



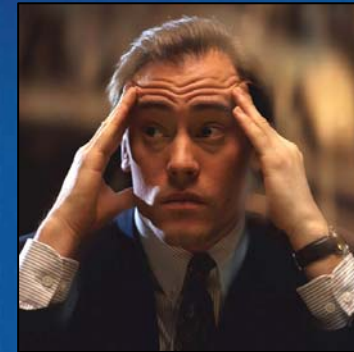
Determination of Dispatch Takeoff Weight

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Determination of Dispatch Takeoff Weight

- Seems easy - start with the empty weight of the airplane and add the weight of all items loaded!



- Not always that straightforward
- Is everything actually weighed prior to the flight?
- Does everything need to be physically weighed?
- How is the airplane empty weight determined?
- How accurate does this empty weight need to be?

Determination of Dispatch Takeoff Weight

Intent of this presentation:

- 1) Review the main components contributing to an aircraft's takeoff weight
- 2) Review applicable FAA and JAR-OPS 1 guidance and requirements for determining the weight of everything on-board an aircraft
- 3) Summarize common methods used by airlines for determining the weight of everything on-board an aircraft (based on results of informal survey responded to by 22 airlines)

Determination of Dispatch Takeoff Weight

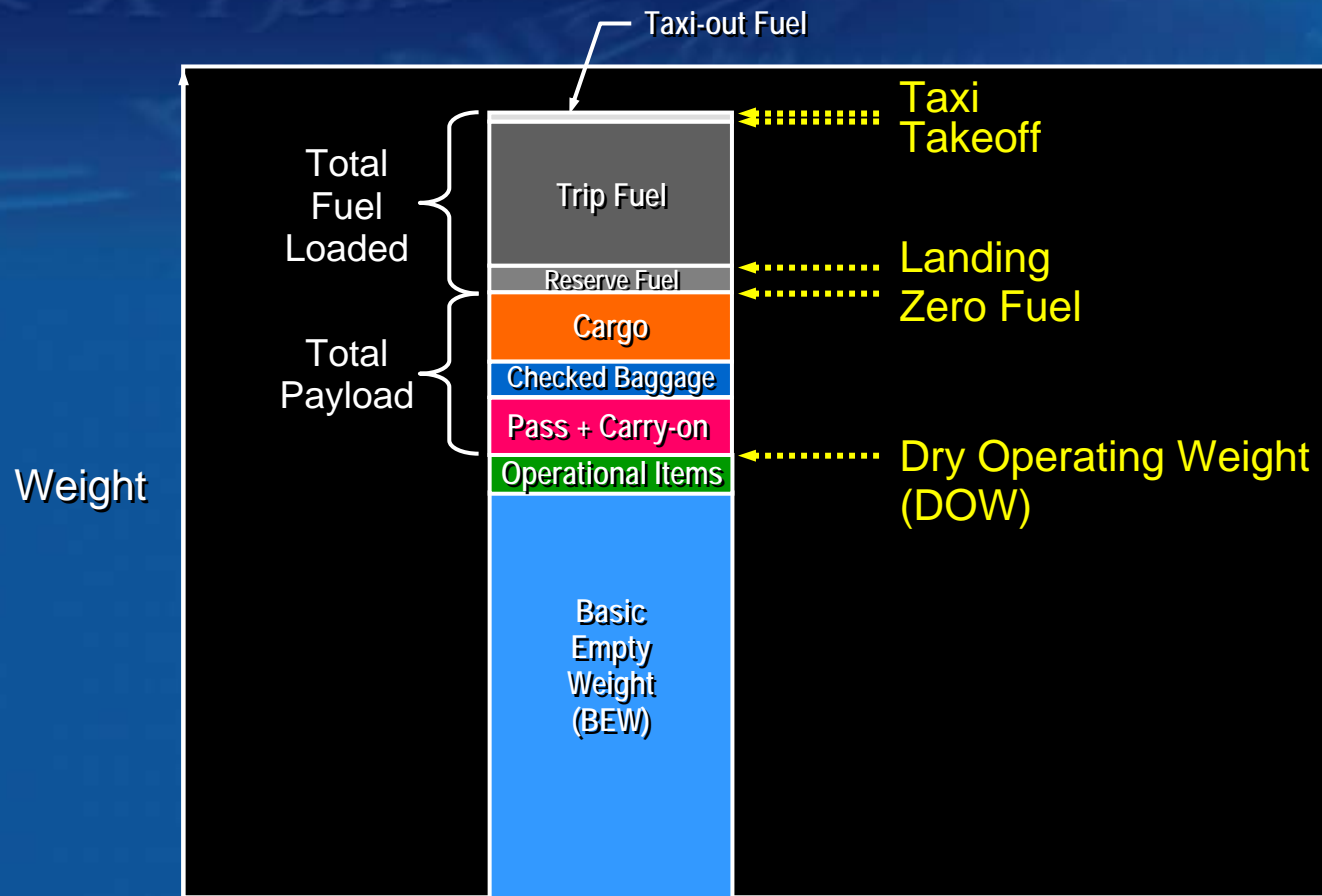


Per FAA AC 120-27E:

“Typically, an operator **calculates takeoff weight** by **adding** the **operational empty weight** (OEW) of the aircraft, the weight of the **passenger, cargo** payload, and the weight of **fuel**. The objective is to calculate the takeoff weight and CG of an aircraft as accurately as possible.”

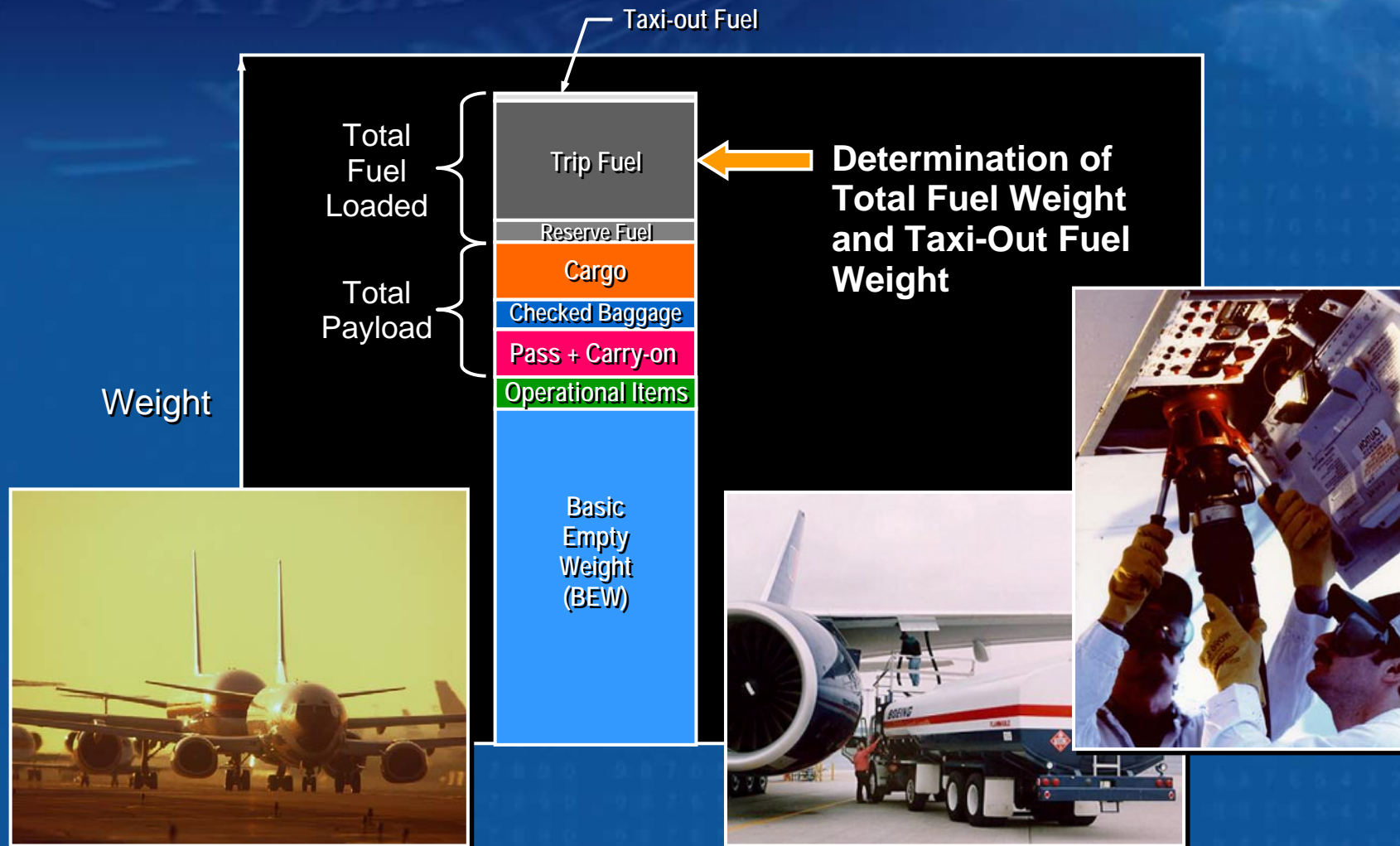
Determination of Dispatch Takeoff Weight

Components of Taxi and Takeoff Weight



Determination of Dispatch Takeoff Weight

Components of Taxi and Takeoff Weight



Determining Weight of Total Fuel

- JAR-OPS 1.605(e):

“An operator must determine the mass of the fuel load by using the actual density or, if not known, the density calculated in accordance with a method specified in the Operations Manual.”

- FAA AC 120-27E, Chapter 1, Sect. 2, paragraph 106:
(to determine the weight of each fluid used aboard the aircraft)

“An operator should use one of the following:

- a. The actual weight of each fluid,
- b. A standard volume conversion for each fluid, or
- c. A volume conversion that includes a correction factor for temperature.”

