HELICOPTER TACTICAL LOADING

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ADVANCE SHEET

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UNITED STATES ARMY AVIATION SCHOOL
FORT RUCKER, ALABAMA

DEPARTMENT OF TACTICS
UNITED STATES ARMY AVIATION SCHOOL
Fort Rucker, Alabama

File No. 597-1
597-3

PERFORMANCE OBJECTIVES

HELICOPTER TACTICAL LOADING

1. KNOWLEDGES: Without the aid of notes or references, the student will be able to correctly list or write —

    a. The major difference between prepared type cargo and miscellaneous type cargo.

    b. The restraint criteria for helicopters of the UH-1 type as stated in AR 705-35.

    c. The capacity of the tiedown fittings in the UH-1.

    d. The percent effectiveness of the 30/30-degree angle of tie.

    e. The formula used to determine the number of devices needed to secure cargo.

    f. One of two major differences in applying lashing formula to prepared cargo and miscellaneous cargo.

2. SKILLS: Without the aid of notes or references, the student will be able to correctly solve or compute a sample problem, finding the number of restraint devices necessary to secure a cargo when given the weight of cargo, restraint criteria of aircraft, tensile strength of tiedown provisions, and percent of effectiveness for angle of tie used.

NOTES

*WEIGHT &
BALANCE*

TM 57-210

File No. 597-1
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ADVANCE SHEET

HELICOPTER TACTICAL LOADING

PURPOSE: This presentation is designed to describe to the basic student the more important aspects of tactical loading of helicopters, emphasis being on loading factors during combat or field conditions.

SCOPE: Classroom work will be divided into two general areas.

1.   Conference covering a brief introduction to the subject and restraint of cargo.

2.   A "programed block of instruction" will be presented containing a workbook which the student will complete at his own speed. The workbook will cover—

    a.   Aircraft requirements.

    b.   External loading of helicopters.

    c.   Internal loading of helicopters.

    d.   Center of gravity (cargo).

    e.   Troop briefing considerations.

STUDY ASSIGNMENT:

1.   Scan: None.

2.   Study: None.

3.   Read: Advance Sheet.

SPECIAL INSTRUCTION: None.

SUPPLEMENTAL MATERIAL: Restraint of cargo (all other topics covered in workbook).

1.   Forces acting on cargo.

    a.   Forward, aft, lateral, and vertical forces must be restrained against.

    b.   Restraint devices designed to restrain cargo are applied, attached to the cargo itself or over, around, or through the cargo holding it to the cargo floor.

2.   Restraint is the amount of force necessary to keep the cargo from moving in any direction.

a.   These forces are expressed in "forces of gravity" or more commonly called G's.

b.   The cargo must be restrained against more than its normal weight because of these forces or G's, acting on the cargo under abnormal conditions (forced landings, accelerations, vibrations, rough air, etc.).   These forces cause the cargo to actually weigh many times more than its normal weight.

c.   To properly restrain cargo under these possible abnormal conditions, "restraint criteria" are established by the manufacturer and published in the Operator's Handbook (-10).

d.   When this figure is applied to the formula used to determine the number of tiedown devices necessary to restrain the cargo, we are assured that we have enough restraint available.

3.   Each restraint device has a rated tensile strength.

EXAMPLE: A-1A device - 1250 pounds tensile strength.

a.   This strength is misleading. Very seldom will 100 percent of this strength be available. This varies with the angles at which the devices are applied to the cargo.

b.   To determine what percent of the effective strength of the device we have available, refer to Annex A and Annex B. These charts will give the percent effectiveness if you know the angles at which the device is applied to the cargo.

4.   The formula for determining the number of devices needed for a particular cargo is as follows:

$$\frac{\text{Weight of object x restraint criteria}}{\text{Tensile strength of device x percent effective}} = \text{Number of devices needed.}$$

a.   The weight of the object is known.

b.   Restraint criteria is given for all four directions.

