding is used 17 months after the initial bid and is reset only as each subsequent yearly option is elected. Under the terms of the USTRANSCOM contract, carriers are only compensated with a BAF for a rise in prices making the market price at the time of bidding the price of fuel at which the carrier assumes all fuel costs.

The final price of fuel established on the first day of the shipping month is compared to the baseline price to determine any BAF compensation. In the industry, the price on the date of shipment isn't the market spot price that day but rather, a rolling average, usually between one and three months. The price quoted on any given day within a month is the same and comprised of the average price over the specified length of time.

2.6.3. Prices of Different Fuels

In calculating BAFs, some carriers simplify their formula by tracking bunker fuels exclusively while others also track MDO prices. Doing so also requires that a fixed ratio of the two fuels is established to reflect the fuels as they are used by the carrier. The prices of the two fuels, shown in Figure 7, are highly correlated at 0.95 so tracking one or both will have little effect on the BAF calculation. As the price of one moves up, the other does by a similar amount, and the total rate of change is similar to using bunker fuel exclusively. However, as the baseline prices set at the time of bidding are fixed as the full responsibility of the carriers, calculation simplification is secondary to an accurate representation of the carrier cost structure.

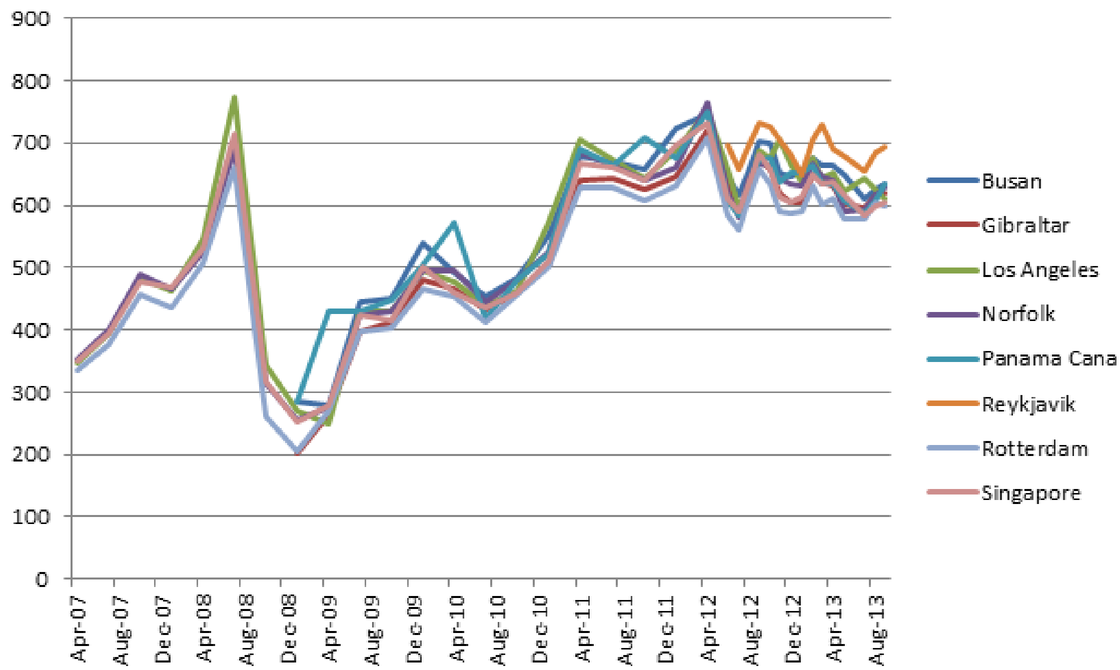
Source: Bunkerworld

Figure 7. Worldwide average fuel prices by type, 2007-2013.

2.6.4. Prices at Different Locations

The location of the bunker fuel purchases is factored into the industry BAF calculations of carriers reflecting the locations of the trade. While regional differences in spot price do exist, the price at any port is highly correlated with other ports as they both reflect the prevailing worldwide supply. The recent pattern is shown in Figure 8.

While the data suggest using any single port's bunker price may be sufficient as that port's price will track the worldwide price, the Volpe BAF calculation draws prices from 8 ports around the world and associates them with specific lanes. This specificity, in conjunction with the ECA factors, allows the calculated BAFs to reflect the regulatory conditions and fuels available on each lane.



Source: Bunkerworld

Figure 8. IFO 380 (HS) price by port, 2007-2013.

2.6.5. Fuel Consumption Factors

Many factors affect the amount of fuel needed to move a cargo from origin to destination, but a practical BAF can only incorporate a small number of them. The objective is to find ways to estimate fuel consumption under realistic conditions that reflect a recent historical baseline, but will also hold true, on average, under future conditions that may be much different.

In creating the typical vessels that serve as the fuel allocation base of the BAF calculation, a relational database was used to merge two data sources. One data source, the IBS data made available by USTRANSCOM contains multiple tables with varying information that identifies the vessels that may potentially be used for a shipment. The second data source is the Containership and Roll-on/Roll-off (RoRo) Shipping Vessel Registers purchased from Clarkson Research Services, which identify design specifications for specific vessels. The two data sources were matched by vessel name to create the average vessel for each lane.

The IBS data are contained in a series of linked tables that identify, among other things, voyage identifiers, origin-destination pairs, routes, ports, mode of transportation, vessel schedules, carriers, and other aspects of the shipping process. Using the offers and bookings database, the set of all vessels used for a given shipment was identified. These data represent the total set of vessels that were actually booked for a shipment. There are 3,124 unique vessels identified in the IBS dataset.

Clarkson Research Services is a 3rd party shipping research firm, similar to Lloyd's List or Jane's Ships, that collects data on shipping vessels worldwide. The data includes design specifications such as vessel tonnage, cargo capacity, engine type, etc. For containerships, the fields used were total TEU capacity, vessel service speed, and fuel consumption at vessel service speed. For RoRo vessels, the fields used were net registered tonnage (as a measure of capacity), vessel service speed, and fuel consumption at vessel service speed. There are 5,114 vessels in the container registry and 1,772 vessels in the RoRo registry.

While the IBS data contain the IRCS unique vessel identifier, Clarkson uses their own proprietary vessel identifier number making a match on that impossible. Instead, the two datasets were matched on the vessel name contained in both. Although the majority of ships were matched using vessel names, 581 vessels in the IBS data were not matched with either Clarkson database. Three possible reasons may explain the unmatched vessels. First, only active vessels were used in the averages to best reflect future operating conditions. If a vessel in the IBS data had a listed "Inactive Date" it was excluded from the analysis. Second, typos or differences in punctuation may exist in either dataset that prevent matching on the vessel name. For example, the vessel "A P MOLLER" in the IBS data didn't match with "A.P. Moller" in Clarkson. Finally, the Clarkson dataset simply may have no record of some U.S.-flagged vessels used by USTRANSCOM.

After mechanically matching the two datasets, a manual inspection of unmatched vessels was performed. This check allowed for matching ships from the two databases that may have been missed due to differences in naming conventions.

Matching the two data sets allowed for the creation a typical vessel average for each lane by averaging the vessel specifications from Clarkson for all vessels identified in IBS with a particular lane. This typical vessel represents the potential vessel that is available for service on a particular lane. Where there were sufficient observations to calculate a meaningful average, it represents only those vessels that actually did carry USTRANSCOM shipments. Furthermore, the typical vessel is weighted by the frequency those vessels were booked.

Within each lane, containership typical vessels were created for exclusively U.S.-flagged vessels as well as world vessels. The typical vessels were constructed from 1,557 worldwide matched vessels and 67 U.S.-flagged. In some lanes, there were no associated U.S.-flagged vessels or insufficient data to calculate a meaningful average and the world average for the lane is substituted. In lanes with little or no associated vessels (either U.S.-flagged or worldwide), the overall U.S.-flagged average vessel was used.

Over all lanes, foreign flagged containership vessels have greater capacity and higher fuel economy per TEU (although total fuel consumption is higher), seen from Table 14. As the world typical vessel is more fuel efficient, using it as the basis of the BAF calculation would incentivize carriers to use modern, fuel-efficient vessels. However, the USTRANSCOM contract stipulates that preference goes to U.S.-flagged vessels when available. Therefore, the U.S.-flagged typical vessel will be used for the BAF calculation in all lanes where it is available.

Table 14. Average Containership for Lane 1, by Flag

Flag	TEU Capacity	Service Speed	Daily Fuel Consumption (tons)	Daily Fuel per Cargo Unit	Observations
US	3,914.1	23.2	145.5	0.0372	54
World	4,057.3	23.2	143.9	0.0355	507

Creating the typical RoRo vessel followed the same procedure, although with far fewer vessels and active lanes, more worldwide data was used in individual lanes. The data yields 46 U.S.-flagged vessels as well as 259 worldwide matched vessels. Opposite of the containership results, U.S.-flagged RORO vessels were larger, faster, and more fuel efficient than their worldwide counterparts.

For RoRo vessels, finding an average capacity was more difficult as there are several potential measures that can be used including the vehicle capacity, trailer capacity, and various tonnage capacity measures. None of which matched USTRANSCOM's desire to express RoRo capacity in terms of measurement tons as was used in the previous study. Measurement tons is not a measure of weight but rather volume, equaling 40 cubic feet. While the Clarkson dataset was missing measurement tons, it did contain net tonnage, a calculated measure representing the useful volume of a vessel's cargo spaces, expressed in tons equaling 100 cubic feet. Multiplying net tonnage by 2.5 converts to estimated measurement ton capacity. The summary is shown in Table 15.

Table 15. Average RoRo Ship for Lane 7 by Flag

Flag	Estimated Measurement Ton Capacity	Service Speed	Daily Fuel Consumption (tons)	Daily Fuel per Cargo Unit	Observations
US	48,719.9	19.8	53.3	0.00152	38
World	48,710.3	19.9	53.1	0.00152	59

In some cases, there were insufficient data to calculate an average for the typical vessel. However, this does not necessarily mean there were no USTRANSCOM shipments on that route over the timeframe of the data, only that none were matched between the two datasets. In cases where there were few (or no) U.S.-flagged vessels for a trade but sufficient worldwide vessels on that lane, worldwide data was used. Lane specific data captures any geographical constraints on vessels such as requirements to use narrower vessels through the Panama Canal and was used on Lane 09 USEC to Hawaii. In other cases where few or no worldwide vessels were associated with a lane, the overall U.S.-flag average vessel was used as it represents the potential vessel for that lane.

In a small number of lanes, the resultant fuel consumption factor (vessel fuel consumption divided by vessel capacity) was statistically significantly different from other average values. Where a lane's vessel fuel consumption factor was outside two standard deviations from the median, the U.S.-FLAG average vessel was used.

Table 16. Composite US Flag Ships

	Capacity	Speed	Fuel / Day	Fuel/CU/day
US Container	3,323	22.7	125.9	0.0379
US RoRo	49,685	21.2	49.0	0.00137

It is important to note that trades with the least USTRANSCOM activity, if used, may not have the demand for volume/capacity as is represented by the overall U.S.-flag average vessel shown in Table 16. It is possible that a carrier may choose to use smaller, and likely older and less efficient, vessels to move a smaller volume of cargo. Therefore, while the overall U.S.-flag average vessel is presently used to calculate that lane's Technical Factor, USTRANSCOM may determine that another lane's typical vessel or Technical Factor is most appropriate.

2.6.6. Transit Time Estimation

Knowing the typical vessel for each lane allows calculation of the average fuel consumed per cargo unit, per day. In order to then find the total fuel consumption per cargo unit, the number of days per trip is needed. Because a lane includes more than one port pair, a weighted average of inter-port distances was developed to represent the average distance between ports for the lane.

Transit time and vessel steaming days are obtained through the NETPAS Distance software package that calculates the nautical miles between each of a sequence of ports that are served by a particular lane. To find the representative steaming days for a lane, the top 3 ports (as determined by TRANSCOM traffic volumes) on each side of a lane were plotted in the NETPAS software. The software breaks down distance into shares within and outside an ECA. Nautical miles were converted to steaming days using average ship speed. The result is a vessel journey distance that approximates a typical journey for each lane, including both total nautical miles and the share within an ECA. To calculate the technical factor, nautical miles were converted to steaming days using average ship speed. These non-direct, representative lane distances replaced the circuity factor while also identifying the portion of a lane spent within an ECA.

2.6.7. Ship Characteristics per Lane

Data from the IBS database were used to match vessel information with data from Clarkson to match ship names to specific USTRANSCOM lanes. A table was created to match vessel characteristics on each lane for both U.S. Flag vessels (shown in Table 17) and all vessels used on each lane (shown in Table 18).

Analysis of the composite ships with the characteristics of ships on a given lane show relatively close similarities in TEU Capacities, and speed. It should be noted, however, that due to the relative small size of the sampling, the averages may be considerably different from the composite averages and that due to the limited number of observations in some of the lane cases or statistical outliers as described in Section 2.3.5, the figures in may not be representative of the final vessel characteristics selected for the BAF calculation but rather an average vessel was used.

Table 17. Characteristics of U.S. Flagged Vessels by Lane

Lane	Average Total TEU Capacity	Average Vessel Service Speed (Knots)	Average Fuel Consumption (tons/day)	Number of Observations
1	3914	23.2	145.5	54
2	3029	21.1	103.9	40
3	2659	22.6	113.8	48
4	3352	21.7	116.3	56
5	2721	20.6	91.1	36
6	3749	22.7	126.4	35
7	3272	21.6	110.2	41
8	1895	18.5	64.6	31
9	2265	19.7	75.3	27
10	3246	22.0	108.3	23
11	3335	22.1	111.4	30
12	3763	22.8	127.2	37
13	3718	22.7	125.4	32
14	3015	21.4	105.5	27
15	2770	21.2	95.9	26
16	3200	23.1	129.9	41
17	4168	23.5	140.6	5
18	2361	21.0	0.0	1
19	4426	23.9	163.3	51
20	3919	23.0	132.4	40
23	3012	20.9	105.1	38
24	3208	21.9	108.6	24
25	4203	23.4	144.4	38
26	2020	20.4	79.0	41
27	3086	21.3	109.0	34
28	3855	22.7	139.5	14
29	1714	20.0	70.6	7
30	3027	22.2	104.8	4
31	3412	22.3	106.7	5
32	3273	22.0	109.3	24
33	2901	21.1	100.4	9
34	3560	22.3	121.5	36
35	3349	22.8	124.5	3
36	3929	22.9	136.3	35
37	1889	21.5	136.7	19

39	3815	22.7	127.0	16
40	4370	23.8	146.5	24
42	2086	21.6	122.3	14
43	4259	23.6	145.1	9
46	1811	18.4	61.5	7
47	3412	21.7	120.9	52
48	2604	20.2	88.9	37
49	3405	21.6	122.2	36
50	4071	23.2	143.2	40
51	3926	22.8	143.1	55
52	3899	23.1	131.6	27
53	4650	24.3	158.9	12
54	2903	22.9	120.4	39
55	4544	24.2	151.5	16
56	4546	24.2	151.5	11
57	4009	23.2	135.9	39
58	3200	21.6	110.0	1
59	3200	21.6	110.0	1
60	3814	22.6	127.8	32
61	3848	23.8	150.3	36
62	3658	23.0	117.2	4
63	2956	21.8	100.0	4
64	3199	21.9	109.7	6
65	4040	23.2	138.4	12
66	4215	23.4	141.1	14
67	3862	22.6	132.7	30
68	4591	24.2	153.3	7
69	4765	24.5	174.0	4
70	3257	22.0	111.7	9
71	3560	22.1	120.9	34
72	4403	24.2	162.9	18
73	4407	23.9	147.4	27
74	4431	23.9	149.2	35
75	3900	22.7	133.4	35
76	4658	24.2	156.5	2
77	3599	23.1	138.7	15
78	3270	22.8	129.2	13
79	2642	22.8	112.3	33
80	4182	24.0	159.6	34
81	2674	22.7	111.0	28
82	3046	21.5	108.4	25
83	2248	21.3	87.0	20
84	364	14.5	13.5	1
85	3018	21.9	114.6	46
86	3217	21.9	110.3	10
87	3237	22.0	110.0	1
88	3296	21.2	113.0	10
89	4547	24.2	163.5	17
90	1888	18.2	67.8	7
91	2788	20.4	95.4	36
92	4156	23.2	140.4	11
93	811	15.5	30.0	2

94	4113	23.4	138.6	25
95	3681	22.7	124.9	22
96	3790	22.9	128.2	16
97	3459	22.3	117.8	21
99	369	15.5	15.0	1

For each of the Critical Routes, the approximate distances, speed, and fuel consumption of the main engines were used to calculate estimated voyage times in days, fuel consumption per miles, and approximated fuel consumption for a single trip.

Table 18. Characteristics of All Vessels by Lane

Lane	Average Total TEU Capacity	Average Vessel Service Speed (Knots)	Average Fuel Consumption (tons/day)	Number of Observations
1	4057	23.2	143.9	507
2	3729	22.0	121.3	532
3	2662	22.4	110.1	191
4	3687	22.1	122.2	813
5	2791	21.1	90.2	377
6	3293	21.9	107.2	430
7	3087	21.6	101.5	450
8	2603	20.3	84.9	232
9	2602	20.4	79.9	97
10	3043	21.7	100.0	146
11	2945	21.5	95.3	234
12	3080	21.7	100.8	306
13	2995	21.7	98.9	266
14	2373	20.3	73.9	85
15	2596	20.7	80.0	55
16	3270	23.0	125.2	165
17	3160	23.1	108.1	14
18	1208	18.9	45.0	21
19	4697	23.9	164.7	554
20	3283	21.9	107.7	583
25	3057	21.2	99.9	208
26	3337	21.7	103.0	332
27	4254	23.4	139.2	169
28	2317	20.7	82.0	149
29	3123	21.4	100.8	126
30	1947	20.0	64.2	91
31	1723	20.0	70.4	30
32	2384	22.3	81.8	6
33	2027	19.1	63.9	18
34	3184	22.0	105.0	197
35	2453	20.9	81.3	84
36	3237	21.6	103.5	544
37	3654	23.1	130.6	8
39	4128	23.1	132.3	98
40	1293	19.3	51.4	110
42	2418	20.8	81.7	17
43	1278	18.6	44.2	190
46	3141	21.7	103.2	235
48	2106	21.2	91.6	47
49	1126	18.1	40.7	63
50	5048	24.8	140.0	2

51	5029	25.0	135.0	1
52	2422	19.6	78.8	20
53	3487	22.0	118.5	394
54	3207	20.9	98.2	601
55	4061	22.3	134.5	306
56	3962	22.7	131.3	409
57	4399	23.1	150.3	501
58	3174	21.6	101.9	195
59	2801	21.3	92.3	72
60	2589	22.0	102.6	251
61	2643	21.2	83.5	196
62	2810	21.1	89.8	82
63	3695	22.4	120.6	554
64	1005	18.5	38.5	22
65	4567	22.9	152.2	5
66	3141	21.8	103.4	336
67	3899	23.6	147.1	248
68	1526	19.0	57.9	16
69	1449	19.1	67.2	12
70	2090	19.4	63.3	178
71	3915	23.3	131.2	47
72	3871	22.9	125.8	44
73	3609	22.3	118.3	223
74	1446	19.2	49.2	143
75	3826	23.0	129.0	22
76	2019	19.5	63.3	180
77	3829	22.0	118.1	475
78	4185	23.7	145.7	84
79	2804	21.5	94.1	175
80	3783	22.6	124.1	472
81	3910	22.4	127.1	591
82	1011	17.9	36.7	96
83	1920	20.1	64.4	54
84	1812	20.1	64.4	30
85	2590	22.6	109.1	88
86	4035	23.6	148.2	121
87	2115	21.2	84.9	104
88	3303	22.1	109.6	96
89	2488	21.6	90.8	44
90	1177	18.6	44.3	40
91	3196	22.0	110.1	148
92	3032	21.7	97.2	113
93	4803	22.3	140.0	26
94	2854	21.2	90.7	45
95	4164	23.6	141.4	50
96	4131	22.3	137.3	53
97	2786	21.0	87.9	107
99	3165	21.8	105.8	19

2.6.8. Model Calculation and Results

The attached workbook titled “2013 BAF Calculation 092513” details the calculation for determining the USTRANSCOM BAF for each trade. The tab “Trade Technical Factors” contains the final BAF technical factors using the variables and factors from subsequent tabs. The following tabs contain the underlying vessel and fuel data used in the calculation, transit times, and other factors. Using the sample fuel price data in the workbook, BAF charges may be simulated over a specified baseline period or changing factor values in the model.

The source for fuel data is the Bunkerworld online fuel price service, including prices for IFO380 (HS), 1% LS IFO380, and MGO. The ports used in the averages include Busan, Gibraltar, Los Angeles, Norfolk, Panama Canal, Reykjavik, Rotterdam, Singapore.

The technical factors are calculated for each lane by dividing that lane's typical ship fuel consumption (measured in metric tons) by its cargo unit capacity to get the fuel consumed per cargo unit, per day, using equation [1] on p. 12:

For breakbulk cargo, the cargo capacity of a typical RoRo vessel was adjusted downward to reflect “broken stowage,” the wasted space between trucks, tanks, or other cargo that cannot be utilized as the cargo is irregularly shaped. USTRANSCOM assumes a 28% loss of cargo capacity due to broken stowage. In calculating the daily fuel consumption per cargo unit, the vessel cargo capacity was multiplied by 0.72 to adjust for this loss.

After calculating the daily fuel consumption per cargo unit, the overall length of the voyage is needed to get total voyage fuel consumption per cargo unit. Daily consumption is multiplied by the average transit time.

Voyage consumption per cargo unit is then multiplied by the Input Substitution Factor and the Risk Distribution Factor to adjust for carrier routing decisions and the sharing of risk between USTRANSCOM and carriers, yielding the final Trade Technical Factors:

$$[14] \qquad \text{Technical Factor} = F_{CU} \times Risk\ Sharing\ Factor$$

(see equation [1] on p. 12, and section 2.2 on p. 12) and

$$[15] \qquad F_{CU} = baseF_{CU} \times Subfac$$

where the $baseF_{CU}$ is the fuel consumption estimate for baseline conditions as described in section 2.3 “Fuel Consumption per Cargo Unit” on p. 16, and *Subfac* is defined in section 2.3.5 “Input Substitution” on p. 19.