Source for Weight of Total Fuel



Source of Weight for Fuel Load Prior to Engine Start

% of Airlines Responding*	Response
45.5%	Fueling truck paperwork with cockpit gauge readings used as a second check
40.9%	Cockpit gauge readings only
9.1%	Fueling truck paperwork only
4.5%	Fuel ordering information (no good system yet in place for a final cross-check between what was ordered and what was actually received)

(*Based on informal survey of 22 airlines)

Source for Weight of Fuel Burned Prior to Takeoff (Taxi-out Fuel)

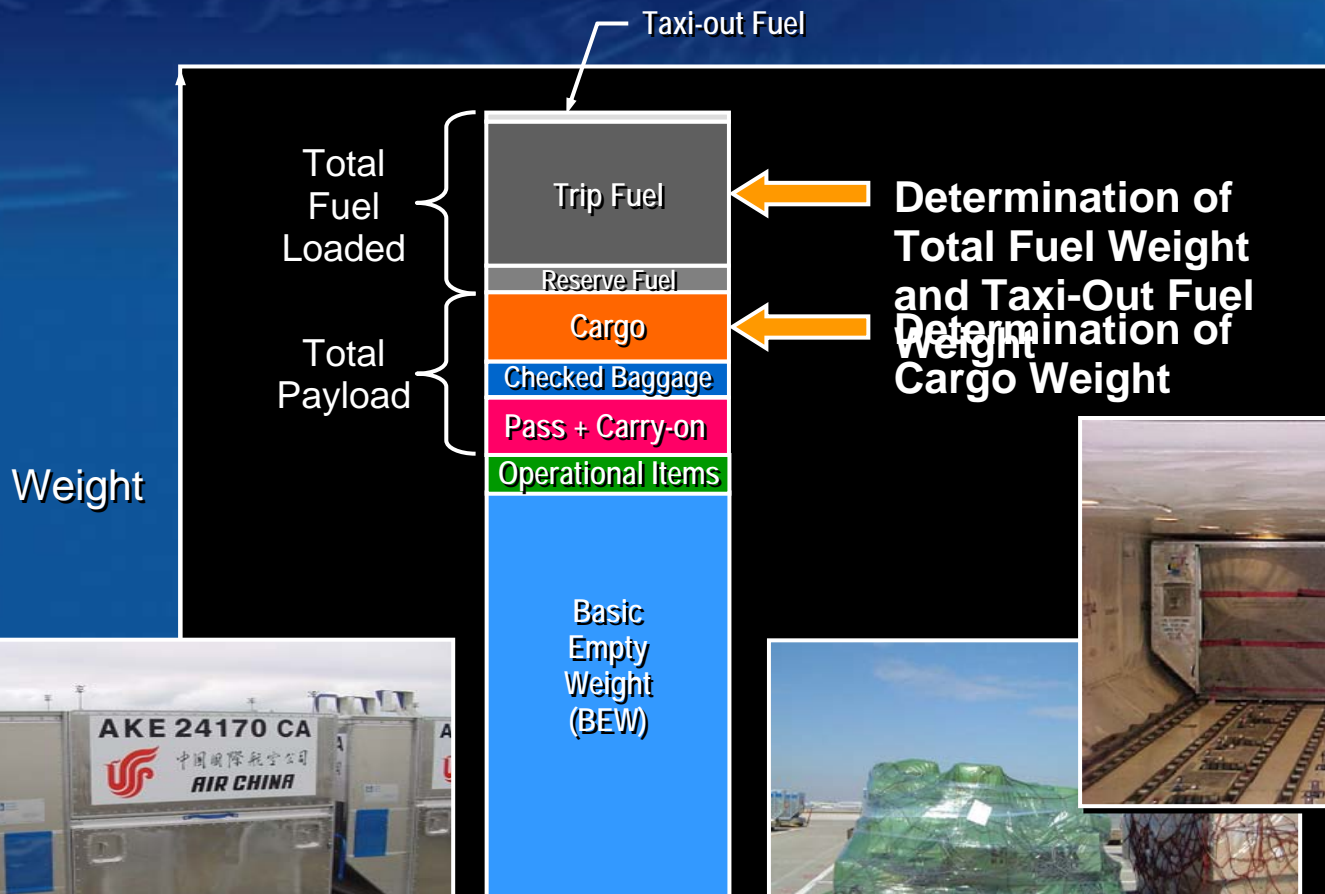


% of Airlines Responding*	Response
54.6%	Based on statistical taxi time data collected by airline for the various airports out of which they operate. Statistical taxi times are multiplied by the Boeing-provided values of nominal taxi fuel flow in to obtain planned total taxi-out fuel. (Nominal taxi fuel flow published in the FPPM or the INFLT database).
27.4%	Based on assumed, fixed taxi-out time that does not vary with airport. Assumed taxi time multiplied by Boeing-provided values of nominal taxi fuel flow in to obtain planned total taxi-out fuel.
4.5%	Do not account for any fuel burned during taxi-out as taxi times are always very short.
4.5%	Based on standard taxi times as reported in the AIP (Aeronautical Information Publication). If times are not published in the AIP for a given airport then use standard of 15 minutes total taxi-out time. Use Boeing nominal taxi fuel flow rates.
4.5%	Based on standard, single value for total fuel used prior to takeoff. Value is based on average experience, and is meant to include all fuel used prior to takeoff, including the APU.
4.5%	Methodology for handling of fuel burned prior to takeoff is proprietary.

(*Based on informal survey of 22 airlines)

Determination of Dispatch Takeoff Weight

Components of Taxi and Takeoff Weight



Determining Weight of Cargo



- FAA AC 120-27E, Chapter 2, Sect. 2, paragraph 207.a.:
“An operator should use **actual weights** for company materials, aircraft parts, and **freight** carried aboard an aircraft.”
- FAA AC 120-27E, Appendix 1, Item 8:
“**Freight. Cargo carried for hire** in the cargo compartment that is not mail or passenger bags.”
- FAA AC 120-27E, Chapter 2, Sect. 2, paragraph 207.b.:
“An operator should use the weights provided with manifested mail shipments to account for the weight of the mail.”

*(**JAR-OPS 1** requirements are very **similar**, requiring **actual weights** be used)

