



## AIRLIFT MISSION—MATHEMATICS II

*Students will learn about the history of airlift missions (both humanitarian and combat) as well as to learn about mathematics related to these operations, such as scenarios involving the loading of cargo. The U. S. Air Force's Global Reach is emphasized!*

### LESSON PLANS “M’ and “N”

#### Learning Objectives

The students will

- Learn about basic mathematics related to airlift operations, while working in cooperative learning teams
- Learn about the dynamics of solving problems while working in a cooperative learning team environment
- Explain the steps used by their team to identify and solve math scenarios/problems given to the whole class
- Explain why their team's solutions are valid/correct
- Learn about the history of both humanitarian and combat airlift missions around the world
- Learn about the variety of cargo and refueling aircraft which have been used throughout recent history
- Learn about the U. S. Air Force's successful development of “Global Reach and Global Power”

#### Introduction/Background

Airlift and transport missions were not a real priority during the early years of flight, primarily because the small aircraft at the time were not conducive to large cargo loads or multi-passenger movement. As airplanes developed and their size and capacity increased, airlift operations became a reality. The very first successful airlift was accomplished by Germany in 1936, when they transported 20,000 stranded Spanish troops across the Strait of Gibraltar and on to Seville, Spain. It took the Germans 677 flights (sorties) using their modified Junkers Ju.52 trimotor aircraft. After hearing the news of this successful, initial airlift, other countries began developing their own cargo/transport Aircraft. The British utilized transport-bombers, such as Their Vickers Victoria airplane. The United States developed transports that were actually Douglas DC-3 and Douglas DC-4 commercial airliners, and with modifications, these two aircraft became C-47 “Skytrains” and C-54 “Skymasters,” respectively. The conversions included removing the airliner interiors, adding heavier floors and creating large cargo doors. C-47s were affectionately called “Gooney Birds,” and the Army Air Corps first ordered these cargo airplanes in 1940. By the end of World War II, over 9,300 “Skytrains” had been procured. C-54 “Skymasters” could carry much heavier loads than the C-47s (28,000 pounds of cargo versus 6,000 pounds) and the U. S. military (the Army Air Corps and Navy) began using C-54s in 1942.

**Grade Level:** 4—6

#### National Standards for Mathematics:

Number and Operations, Problem Solving, Measurement, Geometry, Algebra and Communication

#### National Science Education Standards:

Science as Inquiry, Science and Technology and Science in Personal and Social Perspectives

#### National Standards for History:

Chronological Thinking and Historical Comprehension

#### Materials Required:

- Magic board and markers
- PowerPoint presentation
- Laptop, monitor, digital projector
- Demo items as listed within lesson plan

#### Resources:

- General Information:  
<http://www.amc.af.mil/library/factsheets/factsheet.asp?id=229> and [id=239](http://www.amc.af.mil/library/factsheets/factsheet.asp?id=239) and  
[http://www.centennialofflight.gov/essay/Air\\_Power/cargo/AP19.htm](http://www.centennialofflight.gov/essay/Air_Power/cargo/AP19.htm) and  
<http://www.futurefirepower.com/us-air-force-airlift-global-us-military-aircraft> and  
<http://www.theaviationzone.com/factsheets/c5.asp> (and [c17.asp](http://www.theaviationzone.com/factsheets/c17.asp) and [c130.asp](http://www.theaviationzone.com/factsheets/c130.asp)) and  
[www.konnections.com/airlift/berlin.htm](http://www.konnections.com/airlift/berlin.htm) and  
[www.caa.govt.nz](http://www.caa.govt.nz) and [http://www.grc.nasa.gov/WWW/k-12/WindTunnel/Activities/balance\\_of\\_forces.html](http://www.grc.nasa.gov/WWW/k-12/WindTunnel/Activities/balance_of_forces.html) and <http://avstop.com/technical/weightbal.htm> and [http://www.dod.mil/execsec/adr96/airforce\\_report.html](http://www.dod.mil/execsec/adr96/airforce_report.html) and <http://www.af.mil/information/factsheets/index.asp> and <http://www.Airforce.com/learn-about/history/part4/> and <http://www.answers.com/topic/air-mobility-command> and <http://www.grc.nasa.gov/WWW/K-12/airplane/acg.html> and  
[www.nationalmuseum.af.mil/education](http://www.nationalmuseum.af.mil/education)