The final technical factors for each trade and identified route are shown for each type of cargo unit, TEUs, FEUs, and Measurement Tons. To get the final surcharge when prices are above or below the 20% baseline price, these technical factors are multiplied by the difference in price. These technical factors, shown in the attached workbook, are compared to industry practice and the previous Volpe technical factors in the subsequent sections. (see “All Factors Combined” on page 55).

2.6.9. Comparison of Fuel Consumption Factors and Transit Times with Maersk Lines

Maersk lines operates over many of the same lanes served under the USTRANSCOM contract in addition to being the carrier that provides the most public information about the composition of its BAF. Comparing the variables in the BAF Maersk charges its shippers to analogous components within the new BAF methodology described in this report provides an important industry check. It should be noted that this comparison is not with Maersk's new "standard bunker factor" to be deployed, but the current method. Maersk publicizes information on its BAF formula on its website for its liner services, including fuel consumption rates, transit times, and vessel utilization rates. As many lanes are broad geographical areas, serving several countries within each, proxies were used to select Maersk services that closely mimicked the USTRANSCOM lanes covered by the prior study.

The "trade specific constant" within Maersk's BAF, contains a fuel consumption figure (tons of fuel per TEU, per day), the transit time for the lane (1/2 the round trip time), and an imbalance factor which is "the ratio of headhaul to backhaul, measuring the inequality between imports and exports in each trade." This constant is multiplied by the change in bunker price above a trade-specific price. While the imbalance and price factors are trade specific and not generally comparable to the new BAF methodology, the fuel consumption and transit time figures are. The comparison is shown in Table 19.

Table 19. Sample Maersk services used as a proxy for trade technical factor comparison

Lane or Route ID	USTRANSCOM Lanes & Routes Lane/Route Description	Maersk Proxy Lanes Departure	Arrival
01	U.S. West Coast - Far East	USWC	South Korea
02	Continental Europe, United Kingdom, Ireland - Middle East, South Asia, Indian Ocean	Netherlands	Kuwait

Overall, the Maersk fuel consumption per TEU figures closely align with the fuel consumption figures estimated by the typical ships, shown in Figure 9. The average daily fuel consumption factor as estimated by the new methodology was 94% that of the Maersk fuel consumption figures, suggesting that across lanes, fuel consumption was closely related. Looking within individual lanes, while the values are still positively related (correlation coefficient = 0.30), differences in fuel consumption become more apparent. For services operating largely in the Atlantic and Mediterranean, Maersk vessels consumed more fuel per TEU than the typical ships as estimated by this methodology, while Maersk vessels were relatively more efficient in Transpacific or Indian Ocean voyages, suggesting differences in fleet vessel composition by trade location.

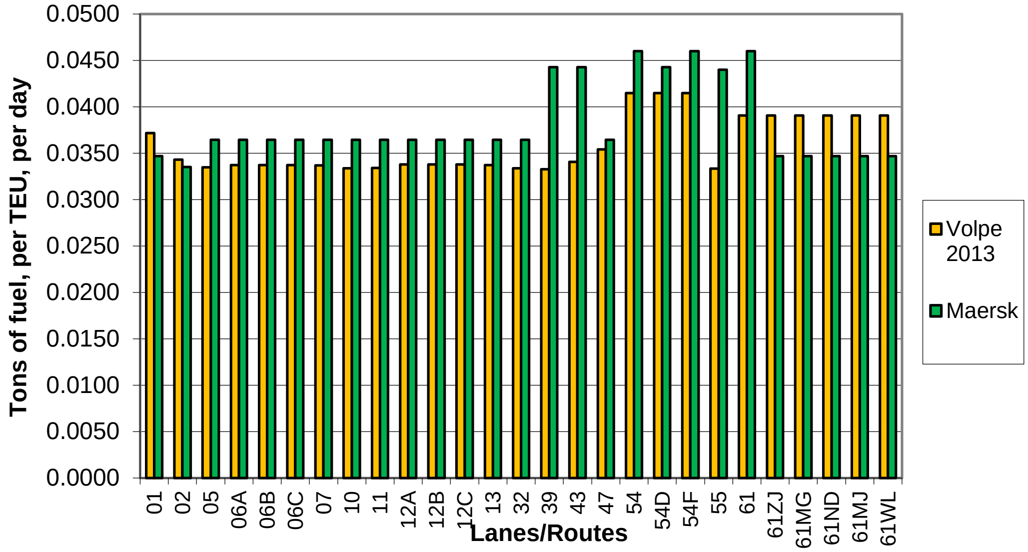


Figure 9. Daily fuel consumption factor, Maersk vs. 2013 methodology.

source: Volpe calculations.

Maersk's transit times were also relatively closely related with the estimated transit times of this methodology, shown in Figure 10. On average, the transit time of Maersk was 7.2 days higher than the estimated transit times across lanes. Within lanes, the estimated transit times have a tighter relationship with Maersk's times (correlation coefficient = 0.60) than did the fuel consumption figures. Although Maersk transit times were consistently higher in the Far East, this was balanced by lower times to the Middle East, South Asia, and the Indian Ocean in routes 13 & 47.

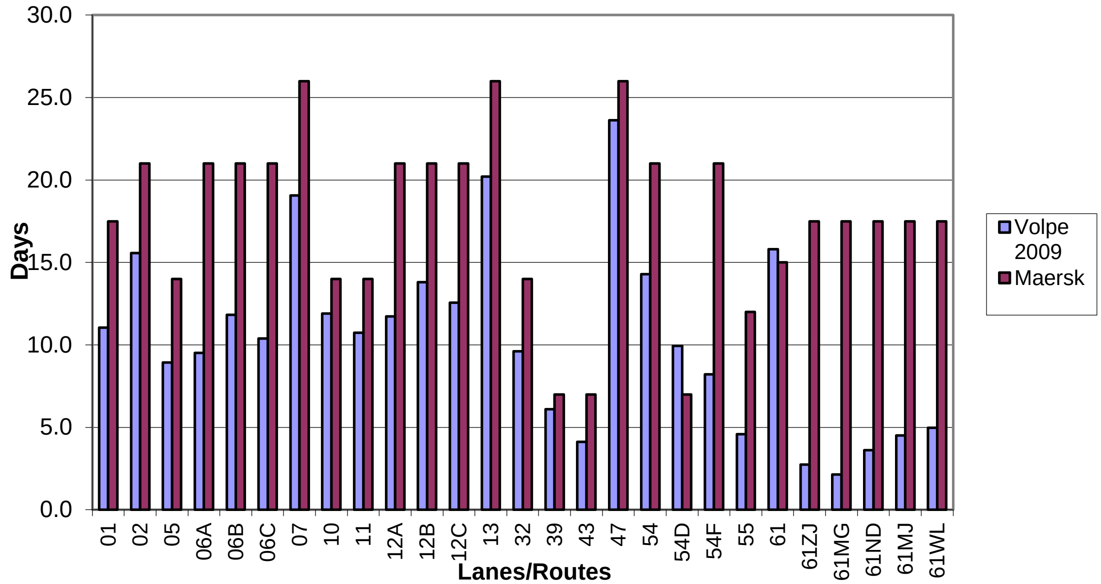


Figure 10. Average transit time by lane, Maersk vs. Volpe 2009 methodology.

As each BAF method is based on internal practices, differences in specific fuel consumption and transit time values may be explained by the operational differences between Maersk and the average USTRANSCOM carrier. How these factors are combined in the final calculation is also different. Maersk uses trade specific values for vessel utilization which may raise or lower the final BAF while the methodology presented in this report assumes a full container utilization rate. Also, Maersk applies a BAF only above a certain price, their "Base Bunker Element," which is also trade specific, while this methodology applies a BAF to all trades at prices above the 20% threshold. Section 2.8 of this report compares the final trade technical factors for Maersk and the new methodology with the 1993 figures currently used by USTRANSCOM.

2.6.10. Transhipment

Cargo shipped halfway around the world may not arrive at its final port on the same ship it was initially loaded onto. If the tradeoffs in voyage design between the economies of carrying more cargo versus the diseconomies of circuitous routes result in itineraries of about 5-6 ports, then cargo may be off-loaded at an intermediate port and put on another voyage. The cost of unloading and reloading is less than the inefficiency of trying to serve too many ports on one voyage. A hypothetical pair of connected voyages is shown in Figure 11.

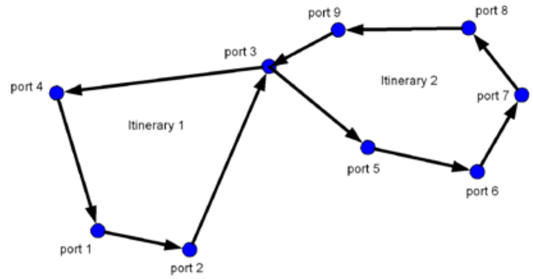


Figure 11. Voyages linked by transshipment.

This could be considered a form of hub-and-spoke networking: cargo is carried to a location that is common to another route. Each voyage used to carry the cargo to its ultimate destination can be assumed to have a circuity pattern similar to others simply because less efficient or less productive itineraries are squeezed out by market economics. Hence, for purposes of calculating a BAF, it is not necessary to separately consider whether the cargo is transhipped or is carried on a single bottom for the whole trip.

2.6.11. Input Substitution Factor

Fuel is one of many input factors in the production of ocean vessel freight service. Economic theory suggests that when relative prices of inputs change, the mix of inputs should shift so as to maintain the lowest cost for a given level of output. The extent to which the proportions of inputs change in response to price changes depends upon the ability to substitute among inputs within the production function, which, in turn, depends on the technology of the industry and the firm. These substitution elasticities have implications for the design of economically efficient and equitable fuel adjustment factors applied to freight services purchased in advance of the time of delivery.

Fuel is only one component of the production function for vessel freight services, but it appears to be the only component singled out for surcharge treatment.

A production function is a multidimensional relationship between a set of inputs, on the one hand, and the output or outputs on the other. There are many ways to produce the same output, some of them more “productive” than others, meaning that for some production combinations the same output could be produced with less of some input but no more of any input, or the same resources could produce more output.

Assuming the input combination and production process is along the production frontier, the most efficient mix of inputs is the one that produces each quantity of output at the lowest cost. The combination of the production function and the vector of prices of inputs, optimized to produce at the lowest cost, is the firm's cost function. For the competitive firm, the quantity of output is determined by the intersection of the marginal cost function with the market price.

Speed and fuel consumption are closely related. Engine power is designed so as to move the vessel at a suitable cruising speed under normal conditions, with some reserve power to spare. A vessel might cruise at 75-85% of its maximum power at a speed of 22 knots, for example. Under heavy weather conditions or to catch up to a schedule, steaming speed may be temporarily increased.

When speed is increased, fuel consumption not only increases per hour but also per mile over-the-ground. Like air resistance only more so, water resistance causes energy efficiency to decline with increasing speed. All freight vessels are displacement hulls (rather than planing hulls), which means the ship is effectively climbing a hill that gets steeper as speed goes up.

Vessel speed is also constrained by schedule, for liners. The route and itinerary of a voyage is typically designed to service each port weekly at normal steaming speeds. If the price of fuel doubles, for example, the vessel will try to steam more slowly while still maintaining its schedule. If the price of fuel stays doubled, the carrier is likely to seek ways to service the same ports with more vessels or a different schedule.

An important fuel aspect of slow speed diesels has been the ability to operate on the lower cost heavy fuel oils (HFO), which also, however, contain much higher levels of sulfur than the cleaner marine diesel oil (MDO) fuels. California Code of Regulations recently (2009) adopted the most stringent shipping environmental regulations in the world applicable to within 24 nautical miles of the California coast. The legislation

"requires the use of low sulfur marine distillate fuels in order to reduce emissions of particulate matter (PM), diesel particulate matter, nitrogen oxides and sulfur oxides from the use of auxiliary or diesel electric engines, main propulsion diesel engines, and auxiliary boilers on ocean going vessels within any of the waters subject to this regulation."

There are also indications that the international shipping industry is expected to adopt similar emissions regulations by 2015, to limit these sulfur oxide and other exhaust pollutants, including carbon dioxide.

When these stricter regulations pass worldwide, it will affect how marine engineers and naval architects design and retrofit systems and tank capacities on existing and new ships to accommodate these coastal operating constraints.

Because the efficient mix of inputs and scale of output for the producer depends upon the prices of its inputs, the efficient pricing of the firm's outputs should not alter the firm's incentives to select the cost-minimizing mix of inputs. In no sense should a BAF be seen as a payment or compensation for fuel costs. The firm produces ocean freight services, and it should do so in a way that minimizes its (and society's) costs. If the price of fuel goes up relative to other inputs, the producer should shift its input mix so as to use less of the relatively scarce input.

This might be done by slowing down (using less fuel per vessel mile but requiring more vessels to provide the same overall cargo-movement capacity), by increasing the load factor (altering schedules or offering incentives to reduce spare capacity on each vessel), by shifting routes and steaming times to minimize conflict with weather conditions, etc.

The cost function is the production function optimized for input prices. Knowing the prices or unit costs of the inputs, the least cost point on the isoquant can be calculated. A line whose slope is equal to the price ratio of the inputs gives the locus of points with a constant total expenditure. The closer the line is to the origin, the lower the total cost. Hence, a line with the slope of the price ratio and just tangent to the isoquant gives the largest output for that cost. If the price of fuel equals 2 and the price of all other inputs equals 4, then the minimum cost point on the TM = 9.0 isoquant occurs at F = 6.2 and L = 6.2; this point is labeled “Initial Price” and is where the solid line with a slope of 2/4 = 0.5 is tangent to the isoquant.

A simple (abstract) numerical example is constructed in Table 20. Initial equilibrium prices and quantities are shown in the first column, with quantities optimized for given input prices and a fixed output of 9.0 units. The price of fuel is then assumed to increase by 125%. Given the initial input quantities and fixed proportions in production (i.e., only the given mix of inputs is capable of producing the given output, or the firm is otherwise unable or unwilling to change its input mix), the increased fuel price causes total costs to increase by 42%.

Table 20. Numerical Example of Input Substitution

	Initial Price		**Fixed Proportions**		**Efficient Inputs**	
	price	quantity	price	quantity	price	quantity
F (fuel)	$ 2.00	6.2	$ 4.50	6.2	$ 4.50	3.6
L (other)	$ 4.00	6.2	$ 4.00	6.2	$ 4.00	8.2
percent change in fuel price			125%		125%	
total cost		$ 37.44		$ 53.04		$ 49.06
percent change in total cost				42%		31%
efficient cost % of fixed input cost						74%
fuel share of cost		33%		53%		33%
fuel productivity (alpha)	0.4					
other input productivity (beta)	0.8					

In order to maintain the incentive for efficient adjustment of inputs in response to changes in input prices, the BAF should not compensate carriers for the full change in fuel cost while holding the input mix constant. Although the actual production function for vessel shipping has not been fully modeled, it clearly is not one in which the proportions between fuel and other inputs is fixed. Compensation based on an (implicit) assumption of fixed input proportionality removes the incentive to optimize fuel consumption within the input mix, and overcompensates carriers.

Conceptually, the Substitution Factor is equal to one minus the percentage cost savings from re-optimizing the input mix after a change in the price of fuel. It depends on the elasticity of substitution between fuel and all other inputs, and the share of fuel in total cost. If the elasticity of substitution is zero, the substitution factor = 1.0, because no savings are possible. If the elasticity of substitution is -1.0, as in the Cobb-Douglas function, the substitution factor is around 75%. The correct value for ocean shipping probably lies between 80% and 90%.

The substitution factor is a technical factor in the sense that there is an empirical value that may not be known precisely but could in principal be measured. It may vary substantially from one ship and carrier to another, but the magnitude could be established as an industry norm.

2.7. Risk Sharing Factor

The substitution factor sets the upper bound on what constitutes full compensation for a fuel price change, but as a matter of policy it is not necessary to provide full or 100% compensation. The BAF is a mechanism for risk distribution, and how that risk is distributed is subject to negotiation and USTRANSCOM policy. If carriers are in the best position to forecast risk and take appropriate actions to minimize the impacts, then they should bear the risk directly; they will pass on the costs in their base freight rates. Alternatively, if the risk is largely out of anyone's control (or any of the relevant parties), and shippers (USTRANSCOM) can absorb the uncertainty of not knowing actual costs until the time of delivery, then shippers can bear the risk. The risk distribution factor assigns some proportion of the risk to each party.

The risk distribution factor can vary (in percentage terms) between zero (no BAF, all risk of price volatility borne by carriers) and 100% (USTRANSCOM bears the cost of price volatility, up to the efficient re-optimization of fuel consumption). The more of the risk that is borne by shippers, the lower should be the base freight rates, assuming adequate competition among carriers.

The existence of the BAF is in part a consequence of the requirement by USTRANSCOM to quote fixed freight rates up to 18 months (with options for extension) in advance of the service date. Commercial carriers normally quote rates that are good for 30 days or perhaps as long as 6 months. USTRANSCOM could reduce the need for a BAF - hence the risk distribution factor - by allowing carriers to revise their rates more frequently. While USTRANSCOM can negotiate whatever terms it finds satisfactory, removing some of the risk of price volatility over a time period for which forecasting is very uncertain is probably worth the reduction in the corresponding freight rates.

At the same time, it is probably not desirable for USTRANSCOM to bear all of the risk. In addition to erring on the side of avoiding overcompensation to carriers (carriers make money on higher fuel prices), the risk of cost increases should be shared between shipper and carrier. This preserves the incentives for each party to be efficient and to seek ways to minimize the cost of price volatility. A price increase is an adverse event whose burden can be assigned to one party, or shared.

2.7.1. Buffer Threshold and Risk Distribution

The BAF contains two components that allocate price volatility risk between the shipper and the carrier: the explicit risk distribution factor, and the threshold value used to determine whether a BAF is paid or not. The higher the risk distribution factor, the larger the share of risk that is borne by USTRANSCOM, the shipper. The higher is the threshold for the buffer zone, the more of the price risk that is borne by the carrier. These two factors can be combined as shown in Table 21.

Table 21. Interaction of Buffer Threshold and Risk Distribution Factor

	Low Risk Distribution Factor	High Risk Distribution Factor
Low Buffer Threshold	BAF is more frequently invoked, but carrier compensation is smaller in magnitude; all risk is borne proportionately but mostly by the carrier	BAF is frequently invoked and shipper bears most of the cost of risk
High Buffer Threshold	Carrier bears a large amount of basic risk, and receives only a small compensation for large price fluctuations	BAF is rarely invoked, but compensation is high when large price fluctuations occur.

The extremes are on the reverse diagonal, for which the combinations of the two factors align in the same direction. A high buffer threshold and low risk allocation factor, for example, place most of the risk on the carrier; deviations from the base fuel rate must be large before any compensation is paid, and even then the share borne by USTRANSCOM is limited. A large buffer zone combined with high share of risk assigned to the shipper places an emphasis on distinguishing what is "normal" (everyday risk typically borne by carriers, and readily mitigated) from what is "unusual" (deemed outside what carriers can reasonably be expected to absorb).

The suggested values for BAF purposes of 20% for the buffer trigger and 75% for the USTRANSCOM share of risk falls on the inner edge of the high-high box in the table. This is roughly akin to catastrophe insurance, in which most of the risk is borne by the insured, but for rare extreme events the compensation is sufficient to avoid ruin.

2.7.2. Base Price Bidding Process

USTRANSCOM base freight rates are set through a process involving the Surface Deployment and Distribution Command (SDDC) CARE program management office, ocean liners and USTRANSCOM. The establishment of new base freight rates at the start of a contract (e.g. USC-06), and for each subsequent option year, begins with the SDDC CARE program management office creating a new option year database within the CARE system. Once created, this new CARE database is made accessible to carriers who are able to enter their proposed base freight rate prices into the system. Carriers currently have a window of thirty days, or one month, during which they are allowed to enter proposed base freight rates into CARE.

At the end of the initial updating period the CARE system is locked and the proposed shipping rates examined by USTRANSCOM. During this evaluation process, base rates that are outliers or determined to be too high are identified and flagged. Once this initial evaluation, which takes around 4 weeks, is complete the CARE system is again opened to carriers. At this point the carriers, who can see which rates have been flagged as too high, have an opportunity to make adjustments to their proposed rates. This adjustment period lasts for up to two weeks after which the CARE system is again closed.

Following these adjustments, a final evaluation of the carriers revised proposed base freight rates is then performed. During this evaluation, which takes around two weeks, the proposed carrier rates are either accepted or rejected by USTRANSCOM. After this the SDDC CARE program management office will take around 30 days to run tests on the final base rate data. Once this task is complete, the new base freight rates will be made available for use by USTRANSCOM shippers via a linkage between the Integrated Booking System (IBS) and CARE.

As it currently stands, it takes approximately five months to get from the start of the bidding process through to the first shipments being made using the new base freight rate structure. Around 6 weeks is taken up with carriers entering their proposed shipping rates into the CARE system and then subsequently revising these rates. USTRANSCOM's evaluation process takes a total of six weeks: four for the first review round and two for the second. The checking of the CARE database by the SDDC CARE program management office runs for a further month-long period. Finally, there is a one month lag between the release of the new base freight rates and the first shipments being made under these rates. This is due to new rates needing to be made available to shippers a minimum of 30 days prior to the start of the new contract or option. For example, if new rates are released to shippers on April 1st, the earliest shipments could be made using these rates would be May 1st. Once a contract is in place, USTRANSCOM noted that, depending upon who the shipper is, the typical time between a shipper making a commitment to purchase shipping services and the delivery of these services is somewhere between 2 - 30 days.

USTRANSCOM has indicated that when moving from the initial year of the contract period to subsequent option years it may be possible to reduce the time taken for the initial step of this bidding process. The CARE database allows for carriers to copy over rates from one option year to the next. All rates can then be adjusted up or down using a common percentage (e.g. move all rates up by 3%). This functionality may allow carriers to be more efficient in updating option year rates and possibly allow for reducing the initial CARE base rate updating process from one month to three weeks.