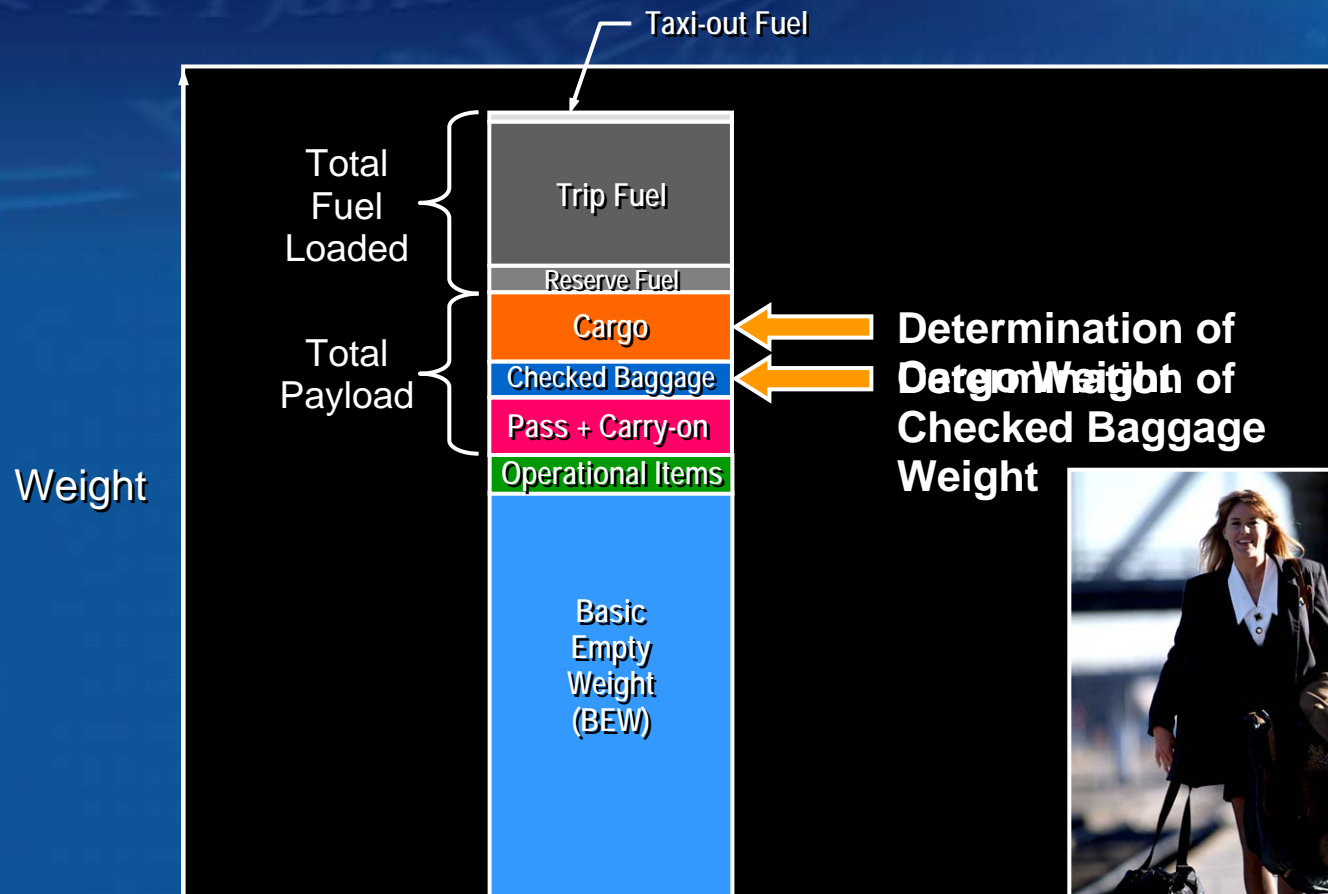
Source of Cargo Weight



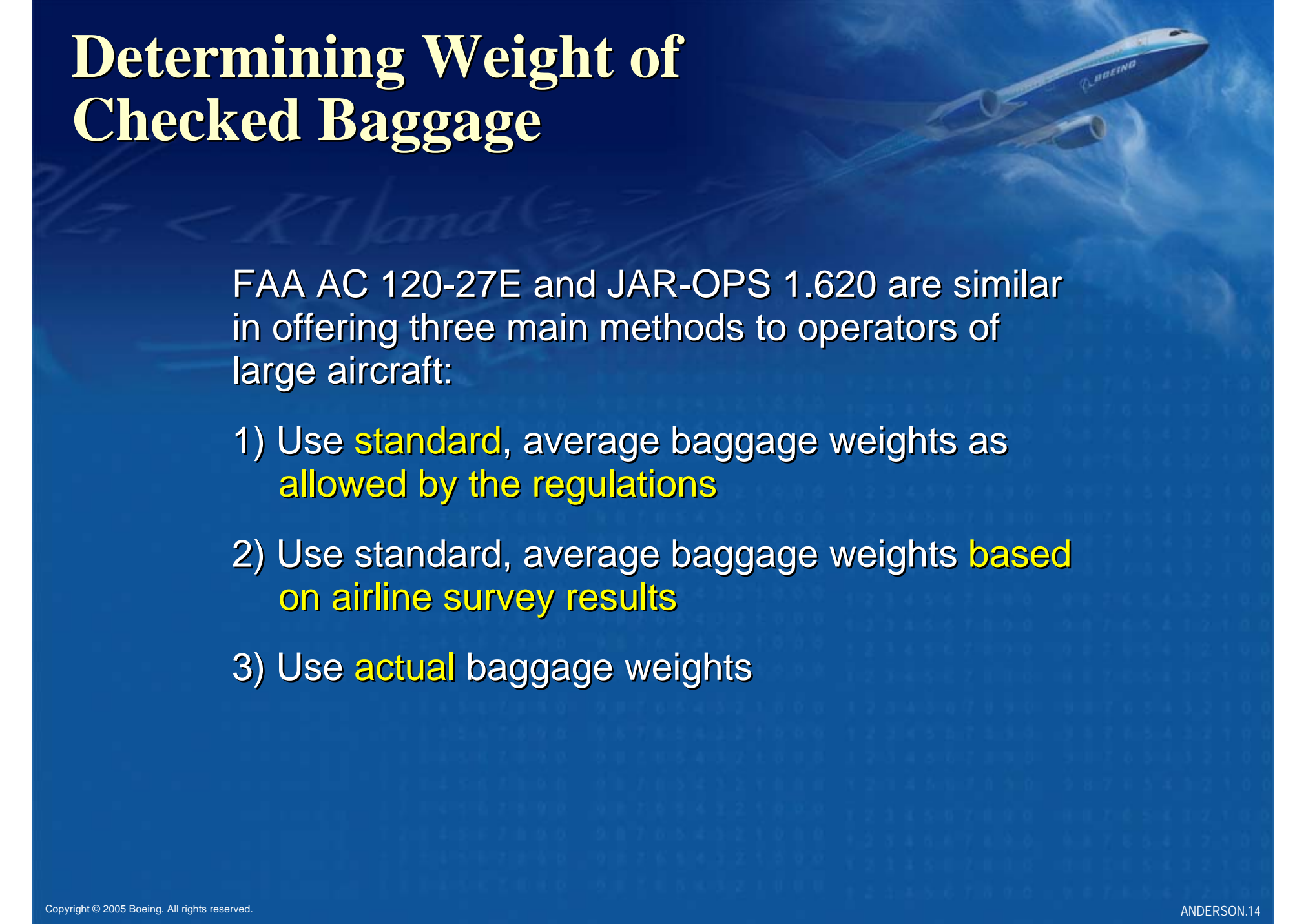
Of 22 operators responding to an informal survey **all that carry cargo reported using actual cargo weights** as weighed by them, or as reported to them by a provider of the cargo.

Determination of Dispatch Takeoff Weight

Components of Taxi and Takeoff Weight



Determining Weight of Checked Baggage



FAA AC 120-27E and JAR-OPS 1.620 are similar in offering three main methods to operators of large aircraft:

- 1) Use **standard**, average baggage weights as **allowed by the regulations**
- 2) Use standard, average baggage weights **based on airline survey results**
- 3) Use **actual** baggage weights

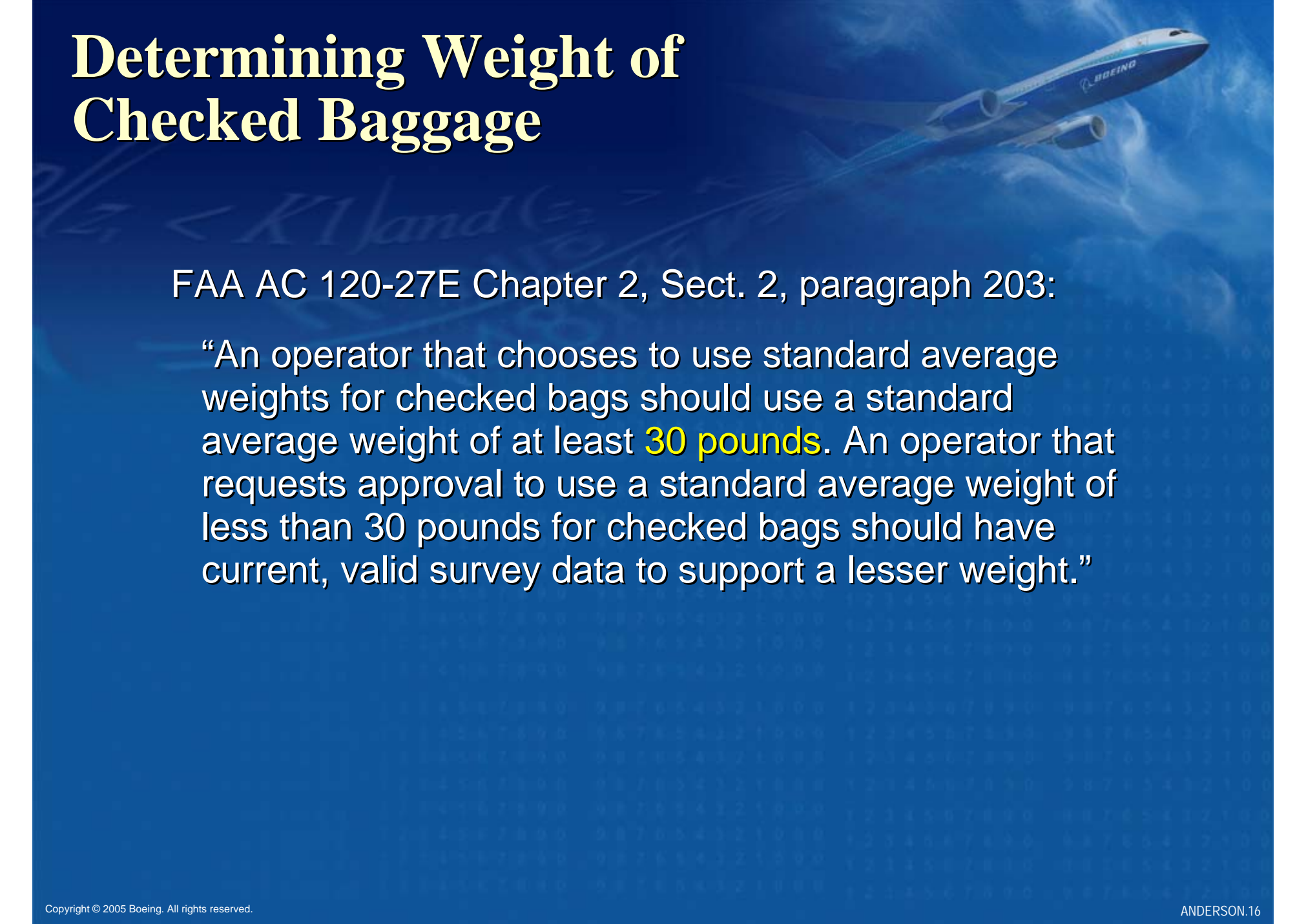
Determining Weight of Checked Baggage



JAR-OPS 1.620 (f) Mass values for baggage

Type of Flight	Baggage Standard Mass
Domestic	11 kg
	<i>24.3 lb</i>
Within the European Region	13 kg
	<i>28.7 lb</i>
Intercontinental	15 kg
	<i>33.1 lb</i>
All Other	13 kg
	<i>28.7 lb</i>


Determining Weight of Checked Baggage



FAA AC 120-27E Chapter 2, Sect. 2, paragraph 203:

“An operator that chooses to use standard average weights for checked bags should use a standard average weight of at least **30 pounds**. An operator that requests approval to use a standard average weight of less than 30 pounds for checked bags should have current, valid survey data to support a lesser weight.”

Determining Weight of Checked Baggage



- FAA AC 120-27E Chapter 2, Sect. 2, paragraph 203.a.:
“**Heavy bags** are considered any bag that weights **more than 50 pounds but less than 100 pounds**. An operator should account for a heavy bag by using one of the following weights:
 - 1) A standard average weight of 60 pounds
 - 2) An average weight based on the results of a survey of heavy bags, or
 - 3) The actual weight of the heavy bag.”
- FAA AC 120-27E Appendix 1, Item 9:
“Bags that are **100 pounds or more are considered freight.**”
(weight must be based on actual weighing)