From 1942 through 1947, the Army Air Corps procured 1,164 C-54 “Skymasters.” Special Note: the U. S. Air Force was not a separate branch of the U. S. military until 1947. However, from its very beginnings as a distinct entity, the Air Force has NOT just used its airlift capabilities to transport combat troops and supplies into, and out of, theaters of war (as exemplified by Operation Desert Storm, one of the largest strategic airlifts since World War II). Humanitarian airlift efforts have always been a key component and top priority for the Air Force, and these missions have made an extremely positive impact on the lives of countless individuals around the world. For example, in June 1948, when the Air Force was still in its infancy, the Soviet Union decided to block all roads, railways and rivers going into the city of Berlin (which was still in ruins after World War II). They cut all power as well, so the 2.5 million inhabitants of West Berlin faced certain starvation. There were, however, three narrow air corridors left open, as the Soviets thought the Allies’ airlift capabilities would be negligible. The United States, Britain and France agreed to join forces to keep West Berliners supplied with coal and food, and above all, to keep them free from Soviet rule. The Berlin Airlift, nicknamed “Operation Vittles” lasted for fifteen straight months, and nearly 2.3 million tons of supplies (4.6 billion pounds) were flown into Berlin during 277,000 flights (there was one flight every three minutes)! The workhorses for this incredible humanitarian airlift were C-47s and C-54s, and that is what makes this whole airlift operation so amazing—none of the gigantic cargo aircraft of today, such as the C-17 “Globemaster III,” the C-5 “Galaxy” and the C-130 “Hercules,” were in existence! More recently, the Air Force has been heavily involved in global humanitarian airlift missions, which provide relief and assistance to victims of civil war, famine, floods, earthquakes, wildfires, harsh winter weather, etc. Some of the countries that have benefitted from these humanitarian operations include Somalia, Bosnia, Kosovo, Greece, Peru, Ecuador, Venezuela, the former Soviet Republics, Rumania, Rwanda, Iraq, Turkey, Mozambique, Madagascar, Pakistan, India, Japan, Haiti, Honduras, El Salvador, Nicaragua, Afghanistan and Indonesia! Some of our states that have benefitted from the Air Force’s humanitarian efforts include Oklahoma, Kansas, South Dakota, Louisiana, Hawaii, California and Florida. In 1992, the Military Transport Service (airlift division) merged with Strategic Air Command’s refueling operations to form the Air Mobility Command (AMC). AMC is a major command which is headquartered at Scott Air Force Base in Illinois, and it provides worldwide cargo and passenger delivery, air refueling and aeromedical evacuation. It is also the command which is the focal point for all Air Force humanitarian airlift operations. With regard to air refueling operations, the two primary aircraft that allow the Air Force to have such amazing “Global Reach” are the KC-135 “Stratotanker” and the KC-10 “Extender.” They extend the range of our tactical fighters and strategic bombers during overseas operations, and they also provide refueling support to the Navy, the Marine Corps and many aircraft of our allied nations. Not only do these aircraft play a key role in the mobilization of our military assets, they are also capable of transporting litter and ambulatory patients utilizing patient support pallets during aeromedical evacuations! Regarding modern cargo aircraft, such as the C-17 and the C-5, their inherent performance and flexibility greatly improve the ability of the Air Force’s ‘total airlift system’ to fulfill its global air mobility requirements. These requirements have increased significantly, since the size and weight of U. S. mechanized firepower and equipment have grown in response to the improved capabilities of our potential adversaries. Finally, the ultimate measure of airlift efficacy is the ability to rapidly project and sustain an effective combat force in close proximity to a potential theater of war. Most assuredly, the U. S. Air Force has that ability! And, its proficiency in providing humanitarian aid is beyond repute!

## **Procedures:**

Special Note: Teachers may use as much of the information contained within the “Introduction/Background” section as they deem appropriate for their class/students; teachers may wish to use all of the items contained within this “Procedures” section, or they may wish to create their own derivatives and/or related steps.

