



## AIRLIFT MISSION MATHEMATICS

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

### LESSON PLAN (A)

#### 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 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/API9.htm](http://www.centennialofflight.gov/essay/Air_Power/cargo/API9.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 (in cooperative learning teams of three, four or five students each).
- Hook: have a student volunteer come to the front of the classroom and put their arms around a globe or an inflated earth ball. Tell the class that this student’s arms represent the “Global Reach” of the U. S. Air Force!
- Tell the students that there is no place on earth that the Air Force cannot reach with, for example, humanitarian aid, which may include 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): <http://www.nationalmuseum.af.mil/shared/media/document/AFD-121218-021.pdf>
- Briefly discuss the content of the PowerPoint slides and allow students to ask questions.
- Form the students into cooperative learning Airlift Mission Math teams of three, four or five students each.

### Procedures (continued)

- Tell the students that you are going to continue with the earth/globe theme, and use the globe or inflated earth ball as a demonstration piece. Draw a circle on the board representing the earth and include a center point.
- Ask what the circumference of a circle is—trace around it; ask what the actual circumference of the earth is.
- Using a round number for earth's circumference (25,000 miles) ask the student teams how many times a C-5 "Galaxy" aircraft would need to be refueled to travel completely around the world. Tell them that this C-5 is flying with a small load (on a training flight) and can go about 6,250 miles before needing to be refueled.
- Walk around the classroom and assist cooperative learning teams as needed (calculators are permitted).
- Ask each team to tell the rest of the class how many times this C-5 would (hypothetically) need to be REFUELED (for our purposes, assume it took off with full fuel tanks, and the correct answer is three times)!
- Draw sections on your circle so that it resembles a pie with four slices. Ask teams to express, in fractions/decimals/percentages/degrees, the distance represented by one "leg" of this C-5's trip (1/4; .25; 25%, 90 deg.), halfway around the earth (2/4; 1/2; .50; 50%, 180 deg.), 3/4; .75; 75%, 270 deg. (show each "leg" on board).
- Ask the teams to calculate how many gallons of jet fuel this C-5 burned to go three-fourths of the way around the earth, if one complete refueling takes 51,450 gallons of fuel. The correct answer is 154,350 gallons!
- Tell the students they are now switching to a C-17 "Globemaster III" flight that also goes around the world! Give teams this information: this C-17 is loaded with 160,000 pounds of cargo; this C-17's range with full fuel tanks is about 2,400 NAUTICAL MILES. In order for teams to convert to STATUTE MILES they must realize that a nautical mile is 796 feet longer than a statute mile, or 115% longer than a statute mile.
- Have the student teams use the same 25,000 statute mile earth circumference, and allow them ample time to discuss and to calculate how many times the C-17 would need to be refueled to fly around the world.
- Walk around the classroom and assist the student teams when absolutely necessary.
- Have the teams describe how they came up with their answer(s) and write the information on the board.
- Student teams should have converted the 2,400 nautical miles into statute miles by multiplying the 2,400 by 115% (by 1.15) and that yields 2,760 statute miles per refueling. If students divide 25,000 by 2,760, the quotient is 9.0579; therefore, this C-17 would need to be refueled eight times for its trip around the earth!
- Have teams express (fraction/decimal/percentage/degrees) one leg of the C-17's trip (1/9; .11; ~11%, 40 deg)!
- If our C-5 (with no cargo) burns 206,000 gallons of jet fuel to circle the globe, and our C-17 (fully loaded) uses 244,000 gallons, ask the teams how much more fuel is used by the C-17 (expressed in a percentage). Student can divide 244,000 by 206,000 OR use the ratio 206 divided by 100 times 244 divided by x (18.45%).

### 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 (where cooperation is key)!

### Extension

Have the student teams choose an airlift/cargo/refueling aircraft (past or present) and allow them a few days to research that aircraft. Have each team share their findings with the rest of the class within a few days.

### 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