Source of Checked Baggage Weight

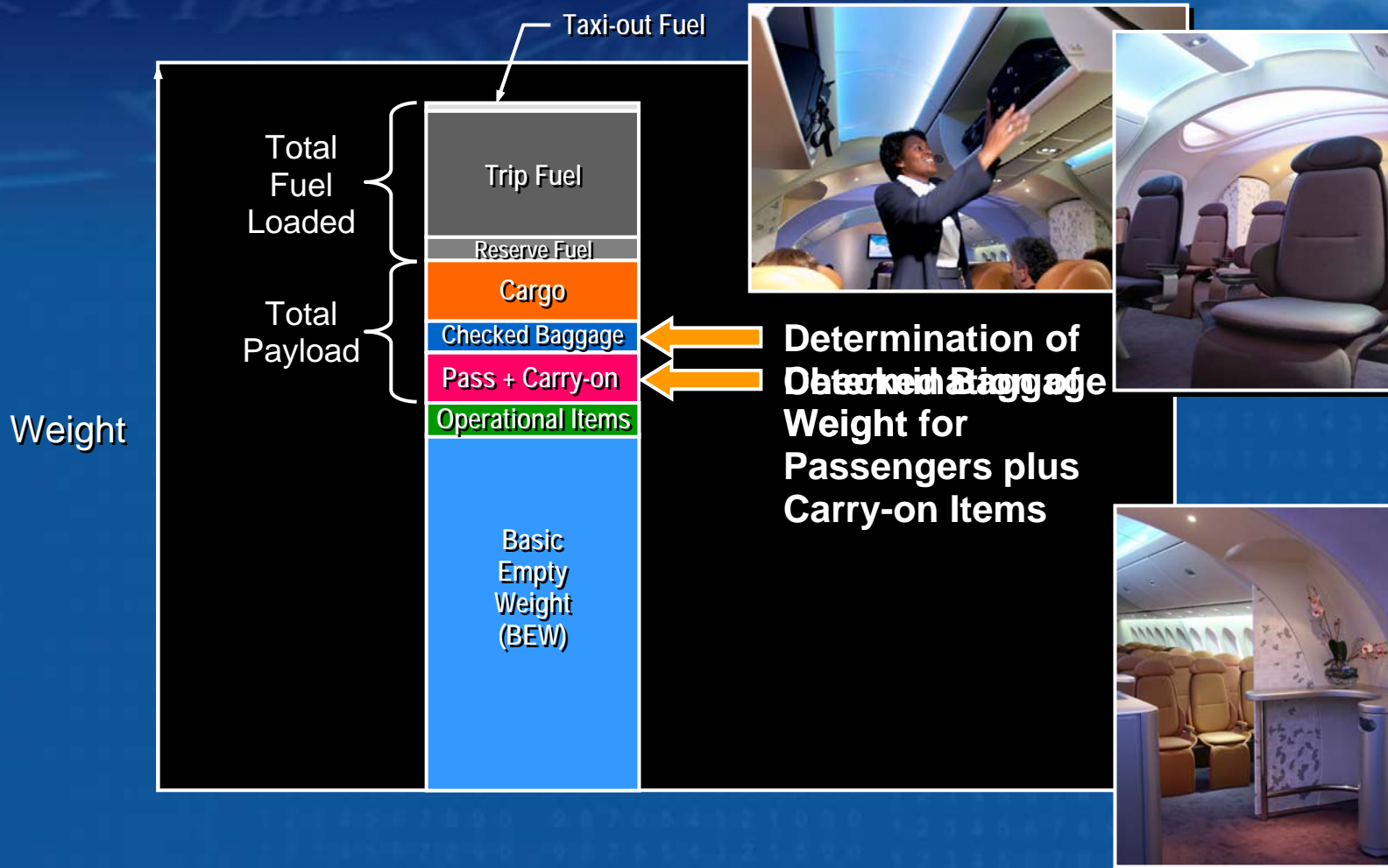
Source of Checked-Baggage Weight

% of Airlines Responding*	Response
63.7%	<p>Based primarily on actual weighing of checked bags for every flight. Any additional weight for ULD (if baggage loaded in ULDs) is added to baggage weight.</p> <hr/> <p><i>Half of these respondents included that if actual weights are not available at a given station, then standard weights are used. Standard weights reverted to were either the regulatory standards, or airline's survey-based standards ranging from 15 kg/bag to 20 kg/bag depending on the individual airline.</i></p>
22.7%	Based on standard regulatory allowances as published in either JAR-OPS 1.620 (f) or FAA AC 120-27E
9.1%	Based on average baggage allowances as determined by airline's survey results. (One airline reporting in this category offered further information stating that their allowances ranged from 30 lb to 38.5 lb/bag (13.6 to 17.5 kg/bag) depending on the specific route.)
4.5%	Based on fixed allowance of 15 kg per checked bag (did not report the basis of that value)

(*Based on informal survey of 22 airlines)

Determination of Dispatch Takeoff Weight

Components of Taxi and Takeoff Weight



Determining Weight of Passengers Plus Carry-On Items



FAA AC 120-27E and JAR-OPS 1.620 are similar in offering the following three main methods to operators of large aircraft:

1. Use **standard**, average passenger plus carry-on weights as **allowed by the regulations**
2. Use **standard**, average passenger plus carry-on weights **based on airline survey results**
3. Use **actual** passenger plus carry-on weights

Determining Weight of Passengers Plus Carry-On Items



JAR OPS 1.620 (d) Mass values for Passengers
(aircraft with 30 or more seats)

Type of Flight	Male	Female	Adult
All flights except holiday charters	88 kg	70 kg	84 kg
	<i>194.0 lb</i>	<i>154.3 lb</i>	<i>185.2 lb</i>
Holiday charters	83 kg	69 kg	76 kg
	<i>183.0 lb</i>	<i>152.1 lb</i>	<i>167.6 lb</i>
Children	35 kg	35 kg	35 kg
	<i>77.2 lb</i>	<i>77.2 lb</i>	<i>77.2 lb</i>

Determining Weight of Passengers Plus Carry-On Items



- Per JAR-OPS 1.620 (a):
“An operator shall compute the **mass of passengers** and checked baggage using either the **actual weighed mass** of each person and the actual weighed mass of baggage or the standard mass values...”
- Per JAR-OPS 1.620 (b):
“**If determining the actual mass by weighing**, an operator must ensure that passengers’ personal belongings and hand baggage are included. **Such weighing must be conducted immediately prior to boarding and at an adjacent location.**”

Determining Weight of Passengers Plus Carry-On Items



FAA AC 120-27E, Chapter 2, Section 2, paragraph 201:
Standard Average Passenger Weights

Type of Flight	Male	Female	Adult Average	Child
Summer Flights	200 lb	179 lb	190 lb	82 lb
	<i>90.7 kg</i>	<i>81.2 kg</i>	<i>86.2 kg</i>	<i>37.2 kg</i>
Winter Flights	205 lb	184 lb	195 lb	87 lb
	<i>93.0 kg</i>	<i>83.5 kg</i>	<i>88.5 kg</i>	<i>39.5 kg</i>

Determining Weight of Passengers Plus Carry-On Items



Per FAA AC 120-27E, Chapter 2, Sect. 5 paragraph 220 and 221, if an operator is **using actual weights**:

“An operator may determine the actual weight of passengers by –

- a. **Weighing each passenger** on a scale before boarding the aircraft (types of weight scales and scale tolerances will be defined in the operator’s approved weight and balance control program); **or**
- b. **Asking each passenger his or her weight.** An operator should add to this asked (volunteered) weight at least 10 pounds to account for clothing. An operator may increase this allowance for clothing on certain routes or during certain seasons, if appropriate.”

“To determine the actual weight of a **personal item, carry-on bag**, checked bag, plane-side loaded bag, or a heavy bag, an operator should **weigh the item on a scale.**”

Determining Weight of Passengers Plus Carry-On Items



- FAA operators have one additional method available per AC 120-27E; **Segmented Passenger Weights**
- Per FAA AC 120-27E Chapter 2, Sect. 4, paragraph 217.a.:
“The concept of segmented weights involves adding a portion of the standard deviation to an average weight to increase the confidence that the actual weight will not exceed the average weight.”

Determining Weight of Passengers Plus Carry-On Items

FAA AC 120-27E, Chapter 2, Section 4:
Segmented Passenger Weights - Summer Season
(aircraft with ≥ 54 seats)

Ratio of Male to Female Passengers										
0/100	10/90	20/80	30/70	40/60	50/50	60/40	70/30	80/20	90/10	100/0
188 lb	190 lb	192 lb	194 lb	196 lb	198 lb	200 lb	202 lb	204 lb	206 lb	208 lb
85.3 kg	86.2 kg	87.1 kg	88.0 kg	88.9 kg	89.8 kg	90.7 kg	91.6 kg	92.5 kg	93.4 kg	94.3 kg

- Based on same set of data that produced the standard AC weights by adding a portion of the standard deviation to attain a 95 percent confidence interval with a 1% error
- Operators are instructed to add 5 pounds to these weights to obtain segmented winter weights for adults
- For children ages 2 years to less than 13 years of age it is acceptable to use the standard AC weights even if segmented weights are used for adults
- Weights for children less than 2 years of age have been factored into this table

Source of Weight for Passengers Plus Carry-On Items



% of Airlines Responding*	Response
31.8%	Based on standard weights as determined by airline survey results. (Weights used are considered somewhat proprietary, and will therefore not be reported here.)
	<i>Of these 7 respondents: 1 uses standard weights that vary by route and season, but no accounting for male/female/children separately unless children's weight required because aircraft near a takeoff limit weight; 2 keep track of male/female/children separately, but no weight variation by route or season; 1 accounts for adults, children, and infants separately (but not male vs. female), and varies weights for different routes but not for different seasons; 3 use a single survey-based weight for all passengers on all routes regardless of season; (1 of these last 3 is in the process of switching to the standard weights of FAA AC 120-27E).</i>
27.3%	Based on JAR-OPS 1 standard allowances (including different weights for charter versus scheduled operations).
	<i>Of these 6 respondents, 3 use one standard adult weight (no male/female split) and account for children separately. (1 of these 3 reported also accounting for infants at 10 kg each.) 1 of these 6 respondents uses the standard adult weight for all passengers, including children, and 2 of these 6 respondents account for male, female, and children separately.</i>

(*Based on informal survey of 22 airlines)

Source of Weight for Passengers Plus Carry-On Items (continued)