- Write (on board) the things that will be covered/discussed/reviewed in class including: the history of airlift operations, the types of aircraft used to transport cargo, passengers and fuel, a PowerPoint presentation, Airlift Mission Mathematics activities (for cooperative learning teams). **LESSON PLAN “M” :**
- Hooks: hold up a Styrofoam glider and tell the students that this is a C-17 “Globemaster III” cargo airplane! Make sure the class understands what ‘humanitarian aid’ means, and how it can change lives for the better!
- Tell the students that there is no place on earth (where people need help) that the Air Force cannot reach with, for example, clean water, food, medical supplies, school supplies, fuel, grain, tents, bedding and farm items!
- Show the students the PowerPoint presentation of past and present airlift aircraft, refueling aircraft and airlift missions (both humanitarian and combat) at <http://www.nationalmuseum.af.mil/shared/media/document/AFD-121218-021.pdf>. Emphasize the C-17 slide.
- Briefly discuss the content of the PowerPoint slides and allow students to ask a few questions.
- Form the students into cooperative learning Airlift Mission Math teams of four or five students each.

## Procedures (continued)

- Ensure that each team has plenty of paper, pencils and a calculator or two.
- Draw a rectangle on the board and tell the teams that this represents a special pallet that is used by the Air Force to take cargo all over the world to relieve the suffering of people in need. It is called a 463L pallet.
- Within your classroom, you may wish to make an outline of the perimeter of a 463L pallet (using string or ribbon) so students can grasp just how big a 463L really is (88 inches x 108 inches x 2.25 inches thick)! If it is practical, have all students stand within the outline. Ask them how much weight they think one pallet can hold (10,000 pounds)! Ask them how many pallets they think a C-17 can hold within its cargo bay/floor (18)! Write the dimensions and weight maximum for one of these pallets on the board for student team reference.
- Tell the teams that they will now work together on some math scenarios related to loading cargo on a C-17 and they may draw rectangles on their papers to signify pallets on the aircraft.
- **Scenario #1:** your team has to load food, water and tents (for humanitarian aid) to help people whose city (in Honduras) was hit by a big earthquake and flooding. Write this on the board for students to refer to: food = 39,000 pounds; water = 57,000 pounds; tents = 60,000 pounds. Tell the students that their C-17 has a total cargo (weight) capacity of 160,000 pounds. Give teams ample time to calculate how many pallets of each commodity they will need to load onto their aircraft for transport to Central America. Walk around the room, but assist teams only when absolutely necessary!
- Ask different teams what they came up with for the food, the water and the tents. The answers: food will require four pallets to get the 39,000 pounds onto the airplane; the 57,000 pounds of water will need six pallets; six pallets will also be required to handle the tents. The total pallet count, therefore, is 16 and the total weight is 156,000 pounds—both are within the C-17's parameters for cargo!
- **Scenario #2:** your team has to load bales of hay to feed starving cattle that have been stranded in a blizzard in Kansas. Write this on the board for the student teams to follow: each bale of hay weighs 80 pounds and is 22" wide by 36" long (tell teams not to worry about bale height for this exercise, but the bales can be stacked ten high on a pallet). Tell teams that the 160,000 pound restriction is still in effect, as is the 18-pallet maximum cargo load. Draw rectangles on the board inside your pallet rectangle as you discuss how many bales will fit on the first layer of a pallet: 22" x 4 = 88" and 36" x 3 = 108"—so one layer contains 12 bales. Tell them that they are looking for the following: how many bales of hay can fit on a pallet, how much weight is on each pallet, how much weight is in the entire humanitarian shipment and how many pallets will be required.
- Ask different teams for their answer to a particular part of the scenario. The answers: each layer has 12 bales, and when they are stacked 10 high, there are 120 bales per pallet. If one bale weighs 80 pounds, the full pallet weight is 9,600 pounds! As the maximum weight for our C-17's cargo is 160,000 pounds, 16 pallets at 9,600 pounds yields a total cargo weight of 153,600 which is well within the parameter, and 16 pallets is as well.
- **END OF LESSON PLAN "M;" / BEGINNING OF LESSON PLAN "N" :**
- **Scenario #3:** Tell the teams that you are changing airplanes for this mission, and you are deploying a C-5 "Galaxy," the largest cargo aircraft in the world! Tell them that the C-5 has a payload/cargo capacity of an amazing 285,000 pounds, and it can hold twice as many 463L pallets as the C-17 (36)! Write this new weight maximum and pallet count on the board for student team reference. Back to the scenario: there has been a terrible natural disaster, and it has effected several countries in Asia. Tell the teams that they must load water, food, medical supplies, blankets and tents to provide relief to the suffering people in these countries. The base supply depot has already loaded each pallet with these needed items, but the teams must figure out how many of each palletized commodity they will need to load onto the C-5. Write this on the board for students to refer back to: each loaded pallet weighs 7,900 pounds, regardless of the item; there must be eleven pallets of water on the shipment (86,900 pounds); the number of pallets of food needs to be twice the number of pallets for the other three remaining commodities (twice the pallet count for food as there is for medical supplies, blankets and tents). Give teams ample time to use the information and clues, and to calculate how many pallets of food, medical supplies, blankets and tents need to be loaded onto their C-5 "Galaxy."
- Ask different teams for their answers. The answers: since each pallet weighs 7,900 pounds, the total weight for all 36 pallets would be 284,400 pounds, which is under the 285,000-pound parameter for the C-5; there must be eleven pallets of water onboard, so the remaining pallet count is 25; the food pallet count must be twice that of each of the other three items, so student teams would need to load ten pallets of food, five pallets of medical supplies, five pallets of blankets and five pallets of tents!
- Announce to the class that the final 'scenario' involves the C-5 humanitarian mission they just worked on, but the teams will be working on ratios and percentages this time. If the students haven't worked much on (pg 4)