2.8. 20-to-40 Foot Container Equivalence (TEUs vs. FEUs)

The container cargo BAF calculation is done on a twenty foot equivalent or TEU basis. This a standard measure for containerized ocean liner freight with one TEU referring to a twenty foot long shipping container, generally measuring 20 feet by 8 feet by 8 feet 6 inches. Along with twenty foot containers, forty foot containers are also commonly used in moving cargo. This container measures 40 feet by 8 feet by 8 feet 6 inches, which is twice the size of a twenty foot container. The volume of one forty foot container, or forty foot equivalent unit (FEU), is the equivalent of two TEU's.

Since USTRANSCOM utilizes both sizes of containers for shipments—although one of their largest shippers, the Defense Commissary Agency (DeCA) tends to use predominately forty foot containers—it is necessary to be able to convert between an FEU and a TEU for purposes of consistency when calculating a BAF.

2.8.1. Weight versus Volume

Converting between an FEU and TEU can be done using either container weight or volume. Containers will "cube out," when reaching their maximum capacity by volume. In this case a 40-foot container would then hold exactly twice as much cargo as a 20-foot container, and the appropriate conversion factor would be 2-1 (or, as a multiplier, 2.0). This relationship, however, does not hold when cargo reaches the maximum container payload weight. For example, if the approximate payload weight of a twenty foot container is 48,000 lbs and for a forty-foot container 59,000 lbs then when "weighing-out," the forty-foot container will hold approximately 23% more cargo than a twenty-foot container. This would imply a weighing-out conversion factor of 1.23-1 (or a 1.23 multiplier) based on maximum payload weight. If the maximum gross weight of the container is used (payload plus tare), then the conversion factor is 1.27.

The average of these two values is 1.25, which is the same as the 5-4 ratio used by carriers. Restrictions on the weight of cargo carried by trucks moving cargo to and from ports, however, add another aspect to the analysis. Ocean Carrier Equipment Management Association (OCEMA) guidelines recommend a 44,000 lbs maximum weight on both 20-foot and 40-foot containers, indicating that a realistic ratio for "weighing-out" containers can be as low as 1.0.

Theoretically, these two ratios establish the bounds for the conversion factor for an FEU. For example, if USTRANSCOM is shipping all relatively light goods, such as pillows, in forty-foot containers, then the cargo would cube out and the applicable network wide factor would be 2.0. In contrast, if they are shipping small but heavy items, such as steel ball bearings, then the cargo would weigh out prior to filling all available space in the forty-foot container. In this case, the conversion factor would be 1.0. Since USTRANSCOM ships a combination of light and heavy goods, a conversion factor that blends cubing out and weighing out values may be most appropriate.

2.8.2. Industry Survey

To provide some context for this container equivalence analysis, a review of conversion factors currently used by industry was performed. A survey of information from several ocean carriers and conferences revealed no consensus on a single worldwide conversion of TEU to FEU for the purposes of a BAF calculation. Carriers appear to choose either the volume-based 2-1 factor or the (roughly) weight-based 5-4 factor. Though not expressed explicitly by carriers, this latter ratio appears to be based upon a maximum container weight of 52,911 lbs for twenty-foot containers and 67,911 lbs for forty-foot containers and a payload cargo weight for a TEU of 48,000 lbs and FEU of 59,000 lbs. No carriers were found to use a factor that blends the two multipliers.

Using one convention or the other seems to be driven more by the trade than the carrier. All carrier data reviewed showed a 2-1 option on at least one trade, but not all carriers use the same conversion within trades. Trades in and out of Europe are all on a 2-1 basis. US trades across the Atlantic seem to all be 2-1, while trans-Pacific trades are all 5-4. Other trades generally not following the 2-1 conversion include South America and Australia.

Historical BAFs for the Trans-Atlantic Carrier Alliance, which disbanded after the EU's recent regulation dissolving conferences, show that the U.S. to Europe trade was also on a 2-1 under conferences. In the Pacific, the Transpacific Stabilization Agreement and Westbound Transpacific Stabilization Agreement carrier conferences continue to use the 5-4, while the non-affiliated MOL and Maersk Line use 5-4 and 2-1 respectively.

The ocean carrier American Presidential Lines (APL) uses a 5-4 ratio on trans-Pacific routes and appears to use 2-1 on all others. For its European trades CAM-CGM uses a 2-1 conversion factor, as does the Mediterranean Shipping Company (MSC). A 2-1 conversion ratio is also used by Hapag-Lloyd on European trades while a 5-4 factor is used on trans-pacific routes.

It seems that the 2-1 is the newer conversion factor. This hints that the industry is evolving in this direction, led by all EU trades adopting the 2-1 and some European carriers shifting to 2-1 worldwide. This trend may be an effort to move towards simplicity and its ability to be applied to containers larger than 40ft. Nonetheless, without understanding what went into the decision for individual carriers to select either option, it is difficult to make a recommendation based on industry practice, as there is not one standard conversion factor. What this research does show, however, is that to be consistent with industry practice, a conversion factor developed for USTRANSCOM would need to be based on either volume or weight or a blend of the two.

2.8.3. Developing a USTRANSCOM Conversion Factor

A central element of the FEU conversion factor is determining the relationship between the percent of cargo in forty-foot containers that is expected to weigh out compared with cube out. When cargo cubes out before weighing out, the relationship between a TEU and FEU is related to volume. When weighing out, the cargo has reached the weight capacity of the container before its volume has been reached.

This relationship will depend upon the type of goods being shipped and any restrictions placed upon the use of space and maximum payload weight. One of USTRANSCOMS largest shippers, The Defense Commissary Agency (DeCA), indicated that when using forty-foot dry containers they encounter cubing out when moving light snacks and weighing out with canned or bottled products. More specifically, they noted that when using dry containers their cargo tends to weigh out on somewhere around 92% of shipments. In contrast, DeCA cargo cubes out around 100% of the time when using refrigerated containers, which is in large part due to the requirement to leave space around refrigerated cargo. Furthermore, the need to ensure cargo is unharmed during shipment requires limiting the number of layers of product. As a result, only around 55% of the actual volume is utilized for cargo in refrigerated containers. In a similar way, at the request of distributors, and to protect cargo from being damaged, only around 65% of the actual volume is utilized for dry containers. Finally, to meet the weight restrictions placed on trucks traveling on the U.S. highway system, DeCA places a maximum payload weight of 40,000lb on both twenty-foot and forty-foot containers.

A review of 2008 CONUS shipping data contained in IBS database also provided some insight into the relationship between the use of twenty-foot and forty-foot dry and refrigerated containers. Consistent with the informal data from DeCA, the majority, or 64% out of the 30,571 total shipments in 2008 were made using forty-foot containers (this translates into 48,469 forty-foot containers compared with 24,105 twenty-foot containers). Also reflecting the information from DeCA, 98% of the forty-foot containers weigh 40,000 lbs or less. In the case of twenty-foot containers, 51% weigh less than 20,000 lbs and 86% less than 25,000 lbs. Even though DeCA noted that they set a 40,000 lbs weight limit on both containers sizes, it appears as if cargo in twenty-foot containers tends not to reach this maximum.

2.8.4. A Network-Wide Conversion Factor

A vessel is constrained by its space capacity, measured in TEUs. Because a 40-foot container takes up twice as much space, the cost of the larger container is twice the smaller size times the opportunity cost of the space, per TEU. The market value is reflected in the capital cost of building the ship, per TEU. From a space perspective, a 40-foot container is twice the cost of a 20-footer. Its share of the basic fuel cost to power the vessel is 2:1.

Weight, however, is also an important cost factor. Every kilo of weight, whether payload or container weight, sinks the hull of the vessel deeper in the water and requires more fuel to push the vessel forward. The operating cost of moving a vessel loaded to its waterline is much greater than moving it with ballast only. If the payload weight limit is binding on a 40-footer, then a 20-footer could have carried all or most of the cargo, and the additional cost of the larger size is less than twice the weight of the smaller unit.

It is not necessary to know precisely what these unit costs are in order to estimate the cost relationship between a 20-footer and a 40-footer. Instead, the degree to which the cargo is dependent upon volume (cube space) rather than weight (weigh out) can be used to establish the relationship.

The rules used to infer a conversion factor for an individual container are outlined in Table 16. These rules were applied to over 70,000 containers shipped by USTRANSCOM in 2008, using data extracted from IBS. The 40,000lb weight limit for both container sizes, which is consistent with DeCA practice and the guidelines suggested by OCEMA for when moving cargo on U.S highways, serves as a threshold weight.

Table 16. Assumed conversion factors for container types by actual weight

van type	actual weight under 20K lbs	actual weight over 20K but less than 40K	actual weight over 40K
refrigerated containers	2	2	2
20-foot dry container	2	1+(40K-actual weight)/20K	1
40-foot dry container	2	2	1.5

Based on the air space requirements with refrigerated cargo and DeCA experience, all refrigerated containers are assumed to cube out before weighing out. A 40-foot container therefore contains twice the weight for this type of cargo as a 20 footer.

If the actual payload for a 20’ dry container is under 20,000 lbs, then it is assumed that the cargo has cubed out. A 40’ footer containing the same stuff would weigh twice as much, or the contents of two twenty-foot containers carrying the same cargo would fit into a forty-foot container. Hence the conversion is 2.0.

Cargo in a twenty-foot container weighing 40,000 lbs or more is assumed to have weighed out. These same goods carried in a forty-foot container would also weigh out that container as well, making the weights the same and yielding a multiplier of 1.0.

Between 20,000 lbs and 40,000 lbs the multiplier would be expected to move in a linear fashion from 2.0 to 1.0 as the conversion factor moves from cubing out to weighing out. A linear interpolation is shown in the table and in the diagram in Figure 12.

Figure 12. Graphic representation of TEU/FEU conversion function.

If a forty-foot container is holding less than 40,000 lbs, it is assumed to have cubed-out before weighing out. These goods would require two twenty-foot containers to move them, and the multiplier would be 2.0.

A forty-foot container with 40,000 lbs or more of cargo may have cubed out or weighed out; without further information, either case would be equally likely, implying an average multiplier of 1.5.

The results of applying these rules to the IBS data are summarized in Table 22. Average conversion factors for each container type, using the rules in Table 16, are averaged over all containers used by USTRANSCOM, for a network-wide average of 1.86 FEUs for each TEU.

Table 22. TEU/FEU Conversion Factor

20 FT Container Average Conversion Factor	1.85
40 FT Container Average Conversion Factor	1.87
20 FT as percent of all containers	33%
40 FT as percent of all containers	67%
Combined Weighted Conversion Factor	1.86

source: estimated from IBS data (CONUS only)

2.9. All Factors Combined

Both the technical substitution factor and the policy risk sharing factor can be set for at least a year or the life of the contract, and multiplied together to give a single number. The number scales the fuel cost factor (fuel consumption per TEU times the change in fuel price) downward by some amount. Although the motivations for each component are entirely different, they are both set for a period of at least a year (unlike the fuel price change) and reduce to a single number.

2.9.1. Technical Factor Comparison Between 2009 and 2013 Volpe Studies

The key difference between the 2009 and 2013 technical factors is new method of estimating distance of a lane by mapping real-world routings based on USTRANSCOM shipments obtained from IBS. Depending, however, on the values chosen for the Input Substitution Factor and the Risk Distribution Factor, the Technical Factors may be either higher or lower than the technical factors reported in the 2009 study. As these factors will be chosen in the future by USTRANSCOM or negotiated between USTRANSCOM and the carriers, the Technical Factors displayed in this section are subject to change. The technical factors shown in this section will assume values of 0.8 for the Input Substitution Factor and 0.75 for the Risk Distribution Factor.

Results with these assumptions are shown in Table 23, Figure 13, and Figure 14. With the input and risk factors set at the above recommended levels, the new trade technical factors are, on average, 1/3 less the previous figures. The overall results for breakbulk cargo are similar to that of TEUs, with the average technical factor per measurement ton dropping by nearly 2/5, although a few routes saw an increase in the breakbulk technical factor.

Table 23. Technical Factor Comparison (0.8 for Input Substitution Factor, 0.75 for Risk Factor)

	2013 Technical Factors			2009 Tech Factors		
Lane	**TEU**	**FEU1**	**MT**	**TEU**	**FEU2**	**MT**
01	0.246	0.458	0.0113	0.410	0.762	0.0227

02	0.320	0.596	0.0159	0.525	0.977	0.0243
05	0.179	0.334	0.0078	0.281	0.523	0.0156
06	0.229	0.426	0.0118	0.315	0.586	0.0173
06A	0.193	0.358	0.0099	0.273	0.508	0.0150
06B	0.239	0.445	0.0123	0.345	0.642	0.0189
06C	0.210	0.390	0.0108	0.338	0.629	0.0185
07	0.385	0.717	0.0189	0.595	1.106	0.0297
10	0.238	0.443	0.0115	0.319	0.593	0.0221
11	0.215	0.400	0.0108	0.345	0.641	0.0176
12	0.276	0.513	0.0143	0.466	0.866	0.0239
12A	0.238	0.442	0.0123	0.420	0.781	0.0215
12B	0.280	0.521	0.0145	0.516	0.960	0.0265
12C	0.255	0.474	0.0132	0.506	0.941	0.0259
13	0.409	0.761	0.0209	0.570	1.060	0.0363
16	0.250	0.466	0.0111	0.376	0.700	0.0137
32	0.192	0.358	0.0087	0.364	0.678	0.0155
39	0.122	0.227	0.0104	0.122	0.227	0.0117
43	0.084	0.157	0.0085	0.155	0.288	0.0102
47	0.502	0.934	0.0196	0.898	1.670	0.0394
54	0.355	0.661	0.0093	0.483	0.898	0.0195
54D	0.247	0.460	0.0065	0.499	0.929	0.0201
54F	0.205	0.381	0.0053	0.438	0.815	0.0177
55	0.092	0.170	0.0097	0.205	0.382	0.0097
61	0.370	0.689	0.0169	0.163	0.304	0.0067
61MG	0.050	0.093	0.0023	0.115	0.214	0.0047
61MJ	0.106	0.197	0.0048	0.241	0.449	0.0099
61ND	0.085	0.158	0.0039	0.127	0.236	0.0052
61WL	0.117	0.217	0.0053	0.267	0.496	0.0109
61ZJ	0.064	0.120	0.0029	0.149	0.277	0.0061
79	0.275	0.512	0.0105	0.229	0.426	0.0096
79AG	0.102	0.190	0.0039	0.195	0.362	0.0081
Average	0.248	0.462	0.012	0.387	0.719	0.019

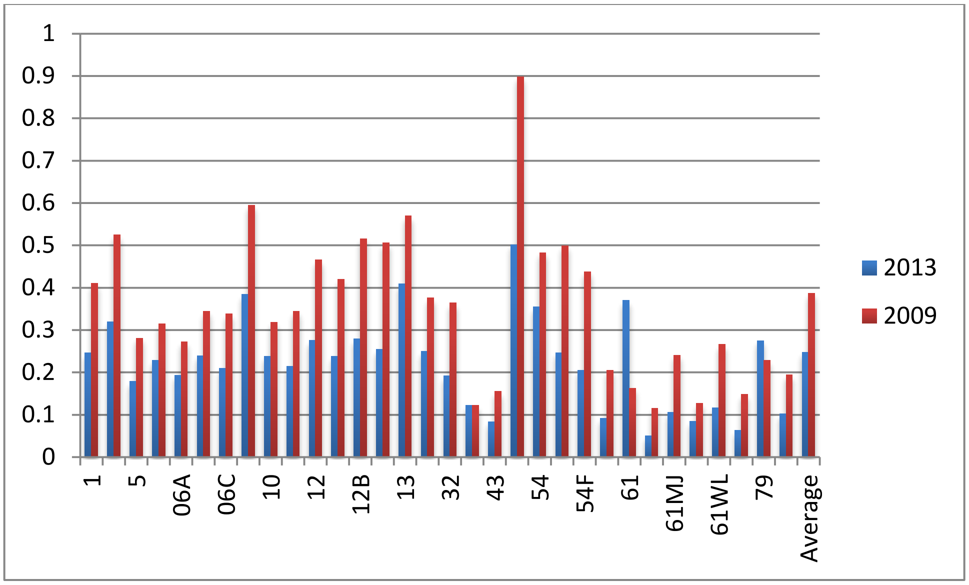


Figure 13. 2009 and 2013 Volpe TEU technical factor comparison (0.8 for Input Substitution Factor, 0.75 for Risk Factor)

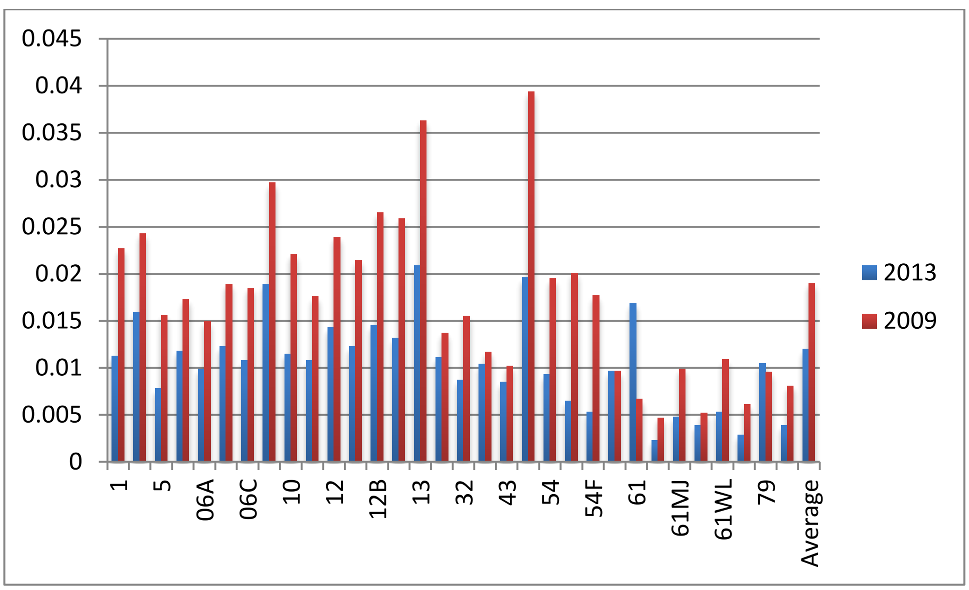


Figure 14. 2009 and 2013 Volpe Breakbulk technical factor comparison (0.8 for Input Substitution Factor, 0.75 for Risk Factor)

Using the previously described BAF calculation methodology with the recommended input (0.8) and risk (0.75) factors, Table 24 displays the final technical factors for each lane and identified route. The technical factors are reported for TEUs, FEUs, and Measurement Tons. The factors represent the amount of fuel required to move a cargo unit within a trade. In practice, this technical factor, expressed in tons, is multiplied by the price of bunker fuel outside the 20% buffer, resulting in a BAF surcharge in dollars per cargo unit.

Table 24. Final Technical Factors by Lane, Input Substitution (0.8) and Risk Sharing Factor (0.75)

Lane	Lane Description	TEU	FEU[1]	MT
01	U.S. West Coast - Far East	0.246	0.458	0.0113
02	Continental Europe, United Kingdom, Ireland - Middle East, South Asia, Indian Ocean	0.320	0.596	0.0159
03	U.S. West Coast – Hawaii	0.135	0.252	0.0054
04	Middle East, South Asia, Indian Ocean Interport	0.052	0.097	0.0025
05	U.S. East Coast - Continental Europe, United Kingdom, Ireland	0.179	0.334	0.0078
06	U.S. East Coast – Mediterranean	0.229	0.426	0.0118
07	U.S. East Coast - Middle East, South Asia, Indian Ocean	0.385	0.717	0.0189
08	U.S. East Coast - Far East	0.602	1.119	0.0302
09	U.S. East Coast – Hawaii	0.307	0.572	0.0127
10	U.S. Gulf Coast - Scandinavia, Baltic Sea	0.238	0.443	0.0115
11	U.S. Gulf Coast - Continental Europe, United Kingdom, Ireland	0.215	0.400	0.0108
12	U.S. Gulf Coast – Mediterranean	0.276	0.513	0.0143
13	U.S. Gulf Coast - Middle East, South Asia, Indian Ocean	0.409	0.761	0.0209
14	U.S. Gulf Coast - Far East	0.502	0.933	0.0301
15	U.S. Gulf Coast – Hawaii	0.287	0.534	0.0169
16	Hawaii - Far East	0.250	0.466	0.0111
17	U.S. Great Lakes - Continental Europe, United Kingdom, Ireland	0.165	0.307	0.0085
18	Caribbean Interport	0.017	0.031	0.0004
19	Far East Interport	0.135	0.251	0.0076
20	Mediterranean Interport	0.083	0.154	0.0044
21	Canada East Coast – Mediterranean	0.226	0.420	0.0087
22	Canada East Coast - Continental Europe, United Kingdom, Ireland	0.132	0.245	0.0051
23	U.S. West Coast - Continental Europe, United Kingdom, Ireland	0.389	0.724	0.0179
24	Scandinavia, Baltic Sea - Continental Europe, United Kingdom, Ireland	0.063	0.118	0.0028
25	U.S. West Coast – Mediterranean	0.354	0.659	0.0184
26	U.S. West Coast – Alaska	0.125	0.233	0.0030
27	Hawaii - Continental Europe, United Kingdom, Ireland	0.412	0.767	0.0204
28	U.S. West Coast - Central America/Mexico	0.167	0.310	0.0067
29	Alaska Interport	0.113	0.209	0.0035
30	U.S. East Coast – Greenland	0.131	0.244	0.0055
31	U.S. East Coast – Iceland	0.123	0.230	0.0057
32	U.S. East Coast - Scandinavia, Baltic Sea	0.192	0.358	0.0087
33	U.S. East Coast – Azores	0.096	0.178	0.0060
34	Continental Europe, United Kingdom, Ireland - Mediterranean	0.168	0.313	0.0081