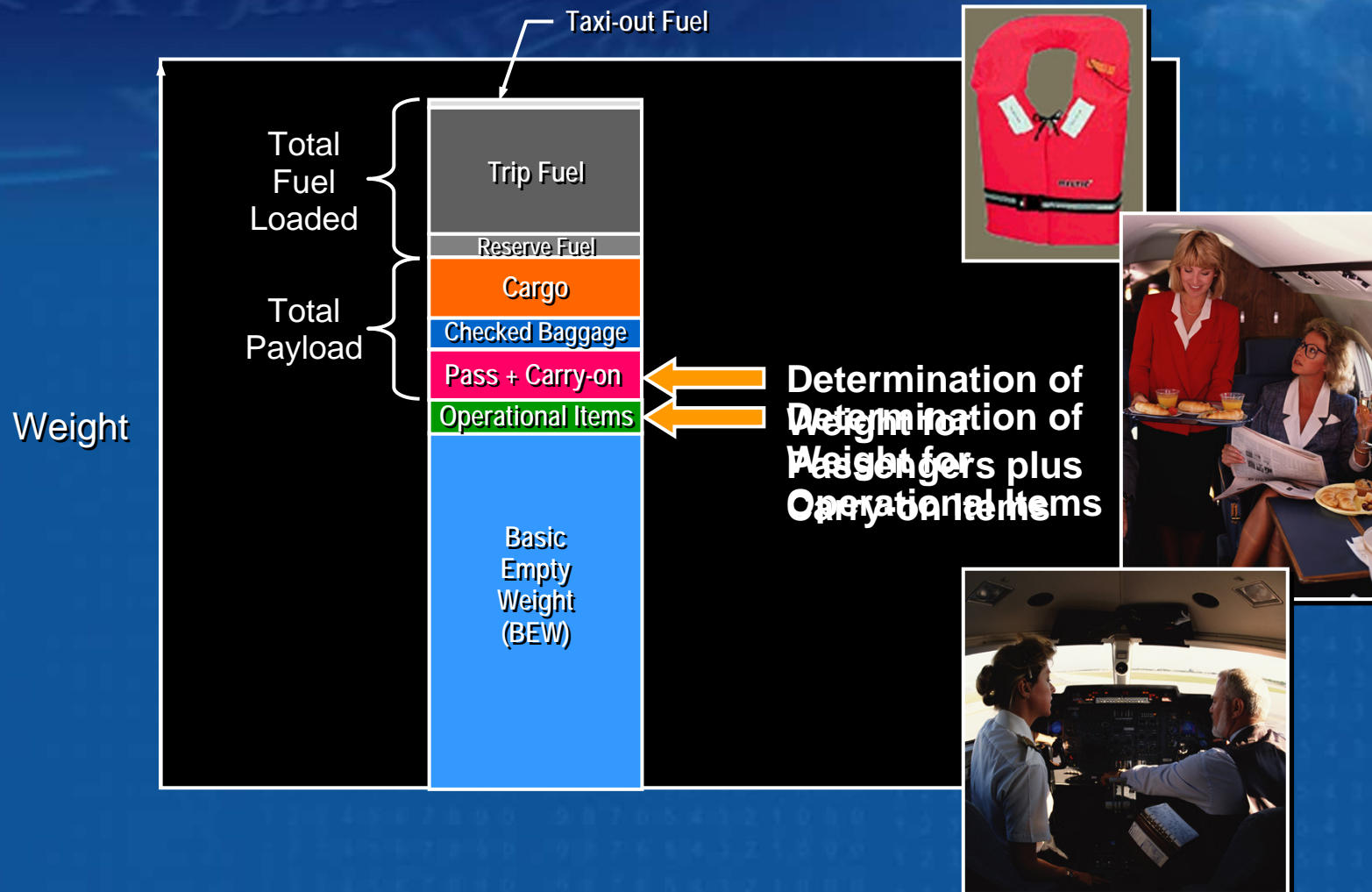


% of Airlines Responding*	Response
18.2%	<p>Based on standard weights allowed by airline's local regulatory authority (different from JAR-OPS or FAA AC 120-27E values).</p> <hr/> <p><i>Of these 4 respondents, none keep track of male versus female, 2 account for children separately.</i></p>
18.2%	<p>Based on FAA AC 120-27E allowances including seasonal weight variations (except for a few certain cities).</p> <hr/> <p><i>Of these 4 respondents, 1 uses a single standard adult weight (no male/female split) and accounts for children separately; 1 separately tracks male/female/child; 2 use a single standard weight for all passengers, including children.</i></p>
4.5%	<p>Based on JAR-OPS 1 standards with separate accounting of male/female/child. In addition, add 6 kg per business-class passenger and 12 kg per first-class passenger to account for additional carry-on. (This airline also stated that there are a few specific routes where actual passenger weights are used, but information on how these weights are obtained was not provided)</p>
0.0%	<p>Based on FAA's 'segmented' weights methodology.</p>

(*Based on informal survey of 22 airlines)

Determination of Dispatch Takeoff Weight

Components of Taxi and Takeoff Weight



Determining Weight of Operational Items

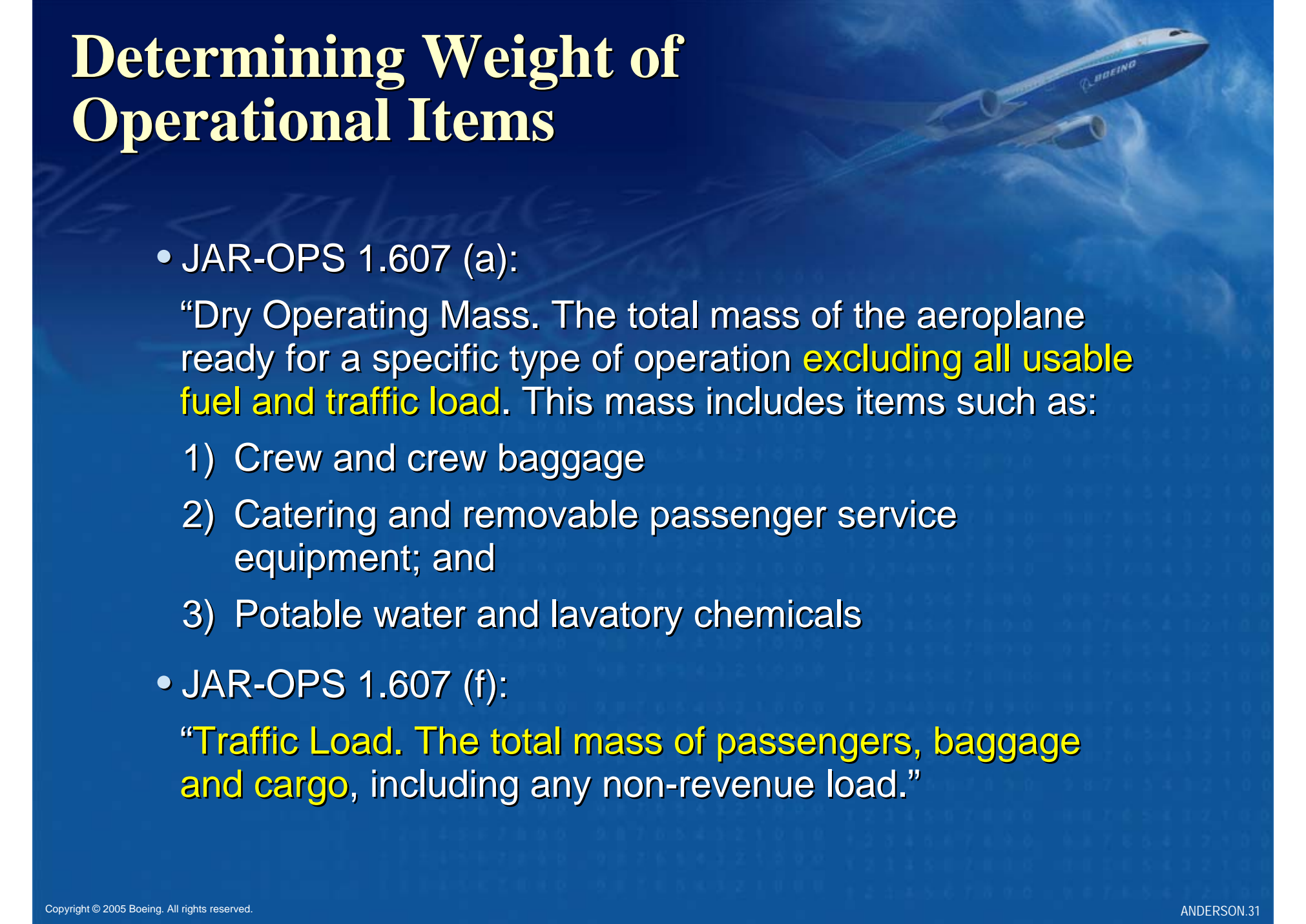


- One definition of Operational Items:

Operational items include items that could vary with route length, route type, or number of passengers carried (items other than usable fuel, cargo, checked baggage, and passengers plus carry-on items)

- Operational 'Items' includes flight crew, cabin crew, and their baggage
- Differences between operators as to what is included in 'operational items'
- Regulations are not entirely specific as to what must be included

Determining Weight of Operational Items



- JAR-OPS 1.607 (a):

“Dry Operating Mass. The total mass of the aeroplane ready for a specific type of operation **excluding all usable fuel and traffic load**. This mass includes items such as:

- 1) Crew and crew baggage
- 2) Catering and removable passenger service equipment; and
- 3) Potable water and lavatory chemicals

- JAR-OPS 1.607 (f):

“**Traffic Load. The total mass of passengers, baggage and cargo**, including any non-revenue load.”

Determining Weight of Operational Items



FAA AC 120-27E, Appendix 1, Item 22 defines Operational Items as:

“Personnel, equipment, and supplies necessary for a particular operation but not included in basic empty weight. These items may vary for a particular aircraft and may include, but are not limited to, the following:

- a. Crewmembers, supernumeraries, and bags;
- b. Manuals and navigation equipment;
- c. Passenger service equipment, including pillows, blankets, and magazines;
- d. Removable service equipment for cabin, galley, and bar;
- e. Food and beverage, including liquor;
- f. Usable fluids, other than those in useful load;
- g. Required emergency equipment for all flights;
- h. Life rafts, life vests, and emergency transmitters;
- i. Aircraft unit load devices;
- j. Potable water;
- k. Drainable unusable fuel;
- l. Spare parts normally carried aboard and not accounted for as cargo; and
- m. All other equipment considered standard by the operator.”

Determining Weight of Operational Items

- JAR-OPS 1.605(c):

“An operator must determine the mass of all operating items and **crew members** included in the aeroplane dry operating mass by **weighing or by using standard masses.**”
- FAA AC 120-27E, Chapter 2, Sect. 2, paragraph 206.a:

“An operator may choose to use the **standard crewmember weights** shown in Table 2-3 or conduct a survey to establish average crewmember weights appropriate for its operation.”

Determining Weight of Operational Items

JAR-OPS 1.615 Mass values for crew:

- a) “An operator shall use the following mass values to determine the dry operating mass:
 - 1) Actual masses including any crew baggage; or
 - 2) Standard masses, including hand baggage, of **85 kg for flight crew members and 75 kg for cabin crew members**; or
 - 3) Other standard masses acceptable to the Authority.”
- b) “An operator must correct the dry operating mass to account for any additional baggage.”