### Procedures (continued)

- percentages, you may wish to cover/review a few simple examples, such as 25% or 50% of a whole pie, etc.
- Write 100% on the board, and tell the student teams that, for the C-5 mission, 36 pallets represents 100% of the shipment. To arrive at the percentage of the shipment allotted to water (11 pallets) you can take 11 and divide by 36 (total pallets). The answer is 30.55, and that is the percent-to-total for the pallets of water. It can also be solved by using a simple ratio: 36 is to 100 as 11 is to  $x$  (written  $36/100$  times  $11/x$ ). To find the answer, you multiply 11 times 100 (which equals 1,100) and then divide the 1,100 by 36, which yields the same answer: 30.55%. Tell the teams it's just another method to calculate percentages.
- Challenge the teams to calculate what the percentage-to-total is for each of the remaining items (food = 10 pallets, medical supplies = 5 pallets, blankets = 5 pallets and tents = 5 pallets). Give teams ample time to work.
- Ask different teams how they arrived at their percentages. The solutions using ratios follow:

$$\frac{36}{100} \times \frac{10}{x} \quad (10 \text{ times } 100 \text{ equals } 1,000 \text{ and } 1,000 \text{ divided by } 36 \text{ equals } 27.77\%)$$

$$\frac{36}{100} \times \frac{5}{x} \quad (5 \text{ times } 100 \text{ equals } 500 \text{ and } 500 \text{ divided by } 36 \text{ equals } 13.88\%)$$



A C-17 “Globemaster III” taking off on a humanitarian mission!

### Assessment/Evaluation

The students should be evaluated on class participation, listening skills and ability to follow verbal instructions, especially when they are being given problems to solve in cooperative learning teams.

### References

- The C-47: Flying Workhorse of WWII* by Richard D. Harvey; Bloomington, IN: Author House; 2005
- C-54-PLM Revisited* by Ralph L. Stevenson, Jr; Sante Fe, NM: Sunstone Press; 2010
- Humanitarian Airlift Operations* by Daniel L. Haulman; Washington, DC: U. S. Printing Office; 1998
- The Lockheed Martin C-130 Hercules* by Peter C. Smith; Manchester, England: Crecy Publishing Ltd.; 2010
- The “C” Planes: U. S. Cargo Aircraft 1925 to the Present* by Bill Holder & Scott Vadnais; Atglen, PA: Schiffer Publishing Ltd.; 1996
- The Boeing C-135 Series: Stratotanker, Stratolifter and other Variants* by Don Logan; Atglen, PA: Schiffer Publishing Ltd.; 1998