35	(Reserved)	-	-	-
36	Mediterranean – Hawaii	0.427	0.794	0.0261
37	U.S. East Coast – Caribbean	0.075	0.139	0.0014
38	(Reserved)	-	-	-
39	U.S. East Coast - Central America/Mexico	0.122	0.227	0.0104
40	(Reserved)	0.097	0.181	0.0044
41	(Reserved)	-	-	-
42	U.S. Gulf Coast – Caribbean	0.105	0.195	0.0054
43	U.S. Gulf Coast - Central America/Mexico	0.084	0.157	0.0085
44	(Reserved)	-	-	-
45	U.S. Great Lakes - Far East	0.640	1.190	0.0247
46	U.S. Great Lakes – Mediterranean	0.303	0.563	0.0106
47	U.S. West Coast - Middle East, South Asia, Indian Ocean	0.502	0.934	0.0196
48	Continental Europe - United Kingdom, Ireland Interport	0.024	0.044	0.0010
49	Far East - Continental Europe, United Kingdom, Ireland	0.496	0.923	0.0218
50	Far East – Mediterranean	0.444	0.827	0.0246
51	Far East - Middle East, South Asia, Indian Ocean	0.312	0.580	0.0168
52	U.S. East Coast - Black Sea	0.289	0.538	0.0138
53	U.S. West Coast - South America	0.159	0.296	0.0073
54	U.S. West Coast – Oceania	0.355	0.661	0.0093
55	U.S. East Coast - South America	0.092	0.170	0.0097
56	U.S. Gulf Coast - South America	0.117	0.218	0.0107
57	Mediterranean - Middle East, South Asia, Indian Ocean	0.215	0.400	0.0113
58	Far East - South America	0.035	0.065	0.0023
59	(Reserved)	-	-	-
60	U.S. East Coast – Africa	0.305	0.566	0.0153
61	Far East – Oceania	0.370	0.689	0.0169
62	Continental Europe, United Kingdom, Ireland – Iceland	0.089	0.165	0.0029
63	Iceland – Mediterranean	0.125	0.232	0.0048
64	Continental Europe – Azores	0.076	0.142	0.0036
65	Central America/Mexico - Continental Europe, United Kingdom, Ireland	0.221	0.411	0.0096
66	Central America/Mexico – Mediterranean	0.225	0.418	0.0102
67	U.S. West Coast – Africa	0.679	1.262	0.0288
68	Central America/Mexico - South America	0.067	0.125	0.0062
69	Central America/Mexico – Oceania	0.445	0.828	0.0196
70	Azores – Mediterranean	0.118	0.219	0.0049
71	Continental Europe, United Kingdom, Ireland – Africa	0.295	0.549	0.0138
72	Continental Europe, United Kingdom, Ireland – Oceania	0.566	1.053	0.0239
73	U.S. Gulf Coast – Africa	0.309	0.575	0.0171
74	Mediterranean – Africa	0.277	0.514	0.0151
75	Africa - Middle East/Persian Gulf/Gulf of Oman	0.384	0.714	0.0202

76	Central America/Mexico Interport	0.096	0.178	0.0060
77	U.S. East Coast – Oceania	0.499	0.929	0.0193
78	U.S. Gulf Coast – Oceania	0.434	0.807	0.0230
79	Hawaii – Oceania	0.275	0.512	0.0105
80	Oceania - Middle East, South Asia, Indian Ocean	0.422	0.785	0.0216
81	Oceania Interport	0.119	0.221	0.0035
82	Alaska - Far East	0.190	0.353	0.0062
83	Alaska – Oceania	0.304	0.565	0.0096
84	Caribbean - Central America, Mexico	0.055	0.103	0.0018
85	Hawaii - Middle East, South Asia, Indian Ocean	0.566	1.054	0.0275
86	Mediterranean - Scandinavia, Baltic	0.177	0.329	0.0082
87	Far East – Scandinavia	0.414	0.770	0.0204
88	Continental Europe, United Kingdom, Ireland – Caribbean	0.165	0.308	0.0066
89	Mediterranean – Oceania	0.370	0.687	0.0160
90	Far East – Africa	0.396	0.736	0.0129
91	Alaska - Middle East, South Asia, Indian Ocean	0.429	0.798	0.0133
92	Caribbean - Middle East	0.337	0.626	0.0161
93	Far East - Central America/Mexico	0.334	0.621	0.0136
94		0.080	0.148	0.0040
95		0.188	0.351	0.0081
96		0.027	0.050	0.0012
97		0.159	0.295	0.0067
98		0.017	0.032	0.0007
99	Caribbean – Africa	0.134	0.250	0.0052
06A	U.S. East Coast - Western Mediterranean	0.193	0.358	0.0099
06B	U.S. East Coast - Eastern Mediterranean	0.239	0.445	0.0123
06C	U.S. East Coast – Adriatic	0.210	0.390	0.0108
12A	U.S. Gulf Coast - Western Mediterranean	0.238	0.442	0.0123
12B	U.S. Gulf Coast - Gulfern Mediterranean	0.280	0.521	0.0145
12C	U.S. Gulf Coast – Adriatic	0.255	0.474	0.0132
54D	U.S. West Coast – Guam	0.247	0.460	0.0065
54F	U.S. West Coast – Kwajalein	0.205	0.381	0.0053
61MG	Guam – Okinawa	0.050	0.093	0.0023
61MJ	Guam – Singapore	0.106	0.197	0.0048
61ND	Guam – Japan	0.085	0.158	0.0039
61WL	Guam – Thailand	0.117	0.217	0.0053
61ZJ	Guam - Korea (South)	0.064	0.120	0.0029
79AG	Hawaii – Kwajalein	0.102	0.190	0.0039
Average		0.248	0.462	0.012

2.10. Updating BAF Values

Data and parameters used in the calculation of the BAFs changes over time, and hence the BAFs need to be updated periodically. Some data values may change a lot in a short time, others evolve more slowly. Table 25 lists the various data and parameters that go into the BAF calculation, along with suggested time frames for updating the inputs.

Table 25. Timing for Updating Price and Technical Factors

BAF Component	Trigger for Updating	Expected Frequency	Disaggregation
Price			
Baseline Price	whenever new rates are bid or posted	up to 3 months prior to acceptance (effectively annually)	each lane or region
Current Price	when service takes place	average of prices for the service month (effectively each month)	each lane or region
ECA factors	whenever major changes occur in environmental regulations or policy constraints that affect emissions requirements	revise annually	each lane
Price Buffer	range of risk considered sharable	anytime	single BAF parameter
List of Ports for Fuel Prices	representative of geographic variations in fuel prices	when major changes in traffic volumes occur	probably 8-30 ports total
Relevant Fuel Types and Grades	currently driven by environmental regulation, primarily air pollution	whenever regulations are implemented	ECA factor by lane
Lane-to-Port Mapping	one or more selected ports determines applicable fuel prices; can be refined	whenever match does not reflect relevant prices	2-6 ports for each lane
Fuel Consumption			
Fuel Efficiency	when technology accumulates a significant gain in fuel efficiency (Triple-E: scale economies, propulsion efficiency, environmental performance)	up to 5 years	average ship by lane
Fleet Mix	when scrappage results in significant changes in performance	about 5 years	average ship by lane
Substitution	depends upon development of technology for fuel versus speed	short run (approximately 1 year)	
Lane Structure	trades that are relatively	whenever TRANSCOM	approximately 100

	homogeneous for BAF calculation	trades develop in ways not adequately summarized by lanes (not less than 5 years)	lanes worldwide
Capacity	full effective capacity of containership or roro vessel (not due to imbalance or other demand characteristics)	approximately every 5 years, or more	typical composite vessel by lane
FEU/TEU Conversion	prices quoted in most common units	FEU until displaced	single constant parameter
Speed	average speed for given fuel consumption rate (steaming days per vessel trip)	endogenous	implicit in lane fuel consumption
Broken Stowage Factor	depends upon internal vessel configuration relative to load characteristics	may evolve slowly, thus it should be monitored	roro vessels
Risk Sharing			
TRANSCOM responsibility	share of price volatility risk absorbed by TRANSCOM should decline experience	when contract is renewed, at least every 5 years	single BAF parameter
Required Time Horizon	time from base rate bidding to actual service date increases shipper responsibility	whenever time overhang is shortened or lengthened	single BAF parameter

2.10.1. Implementing the BAF

Implementation of the BAF is timed so as to match the appropriate phase of procurement of shipping services:

Calculate the base price immediately prior to the start of contract pricing going into force.
Calculate the current price each month after the contract begins.
Revise base price whenever new prices are posted.
Extract the relevant data from Bunkerworld and insert into the Volpe BAF calculator.
If the calculation shows a positive BAF, add that to the base container or measurement ton price; if the BAF calculation shows a negative, subtract that from the base cargo unit price.

Fuel costs at prices applicable to the date on which the bid or offer is received are assumed to be incorporated into the base freight rate; thus the BAF is an adjustment relative to the base fuel price. A buffer or threshold change is usually applied, to avoid calculating and imposing BAF charges for minor fluctuations in price. An example is shown in Figure 15.

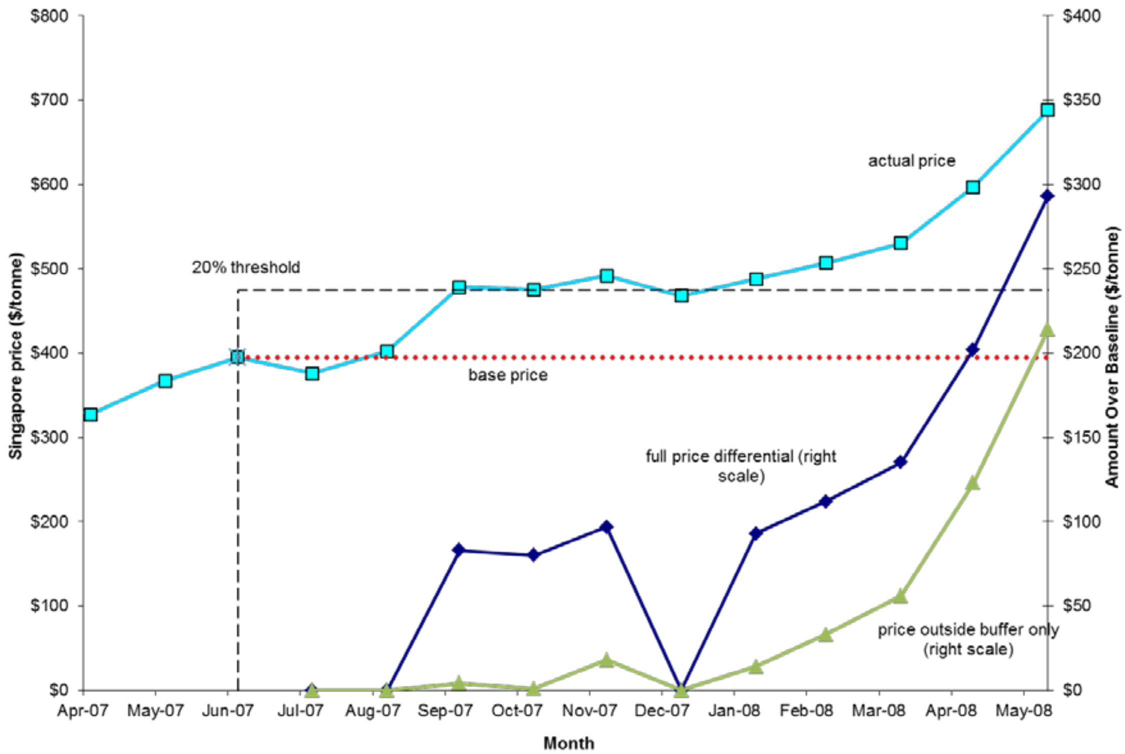


Figure 15. Fuel price differential, with threshold.

The upper line with square marks plots the actual bunker price for a series of months in Singapore when fuel prices were rising. The threshold of 20% is also plotted (higher horizontal dashed line), indicating which months are outside the buffer, triggering a (hypothetical) BAF. The base price is taken to be July 2007, although it could also be a moving average of three months. The price differential, shown as the next lower line (right scale) stays at zero for two months, then shoots up because the threshold is slightly breached. Several months later the price dips slightly below the threshold and the BAF goes to zero for one month.

When the actual price tops the upper buffer (the lower buffer is not shown), a positive BAF is calculated. If it is based on the difference between the base price (horizontal dotted line), the result is the jagged line called “full price differential” representing the difference between the actual price and the base price. This price can bounce around, as shown, between zero and the width of the buffer (about $100).

The recommended method for price volatility compensation is to calculate only the difference between the actual price and the edge of the buffer, yielding the lowest solid line with triangular markers (price outside buffer). The range of price within the buffer band is intended to be included in the base container rate.

2.10.2. Transitioning to the New USTRANSCOM BAF

The revised Volpe BAF calls for more detail in the supporting data than has been required in the past. Several stages in between the existing BAF and a new more detailed one can be handled as phases in implementation. The options below allow differing levels of specificity in the differences between lanes on fuel prices. Lane-specific ECA factors have been estimated, so under current regulations the share of steaming days that occurs within an ECA for that lane can be used to estimate the required fuel mix for each lane.

1. US Average Prices

The price option closest to the existing BAF requires filling in the current prices from the same two ports – Norfolk and Los Angeles – with the lane-specific ECA. BAFs are calculated for each lane using lanes-specific ships, distances, and ECAs but a US averages for fuel prices.

2. World Average Prices

This price option factors in regional worldwide fluctuations in fuel prices by incorporating the price from eight ports worldwide, Busan, Gibraltar, Los Angeles, Norfolk, Panama Canal, Reykjavik, Rotterdam, and Singapore. The price for the region is averaged from ports identified with the region. BAFs are calculated for each lane using lanes-specific ships, distances, and ECAs but a worldwide average for fuel prices.

3. Regional Average Fuel Prices

Because some ports offer consistently higher or lower prices than others, and not all lanes have access to the same ports, there is variation in fuel costs between lanes that is not captured in Options 1 and 2. With regional pricing, the same eight ports from the worldwide average have been selected and grouped to represent the general level of prices in the 5 broad geographic locations. Lanes have been assigned to regions that the lane may travel between or near. The price for the region is averaged from ports identified with the region. BAFs are calculated for each lane using lanes-specific ships, distances, and ECAs but a regional average for fuel prices.

2.11. References

A.P. Moller-Maersk A/S, Annual Report 2008 (English), Copenhagen, DK: Moller-Maersk (2009).

A.P. Moller-Maersk A/S, "The Maersk Line BAF Formula and Calculator", Maersk Line, Available at: http://baf.maerskline.com/Forside.aspx (Last Accessed: April 2009).

APL Lines, Inc, "Rates & Tariffs", APL, Available at: http://www.apl.com/cgi-bin/pricing/surcharge.cgi (Last Accessed: April 2009).

Cariou, Pierre, "Liner Shipping Strategies: An Overview," International. Journal of Ocean Systems Management, Intersciences Enterprises, 1:1 (2008), pp. 2-13.

Cariou, Pierre, and Francois-Charles Wolff, "An Analysis of Bunker Adjustment Factors and Freight Rates in the Europe/Far East Market (2000-2004)," Maritime Economics and Logistics, Palgrave-MacMillan, 8:2 (June, 2006), pp. 187-201.

CMA CGM, Inc., “BAF/CAF Finder”, CMA CGM, Available at: http://www.cma-cgm.com/en/eBusiness/BAFFinder/Default.aspx (Last Accessed: April 2009).

Gaffen, David, “As the Values of Their Vessels Sink, Shippers Become Anchored by Debt: Investors Mutiny as DryShips Plans Another Stock Issue,” Wall Street Journal, (January 30, 2009).

Hapag-Lloyd, Inc., “Ocean Tariff Rates and Surcharges”, Hapag-LLoyd, Available at: http://www.hapag-lloyd.com/en/tariffs/ocean_rates_and_surcharges.html (Last Accessed: April 2009).

Menachof, David A., and Gary N. Dicer, “Risk Management Methods for the Liner Shipping Industry: The case of the Bunker Adjustment Factor,” Maritime Political Management, 28:2 (2001), pp. 141-155.

Miller, John W., “Shippers Taking It Slow in Bad Times: As Volume Drops, Moeller-Maersk Scales Back on Fuel, Napkins and Canal Passages,” Wall Street Journal, (April 8, 2009).

MOL, “Surcharge Notification”, MOL, Available at: http://www.powerinmotion.biz/surcharges/index2.asp (Last Accessed: April 2009).

Nikomboriak, Deuden, “Shipping Cartels: What Can We Do about Them?,” TDRI Quarterly Review, 19:1 (March, 2004), pp. 7-16.

Notteboom, T, and Pierre. Cariou, "Fuel Surcharge Practices of Container Shipping Lines: Is it About Cost Recovery or Revenue Making?," *Proceedings*: *Proceedings of the 2009 International Association of Maritime Economists (IAME) Conference,*, Copenhagen, Denmark (June, 2009).

Regan, Gilbert J., Report of the Bunker Adjustment Factor/Currency Adjustment Factor Mediation, Washington, DC: Military Transportation Management Command (December 14, 2000).

Shaham, Vera, Methodology of Levying Bunker Surcharges, Haifa, Israel: Israel Shipping Research Institute (June, 1980).

Stoller, Gary, “Jet Fuel's Down, But Surcharges Have Stuck,” USA Today, (October 29, 2008).

Transpacific Stabilization Agreement, “TSA Bunker Fuel Charges: A Refined Approach”, TSA, Available at: http://www.tsacarriers.org/fs_bunker.html (Last Accessed: April 2009).

Varian, Hal R., Intermediate Microeconomics: A Modern Approach, 4th ed., New York, NY: W.W. Norton (1996).

Vidal, John, “True Scale of C02 Emissions From Shipping Revealed: Leaked UN Report Says Pollution Three Times Higher Than Previously Thought,” The Guardian, (February 13, 2008).

Westbound Transpacific Stabilization Agreement, “Bunker Charge Fact Sheet (New Formula)”, WTSA, Available at: http://www.wtsacarrirs.org/fs_bunker_newformula.html (Last Accessed: April 2009).

Wilson, Wesley W., and Kenneth L. Casavant, “Some Market Power Implications of the Shipping Act of 1984: A Case Study of the U.S. to Pacific Rim Transportation Markets,” Western Journal of Agricultural Economics, 16:2 (April, 1991), pp. 427-434.

Wright, Robert, “Dead Wait,” Financial Times, (December 18, 2008).

2.12. Response to Industry Feedback on Volpe Study

The following section presents the Volpe Center's response to feedback provided by industry on an initial draft of this report.

The opening three paragraphs of the "Industry" letter to TRANSCOM describe some Volpe studies and negotiations regarding the terms of the contract agreement between the Industry and TRANSCOM. Industry is claiming that the previous negotiations resolved all the interests of both parties and produced a durable framework for future contracts. This framework, the Industry asserts, is now being subverted by yet another Volpe study with a new framework.

2.12.1. Changes in the Volpe Model

Volpe was not present at the negotiations, but their result was a contract that did not conform to Volpe recommendations. In fact, the Volpe framework has not changed from the previous (2009) study commissioned by TRANSCOM, and the recommendations have not changed. The numbers have been updated, and the fuel price component has been elaborated to incorporate the need for more expensive low-sulfur fuels within ECAs, but the underlying structure is unchanged.

The change in the weighting of fuel types in the average fuel price is misstated in the first bullet point. The claim that the assumed fuel mix was changed from 50/50 IFO vs. MDO to 95% IFO is exactly the reverse in the 2013 updated model, which increases the share of expensive fuels from the 2009 model, as a result of the ECA zones. This increases the potential compensation for fuel costs.

The term "reimbursement" is inappropriate in this context, as Volpe does not pretend to know what the carriers actually spent for fuel and does not attempt to match that amount; the USC contract is not an itemized (or auditable) cost-plus structure.

2.12.2. Lower Technical Factor

The second bullet claims the technical factors have been reduced in the current update, which may be true for a number of reasons described in the report including more fuel efficient newbuilds recently brought into service (a process that will only continue as evidenced by the recent launch of the newest "Triple E" (fuel economy, environmental/emissions, scale economy) Ultra Large Container Vessels (ULCV) that can carry up to 18,000 TEU) and the replacement of the circuity factor (which likely overestimated transit time) with distances calculated by NETPAS based on actual TRANSCOM shipments.

The third bullet refers to the substitution factor, implemented in the previous USC contract and unchanged in the present model. Volpe has documented other means for conserving fuel when the price goes up besides slow steaming, such as hull cleaning, propeller design, energy monitoring, vessel trim, etc.

The fourth bullet is mistaken because there are no assumptions in the model about hedging. The statement seems to imply that the purpose of hedging is to increase profits, as opposed to reducing losses. The degree of hedging a carrier engages in is a business decision that is independent of the BAF calculation.

2.12.3. Commercial Practice

Industry claims the Volpe model does not "follow customary Commercial practices…and will fundamentally change the way ocean transportation services are priced in order to compensate for fuel costs." A normal commercial transaction (outside of this industry) would consist of an all-inclusive price that the buyer agreed to before delivery. Because the TRANSCOM contract requires the carrier's price to be available for as long as 18 months in advance of service, the buyer (TRANSCOM) has agreed to absorb the risk of fuel price volatility, which is the range of deviation of actual price from expected price. This could still be considered a "commercial" transaction, in that it transfers a specific risk to the buyer. The volatility risk can be isolated, analytically, and compensation provided if conditions warrant; otherwise, all costs including fuel are contained in the base container or measurement ton price.

The price structure that the Industry follows is NOT a "commercial" pricing structure but, rather, an arbitrary structure. There is no economic rationale for breaking the price of shipping a container into two components, either one of which, or both, may recover more than 100% of actual fuel costs. As the Industry letter later on points out, this structure is in conflict with applicable FARs. What the Industry follows is not only arbitrary, it is against regulations. Needless to say, the Volpe recommendations do constitute a fundamental change from current Industry practice.

2.12.4. Transparency and Continuity

The industry makes much of transparency and continuity. The base price is not, of course, transparent, and depends not only on spreading fixed costs over many units of output, but also on market conditions. The BAF, on the other hand, could be transparent, and is in the Volpe model: all data sources and computations are reproducible by another party, without need of proprietary information from Volpe or carriers. Industry BAFs can be calculated by potential shippers, but there is always at least one factor which cannot be verified by the shipper.

Continuity and the ability to track prices over time are nice features, but with the current Industry BAFs the numbers don't mean much and themselves are subject to unilateral change as evidenced by Maersk's two BAF changes since 2008, as well as TSA changes. With the Volpe structure, base price (all inclusive) can be monitored separately from price volatility risk, and each component can be readily interpreted. The Industry letter claims that their structure allows fuel costs to be tracked separately from other costs, but that is impossible without itemizing and auditing all costs. The Industry will only go so far as to say that fuel is "rarely" incorporated into the base container price.