Determining Weight of Operational Items

FAA AC 120-27E, Chapter 2, Section 2, paragraph 206, Table 2-3: Standard Crewmember Weights

Crewmember	Average Weight	Average Weight with Bags
Flight Crew	190 lb	240 lb
	86.2 kg	108.9 kg
Flight Attendant - Male	180 lb	220 lb
	79.5 kg	97.1 kg
Flight Attendant - Female	160 lb	200 lb
	72.6 kg	90.7 kg
Flight Attendant - Average	170 lb	210 lb
	77.1 kg	95.3 kg
Crewmember Roller Bag	30 lb	NA
	13.6 kg	
Pilot Flight Bag	20 lb	NA
	9.1 kg	
Flight Attendant Kit	10 lb	NA
	4.5 kg	

Source of Flight and Cabin Crew Weights



% of Airlines Responding*	Response
36.4%	Based on standard weight allowances as determined by survey results of airline's flight crews.
18.2%	Based on JAR-OPS weight allowances.
18.2%	Based on FAA AC 120-27E weight allowances.
9.1%	Based on JAR-OPS weight allowances plus additional increments to account for heavier crew baggage.
9.1%	Basis of airline's flight and cabin crew weight allowances is not known by respondent.
4.5%	Based on standard weight allowances authorized by airline's regulatory authority (different from FAA or JAR-OPS allowances).
4.5%	Based on weight allowances published in the Boeing Weight and Balance Manual Chapter 1 (for this airline these allowances happened to be equivalent to AC 120-27C weights).

(*Based on informal survey of 22 airlines)

Source of Weight for Operational Fluids

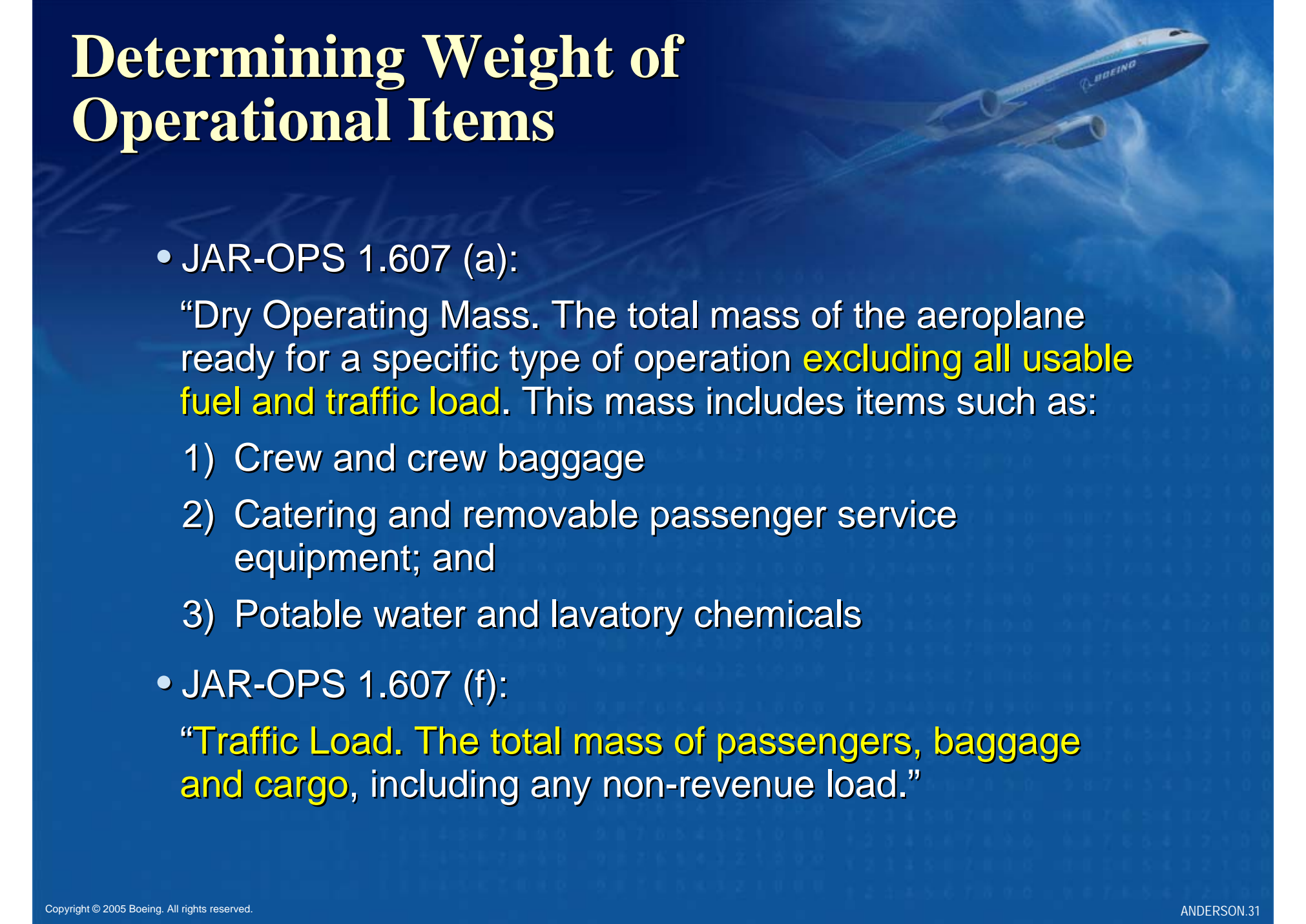
Of 22 operators responding to an informal survey all reported using information from the Weight and Balance Manual, Chapter 1, to determine weight of operational fluids such as potable water, engine and APU oil, unusable fuel, lavatory chemicals and/or pre-charge fluids, etc.

Source of Weight for Operational Items Other Than Flight Crew, Cabin Crew, and Operational Fluids

% of Airlines Responding*	Response
45.5%	Based either on actual weighing results, or weight of items as reported by suppliers. <i>(It was not clear from the responses how often items are weighed. If items are not weighed prior to every flight, and only periodically, then these responses would be included with the following response category which states use of allowances based on actual periodic weighings, leading to 81.9% responding with use of that method.)</i>
36.4%	Based on standard allowances determined by periodic weighings of the actual items.
13.6%	Based on actual weighing results for items easily weighed (no examples were provided), and using 'estimates' for all other items.
4.5%	No response to this survey question.

(*Based on informal survey of 22 airlines)

Determining Weight of Operational Items



- 18 of the 22 survey respondents reported using standard, baseline weight values for all operational items combined into groupings
- Database maintained of DOW's for each aircraft in airline's fleet based on standard operational item groupings
- Some maintain only limited number of specific DOW's; e.g., domestic versus international, some maintain DOW's for each aircraft based on functions of other variables

Determining Weight of Operational Items

Example of DOW Database



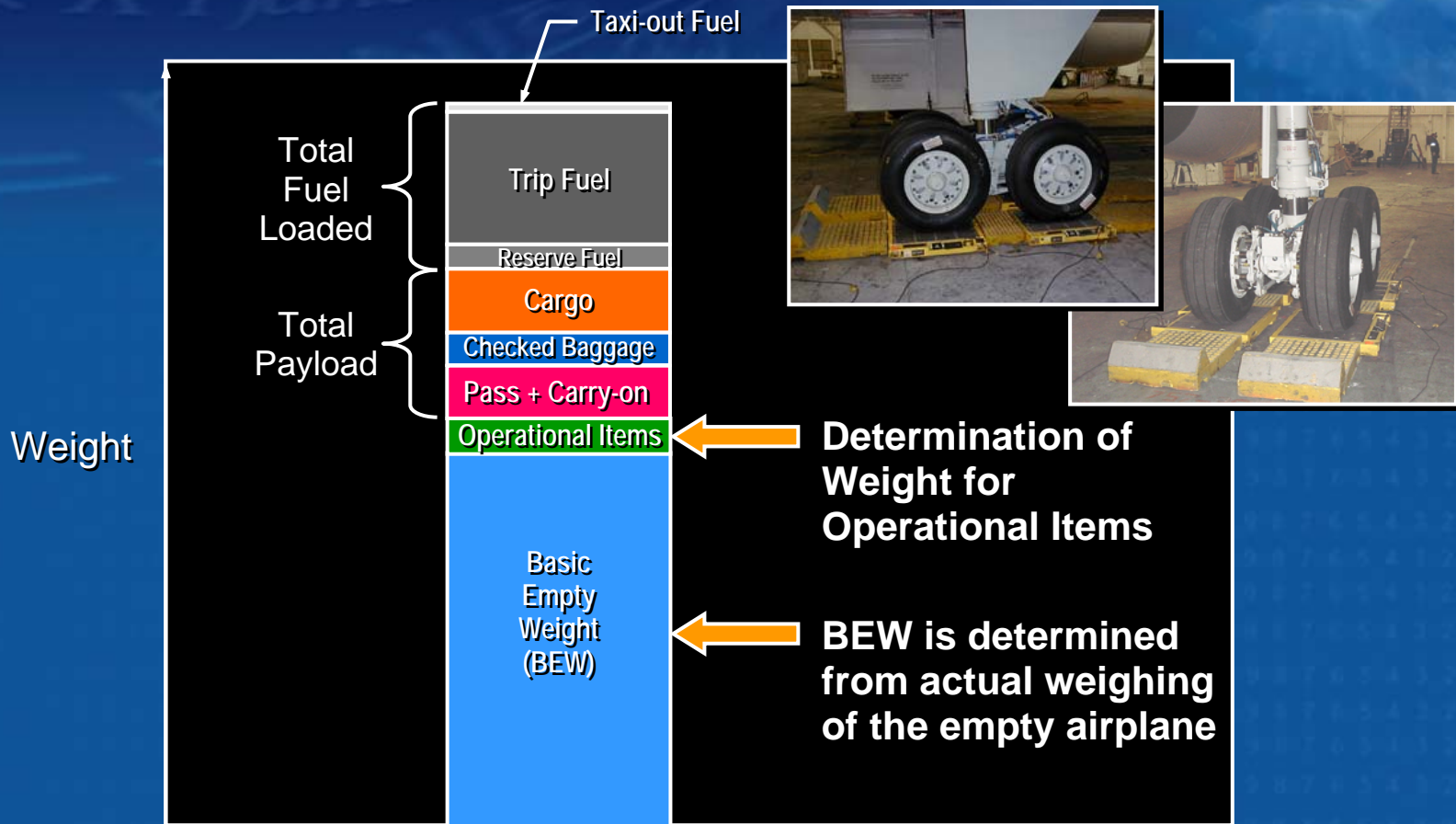
DOW / DOI TABLE																
B737-800																
		AP-001					AP-002					AP-003				
		C A B I N					C A B I N					C A B I N				
		0	4	5	6		0	4	5	6		0	4	5	6	
P.Code - A Inter.	T	2	41,806	42,106	42,181	42,256	2	41,974	42,274	42,349	42,424	2	41,247	41,547	41,622	41,697
			40.20	40.07	41.17	42.28		39.95	39.82	40.92	42.03		39.54	39.41	40.51	41.62
Two Way Catering	T	3	41,891	42,191	42,266	42,341	3	42,059	42,359	42,434	42,509	3	41,332	41,632	41,707	41,782
			38.77	38.63	39.74	40.84		38.52	38.38	39.49	40.59		38.11	37.97	39.08	40.18
P.Code - B Inter.	K	2	41,616	41,916	41,991	42,066	2	41,784	42,084	42,159	42,234	2	41,057	41,357	41,432	41,507
			40.16	40.03	41.14	42.25		39.91	39.78	40.89	42.00		39.50	39.37	40.48	41.59
One Way Catering	K	3	41,701	42,001	42,076	42,151	3	41,869	42,169	42,244	42,319	3	41,142	41,442	41,517	41,592
			38.73	38.59	39.70	40.81		38.48	38.34	39.45	40.56		38.07	37.93	39.04	40.15
P.Code - C Domestic & Ferry Catering	O	2	41,407	41,707	41,782	41,857	2	41,575	41,875	41,950	42,025	2	40,848	41,148	41,223	41,298
			39.04	38.90	40.01	41.11		38.79	38.65	39.76	40.86		38.38	38.24	39.35	40.45
	O	3	41,492	41,792	41,867	41,942	3	41,660	41,960	42,035	42,110	3	40,933	41,233	41,308	41,383
			37.60	37.47	38.58	39.69		37.35	37.22	38.33	39.44		36.94	36.81	37.92	39.03