2.12.5. Base Price Reset

The Industry letter then gets to the heart of the matter, namely, their objection to resetting the base price. As stated in FAR 16.203-2, the price adjustment such as in a BAF may be used when there is "…serious doubt concerning the stability of market or labor conditions that will exist during an extended period of contract performance…" (emphasis added). If the purpose of the BAF is to protect carriers against fuel price fluctuations, then the appropriate reference "during an extended period of contract performance" is the fuel price at the time the container price quotation is offered. The level of prices two, or five, or "many, many" years ago is not relevant. If, however, the purpose of the BAF is to extract more profit, then an arbitrary or fixed baseline is useful because it ensures that the BAF will always be paid (the buffer threshold is always exceeded, and always upward), and the meaning of its magnitude obscured. The arbitrariness is displayed in Maersk's new "standard" BAF, which sets the base price at zero, thereby serving to maximize the magnitude of the BAF fuel surcharge.

2.12.6. Symmetry

The issue of symmetry in the BAF – a negative payment from TRANSCOM is possible – is inherent to the nature of risk sharing: the downside to the shipper of having to pay for an adverse price trend is balanced by the possibility of a refund. As described in FAR 16.203-1, the price adjustment in question "…provides for upward and downward revision of the contract price…" and was intended to protect both the carrier and the government. If the carriers don't want to accept the possibility of a refund on their part, then they can abandon the BAF altogether and retain all the risk. Keeping the symmetry probably does not have much quantitative significance, but it restrains the carriers from using the BAF as a profit center.

2.12.7. Low Sulfur Fuel

The final point is the impact of ECAs. Volpe has taken the trouble to track three fuel types – IFO 380, low sulfur (1%) IFO 380, and MGO – by lane, so that the consequences of restrictions in each lane can be translated into a mix of fuel types for that lane, along with fuel prices at nearby ports. As new ECAs are created, the lane factors can be adjusted correspondingly, and as fuel requirements become more stringent, the cost to the carrier will be reflected in the prices going into the average fuel price formula in the BAF. Thus when the stricter 2015 sulfur levels are implemented, BAFs – if paid – will increase. It is up to the carriers to estimate trends in fuel prices for inclusion in the base cargo unit rate. Whenever new shipping prices are posted by TRANSCOM, if not more frequently, the ECA factors on affected lanes can be updated along with the fuel prices.

3. CURRENCY ADJUSTMENT FACTOR

3.1. Introduction

This report describes the process through which the USTRANSCOM Currency Adjustment Factor (CAF) was updated for use in the USC-7 contract. As part of this Economic Price Adjustment (EPA) refresh, the currency adjustment factor that was developed in 2009 has been updated with additional historical market information. This allows for the CAF refresh to reflect current market conditions for currency volatility, the proportion of port costs relative to total shipping costs, and changes in USTRANSCOM shipping patterns.

The CAF methodology used for this update remains unchanged from the one developed in the 2009 EPA study.[11] This means that the background research and technical elements that were part of the prior study have not been repeated for the refresh and are not presented as part of this report. Rather, this report details the key elements of the CAF model and the process and results of their updating. Readers interested in the technical details of the development of the CAF model should refer to the 2009 EPA study.

3.2. Currency Risk

The CAF is used as a mechanism to adjust for the volatility and risk inherent in international trade and transactions due to currency fluctuations. These fluctuations create uncertainty for the price of goods and services produced in one currency and sold in another. A depreciation of the currency in which a product or service is consumed, relative to where it is produced and invoiced, makes this good or service more expensive. Conversely, an appreciation of the currency in which the sales occur will reduce the price. Critically, though, depending upon a market actors' position, currency volatility can manifest as either a positive or negative cost.

In the case of ocean carriers, payments can be received in one currency (for USTRANSCOM contracts, payment would be in U.S. dollars), while some shipping expenses (e.g., foreign port handling charges) are paid in another currency. Between the time when a base (or contract) freight rate is set (in U.S. dollars) and payment is required for services at a foreign location, currency price fluctuations can expose an ocean carrier to financial uncertainty.

Over a long time-frame, gains and losses from currency volatility will largely tend to offset, but in the near-term, these fluctuations impose a cost on firms trading internationally. For example, to counter currency risk, firms may hold large reserves of foreign currencies, more so than if the exchange rate was fixed, to protect themselves against large fluctuations. These reserves cannot be applied to more productive purposes, representing a cost to the business.

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[11] Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts, July 2009

Key to developing the required components of a CAF is first understanding the type of exchange rate risk being faced by ocean carriers and the mechanisms available for countering this risk. While currency risk can generally be placed into three categories, it is transaction exposure that is most closely aligned with the creation of a CAF methodology.[12] This is due to the fact that ocean carriers working with USTRANSCOM face transaction risk from establishing a current dollar price as part of the base freight rate for a foreign good or service, such as port handling, that will be paid for in foreign currency at a later date.

3.2.1. Managing Exchange Rate Risk

Several techniques are available that would allow a business to manage, or hedge, exchange rate risk. Amongst these is the forward exchange market, which will allow for pre-ordering foreign currency for future delivery at a fixed exchange rate.

Currency options provide another hedging technique. An option provides a business with the opportunity to buy a foreign currency at a future point at a specified exchange rate. If at the future date the cost of the currency is above the option price, the option is exercised, otherwise the option is not used and firm buys at the current spot rate. Other hedging techniques include the currency futures market or currency swaps. These mechanisms reduce the risk to firms by setting a price in advance or setting a maximum price the firm will incur purchasing a foreign currency.

Businesses can also manage exchange rate uncertainty through non-hedging techniques. Payments can be moved forward if the foreign currency is expected to appreciate or held back if it is expected to depreciate. In addition, businesses can move exchange risk to their U.S. clients by invoicing directly in the foreign currency, or they can add a CAF surcharge to their contracts that will move exchange rate risk to their customers.

[12] Transaction Exposure arises from uncertainty around the dollar cost of foreign goods or services. For example, a company may establish a contract for future delivery of foreign goods at a set price in a foreign currency. Between the points in time when the contract is signed and the goods are received and invoiced, the price of the goods in dollars, and hence the cost to the business, may have changed due to exchange rate volatility. The other forms of risk include translation exposure and economic exposure. Translation exposure risk stems from changes in assets and liabilities denominated in a foreign currency. As currencies fluctuate, the dollar value of a company's overseas assets will change due to currency volatility, rather than from changes in the company's market position. Economic exposure risk arises from the uncertainty of the future value of revenues from foreign operations and how this may affect the valuation of the business.

3.2.2. Implications for a CAF

When considering the construction of a CAF methodology, it is important to recognize that exchange rate risk is not unidirectional. A depreciation of the dollar relative to a foreign currency expense increases the dollar denominated cost for the ocean carrier (i.e., it will require more dollars to purchase the foreign currency required for the foreign based service). Conversely, an appreciation of the dollar relative to a foreign currency expense will lower the dollar denominated cost for the ocean carrier.

3.3. Components of a CAF

As determined in the previous study, the key components of a CAF are: foreknowledge of which currencies are potentially subject to a CAF, a baseline rate against which currency fluctuations are measured, a mechanism for acknowledging the positions of carriers and shippers relative to foreign exchange markets (a buffer zone and risk sharing factor), and a technical factor that allows for isolating the amount of shipping costs invoiced in a foreign currency.

3.3.1. Eligible Currencies

Participants in a CAF may elect to subject all worldwide currencies to CAF payments or may choose to focus energy on only a subset of currencies most important to their shipping patters or risk structures. For example, if goods rarely interact with a certain currency, the costs of managing the CAF may be larger than the costs subjected to the currency risk.

3.3.2. Baseline Rate

The baseline rate is the mechanism through which the carrier sets the expected cost in the base freight rate currency for services performed in foreign countries at a later date. Volatility in the exchange rate during a contract period can then be measured against this baseline rate. The longer the base rate remains in effect the higher the risk of unpredictable exchange rate movements.

3.3.3. Risk Sharing

An equitable CAF needs to acknowledge the extent to which one of the parties may be in a more advantageous position to manage exchange rate risk. Since carriers operate in a global environment, they will have experience in dealing with foreign exchange markets. Through buying and selling currencies as part of their operations they are already well positioned to hedge against currency fluctuation using forward markets or other techniques

In contrast, USTRANSCOM are not in a comparable position from which to manage exchange rate volatility. Subsequently, they should not be expected to bear the *entire* risk of currency fluctuations. Moreover, carriers have the ability to make changes to operational practices that influence their exchange rate risk (e.g., adjusting transshipment ports, location of suppliers, timing/details of contracts, etc.), and, as a result of this advantageous position, should bear more of the risk. It should be noted, however, that the 17-month fixed price requirement is one set by USTRANSCOM and, therefore, USTRANSCOM reasonably should bear some exchange rate risk.

3.3.4. Technical Factor

The technical factor is used to ensure the CAF is applied to only those costs that are invoiced in a foreign currency and not to the entire base freight rate. This factor is derived through calculating the ratio of costs in a foreign currency for items such as port handling charges relative to the base freight rate.

3.4. Updating the CAF

The methodology used for updating the CAF EPA remains unchanged from the approach developed in the previous EPA study. As part of the refresh study, it was determined that the CAF approach developed in 2009 was still applicable for use in USTRANSCOM Universal Service Contracts (USC). In particular, the methodology captures key elements of industry approaches to designing a CAF, along with incorporating some additional unique components that were considered relevant to developing a comprehensive currency EPA.

Since the methodology remains unchanged, the main effort of the refresh focused on sourcing current data with which to calculate the CAF. These new data were then added to the existing historical information collected for the previous study, extending the sample size used for the CAF calculation.

The same data sources were used in the refresh as in the previous study. Currency data were obtained primarily from the Pacific Exchange Rate service website from 1992 through June 2012.[13] Information on the technical factor was sourced from industry financial reports and data on USTRANSCOM shipping patterns were sourced from the IBS database.

3.4.1. Choosing Eligible Currencies

As done in the previous study, the currencies to be included in the CAF were selected in a manner to find the optimal number of currencies and calculations, taking into account the cost of complexity, but also capturing the majority of USTRANSCOM's overseas shipments.

The first step in this optimizing process is isolating shipments with origin/destination (O-D) pairs that begin or end in CONUS. No OCONOUS to OCONUS shipments are included in the CAF.

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[13] Other sources of exchange rate data include: OANDA.com, Federal Reserve Bank of St. Louis, Central Bank of Oman, State Bank of Pakistan, Qatar Central Bank, Central Bank of Lithuania, and the Bank of Latvia

CONUS/OCONUS shipments represent 80% of all USTRANSCOM USC traffic. The lanes that are represented by these O-D pairs are then consolidated into nine “superlanes” that correspond roughly to the world’s continents. To simplify implementation, the CAF is applied solely to the three superlanes, which each represent more than 5% USTRANSCOM’s CONUS/OCONUS trade (together comprising 90% of the CONUS/OCONUS traffic and 75% of USC traffic). These three largest superlanes are: Eastern Asia, Western Indian Ocean and Europe/ Mediterranean/Iceland/Greenland.

Table 26: Trade Weighted Superlanes

Superlane Name	**% of**
Eastern Asia	11%
Oceana	0%
Western Indian Ocean (inc. Persian Gulf)	71%
Africa (except Mediterranean Cost)	1%
Caribbean (NOT inc. Guantanamo)	1%
Central America	1%
Europe/Mediterranean/Iceland/Greenland	12%
South America	0%
Black Sea	2%

The next step is identifying the relative importance of each of the currencies within the three CAF superlanes. For this purpose, currencies are grouped by superlane and trade weighted by recent (post 2009) USTRANSCOM shipping patterns. Only currencies that are weighted at 1% or higher are retained. The selected currencies and their respective weights are shown in Table 27.[14] Currency volatility captured within these superlanes accounts for 99% of the trade within the superlanes.

[14] In the Eastern Asia superlane, the 4 currencies retained cover 98% of shipments across 16 overall currencies in that superlane. In the Western Indian Ocean superlane, the 8 currencies retained cover 99% of shipments across 22 overall currencies. In the Europe/Mediterranean/Iceland/Greenland superlane, the 7 currencies retained cover 98% of shipments across the 27 overall currencies.

Table 27: Superlane Currencies

Superlane Name	% of Trade	Currency	Currency Name	Weight
Eastern Asia	**10.89%**	JPY	Japanese yen	54%
		KRW	Korean won	40%
		PHP	Philippine peso	1%
		SGD	Singapore dollar	5%
Western Indian Ocean (inc. Persian Gulf)	**71.02%**	AED	United Arab Emirates dirham	7%
		BHD	Bahraini dinar	2%
		IQD	Iraqi dinar	7%
		JOD	Jordanian dinar	5%
		KWD	Kuwaiti dinar	46%
		OMR	Omani rial	5%
		PKR	Pakistani rupee	26%
		QAR	Qatari rial	2%
Europe/Mediterranean/Iceland/Greenland	**12.20%**	EUR	Euro	63%
		GBP	Pound sterling	4%
		ILS	Israeli new shekel	1%
		LTL	Lithuanian litas	4%
		LVL	Latvian lats	17%
		NOK	Norwegian krone	1%
		TRY	Turkish lira	10%

Changes in USTRANSCOM trading patterns since 2009 resulted in some changes to the superlane currencies. In particular, the Egyptian pound and Polish zloty have fallen out of the European superlane, while the currencies of Lithuania and Latvia have been added. In the

Eastern Asia superlane the Philippine peso has been added. The Iraqi dinar and Omani rial have been added to, and the Djibouti franc removed from, the Western Indian Ocean superlane.

3.4.2. Establishing the Currency Baseline

Volatility around the baseline is at the center of the CAF calculation, and as a result, setting the currency baseline is an important consideration in developing the CAF. Indeed, USTRANSCOM sets base rates and baselines on a yearly basis, and these may remain in place for up to 17 months (through the biding and contract period).

Consistent with the previous study the recommendation is to calculate the baseline rate as the average exchange rate from the month prior to the start of the bidding.

3.4.3. Risk Sharing

Risk sharing in the CAF needs to be consistent with the process by which the contracting period and base rate for USTRANSCOM are set. This is important as the period during which the base rate remains in force will influence how a carrier will view and hedge against the potential level of exchange rate volatility.

At one extreme, a risk-averse carrier could essentially purchase currency at the baseline price to cover the expected future foreign currency expense, eliminating all currency risk. On the other hand, a less risk-averse carrier would determine the expected or normal deviation of the exchange rate during the contracting period and hedge accordingly. The risk share will therefore need to describe the transaction risk associated with the contracting period and have a proxy for the baseline to reflect how carriers will observe the foreign exchange market.

Risk sharing within the USC CAF comes from two methods, the use of a buffer zone around the baseline price, and a risk sharing factor.

3.4.4. Setting the Buffer

The buffer zone reflects the normal deviations, as observed historically, in the exchange rate around a baseline. It is expected that carriers engaging in normal business operations can identify and hedge (at their discretion) against the risk from typical (as observed historically) currency fluctuations. As such, a CAF would not apply inside the buffer zone. Outside this zone, where currency volatility and risk becomes more atypical and harder to effectively hedge against, the burden of risk can then be apportioned across both carrier and shipper through the application of a CAF with a risk-sharing factor.

Recognizing that currency risk is symmetrical, the buffer zone has an upper and lower bound around the baseline. The inclusion of a symmetrical buffer zone is consistent with FAR and DFAR regulations for the application of EPAs.[15]

3.4.5. Measuring Currency Volatility

Defining how to measure currency volatility is an important step in developing a CAF. The various methods through which this can be done were explored at length in the 2009 CAF report. For the purposes of this refresh, however, the methodology for measuring currency volatility, the coefficient of variation, will remain unchanged from the one developed in the previous study.

This CAF approach to measuring currency volatility was carefully constructed to take into account the nature of the USTRANSCOM contracting process. It reflects the fact that a baseline currency rate is set prior to the implementation of the actual carrier base rates, which is the level from which changes in currency rates are measured. This baseline currency rate can remain in place for up to 17 months at the start of each the contract or extension.[16] A monthly frequency was chosen to align the CAF data with the frequency of currency data used to determine movements in the exchange rate.

The mean exchange rate over a 17-month period is used as a proxy for the baseline so that analysis of the buffer zone is not dependent on a particular method for setting the baseline. The standard deviation for each of these periods represents the typical deviation around the mean and provides the bounds for setting the CAF buffer zone. These two measurements are then formulaically converted into a measure of volatility that is can be expressed in common terms across all currencies.

This exchange rate volatility measure remains unchanged for the CAF refresh, though the calculations have been updated with additional data since 2009. Exchange rate volatility is calculated as coefficient of variation, (the standard deviation divided by that mean) value over 17 months. This measure is calculated for sequential 17-month periods beginning in September 1992 and running through June 2012. This provides 14 discrete observations of the expected value of the currency and associated volatility.

A single volatility measure for each of the selected currencies was computed through selecting the 80th percentile value standard deviation from the 14 observations. Selecting the 80th percentile captures 80% of the observed values in the volatility measure. Values above the 80th

[15] Federal Acquisition Regulations and Defense Federal Acquisition Regulations

[16] In each case, bids are taken in month -6 then the contract starts in month 1 and extends through month 12. Months 7-12 then overlap with months -6 to 1 in the next contract.

percentile are considered the out-of-the-ordinary events for which the concept of the CAF was created, and when it should be applied.

3.4.6. Currency Buffer Zone Analysis

Using the methodology described above, volatility measures and buffer zones were calculated for each of the selected currencies. Table 28 below shows the 80th percentile level of 17-month currency fluctuations between September 1992 and June 2012. In general, the extent of currency volatility is less than 10%, with the exception of the Iraqi dinar (which experienced significant volatility in the early-to-mid 2000s) and the Turkish lira. The global median volatility measure is 5.32%,[17] which is below the 6.02% value calculated in the previous study.

Table 28: Expected Currency Volatility

Currency		Expected Volatility
AED	**UAE Dirham**	0.06%
BHD	**Bahraini Dinar**	0.07%
EUR	**European Euro**	5.96%
GBP	**British Pound Sterling**	4.00%
ILS	**Israeli New Shekel**	5.32%
IQD	**Iraqi Dinar**	35.18%
JPY	**Japanese Yen**	6.10%
JOD	**Jordanian Dinar**	0.30%
KRW	**Korean Won**	6.09%
KWD	**Kuwaiti Dinar**	1.15%
LTL	**Lithuanian Litas**	5.36%
LVL	**Latvian Lats**	4.92%
NOK	**Norwegian Krone**	6.06%
OMR	**Omani Rial**	0.00%
PKR	**Pakistani Rupee**	6.01%
PHP	**Philippine Peso**	5.39%

[17] This median refers only to the 19 currencies included in this analysis.

Currency		Expected Volatility
QAR	**Qatari Rial**	0.03%
SGD	**Singapore Dollar**	3.55%
TRY	**Turkish Lira**	20.99%
	Global Median	5.32%

To calculate a superlane buffer, the individual currencies listed above are weighted by the superlane weights presented in Table 27. Through this process, we are able to calculate a single trade-weighted buffer for each superlane, subject to the additional constraints described in Section 3.4.3.1.3; these values are presented in Table 29. The updated buffers are smaller than those calculated in the previous study.

Table 29: Superlane Buffers

Superlane Name	2013	2009
Eastern Asia	5.950%	9.480%
Western Indian Ocean (inc. Persian Gulf)	*5.323%*	*6.020%*
Europe/Mediterranean/Iceland/Greenland	7.158%	8.190%
Global Median	5.323%	6.020%

3.4.7. Addressing Dominant Exchange Rates

The creation of the buffer zone is done on a trade-weight basis. While this methodology is robust to USTRANSCOM’s trade patterns and currency volatility, it doesn’t capture instances whereby a single currency can skew the size of a superlane buffer zone. This could happen in cases where the majority of trade in a superlane goes to a country with a comparatively stable (or even a fixed) exchange rate. In this case the buffer zone would be overly narrow and not reflect the higher variation in the other currencies. To avoid rendering the CAF irrelevant in these circumstances, a second constraint to the buffer size is applied. This additional constraint requires that the buffer for the superlane must also be greater than the median buffer size of the 19 individual currencies. Thus, the rule for choosing buffer size shall be the greater of either the weighted buffer by superlane or the median value across all 19 currencies.

In the case of the updated superlane buffers, the global median is applied to the Western Indian Ocean superlane (the same adjustment was made in the 2009 buffers), and is noted in *italics* in Table 29.

3.4.8. Risk Sharing Factor

A risk sharing factor is included in the updated CAF. This is because, like the BAF and FAF, the CAF is a mechanism for risk distribution, and as such, it should reflect the relative market position of the USTRANSCOM and ocean carriers. Carriers are in a relatively stronger position from which to manage exchange rate risk through the use of currency hedging tools. If this position allows carriers to still manage some of the exchange rate risk, even outside of the CAF buffer zone, then they should bear a larger proportion of risk. On the other hand, if this risk is largely deemed to be outside the control of any one party, then USTRANSCOM can bear more of this risk. The risk sharing factor will assign some portion of the risk to each party. How this risk will be distributed is subject to negotiation and USTRANSCOM policy. The factor itself can vary between 100%, under which USTRANSCOM shoulders the entire risk from currency fluctuations outside of the buffer zone, and 0% placing the entire currency risk onto the carriers.

3.4.9. Technical Factor

The final component of a currency adjustment factor is a technical factor allocating the level of costs in the base freight rate requiring payment in foreign exchange. Typically this relates to the services paid for at foreign ports where cargo is loaded or unloaded. Specific industry information on this topic was hard to obtain, but from the prior study, anecdotal information suggested that somewhere around 5% of shipping costs are in a foreign currency (Hapag-Lloyd) or around 10-15% (Maersk) of costs are for port or short inland movements of goods invoiced in a foreign currency.

The methodology for determining the extent of shipping expenses invoiced in foreign currency is the same as used in the 2009 EPA study. This approach requires first estimating the composition of all shipping costs incurred by carriers, including direct voyage costs (e.g., bunker fuel and port handling charges), capital costs (i.e., vessel financing), administrative costs, and an allocation for profit. It is assumed that these costs, and their relative ratios, will be reflected in base freight rate offers made for moving USTRANSCOM freight.

These four categories form the basis of the foreign expense factor in the current study. The relative shares for each of these categories of these values were determined primarily through shipping company financial reports/presentations and academic literature. Information was gathered from the most recent financial reports from Maersk (2011 data), NYK Line (2012), and China Cosco (2012). In addition, information obtained from American Shipper Magazine and an academic study on shipping costs from the previous study was retained in the calculation of foreign currency costs.

As before, an average shipping cost structure was calculated with profits set at 0%, 5% and 10% (profit data on these specific shipping costs was not part of the financial information reviewed). After adding the profits measure, the data was adjusted to ensure the percentages added to 100. The updated cost structure data is presented in Table 30 below

Table 30: Technical Factor Cost Structure

Carrier Cost Structure	Scenario 1	Scenario 2	Scenario 3
Direct Voyage Cost	67%	64%	61%
Capital Expenses	24%	23%	22%
Administrative Costs	8%	8%	8%
Profit	0%	5%	10%

Terminal costs are estimated to be around 21% of direct voyage costs (which is the same percentage as in the 2009 study). Applying this value to direct voyage costs provides an indication of the percent of costs incurred at ports. From this calculation a port cost factor of 14% is obtained, which is unchanged from the value calculated in the 2009 study. Under the assumption that carriers moving USTRANSCOM freight incur approximately equal costs at both CONUS and OCONUS ports, the port cost factor is divided in half, giving a final CAF technical factor value of 7%.

3.5. Conclusions and Recommendations

This report presents the details of the updated USTRANSCOM CAF factor. An important factor in this update is that the methodology remains unchanged from the approach developed in the 2009 CAF report. As such, the calculation of each of the data driven elements of the CAF, superlanes, currencies, trade weights, buffer zone and technical factor was done in the same manner as in the previous study. The key difference was that additional historical information was included in the models for the update. These additional data increased the sample size from which the various elements of the CAF were calculated and extended the period of observation beyond the recessionary period of 2008-09.

A symmetrical buffer zone remains in place for the updated CAF. This is an important component of the CAF as it is an acknowledgment that it is designed to compensate for unexpected changes in exchange rates that are equally likely to favor either USTRANSCOM or the ocean carriers. The buffer zone function is to protect USTRANSCOM from the risk of typical exchange rate volatility, which carriers, who trade in foreign currency markets, are positioned to counter through hedging techniques if they chose. Importantly, this characteristic of the CAF is consistent with the FAR and DFAR regulations.

Within the buffer zone there is no CAF payable by either party. Outside of the buffer zone the CAF comes into force and a payment is due to one of the parties based on the direction of movement in the currency.

The CAF EPA is broken into three superlanes, which represent more than 90% of USTRANSCOM's CONUS/OCONUS shipments. Aggregating the CAF into these three superlanes keeps the administration of the CAF manageable, while at the same time capturing almost all of USTRANSCOM trade flows.

There are 19 currencies that make up the volatility measure within the three superlanes. These currencies were selected based on how important they were in terms of USTRANSCOM shipping patterns (they must represent more than 1% of the trade in a superlane). Limiting the number of currencies in this fashion reduces the complexity of the final model, while still representing the key USTRANSCOM shipping lanes.

As is the current practice, the baseline remains in force for a period of up to 17 months; this time period was the basis for the currency volatility calculations used to establish the buffer zone. As with the previous CAF, the global median buffer is used on the Western Indian Ocean superlane.

The CAF technical factor remains at 7%.

The monthly currency rate is set as the monthly average rate from two months previously (as is the current practice). To be consistent the baseline rate should be set as a monthly average.

All of these elements are combined into the CAF equation as: CAF =

*(Current Monthly Average Exchange Rate/Base Exchange Rate)-1 * Technical Factor * Risk Sharing Factor*

The CAF will be applied to the 19 major trading currencies being tracked. For example, in the case of the Eastern Asia superlane, if the change in the current monthly average exchange rate relative to the baseline is more than 5.95% higher or lower, then the CAF will be put in place. The exchange rate ratio will be multiplied by the technical factor of 7% and a risk sharing factor. The CAF ratio is then multiplied against the base freight rate to determine the dollar adjustment level.

3.6. References

Biernbaum, Lee, et al., *Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts,* prepared for U.S. DOD/USTRANSCOM, U.S. DOT/Volpe Center, July 2009.

Biernbaum, Lee, et al., *Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts, Addendum to July 2009 Final Report,* prepared for U.S. DOD/USTRANSCOM, U.S. DOT/Volpe Center, September 2009.

4. INLAND INTERMODAL FUEL ADJUSTMENT FACTOR (FAF)

4.1. Introduction

This section of the Economic Price Adjustment study considers the development and use of inland transportation fuel surcharges or a fuel adjustment factor (FAF) for the movement of USTRANSCOM freight. The FAF is similar in concept to the BAF in that its purpose is to protect ocean carriers from the risk of fluctuating fuel prices but is focused on the inland portion of container movements. It was initially developed by overland common carriers (specifically US trucking companies) to pass fuel price volatility along to shippers. USTRANSCOM did not have a FAF provision in place until USC-06.

It should be noted that the term "FAF" or "fuel adjustment factor" is not widely used in the carrier industry. The term "fuel surcharge" is more commonly used in the trucking and rail industries, while the term "inland fuel charge" is used in the ocean carrier industry. The ocean carrier industry uses the terms "BAF" and "FAF" interchangeably in reference to fuel charges associated with the ship itself. "FAF" and "fuel adjustment factor" are commonly used by electric utilities. For the purposes of this study, the term FAF will be used to refer to an economic price adjustment factor applied to the inland portion of USTRANSCOM shipments.

The objective of Volpe's prior study was to determine if a FAF is necessary and feasible for inland transportation services (rail, truck, and barge) associated with ocean liner services supplied to USTRANSCOM. Once deemed necessary and feasible, then the focus was on developing CONUS FAFs together with supporting technical factors to manage the consequences of significant and unexpected fluctuations in fuel prices applicable to inland transportation. The resulting FAFs were to comply with the EPA provisions of the FAR and DFAR regulations. In addition, the methodology employed to calculate the FAFs and technical factors were to be consistent with standard commercial practices and not present significant barriers to the efficient administration of USC-06.

This task was accomplished by conducting a review of trucking, rail, and ocean carrier industry practice related to fuel surcharges; conducting a review of the technical factors related to the fuel consumption associated with the truck and rail movement of containers and the choice of which mode to use in shipping containers to and from ports; identifying readily available sources of historical and current fuel price data; and attempting to characterize current USC shipping patterns in terms of origins and destinations, mode used for the inland move, traffic volumes, and landside distances.

Recommendations for developing the current FAF methodology were presented along with details upon which this recommendation was made, including alternatives considered. That material and the details of the review of trucking, rail, and ocean carrier industry practice related to fuel surcharges is not reproduced here and the interested reader is referred to the prior Volpe report and addenda.[18]

This current report presents the results of an update or "refresh" of the FAF methodology developed by Volpe in its prior study for USTRANSCOM. The focus of the current effort was on updating the data inputs used in calculating the FAF and not on developing a different approach to calculating a FAF.

A literature review was conducted in an attempt to determine if there were any significant changes in reported fuel economy for trucks and intermodal rail since the date of the last Volpe study, i.e. 2009. In addition, the recent literature was reviewed in order to determine if there were any documented changes in the distance at which intermodal rail would be considered the preferred alternative to truck. The result of these efforts was that we were unable to identify any significant changes that would warrant changing these input assumptions in the FAF calculator.

The average intra and inter zonal haul distances used in computing the FAF for the various shipment types were recomputed using the USTRANCOM IBS data on inland destination/origin to/from CONUS ports for 2012. The average dray distance for the inland leg of rail intermodal trips was also recomputed based on the latest IBS data. There were significant changes in many of these inputs to the FAF calculator.

The remainder of this chapter presents a review of the overall approach of the FAF methodology and the sources of input values used in the prior version of the FAF as well as the updated values based on the literature review and Volpe's analysis of the 2012 IBS data.

4.2. FAF Methodology Development

Based on an examination of FAF industry practice and the availability of required data, it is recommended that USTRANSCOM utilize a fuel surcharge (FAF) methodology for the CONUS portion of shipments based on a "distance" approach rather than a "rate" approach.[19] The surcharge would be on a per container basis, in line with current ocean carrier industry practice.

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[18] Biernbaum, Lee, et al., *Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts,* prepared for U.S. DOD/USTRANSCOM, U.S. DOT/Volpe Center, July 2009.

. Biernbaum, Lee, et al., *Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts, Addendum to July 2009 Final Report,* prepared for U.S. DOD/USTRANSCOM, U.S. DOT/Volpe Center, September 2009.

[19] Surcharges based on "distance" are generally expressed as a cost/mile charge increase due to a given fuel price. Surcharges based on a "rate" are generally expressed as a % increase in a base rate as a function of fuel price.

The proposed methodology has the advantages of transparency, credibility and equity (carriers will be fairly compensated for increased fuel costs, but will not be awarded windfall profits). Moreover it requires less input data and arbitrary assumptions. In contrast, a rate based approach presumes knowledge of the carrier's cost structure, specifically fuel costs as a percentage of total costs at the time the base rate was offered and at the current time. The following sections detail the steps through which a FAF methodology was developed.

4.2.1. FAF Inputs

A number of factors and inputs are required for developing the recommended FAF specification:

- Determination of the base period for fuel prices
- Identification of a source of historical and current fuel price data readily available to all parties
- Determination of fuel consumption factors for those modes used in inland transportation
- Determination of the mode most likely to be used for shipments
- Consideration of the alternative approaches to calculating the FAF used by the carrier industries and current SDDC FAFs
- Characterization of historical USC shipping patterns in terms of origins, destinations, traffic volumes, and landside distances
- Definition of various implementation details such as update frequency, the time period used in defining the current fuel price, the use of a "buffer zone", etc.

Each of these factors, and the assumptions made regarding their use in the current approach are discussed in more detail below. This is followed by draft version of the internet site that could be used to present the FAF to the carrier and shipper communities. The model used to produce the FAF tables is included in the Appendix.

4.2.2. Base Period for Fuel Pricing

The FAF fuel price baseline will be established using the same method as done for the BAF. This is currently set as the average for the four month solicitation period for USC-07 (Dec 11 – Marl 12)[20]. Going forward this would be changed to the solicitation period for the USC-07 extension option, if it were decided to implement the proposed FAF under that option. The baseline fuel price would be obtained from the U.S. National Average Diesel Fuel Index published by the

[20] USTRANSCOM/TCAQ-I, Request for Proposal (RFP) #: HTC711-11-R-W004, Universal Services Contract (USC)-7, Scott AFB, IL, 29 Nov 11.

Energy Information Administration of the U.S. Department of Energy[21]. Historical data is available and would be used to establish a fuel price for use as the baseline in FAF computations. Once set, this baseline would apply for the life of the contract.

4.2.3. Fuel Price Data

The Energy Information Administration of the U.S. Department of Energy publishes the U.S. National Average Diesel Fuel Index every Monday, excluding holidays. This is available at their internet site referenced above. This will serve as the source of the "current" fuel price data needed for the monthly updates of the FAF.

4.2.4. Truck Fuel Consumption Factors

A technical factor of six miles per gallon (mpg) was used to estimate truck fuel consumption for a typical USTRANSCOM container inland move. This value accounts for travel over a variety of highway conditions and distances and accounts for idling time. It is also based on a fairly recent sample of truck technology, and actual operating fleets. This could be modified if it turns out that USTRANSCON shipments are especially atypical in terms of average weight. Otherwise the mpg figure may be considered "conservative" since it appears to be based on Gross Vehicle Weight's near the maximum. (See Table 31 below for details on truck fuel consumption data sources.)

The Gross Vehicle Weight (GVW) is the combined weight of the container, cargo, chassis and tractor. In the absence of an over-weight permit, the GVW within CONUS is limited to 80,000 lbs. For 40' and 45' containers the applicable GVW is 80000 lbs. and for a 20' it is 68000 lbs. These limits would also apply to movements by rail since almost all rail movements would involve a truck move on either or both ends of the trip. Larger containers have a maximum allowable cargo weight in the range of 40,500 to 43,500 lbs., while smaller containers have a maximum allowable cargo weight in the range of 36,000 to 39,000 lbs.

Analysis of the IBS data for container movements originating or terminating in CONUS in 2012 indicated that 60% of containers were 40 ft. or larger, while 40% were 20 ft. The average cargo weight of the large containers was 25,800 lbs., and that of the smaller containers was 14,400 lbs.

The mpg figure can be transformed to gallons/mile for computational purposes by taking the reciprocal. This results in a value of 0.1667 gallons/mile. Since each truck transports one

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[21]Weekly Retail Gasoline and Diesel Prices , U.S. Energy Information Administration, (Available at: http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm)

container (of any size), the fuel used in moving one container by truck would be equal to miles times 0.1667gallons/mile.

As part of the FAF update an attempt was made to identify data on truck fuel consumption that might have become available since Volpe's last report to USTRANSCOM. A review of the literature surfaced a number of studies that had data of the same vintage as those referenced in the prior study and a few that incorporated more recent data. Some of these more recent references have been added to Table 31.

While the long term trend is toward more efficient trucks and higher mpg the available evidence does not justify changing our assumed factor at the present time.

Table 31: Truck Factors

MPG	Source	Date	Data TYPE	Weight	Speed
6.5	1	2009	-	80,000 lbs	-
6.5	2	July 2008	Calculated	80,000 lbs	65
6.5	3	April 2008	-	-	-
5.8	4	-	Reported average for 300 trucks	-	-
6.7	5	2006	On-board instrumentation	30,000 – 80,000lbs	29 Average-includes idling time
6.6 (6.0 with idling)	6	-	-	80,000lbs	65
6.03 – 6.48	7	August 2011	Reported fleet averages	-	-
4-7.5	8	2010	compilation	-	-
6.5 (6.2 with idling)	9	2010	Electronic Control Module data	-	35 Average-includes idling time
4.8	10	2009	-	80,000lbs	30-65
5.5-6.5	11	2013	"industry average"	65,000lbs	-
6.0	12	2013	"industry average"	-	-

Sources for table:

1- *Technologies and Policies for Improving Truck Fuel Efficiency & Reducing CO2,* presentation by Anthony Grezler, Vice President Advanced Engineering, Volvo Powertrain Corporation, July 30, 2009. (Available at: http://www.its.ucdavis.edu/files/asilomar/pdf/2012-08-23_2009-Asilomar-Technologies-and-Policies-for-Improving-Truck-Fuel-Greszler.pdf)

2-Ogburn, Michael, et al., Transformational Trucks: Determining the Energy Efficiency of a Class-8 Tractor-Trailer, Rocky Mountain Institute, (2008). . (Available at: http://www.rmi.org/cms/Download.aspx?id=6669&file=T08-1_RMIT

3-Maltz, Arnold, *Promoting Green Supply Chains in North America*, April 22, 2008. (Available at: http://nacts old.asu.edu/files/GTC/Promoting%20Green%20Supply%20Chains%20in%20North%20America.ppt)

4-Banks, Sharon, *Greening the Fleet, Cleaner Air, Lower Carbon, and a Better Economy*. (Available at: http://www.discovery.org/scripts/viewDB/filesDB-download.php?command=download&id=2911)

5-Capps, Gary, et al.,. *Class-8 Heavy Truck Duty Cycle Project Final Report*, ORNL/TM-2008/122, Oak Ridge National Laboratory, (2008). (Available at: http://cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2008-122.pdf)

6-*Improving Efficiency of Freight Movement with EPA's Smartway Transport Partnership*. (Available at: http://www.trbav030.org/pdf2006/136_S_Rudinski.pdf)

7-*Freight Surcharge Index*, The National Transportation Institute, Volume 4, Issue 32, August 24, 2011. (Available at: http://www.energyinstitution.org/files/fsisample.pdf)

8-Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles Committee to Assess Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles; National Research Council; Transportation Research Board (2010). (Available at: Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles)

9-Boriboonsomsin, Kanok, et al., *Analysis of Heavy-Duty Diesel Truck Activity and Fuel Economy Based on Electronic Control Module Data,* Transportation Research Record No. 2191, Transportation Research Board, (2010). (Available at: http://trb.metapress.com/content/h7867j2163711638/fulltext.pdf)

10-Reducing Heavy-Duty Long Haul Combination Truck Fuel Consumption and CO2 Emissions, Northeast States Center for a Clean Air Future, International Council on Clean Transportation, Southwest Research Institute, TIAX, LLC, (2009). (Available at: http://www.nescaum.org/documents/heavy-duty-truck-ghg_report_final-200910.pdf)

11-Richard, Michael Graham," Supertruck" Has 54% Better Fuel Economy Than the Average Long Haul Truck, Global Possibilities, (2013). (Available at: 'SuperTruck' has 54% better fuel economy than the average long-haul truck | "Global Possibilities")

12-Making Semi-Trucks More Efficient, The Truckers Report, (2013). (Available at: Making Semi-Trucks More Efficient)

4.2.5. RoRo Shipments

RoRo shipments are not explicitly identified in the IBS data. It was therefore assumed that RoRo shipments are termed break bulk in IBS. According to the experience of the carriers, almost all RoRo moves are made by truck regardless of distance traveled.

Two FAFs applicable to break bulk shipments were also developed. They are generally the same as the FAF for container shipments in approach and application and differ only in the underlying technical factors.

Analysis of 2012 IBS data indicated that 75% (34,282) of USTRANSCOM shipments with either an origin or destination in CONUS were in containers and the remaining 25% (11,434) of shipments were break bulk. Of the break bulk shipments 65% (7,429) were made up of shipments weighing less than 50,000 lbs. The other 35% (4,005) of break bulk shipments were made up of shipments weighing more than 50,000 lbs. This distinction is important in that the lighter shipment units could be handled by regular truck services, while the heavy shipment units would have to be moved by specialized heavy-hauler trucks operating under oversize/overweight permits.

Two FAFs were developed for break bulk shipments based on the FAF developed for container shipments. The differences among the values of the FAFs for each type of shipment are due to differences in the average haul (as determined from analysis of the IBS data) and in some cases differences in the modal fuel consumption factors.

The fuel factor for break bulk shipments of shipment units of less than 50,000lbs is the same as that used for containers moving by truck. The maximum truck payload under a gross vehicle weight limit of 80,000 lbs. would be about 50,000 lbs. for a conventional van or flatbed trailer. To all intents and purposes the fuel consumption of a conventional tractor trailer operating at or near the 80,000 lb. limit and a tractor hauling a container/chassis operating at or near the weight limit would be the same.

For shipments involving shipment units in excess of 50,000 lbs. specialized heavy hauler equipment would have to be utilized and oversize/overweight permits would be required. For these shipments a truck fuel factor of 0.2192 gallons per mile (4.5 miles per gallon) was used.[22]

[22] David Knapton, "An Investigation of Truck Size and Weight Limits Technical Supplement Vol. 3, Truck and Rail Fuel Effects of Truck Size and Weight Limits", Report DOT-TSC-OST-81-2, prepared for the Office

This is based on the movement of a platform trailer hauling a load of 67,300 lbs., the average weight/shipment unit of "heavy" shipment units as indicated in the IBS data.

4.2.6. Reefer Container Shipments

The carriers noted that in practice almost all reefer containers are shipped by truck, and that reefers require more fuel than dry containers. To account for this distinction, Volpe included a reefer fuel adjustment in the FAF calculation using the methodology described below.

Reefer units are essentially dual mode hybrids. They are powered by small diesel generators (GENSETs) when moving over the road. The GENSET produces electricity which powers the refrigeration unit. At dockside and aboard ship the units are plugged in and run directly on electric power from the dock or ship.

Some values for reefer fuel usage presented in the literature are 0.7 gal /hr., 0.5 gal/hr., 0.65 gal/hr., 1 gal/hr., and .76 to .89 gal/hr.[23] 0.7 gal/hr. is used in this study.

This reefer fuel is in addition to the fuel used in moving the truck and reefer fuel consumption, which is presented in gal/hr., must be converted into gal/trip.

FMCSA regulations limit a driver's hours to a maximum of 11 hours driving and a maximum of 14 continuous hours "on duty". The duty hours must be followed by 10 hours of off duty time with no driving.[24] Assuming an average speed of 50 mph implies that a truck can cover 550 miles per day. Trips beyond 550 miles but less than 1,100 miles would require 2 days. Trips greater than 1,100 miles but less than 1,650 miles require 3 days and trips between 1,650 miles and 2,200 miles require 4 days.

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of the Secretary of Transportation, U.S. Department of Transportation, Transportation Systems Center, Cambridge, MA, July 1981.

[23] *Ibid.*

Richard Beilock and Forrest Stegelin, "Impacts of Fuel Costs, Distance-to-Market, and Equipment Utilization on Relative Costs of Trailer-on -Flatcar and Truck Transportation for Fresh Fruits and Vegetables in the South", Southern Journal of Agricultural Economics, December, 1982, pp. 111-117. (Available at: http://ageconsearch.umn.edu/bitstream/30454/1/14020111.pdf)

Global Refrigeration Systems, Savings Calculator, (Available at: Global Refrigeration Systems * Savings Calculator)

Operating Cost Data Comparison, Truck Transport Refrigeration, LLC, (2013). (Available at: http://trucktransportrefrigeration.com/Data%20Comparison.pdf)

Transport Refrigeration Generator Sets (Available at: Transport Refrigeration Generator Sets | Klinge Corp)

[24] *Summary of Hours-of-Service (HOS) Regulations,* Federal Motor Carrier Safety Administration, (Available at: http://www.fmcsa.dot.gov/rules-regulations/topics/hos/index.htm)

For trips of less than 550 miles reefer fuel was calculated as miles divided by 50 times 0.7 gal/hr. For trips greater than 550 miles we must account for reefer fuel used while the truck is not moving.

For trips between 550 and 1,100 miles reefer fuel would be calculated as miles divided by 50 times 0.7 gal/hr. plus 13 hrs. times 0.7 gal/hr.

For trips between 1,100 and 1,650 miles reefer fuel would be calculated as miles divided by 50 times 0.7 gal/hr. plus 26 hrs. times 0.7 gal/hr.

For trips between 1,650 and 2,200 miles reefer fuel would be calculated as miles divided by 50 times 0.7 gal/hr. plus 39 hrs times 0.7 gal/hr.