Determining Weight of Operational Items

- Many airlines maintain database of standard DOW's based on standard set of operational items (e.g., 2 flight crew, 4 cabin crew, 'x' kgs of catering)
- Flight-specific adjustments applied to standard DOW's as functions of:
 - Route length
 - Route type
 - Number of passengers
 - Type of service provided
- Adjustments mainly to number of crew, amount of catering, and possibly amount of potable water

Determination of Dispatch Takeoff Weight

Components of Taxi and Takeoff Weight



Determining Basic Empty Weight

- One definition of Basic Empty Weight:

The weight of an aircraft including everything that is not easily removable, plus all items that tend to not vary with route length, route type, number of passengers, or amount of cargo

- BEW should not include: usable fuel, cargo, checked baggage, or passengers plus carry-on items
- Differences exist in operator's definitions of what is included in BEW (regulations are not specific as to what must be included)
- Operator's should thoroughly define and document what is, and is not, included in their definition of BEW

Determining Basic Empty Weight

- “Prior to being placed into service, each aircraft should be weighed and the empty weight and CG location established.”
 - FAA AC 120-27E, Chapter 1, Section 1, paragraph 100; similar to JAR-OPS 1.605 (b)
- “New aircraft are normally weighed at the factory and are eligible to be placed into operation without reweighing if the weight and balance records were adjusted for alterations and modifications to the aircraft unless some other modification to the aircraft warrants that the aircraft be weighed.”
 - FAA AC 120-27E, Chapter 1, Section 1, paragraph 100; similar to Appendix 1 to JAR-OPS 1.605 (a)(1)(i)

Determining Basic Empty Weight

- “**Aeroplanes transferred** from one JAA operator with an **approved mass control programme** to another JAA operator with an approved programme **need not be weighed** prior to use by the receiving operator **unless more than 4 years** have elapsed since the last weighing.”
 - Appendix 1 to JAR-OPS 1.605 (a)(1)(i)

Determining Basic Empty Weight



- “**Aircraft transferred** from one operator that has an approved weight and balance program, to another operator **with an approved program, does not need not be weighed** prior to use by the receiving operator **unless more than 36 calendar-months** have elapsed since last individual or fleet weighing, or unless some other modifications to the aircraft warrants that the aircraft be weighed.”
- “Aircraft transferred, purchased, or leased from an operator **without an approved weight and balance program**, and that have been unmodified or only minimally modified, can be placed into service **without being reweighed if the last weighing was accomplished ... within the last 12 calendar months** and a weight and balance change record was maintained by the operator.”

— FAA AC 120-27E, Chapter 1, Section 1, paragraph 100

Determining Basic Empty Weight

- “An operator should take precautions to ensure that it weighs an aircraft **as accurately as possible.**”
- “An operator should establish and follow instructions for weighing the aircraft that are consistent with the **recommendations of the aircraft manufacturer and scale manufacturer.**”
 - FAA AC 120-27E, Chapter 1, Section 1, paragraphs 104.a and 104.b; similar to JAR-OPS 1.605 (a)(4)(iii)

Determining Basic Empty Weight



AMC to Appendix 1 to JAR-OPS 1.605
Required Accuracy of Weighing Equipment

Individual Scale or Load Cell Reading	Required Accuracy
Below 2000 kg	$\pm 1.0\%$
From 2000 to 20000 kg	± 20 kg
Above 20000 kg	$\pm 0.1\%$

(No equivalent in AC 120-27E)

Determining Basic Empty Weight

- Recommended procedures for weighing of Boeing aircraft are published in WBM Chapter 1, Section 1-82-001
- Video released June, 2005; available via mbf.com

Aircraft Weighing

This 24-minute video presents the Boeing recommended procedures for the preparation and weighing of an aircraft with the goal of determining an accurate Basic Empty Weight.



➔ [Download WMV](#) (166 MB)

➔ [Download MPG](#) (184 MB)



Two versions of this video are available for download. The WMV version is a slightly better quality version of the video than the MPG version, however it may not play on all computer systems. The MPG version should play on almost all computer systems.

Determining Basic Empty Weight



- “An operator must establish the mass and the centre of gravity of any aeroplane by actual weighing prior to initial entry into service and thereafter at intervals of **4 years if individual aeroplane masses** are used and **9 years if fleet masses** are used.”
 - JAR-OPS 1.605 (b)
- “The interval between 2 fleet mass evaluations must not exceed **48 months.**”
 - JAR Ops 1.605, Appendix 1, paragraph (a)(3)(iii)

(For a discussion of ‘Fleet Weights’ refer to “Airplane Fleet Weights – Regulations and Application,” written by Michael Penland (Delta Air Lines) and Ed Davis (Boeing), published September, 2003)

Determining Basic Empty Weight

- “*Individual Aircraft Weighing Program.* Aircraft are normally weighed at intervals of **36 calendar months**. An operator may, however, extend this weighing periodto **48 calendar-months** since the last weighing.”
- “*Fleet Weighing.* An operator may choose to weight only a portion of the fleet every **36 months** and apply the weight and moment change determined by these sample weighings to the remainder of the fleet.”
- “An operator should establish a time limit such that all aircraft in a fleet are eventually weighed...the time limit should not exceed 18 years.”
 - FAA AC 120-27E, Chapter 1, Section 1, paragraphs 103.a, 103.b and 103.b.(3)

Determining Basic Empty Weight

“The **accumulated effects** of modifications and repairs on the mass and balance **must be accounted for and properly documented**. Furthermore, aeroplanes must be reweighed if the effect of modifications on the mass and balance is not accurately known.”

— JAR-OPS 1.605 (b)

Determining Basic Empty Weight



“The weight and balance system should include methods, such as a log, ledger, or other equivalent electronic means by which the **operator will maintain a complete, current, and continuous record** of the weight and CG of each aircraft. **Alterations and changes** affecting either the weight and/or balance of the aircraft **should be recorded in this log.**”

— FAA AC 120-27E, Chapter 1, Section 1, paragraph 101

“For most aircraft modifications, computing the weight and balance changes is practical...

1. In those instances when the accuracy of the calculation is questionable, the weight and moment change estimate should be verified by reweighing the aircraft...”

— FAA AC 120-27E, Chapter 1, Section 1, paragraph 103.c

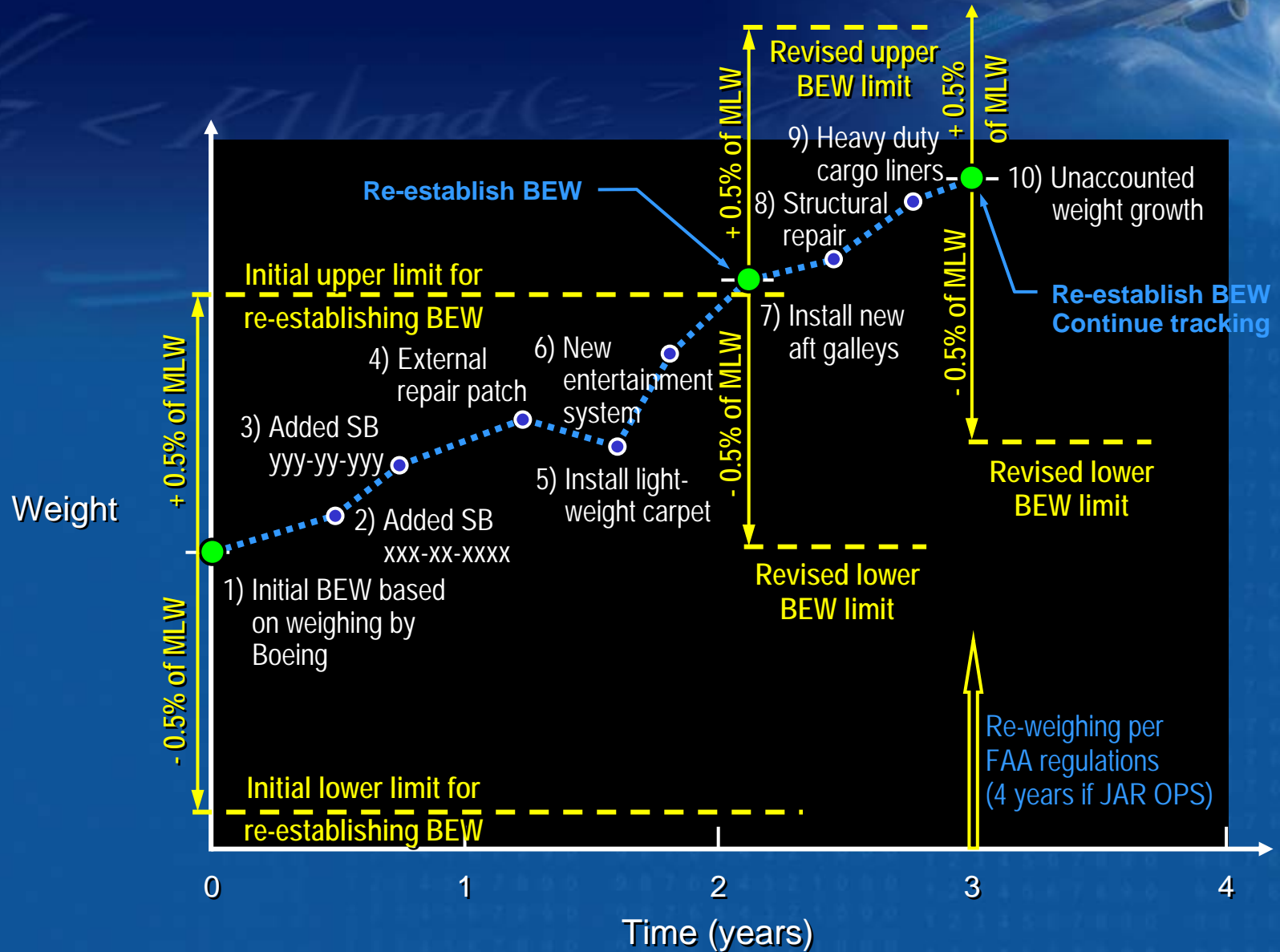
Determining Basic Empty Weight



“The **OEW** and CG position of each aircraft should be **reestablished at the reweighing periods**...In addition, it should be **reestablished** through calculation whenever the cumulative change to the weight and balance log is more than **plus or minus one-half of 1 percent (0.5 percent) of the maximum landing weight**, or whenever the cumulative change in the CG position exceeds one-half of 1 percent (0.5 percent) of the mean aerodynamic chord (MAC).”