4.2.7. Rail Fuel Consumption Factors

The technical fuel factor for intermodal rail fuel consumption for a typical USTRANSCOM container inland move is estimated as 0.0330 gallons per container mile. This factor is based on a value of .001328 gallons/gross ton mile indicated in Table 32 below and appears to be a typical industry average for intermodal operations. A value of 6 gallon/mile provided in source 6 in Table 32 translates into a value of .001579 gallons/gross ton-mile for the typical intermodal train configuration assumed in that analysis.

The gallon/gross ton-mile figure accounts for the fuel used in moving the entire train (cars and locomotives plus cargo). This accounts for the fuel used in rail line-haul operations and does not include fuel used in drayage at either end or in terminal operations.

Using the reported values for typical intermodal train gross weights and typical number of containers per train as reported in the cited studies and summarized in Table 33, Rail Fuel Factors, values of gallons per train mile and gallons per container mile were calculated.

All the analyses cited start with a theoretical capacity of a train in TEU assuming that all containers are the same size. This is reduced by a factor (85% to 90% were cited) to account for the mix of container sizes in a fashion analogous to the broken stowage factor used on ships. TEU were converted to containers within the cited studies using an assumed ratio of 1.8 TEU/container based on a “typical” mix of 20 foot and 40 foot containers.

As part of the FAF update an attempt was made to identify data on intermodal train fuel consumption that might have become available since Volpe’s last report to USTRANSCOM. There was no more recent information in the literature that would warrant changing the assumptions used in the development of the current FAF methodology.

Table 32: Intermodal Rail Factors

Source	Date	Data Type	Containers /Train	Gallons/Gross ton-mile
1	February 2009	Reported actual	300	
2	2004	Reported actual	106	
3	March 2008	Planning value based on industry statistics	240	
4	2004	Planning value based on industry statistics	320 TEU	.0013
5	2007	Planning value based on industry statistics	227 containers 408 TEU	.001328
6	2003	Planning value based on industry statistics	200 FEU	6 gal/mile
7	2007	Planning value based on industry statistics	240 containers 425 TEU	.001328

Table 33: Rail Fuel Factors

	Long Beach (Source: 5)	Houston (Source: 7)	Short Haul Case Studies (Source: 6)	Short Haul TRB Paper (Source: 4)
Gallons/ Gross Ton Mile	0.001328	0.001328	0.001579	0.0013
Gross Train Weight (tons)	5646	6469	3800	6200
Gallons/Train Mile	7.498	8.591	6.000	8.060
Containers/Train	227	240	200	240
Gallons/Container Mile	0.0330	0.0358	0.0300	0.0336

Sources for tables:

1-*Train Traffic Down, But Alameda Corridor Still in The Black*, The Cunningham Report, (2009).

2-*Southeast Arizona Regional Transportation Profile Study*, Nogales Railroad Assessment Study (2005). (Available at: Southeast Arizona regional transportation profile study: Nogales railroad assessment study :: Arizona State Agency Publications)

3- *North Carolina International Terminal, Planning Assumptions,* prepared for North Carolina State Ports Authority, CH2M HILL (2008). (Available at: http://savethecape.org/stcwp1/wp-content/uploads/PDFs/NCITPlanningAssumptions.pdf)

4-Resor, R. R. and Blaze, J. R., *Short-Haul* Rail *Intermodal: Can It Compete With Trucks?* Transportation Research Record No. 1873, Transportation Research Board (2004). (Available at:http://trb.metapress.com/content/c2482j773v151h7k/fulltext.pdf)

5-*2007 Air Emissions Inventory, Section 5 Railroad Locomotives*, Port of Long Beach, (2009). (Available at: http://www.polb.com/civica/filebank/blobdload.asp?BlobID=6021)

6-Casgar, Christina S., et al., *Rail Short Haul Intermodal Corridor Case Studies: Industry Context and Issues,* Foundation for intermodal Research & Education (FIRE), (2003). (Available at: Rail Short Haul Intermodal Case Studies: Industry Context Issues | Federal Railroad Administration)

7-*2007 Goods Movement Air Emissions Inventory at the Port of Houston*, Starcrest Consulting Group, LLC, (2009). (Available at: http://www.portofhouston.com/static/gen/inside-the-port/Environment/PHA-GM-AirEmissions-07.pdf)

4.2.8. Truck/Rail Competitive Break Even Point

There is a significant difference in fuel consumption between truck and intermodal rail in terms of gallons/container mile. In order to accurately estimate the fuel consumption (and fuel cost) associated with the inland move of a container requires knowledge of how the container actually moved, specifically whether it moved by truck or by rail intermodal. This information is not available for USTRANSCOM shipments in IBS. In the absence of historical mode data, the assumption is made that the most likely mode of transport used in moving a container inland would be based on the distance moved. This was the approach used in the previous FAF calculation method.

Containers moving by intermodal rail enjoy a significant line haul cost advantage over truck in terms of $/ton-mile. Nonetheless, rail movements must overcome the cost of getting containers to and from the rail terminals and transferring the containers to and from truck (in most cases) to the train. Thus rail intermodal is generally not cost (or service) competitive with truck for short movements. For the purposes of this study “short” was defined as 700 miles. This is based on a middle ground value of the “conventional wisdom” reported in the literature and indicated in Table 34 below. The “conventional wisdom” is based on the known behavior of shippers who have chosen truck or rail intermodal for their specific shipments, presumably determined on a detailed case by case analysis of their own shipment options.

As part of the FAF update an attempt was made to identify information on the truck/rail competitive break-even point that might have become available since Volpe’s last report to

USTRANSCOM. A review of the recent literature did not yield any new material that would require us to change the truck/rail breakpoint used in the FAF calculator as documented in our previous report to USTRANSCOM. The recent studies and articles echoed the "conventional wisdom" cited in the references used in the prior study. Those reports that were based on any analysis of actual data appear to have relied on much of the same data and references used in the references cited in Volpe's previous report. There does not appear to have been any original work done since our last study that is based on more recent data. Some of these more recent references have been added to Table 34.

Table 34: Truck/Rail Competitive Break Point

Distance (miles)	Source	Date	Basis
500-800	1	2004	Hypothetical study of specific inland moves
600-900	2	2003	"conceptual"
500-750	2	-	"conventional wisdom"
>750	3	February 2008	"conventional wisdom"
>500	4	February 2004	"conventional wisdom"
>700	5	March 2003	"conventional wisdom"
550-750	6	July 2011	"conventional wisdom"
700	7	October 2012	"conventional wisdom"
>500	8	July 2012	"conventional wisdom"
500-750	9	December 2011	"conventional wisdom"

Sources for table:

1-Resor, R. R. and Blaze, J. R., *Short-Haul* Rail *Intermodal: Can It Compete With Trucks?* Transportation Research Record No. 1873, Transportation Research Board (2004). (Available at:http://trb.metapress.com/content/c2482j773v151h7k/fulltext.pdf)

2-*Goods Movement Truck & Rail Study*, Prepared for: Southern California Association of Governments, The Tioga Group, (2003). (Available at: http://s3.amazonaws.com/zanran_storage/www.scag.ca.gov/ContentPages/74216151.pdf)

3-Saenz, Norman, *Supply Chain Optimization 101,* MHIA News, (2008). (Available at: Supply Chain Optimization 101)

4-*A Glance at Clean Freight Strategies, Intermodal Shipping,* U.S. Environmental Protection Agency, Office of Transportation and Air Quality, (2004). (Available at:

http://www.epa.gov/smartway/documents/partnership/trucks/partnership/techsheets-truck/EPA-420-F09-039.pdf)

5-Casgar, Christina S., et al., *Rail Short Haul Intermodal Corridor Case Studies: Industry Context and Issues,* Foundation for intermodal Research & Education (FIRE), (2003). (Available at: Rail Short Haul Intermodal Case Studies: Industry Context Issues | Federal Railroad Administration)

6-Solomon, Mark B., *Rails Try New Route to Intermodal Growth*, DC Velocity, (2011) (Available at: Rails try new route to intermodal growth – DC Velocity)

7-O'Reilly, Joseph, *Rail Intermodal: Where Rail Meets Road*, Inbound Logistics, (2012). (Available at: Rail Intermodal: Where Rail Meets Road - Inbound Logistics)

8- *Strategic Advantages of Moving Mail by Rail,* Report Number: RARC-WP-12-013, U.S. Postal Service Office of Inspector General, Risk Analysis Research Center,(2012). (Available at: https://www.uspsoig.gov/foia_files/rarc-wp-12-013.pdf)

9-Burton, Mark, *Evaluation of Freight Vehicles in Short-Haul Intermodal Lanes,* Report No. NTRCI-50-2011-028, National Transportation Research Center, Inc., University Transportation Center, Knoxville, (2011). (Available at: http://ntl.bts.gov/lib/44000/44200/44239/U30-Evaluation_of_Freight_Vehicles_in_Short-Haul_Imtermodal_Lanes__FINAL_.pdf)

4.2.9. Intermodal Long Distance Shipments

For the purposes of calculating a FAF it is assumed that all long distance shipments—those more than 700 miles—are intermodal and include a truck component. Because of this, the FAF calculation was adjusted to account for the truck component of long-distance moves. The methodology behind this adjustment is outlined below.

In examining this issue further, it was found that typical truck movements associated with intermodal rail movements are not available in the IBS data. There is also little information in the literature on distances by truck to/from intermodal rail terminals. Most published comparative analyses present the "dray" as an additional fixed cost.

On the port end Volpe was able to obtain "typical" distances from dock to intermodal rail terminal. These are for Houston (25 miles), Los Angeles/Long Beach (14 miles), New York-New Jersey (14 miles), and the Port of Virginia (11 miles).[25]

On the inland end, one source reports an average haul of 80 miles, while a second source reports an origin dray of 25 miles and a destination dray of 40 miles for fresh fruits and

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[25] *DrayFLEET: EPA SmartWay Drayage Activity and Emissions Model and Case Studies*, prepared for the U.S. Environmental Protection Agency and the U.S. Federal Highway Administration, The Tioga Group, Inc.,(2008). (Available at: http://www.epa.gov/smartway/documents/partnership/trucks/drayage/final-dray-fleet-report.pdf)

vegetables.[26] The first source also notes the difficulty in estimating dray distance because of the unique circumstances connected with each move.

For those shipments traveling more than 700 miles, the truck component was calculated as the sum of the movement from the port to/from a rail terminal and the movement from a rail terminal to/from the origin/destination. The distances at the port end were taken from the reference above with Los Angeles representing West Coast ports, Houston representing Gulf Coast ports, and New York and Hampton Roads representing East Coast ports.

The IANA North American Intermodal Facilities Directory[27] was used to identify the location of rail intermodal terminals in the states containing the inland origin/destination cities. The terminal nearest the origin/destination city was identified and the distance between the terminal and the origin/destination city was obtained from randmcnally.com. An average truck haul (weighted on the number of containers as indicated in the 2012 IBS data) was then computed for each of the three cases involving intermodal rail moves, East Coast ports to inland states, Gulf Coast ports to inland states and West Coast ports to inland states.

Fuel consumption was calculated as the sum of the fuel used on the truck portion and fuel used on the rail portion. Rail distance was determined as total distance minus the sum of the truck distances at origin and destination.

This approach was only applied to dry container shipments, since little refrigerated traffic moves by rail.

As part of the FAF update an attempt was made to identify data on dray distances that might have become available since Volpe's last report to USTRANSCOM. There was no more recent information in the literature that would warrant changing the port dray assumptions used in the development of the current FAF methodology. However, as noted above, the inland dray distances were recomputed based on the dry container shipments reported in IBS for 2012.

4.3. FAF Methodology

The current approach is one based on a "zonal" system. It does not require the calculation of distance for every shipment, nor knowledge of whether the shipment moved by truck or rail.

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[26] *Freight Diversion and Forecast Report, I-81 Corridor Improvement Study, Tier 1 Environmental Impact Statement*, Virginia DOT. (Available at: http://www.virginiadot.org/projects/resources/freight.pdf)
Richard Beilock and Forrest Stegelin, "Impacts of Fuel Costs, Distance-to-Market, and Equipment Utilization on Relative Costs of Trailer-on -Flatcar and Truck Transportation for Fresh Fruits and Vegetables in the South", Southern Journal of Agricultural Economics, December, 1982, pp. 111-117. (Available at: http://ageconsearch.umn.edu/bitstream/30454/1/14020111.pdf)
[27] IANA Rail Intermodal Terminal Directory & Motor Carrier Service Coverage Directory

The key requirements for this method are the port and the state containing the inland origin/destination of the shipment, which are readily available.

The other methods considered in Volpe's previous study were rejected either due to inaccuracy or the requirement of unavailable data., such as the actual inland distance for each shipment, or a knowledge of whether the shipment actually moved by truck or rail.

The current approach represents a compromise between simplicity (administrative burden) and accuracy, and between current industry practice and procedures related to the BAF under USC-06 and the FAF under SDDC Policy TR-12. It involves the calculation of a FAF for six "zones". These zones are:

- East Coast ports to East Coast states
- East Coast ports to all other states
- Gulf Coast ports to Gulf Coast states
- Gulf Coast ports to all other states
- West Coast ports to West Coast states
- West Coast ports to all other states

The FAF is based on the fuel price differential between a specified base period and the current time period, and the fuel used in moving a shipment an average distance by truck or rail within a given zone or between zones. The approach is similar to current industry practice on FAF for inland CONUS container movements. The approach is more transparent than the current industry practice on FAFs.

The calculated FAF's are based on the widely available diesel fuel price data published by the Department of Energy's Energy Information Agency, typical fuel consumption factors for U.S. trucking and intermodal rail operations, and typical USTRANSCOM inland shipment movements as indicated in the IBS (Integrated Booking System) data for 2012. The proposed approach applies only to the inland CONUS portion of shipments.

A sample internet site for publishing the proposed FAF is presented later in this report.

The FAF calculator used in producing the monthly tables appears in the Appendix. This provides the equations and default input values used in calculating the FAF, along with the link to DOE's monthly diesel fuel price data.

4.3.1. FAF Implementation Details

A number of details have to be specified in order to implement the approach in practice. While most of these of these details are almost arbitrary policy decisions, one is required under FAR, which is the use of a symmetrical FAF. The implementation issues include:

- The base period for fuel prices
- Update frequency

- The period for the current fuel price
- The fuel price increment used in the published tables
- The use of a “buffer zone”
- The use of an asymmetrical FAF or a symmetrical FAF

The proposed approach will incorporate the following implementation details for the purposes of presenting an example of the approach in this report. The final decision with regard to each of these matters lies with USTRANSCOM.

The base period for determining a base fuel price will be the solicitation period for USC-07 (Dec 11-Mar 12). SDDC Policy TR-12 and rail and truck carriers generally specify a base fuel price, but not the time period on which the price is based. Ocean carriers typically do not specify a base fuel price or a current fuel price but generally only provide an inland fuel surcharge figure that will apply for a specified time period.

The FAF will be updated monthly. This is consistent with the USC-07 solicitation, SDDC Policy TR-12, and much of current industry practice in the rail and ocean carrier industry.

The current average fuel price will be determined as specified in the USC-07 solicitation (Attachment 11, section 4.2.2). This average price shall be calculated on or after the first of the month for the prior month and shall apply to shipments in the next month.

A fuel price increment will not be used in the published tables. This is consistent with industry practice in the ocean carrier industry for publishing inland fuel surcharges.

A “buffer zone” has not been included as part of the FAF methodology. This was done to be consistent with industry practice in the trucking, rail, ocean carrier industries, and SDDC Policy TR-12[28].

The FAF will be symmetrical in nature and be responsive to upward or downward fluctuations in fuel prices. This is consistent with the FAR regulations. Nonetheless, this is not consistent with industry practice in the trucking, rail, ocean carrier industries, and SDDC Policy TR-12.

4.3.2. Sample Internet Site

CONUS Inland Fuel Surcharge (FAF) for USC 07 Shipments

1. Application

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[28] *TR-12 Fuel Related Rate Adjustment Policy*, HQ Military Surface Deployment and Distribution Command, 11/19/2012. (Available at: **http://www.sddc.army.mil/GCD/default.aspx).**

The fuel surcharge on the inland CONUS portion of USC-07 shipments will be based on the shipment's origin state and POE (port of embarkation) or the POD (port of debarkation) and the shipment's destination state as indicated in the CONUS Inland Fuel Surcharges (FAF) tables (below).

For the purpose of determining the surcharge East Coast ports will include those within the states of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North/South Carolina, Georgia, and Florida; Gulf Coast ports will include those within the states of Texas, Louisiana, Mississippi and Alabama: and West Coast ports will include those within the states of California, Oregon and Washington.

A different FAF will apply, depending on the type of shipment. A shipment may be a dry container shipment, a refrigerated container shipment, a break bulk shipment with a weight/shipment unit less than or equal to 50,000 lbs., or break bulk shipment where the weight/shipment unit exceeds 50,000 lbs. Carriers will select the appropriate table for determining the FAF applicable to a given shipment.

2. Effective Dates

For shipments picked up between June 1, 2013 and June 30 2013, the calculation of the surcharge will be based on the April 2013 DOE Fuel Price. The surcharge will be updated monthly.

3. Billing Procedures

Carriers will clearly show fuel price adjustments on all paper and electronic commercial freight bills and Bills of Lading and invoices. The amount of any diesel fuel rate surcharge must be shown as a separate item on the carrier's invoice. Contractors are responsible for indicating on their shipment invoice whether a fuel payment is due them, whether no fuel payment is to be made or whether a fuel payment is due SDDC. If a fuel payment is due the Contractor or SDDC, the Contractor shall obtain the value of the payment (or credit) from the surcharge table and indicate this on the shipment invoice. If there is no fuel payment, the Contractor shall indicate on the invoice "No Fuel Adjustment".

Table 35. CONUS Inland Fuel Surcharges (FAF) per dry container. Effective Jun-13

STATE	VIA USEC	VIA USGC	VIA USWC
AL	-$1	$0	-$1
AR	-$1	-$1	-$1
AZ	-$1	-$1	-$1
CA	-$1	-$1	$0
CO	-$1	-$1	-$1
CT	$0	-$1	-$1
DC	$0	-$1	-$1
DE	$0	-$1	-$1
FL	$0	-$1	-$1

GA	$0	-$1	-$1
IA	-$1	-$1	-$1
ID	-$1	-$1	-$1
IL	-$1	-$1	-$1
IN	-$1	-$1	-$1
KS	-$1	-$1	-$1
KY	-$1	-$1	-$1
LA	-$1	$0	-$1
MA	$0	-$1	-$1
MD	$0	-$1	-$1
ME	$0	-$1	-$1
MI	-$1	-$1	-$1
MN	-$1	-$1	-$1
MO	-$1	-$1	-$1
MS	-$1	$0	-$1
MT	-$1	-$1	-$1

4.3.3. Limitations of the FAF Methodology

The proposed approach represents a compromise between simplicity (administrative burden) and accuracy. The fuel surcharges presented in the zonal tables are average values. As a result they may result in an over payment or an under payment for any given shipment in relation to a surcharge that could be calculated if one knew the unique characteristics and parameters associated with each individual shipment. This is a characteristic shared with all inland fuel surcharge approaches currently used by the ocean carrier industry. Over the course of the contract under payments and over payments will likely cancel out.

The current approach applies only to the inland CONUS portion of shipments. It was not deemed to be feasible to develop a credible FAF for the OCONUS inland portion of shipments.

4.4. References

2007 Air Emissions Inventory, Section 5 Railroad Locomotives, Port of Long Beach, (2009). (Available at: http://www.polb.com/civica/filebank/blobdload.asp?BlobID=6021)

2007 Goods Movement Air Emissions Inventory at the Port of Houston, Starcrest Consulting Group, LLC, (2009). (Available at: http://www.portofhouston.com/static/gen/inside-the-port/Environment/PHA-GM-AirEmissions-07.pdf)

Banks, Sharon, *Greening the Fleet, Cleaner Air, Lower Carbon, and a Better Economy*. (Available at: http://www.discovery.org/scripts/viewDB/filesDB-download.php?command=download&id=2911)

Beilock, Richard and Forrest Stegelin, "Impacts of Fuel Costs, Distance-to-Market, and Equipment Utilization on Relative Costs of Trailer-on -Flatcar and Truck Transportation for Fresh Fruits and Vegetables in the South", Southern Journal of Agricultural Economics, December, 1982, pp. 111-117. (Available at: http://ageconsearch.umn.edu/bitstream/30454/1/14020111.pdf)

Biernbaum, Lee, etal., *Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts,* prepared for U.S. DOD/USTRANSCOM, U.S. DOT/Volpe Center, July 2009.

Biernbaum, Lee, etal., *Calculation of Bunker Fuel, Currency, and Inland Freight Fuel Price Adjustment Factors for USTRANSCOM Commercial Shipping Contracts, Addendum to July 2009 Final Report,* prepared for U.S. DOD/USTRANSCOM, U.S. DOT/Volpe Center, September 2009.

Boriboonsomsin, Kanok, et al., *Analysis of Heavy-Duty Diesel Truck Activity and Fuel Economy Based on Electronic Control Module Data,* Transportation Research Record No. 2191, Transportation Research Board, (2010). (Available at: http://trb.metapress.com/content/h7867j2163711638/fulltext.pdf)

Burton, Mark, *Evaluation of Freight Vehicles in Short-Haul Intermodal Lanes,* Report No. NTRCI-50-2011-028, National Transportation Research Center, Inc., University Transportation Center, Knoxville, (2011). (Available at: http://ntl.bts.gov/lib/44000/44200/44239/U30-Evaluation_of_Freight_Vehicles_in_Short-Haul_Imtermodal_Lanes___FINAL_.pdf)

Capps, Gary, et al., *Class-8 Heavy Truck Duty Cycle Project Final Report*, ORNL/TM-2008/122, Oak Ridge National Laboratory, (2008). (Available at: http://cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2008-122.pdf)

Casgar, Christina S., et al., *Rail Short Haul Intermodal Corridor Case Studies: Industry Context and Issues,* Foundation for intermodal Research & Education (FIRE), (2003). (Available at: Rail Short Haul Intermodal Case Studies: Industry Context Issues | Federal Railroad Administration)

DrayFLEET: EPA SmartWay Drayage Activity and Emissions Model and Case Studies, prepared for the U.S. Environmental Protection Agency and the U.S. Federal Highway Administration, The Tioga Group, Inc., (2008). (Available at: http://www.epa.gov/smartway/documents/partnership/trucks/drayage/final-dray-fleet-report.pdf)

Freight Diversion and Forecast Report, I-81 Corridor Improvement Study, Tier 1 Environmental Impact Statement, Virginia DOT. (Available at: http://www.virginiadot.org/projects/resources/freight.pdf)

Freight Surcharge Index, The National Transportation Institute, Volume 4, Issue 32, August 24, 2011. (Available at: http://www.energyinstitution.org/files/fsisample.pdf)

Goods Movement Truck & Rail Study, Prepared for: Southern California Association of Governments, The Tioga Group, (2003). (Available at: http://s3.amazonaws.com/zanran_storage/www.scag.ca.gov/ContentPages/74216151.pdf)

A Glance at Clean Freight Strategies, Intermodal Shipping, U.S. Environmental Protection Agency, Office of Transportation and Air Quality, (2004). (Available at: http://www.epa.gov/smartway/documents/partnership/trucks/partnership/techsheets-truck/EPA-420-F09-039.pdf)

Global Refrigeration Systems, Savings Calculator, (Available at: Global Refrigeration Systems * Savings Calculator)

Improving Efficiency of Freight Movement with EPA's Smartway Transport Partnership. (Available at: http://www.trbav030.org/pdf2006/136_S_Rudinski.pdf)

IANA Rail Intermodal Terminal Directory & Motor Carrier Service Coverage Directory

Knapton, David, "An Investigation of Truck Size and Weight Limits Technical Supplement Vol. 3, Truck and Rail Fuel Effects of Truck Size and Weight Limits", Report DOT-TSC-OST-81-2, prepared for the Office of the Secretary of Transportation, U.S. Department of Transportation, Transportation Systems Center, Cambridge, MA, July 1981.

Making Semi-Trucks More Efficient, The Truckers Report, (2013). (Available at: Making Semi-Trucks More Efficient)

Maltz, Arnold, *Promoting Green Supply Chains in North America*, April 22, 2008. (Available at: http://nacts old.asu.edu/files/GTC/Promoting%20Green%20Supply%20Chains%20in%20North%20America.ppt)

North Carolina International Terminal, Planning Assumptions, prepared for North Carolina State Ports Authority, CH2M HILL (2008). (Available at: http://savethecape.org/stcwp1/wp-content/uploads/PDFs/NCITPlanningAssumptions.pdf)

Ogburn, Michael, et al., Transformational Trucks: Determining the Energy Efficiency of a Class-8 Tractor-Trailer, Rocky Mountain Institute, (2008). (Available at: http://www.rmi.org/cms/Download.aspx?id=6669&file=T08-1_RMIT

Operating Cost Data Comparison, Truck Transport Refrigeration, LLC, (2013). (Available at: http://trucktransportrefrigeration.com/Data%20Comparison.pdf)

O'Reilly, Joseph, *Rail Intermodal: Where Rail Meets Road*, Inbound Logistics, (2012). (Available at: Rail Intermodal: Where Rail Meets Road - Inbound Logistics)

Reducing Heavy-Duty Long Haul Combination Truck Fuel Consumption and CO2 Emissions, Northeast States Center for a Clean Air Future, International Council on Clean Transportation, Southwest Research Institute, TIAX, LLC, (2009). (Available at: http://www.nescaum.org/documents/heavy-duty-truck-ghg_report_final-200910.pdf)

Resor, R. R. and Blaze, J. R., *Short-Haul* Rail *Intermodal: Can It Compete With Trucks?* Transportation Research Record No. 1873, Transportation Research Board (2004). (Available at:http://trb.metapress.com/content/c2482j773v151h7k/fulltext.pdf)

Richard, Michael Graham," Supertruck" Has 54% Better Fuel Economy Than the Average Long Haul Truck, Global Possibilities, (2013). (Available at: 'SuperTruck' has 54% better fuel economy than the average long-haul truck | "Global Possibilities")

Saenz, Norman, *Supply Chain Optimization 101,* MHIA News, (2008). (Available at: Supply Chain Optimization 101)

Solomon, Mark B., *Rails Try New Route to Intermodal Growth*, DC Velocity, (2011) (Available at: Rails try new route to intermodal growth – DC Velocity)

Southeast Arizona Regional Transportation Profile Study, Nogales Railroad Assessment Study (2005). (Available at: Southeast Arizona regional transportation profile study: Nogales railroad assessment study :: Arizona State Agency Publications)

Strategic Advantages of Moving Mail by Rail, Report Number: RARC-WP-12-013, U.S. Postal Service Office of Inspector General, Risk Analysis Research Center,(2012). (Available at: https://www.uspsoig.gov/foia_files/rarc-wp-12-013.pdf)

Summary of Hours-of-Service (HOS) Regulations, Federal Motor Carrier Safety Administration, (Available at: http://www.fmcsa.dot.gov/rules-regulations/topics/hos/index.htm)

Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles, Committee to Assess Fuel Economy Technologies for Medium- and Heavy-Duty Vehicles; National Research Council; Transportation Research Board (2010). (Available at: Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles)

Technologies and Policies for Improving Truck Fuel Efficiency & Reducing CO2, presentation by Anthony Grezler, Vice President Advanced Engineering, Volvo Powertrain Corporation, July 30, 2009. (Available at: http://www.its.ucdavis.edu/files/asilomar/pdf/2012-08-23_2009-Asilomar-Technologies-and-Policies-for-Improving-Truck-Fuel-Greszler.pdf)

TR-12 Fuel Related Rate Adjustment Policy, HQ Military Surface Deployment and Distribution Command, 11/19/2012. (Available at: **http://www.sddc.army.mil/GCD/default.aspx).**

Train Traffic Down, But Alameda Corridor Still in The Black, The Cunningham Report, (2009).

Transport Refrigeration Generator Sets (Available at: Transport Refrigeration Generator Sets | Klinge Corp)

USTRANSCOM/TCAQ-I, Request for Proposal (RFP) #: HTC711-11-R-W004, Universal Services Contract (USC)-7, Scott AFB, IL, 29 Nov 11.

Weekly Retail Gasoline and Diesel Prices , U.S. Energy Information Administration, (Available at: http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm

APPENDIX A: FAF CALCULATOR

The FAF Calculator included in the accompanying EXCEL spreadsheet *FAF Calculator(2013 refresh).xls* is reproduced below. The calculator produces the table of FAFs for each of the zones that would be updated and published monthly on the USTRANSCOM internet site. Tables are produced for four types of shipments; dry containers, refrigerated containers, break bulk shipments with a weight/shipment unit less than 50,000 lbs., and break bulk shipments with a weight/shipment unit greater than 50,000 lbs. The example tables for June 2013 are indicated below.

Example Tables for Dry Container Shipments

Table 36. CONUS Inland Fuel Surcharges (FAF) per dry container

Effective Jun-13

STATE	VIA USEC	VIA USGC	VIA USWC
AL	-$1	$0	-$1
AR	-$1	-$1	-$1
AZ	-$1	-$1	-$1
CA	-$1	-$1	$0
CO	-$1	-$1	-$1
CT	$0	-$1	-$1
DC	$0	-$1	-$1
DE	$0	-$1	-$1
FL	$0	-$1	-$1
GA	$0	-$1	-$1
IA	-$1	-$1	-$1
ID	-$1	-$1	-$1
IL	-$1	-$1	-$1
IN	-$1	-$1	-$1
KS	-$1	-$1	-$1
KY	-$1	-$1	-$1
LA	-$1	$0	-$1
MA	$0	-$1	-$1
MD	$0	-$1	-$1
ME	$0	-$1	-$1
MI	-$1	-$1	-$1
MN	-$1	-$1	-$1
MO	-$1	-$1	-$1
MS	-$1	$0	-$1
MT	-$1	-$1	-$1

STATE	VIA USEC	VIA USGC	VIA USWC
NC	$0	-$1	-$1
ND	-$1	-$1	-$1
NE	-$1	-$1	-$1
NH	$0	-$1	-$1
NJ	$0	-$1	-$1
NM	-$1	-$1	-$1
NV	-$1	-$1	-$1
NY	$0	-$1	-$1
OH	-$1	-$1	-$1
OK	-$1	-$1	-$1

OR	-$1	-$1	$0
PA	$0	-$1	-$1
RI	$0	-$1	-$1
SC	$0	-$1	-$1
SD	-$1	-$1	-$1
TN	-$1	-$1	-$1
TX	-$1	$0	-$1
UT	-$1	-$1	-$1
VA	$0	-$1	-$1
VT	$0	-$1	-$1
WA	-$1	-$1	$0
WI	-$1	-$1	-$1
WV	$0	-$1	-$1
WY	-$1	-$1	-$1

The equations used in calculating each of the surcharges are as follows:

- EC to EC Surcharge= (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/container mile*Average haul EC ports to EC points
- GC to GC Surcharge= (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/container mile*Average haul GC ports to GC points
- WC to WC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/container mile*Average haul WC ports to WC points
- EC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)* Intermodal rail gallons/container mile *Average rail haul EC ports to Rest of US + (Monthly Average Fuel Price - Baseline Fuel Price)* Truck gallons/container mile *Average Truck component EC ports to Rest of US
- GC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)* Intermodal rail gallons/container mile *Average rail haul GC ports to Rest of US + (Monthly Average Fuel Price - Baseline Fuel Price)* Truck gallons/container mile *Average Truck component GC ports to Rest of US
- WC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)* Intermodal rail gallons/container mile *Average rail haul WC ports to Rest of US + (Monthly Average Fuel Price - Baseline Fuel Price)* Truck gallons/container mile *Average Truck component WC ports to Rest of US

Example Tables for Refrigerated Container Shipments

Table 37. CONUS Inland Fuel Surcharges (FAF) per refrigerated container

Effective Jun-13

STATE	VIA USEC	VIA USGC	VIA USWC
AL	-$3	-$1	-$5
AR	-$3	-$4	-$5
AZ	-$3	-$4	-$5
CA	-$3	-$4	$0
CO	-$3	-$4	-$5
CT	-$1	-$4	-$5
DC	-$1	-$4	-$5
DE	-$1	-$4	-$5
FL	-$1	-$4	-$5
GA	-$1	-$4	-$5
IA	-$3	-$4	-$5
ID	-$3	-$4	-$5
IL	-$3	-$4	-$5
IN	-$3	-$4	-$5
KS	-$3	-$4	-$5
KY	-$3	-$4	-$5
LA	-$3	-$1	-$5
MA	-$1	-$4	-$5
MD	-$1	-$4	-$5
ME	-$1	-$4	-$5
MI	-$3	-$4	-$5
MN	-$3	-$4	-$5
MO	-$3	-$4	-$5
MS	-$3	-$1	-$5
MT	-$3	-$4	-$5

STATE	VIA USEC	VIA USGC	VIA USWC
NC	-$1	-$4	-$5
ND	-$3	-$4	-$5
NE	-$3	-$4	-$5
NH	-$1	-$4	-$5
NJ	-$1	-$4	-$5
NM	-$3	-$4	-$5
NV	-$3	-$4	-$5
NY	-$1	-$4	-$5
OH	-$3	-$4	-$5
OK	-$3	-$4	-$5

OR	-$3	-$4	$0
PA	-$1	-$4	-$5
RI	-$1	-$4	-$5
SC	-$1	-$4	-$5
SD	-$3	-$4	-$5
TN	-$3	-$4	-$5
TX	-$3	-$1	-$5
UT	-$3	-$4	-$5
VA	-$1	-$4	-$5
VT	-$1	-$4	-$5
WA	-$3	-$4	$0
WI	-$3	-$4	-$5
WV	-$1	-$4	-$5
WY	-$3	-$4	-$5

The equations used in calculating each of the surcharges are as follows:

- EC to EC Surcharge= (Monthly Average Fuel Price - Baseline Fuel Price)*(Truck gallons/container mile*Average haul EC ports to EC points + Average haul EC ports to EC points/Average speed*Reefer unit gallons/hour)
- GC to GC Surcharge= (Monthly Average Fuel Price - Baseline Fuel Price)*(Truck gallons/container mile*Average haul GC ports to GC points + Average haul GC ports to GC points/Average speed*Reefer unit gallons/hour)
- WC to WC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*(Truck gallons/container mile*Average haul WC ports to WC points + Average haul WC ports to WC points/Average speed*Reefer unit gallons/hour)
- EC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)* (Truck gallons/container mile *Average haul EC ports to Rest of US + Average haul EC ports to Rest of US/Average speed*Reefer unit gallons/hour + Off duty time*Reefer unit gallons/hour)
- GC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*(Truck gallons/container mile *Average haul GC ports to Rest of US + Average haul GC ports to Rest of US/Average speed*Reefer unit gallons/hour + Off duty time*Reefer unit gallons/hour)
- WC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*(Truck gallons/container mile *Average haul WC ports to Rest of US + Average haul WC ports to Rest of US/Average speed*Reefer unit gallons/hour + Off duty time*Reefer unit gallons/hour)

Example Tables for Break Bulk Shipments with a Weight/Shipment Unit Less Than 50,000 Lbs.

Table 38. CONUS Inland Fuel Surcharges (FAF) per trailer

Effective Jun-13

STATE	VIA USEC	VIA USGC	VIA USWC
AL	-$2	-$1	-$5
AR	-$2	-$4	-$5
AZ	-$2	-$4	-$5
CA	-$2	-$4	$0
CO	-$2	-$4	-$5
CT	-$1	-$4	-$5
DC	-$1	-$4	-$5
DE	-$1	-$4	-$5
FL	-$1	-$4	-$5
GA	-$1	-$4	-$5
IA	-$2	-$4	-$5
ID	-$2	-$4	-$5
IL	-$2	-$4	-$5
IN	-$2	-$4	-$5
KS	-$2	-$4	-$5
KY	-$2	-$4	-$5
LA	-$2	-$1	-$5
MA	-$1	-$4	-$5
MD	-$1	-$4	-$5
ME	-$1	-$4	-$5
MI	-$2	-$4	-$5
MN	-$2	-$4	-$5
MO	-$2	-$4	-$5
MS	-$2	-$1	-$5
MT	-$2	-$4	-$5

STATE	VIA USEC	VIA USGC	VIA USWC
NC	-$1	-$4	-$5
ND	-$2	-$4	-$5
NE	-$2	-$4	-$5
NH	-$1	-$4	-$5
NJ	-$1	-$4	-$5
NM	-$2	-$4	-$5
NV	-$2	-$4	-$5
NY	-$1	-$4	-$5
OH	-$2	-$4	-$5
OK	-$2	-$4	-$5
OR	-$2	-$4	$0
PA	-$1	-$4	-$5
RI	-$1	-$4	-$5
SC	-$1	-$4	-$5
SD	-$2	-$4	-$5
TN	-$2	-$4	-$5
TX	-$2	-$1	-$5
UT	-$2	-$4	-$5
VA	-$1	-$4	-$5
VT	-$1	-$4	-$5
WA	-$2	-$4	$0
WI	-$2	-$4	-$5
WV	-$1	-$4	-$5
WY	-$2	-$4	-$5

The equations used in calculating each of the surcharges are as follows:

- EC to EC Surcharge= (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/trailer mile*Average haul EC ports to EC points
- GC to GC Surcharge= (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/trailer mile*Average haul GC ports to GC points
- WC to WC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/trailer mile*Average haul WC ports to WC point
- EC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)* Truck gallons/trailer mile *Average haul EC ports to Rest of US
- GC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/trailer mile *Average haul GC ports to Rest of US
- WC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/trailer mile *Average haul WC ports to Rest of US

Example Tables for Break Bulk Shipments with a Weight/Shipment Unit Greater Than 50,000 Lbs.

Table 39. CONUS Inland Fuel Surcharges (FAF) per shipment unit

Effective Jun-13

STATE	VIA USEC	VIA USGC	VIA USWC
AL	-$3	-$1	-$6
AR	-$3	-$5	-$6
AZ	-$3	-$5	-$6
CA	-$3	-$5	$0
CO	-$3	-$5	-$6
CT	-$1	-$5	-$6
DC	-$1	-$5	-$6
DE	-$1	-$5	-$6
FL	-$1	-$5	-$6
GA	-$1	-$5	-$6
IA	-$3	-$5	-$6
ID	-$3	-$5	-$6
IL	-$3	-$5	-$6
IN	-$3	-$5	-$6
KS	-$3	-$5	-$6
KY	-$3	-$5	-$6
LA	-$3	-$1	-$6
MA	-$1	-$5	-$6
MD	-$1	-$5	-$6
ME	-$1	-$5	-$6
MI	-$3	-$5	-$6
MN	-$3	-$5	-$6
MO	-$3	-$5	-$6
MS	-$3	-$1	-$6
MT	-$3	-$5	-$6

STATE	VIA USEC	VIA USGC	VIA USWC
NC	-$1	-$5	-$6
ND	-$3	-$5	-$6
NE	-$3	-$5	-$6
NH	-$1	-$5	-$6
NJ	-$1	-$5	-$6
NM	-$3	-$5	-$6
NV	-$3	-$5	-$6
NY	-$1	-$5	-$6
OH	-$3	-$5	-$6

OK	-$3	-$5	-$6
OR	-$3	-$5	$0
PA	-$1	-$5	-$6
RI	-$1	-$5	-$6
SC	-$1	-$5	-$6
SD	-$3	-$5	-$6
TN	-$3	-$5	-$6
TX	-$3	-$1	-$6
UT	-$3	-$5	-$6
VA	-$1	-$5	-$6
VT	-$1	-$5	-$6
WA	-$3	-$5	$0
WI	-$3	-$5	-$6
WV	-$1	-$5	-$6
WY	-$3	-$5	-$6

The equations used in calculating each of the surcharges are as follows:

- EC to EC Surcharge= (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/mile*Average haul EC ports to EC points
- GC to GC Surcharge= (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/mile*Average haul GC ports to GC points
- WC to WC Surcharge = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/mile*Average haul WC ports to WC points
- EC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/mile *Average haul EC ports to Rest of US
- GC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/mile *Average haul GC ports to Rest of US
- WC to Rest of US = (Monthly Average Fuel Price - Baseline Fuel Price)*Truck gallons/mile *Average haul WC ports to Rest of US

The required input values are presented below. Most of these are default values and would not normally change. However, there would be value to periodically updating them.

Shipments were assigned to the appropriate category, e.g., East Coast port to East Coast point. The shipments moving between the top origin to POE pairs and the top POD to destination pairs in CONUS (measured in terms of number of containers or shipment units) as reported in IBS for 2012 were used in computing an average haul.

Within each category, distances were obtained for each zone pair for OD pairs containing 90%-95% of all container flows or shipment unit flows in the case of break bulk. In a few cases the OD pairs were limited to the top 100 OD pairs. These distances were obtained from the distance files developed for the previous report where available. Distances for OD pairs not available in the files from the previous study were obtained from Rand McNalley.com.

The baseline fuel price is currently set as the average for the four month solicitation period for USC-07 (Dec 11 – Mar 12). Going forward this would be changed to the solicitation period for the USC-07 extension option. The baseline fuel price would be obtained from the U.S. National Average Diesel Fuel Index published by the Energy Information Administration of the U.S. Department of Energy. Historical data is available[29] and would be used to establish a fuel price for use as the baseline in FAF computations. Once set, this baseline would apply for the life of the contract.

In practice, the FAF tables would be updated monthly. This would require specification of the current month, the prior month (that for which the latest monthly fuel price data were available), and the upcoming month (that for which the FAF would be in effect). The fuel price data for the prior month would be obtained from the same DOE internet site noted above. This is the price used as the "Monthly Average Fuel Price".

Input Values-Dry Container Shipments

- Average haul EC ports to EC points 154
- Average haul GC ports to GC points 194
- Average haul WC ports to WC points 83
- Average haul EC ports to rest of US 1043
- Truck Component EC ports to rest of US 108
- Average haul GC ports to rest of US 1626
- Truck Component GC ports to rest of US 77
- Average haul WC ports to rest of US 2042
- Truck Component WC ports to rest of US 77
- Truck fuel factor gallons/container mile 0.1667
- Intermodal rail fuel factor gallons/container mile 0.033
- Baseline Period Dec 11 - Mar 12

[29] http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm

- Baseline Fuel Price $3.94
- Current Month May-13
- Prior Month Apr-13
- Monthly Average Fuel Price Prior Month $3.93
- Next Month (FAF in Effect) Jun-13

Input Values-Refrigerated Container Shipments

- Average haul EC ports to EC points 243
- Average haul GC ports to GC points 216
- Average haul WC ports to WC points 42
- Average haul EC ports to Rest of US 1103
- Average haul GC ports to Rest of US 1384
- Average haul WC ports to Rest of US 1783
- Truck fuel factor gallons/container mile 0.1667
- Reefer unit fuel factor gallons/hour 0.7
- Average speed miles/hour 50
- Baseline Period Dec 11 - Mar 12
- Baseline Fuel Price $3.94
- Current Month May-13
- Prior Month Apr-13
- Monthly Average Fuel Price Prior Month $3.93
- Next Month (FAF in Effect) Jun-13

Input Values-Break Bulk Less Than 50,000 Lbs./Shipment Unit

- Average haul EC ports to EC points 264
- Average haul GC ports to GC points 387
- Average haul WC ports to WC points 157
- Average haul EC ports to Rest of US 1022
- Average haul GC ports to Rest of US 1808

- Average haul WC ports to Rest of US 2138
- Truck fuel factor gallons/trailer mile 0.1667
- Baseline Period Dec 11 - Mar 12
- Baseline Fuel Price $3.94
- Current Month May-13
- Prior Month Apr-13
- Monthly Average Fuel Price Prior Month $3.93
- Next Month (FAF in Effect) Jun-13

Input Values-Break Bulk Greater Than 50,000 Lbs./Shipment Unit

- Average haul EC ports to EC points 215
- Average haul GC ports to GC points 300
- Average haul WC ports to WC points 132
- Average haul EC ports to Rest of US 847
- Average haul GC ports to Rest of US 1632
- Average haul WC ports to Rest of US 2165
- Truck fuel factor gallons/trailer mile 0.2192
- Baseline Period Dec 11 - Mar 12
- Baseline Fuel Price $3.94
- Current Month May-13
- Prior Month Apr-13
- Monthly Average Fuel Price Prior Month $3.93
- Next Month (FAF in Effect) Jun-13