- FAA AC 120-27E, Chapter 1, Section 1, paragraph 102.a; similar to Appendix 1 to JAR-OPS 1.605 (a)(1)(ii)

Tracking Aircraft BEW (example)



Determining Basic Empty Weight

- Operators receiving **new airplanes** from Boeing can base their BEW on Boeing-provided Delivery Empty Weight (DEW)
- **DEW** provided in **WBM Chapter 2**; consider same as Boeing-defined BEW
- Airlines should use information provided in WBM Chapter 2 Inventory List to adjust Boeing DEW to create airline's BEW

Determining Basic Empty Weight



BOEING COMMERCIAL AIRPLANE GROUP

MODEL 777 - 36NER

WEIGHT AND BALANCE CONTROL AND LOADING MANUAL

Chapter 2 reported DEW

SECTION: 011 DELIVERY EMPTY WEIGHT DERIVATION

DELIVERY EMPTY WEIGHT

DESCRIPTION	WEIGHT KG.	ARM IN.	MOMENT KG. IN.
SCALE WEIGHT	167686.3		206656257
Moment Change Flaps 15 Deg. to Down	0.0		20900
ADDITIONS TOTAL	1111.9		1510554
DEDUCTIONS TOTAL	-36.0		-23496
DELIVERY EMPTY WEIGHT	168762	(1233.5)	208164215
12 F/C + 42 B/C + 310 T/C = 364 Total Passenger Configuration (Wheels and Flaps Down)			

$$\text{C.G.} = \frac{\text{ARM} - 1174.5}{2.785} = \text{21.2\% MAC}$$

Determining Basic Empty Weight



BOEING COMMERCIAL AIRPLANE GROUP
FLIGHT LOADING MANIFEST
 777-36NER

FLIGHT NO.
DELIVERY

Delivery Manifest

ITEM	WEIGHT KILOGRAMS	MOMENT KG-IN	C.G. % MAC
BASIC EMPTY WEIGHT	168762	208164215	21.2 %
POTABLE WATER (354 GALS)	1337	3012395	
CREW & FLIGHT BAGS (4)	363	363	
DELIVERY DOCUMENTS	80	184000	
CABIN CREW (3)	218	65400	
FOOD & BEVERAGE	180	18000	
STOW IN PLACE	68	142800	
FLYAWAY KIT	8	1456	
OPERATIONAL EMPTY WEIGHT	171016	211588629	22.5 %
PASSENGERS (11)	923	276900	
BAGGAGE, FWD COMPARTMENT			
BAGGAGE, AFT COMPARTMENT			
CARGO, FWD COMPARTMENT			
CARGO, AFT COMPARTMENT			
BAGGAGE, AFT BULK	540	1155600	
CARGO, AFT BULK			
ZERO FUEL WEIGHT (Flaps & Wheels Down)	172479	213021129	21.8 %

Determining Basic Empty Weight



SECTION: 095 GROUND HANDLING AND MISCELLANEOUS ITEMS		QUANTITY:					
ITEM NO.	ITEM DESCRIPTION	UNIT WEIGHT KG.	MOM ARM IN.	R E Q	M E W	W E G H	D E L
GROUND HANDLING EQUIPMENT							
095 -1	DOWN LOCK, NOSE GEAR (INSTALLED IN GEAR)	0.2	100	1	0	1	0
095 -2	GROUND LOCK, M.L.G. (INSTALLED IN GEAR)	0.3	1340	4	0	4	0
095 -3	GROUND LOCK, NOSE J32011-7 (284W8142-4#B) (STOWED IN BOX)	0.2	126	1	0	1	1
095 -4	GROUND LOCK, M.L.G. J32011-3 (284W8142-4#B) (STOWED IN BOX)	0.3	126	4	0	4	4
095 -5	PLUMB BOB	0.5	1340	0	0	0	0
095 -6	WHEEL CHOCK	16.8	1345	0	0	1	0

Included in DEW

Not Included in DEW

Determining Basic Empty Weight



MODEL 777 - 36NER

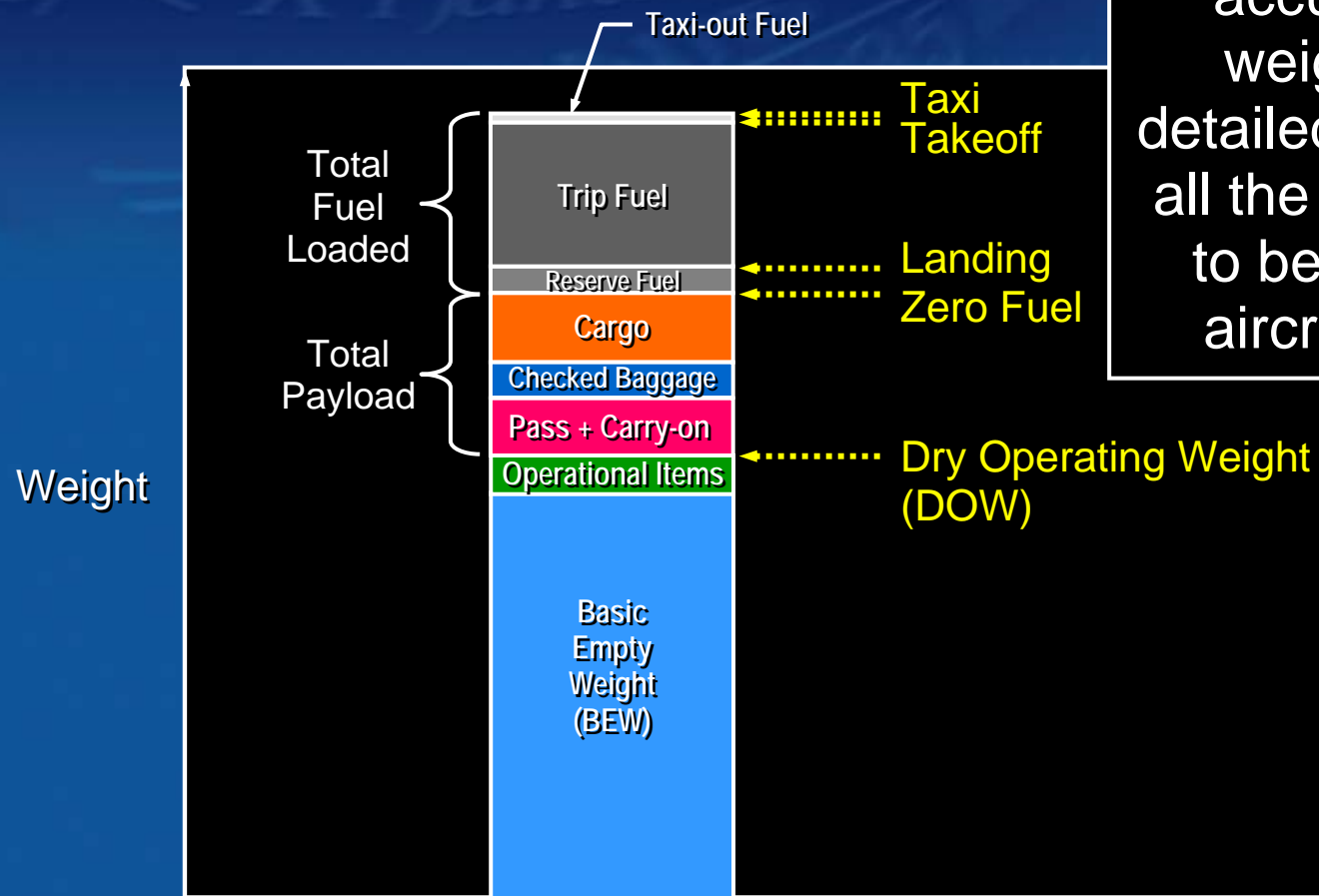
WEIGHT AND BALANCE CONTROL AND LOADING MANUAL

INVENTORY LIST

Potable Water is Not included in DEW

SECTION: 090 FLUIDS		QUANTITY:					
ITEM NO.	ITEM DESCRIPTION	UNIT WEIGHT KG.	MOM ARM IN.	R E Q	M E W	W G H	D E L
WATER							
090 -14	WATER, POTABLE - 3 TANKS (345.0 GAL.)	1305.1	2277	1	0	0	0
090 -15	WATER, POTABLE - LINES (9.0 GAL.)	34.1	1340	1	0	0	0

Summary



Determining an accurate takeoff weight requires detailed accounting of all the items planned to be onboard the aircraft at takeoff

Summary

- Some items based on actual weights for the given flight (e.g., cargo)
- Some items based on statistical allowances from actual weighings of similar items; either regulatory-based or based on airline-survey (e.g., passengers, crew, baggage)
- Some items based on actual weighings with analytical adjustments applied for known changes (e.g., BEW)

Bottom line is simply: The weight of everything onboard an aircraft must be accounted for as accurately as possible (but not accounted for more than once!)