EXAMPLE: UH-1 (From AR 705-35)

    Forward   -   4 G's

    Aft   -   2 G's

    Vertical   -   2 G's

    Lateral   -   1.5 G's

The number of devices needed to restrain the cargo in each of these directions must be computed. So each of these figures must be applied to the formula and the number of devices found for that direction.

c.   The tensile strength of the device is determined by the type of device utilized.

d.   The percent effectiveness, if found from Annexes A or B, is based on the angles involved.

5.   Cargo with tiedown provisions. Container specifically designed to hold cargo falls in this category. They usually have rings, hooks, etc., built onto them so that the device can be attached directly to the cargo.

a.   At least four devices are necessary to restrain this type of cargo, one at each corner of the container.

b.   The angles are measured in two planes.

(1)   The angle measured between the device and the cargo floor.

(2)   The angle measured between the device and the longitudinal axis of the helicopter.

c.   The best general angles to use if possible are 30/30. These angles give the best overall percentage and should be used whenever possible.

d.   Example problem: What would be the minimum number of devices needed for a 400-pound container using the A-1A device with restraint criteria of 4 G's forward, 2 G's aft, 2 G's vertical, and 1.5 G's lateral? Use the 30/30-degree angle of tie.

4 G's forward:

$$\frac{400 \times 4}{1250 \times .75} = 1.7 \text{ or } 2 \text{ devices forward.}$$

2 G's aft:

$$\frac{400 \times 2}{1250 \times .75} = 0.9 \text{ or } 2 \text{ devices aft.}$$

2 G's vertical:

$$\frac{400 \times 2}{1250 \times .50} = 1.3 \text{ or } 2 \text{ devices vertically.}$$

1.5 G's lateral:

$$\frac{400 \times 1.5}{1250 \times .43} = 1.1 \text{ or } 2 \text{ devices laterally (on each side).}$$

In this problem the devices applied fore and aft are enough to take care of the vertical and lateral forces. So a total number of four devices is necessary to safely restrain this cargo.

NOTES

Annex A (PERCENTAGE RESTRAINT CHART) To Advance Sheet

HELICOPTER TACTICAL LOADING

INSTRUCTIONS

1. For cargo <u>with</u> tiedown provisions—

   a. Estimate needed angle between device and cargo floor (across top).

   b. Estimate needed angle between device and longitudinal axis of the aircraft.

   c. Cross-reference angles; this gives you—

      (1) Percentage effectiveness longitudinally (fore and aft).

      (2) Percentage effectiveness laterally (side-to-side).

   d. Apply percentages to formula.

2. For cargo <u>without</u> tiedown provisions—

   a. For percentage <u>longitudinally</u>.

      (1) Estimate needed angle between longitudinal devices and cargo floor.

      (2) Read along <u>0° line</u> to figure underestimated angle.

      (3) Apply this figure to the formula to find necessary devices to be applied fore and aft.

   b. For percentage <u>laterally</u>.

      (1) Estimate needed angle between lateral devices and cargo floor.

      (2) Read down from the selected angle to the bottom line (90-degree line) and find the percent of lateral effectiveness.

      (3) Apply this figure to the formula to find necessary devices to be applied <u>LATERALLY</u>.

PERCENTAGE RESTAINT CHART

ANGLE BETWEEN DEVICE AND CARGO FLOOR

ANGLE BETWEEN DEVICE AND LONGITUDINAL AXIS OF THE AIRCRAFT

		5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°
0°	LONG.	99.6	98.5	96.6	93.9	90.6	86.6	81.9	76.6	70.7	64.3	57.4	50.0	42.3	34.2	25.9	17.4
	LATERAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5°	LONG.	99.2	98.1	96.2	93.6	90.2	86.3	81.6	76.3	70.4	64.0	57.2	49.8	42.1	34.1	25.8	17.3
	LATERAL	8.7	8.6	8.4	8.2	7.9	7.5	7.1	6.7	6.2	5.6	4.9	4.4	3.7	2.9	2.3	1.5
10°	LONG.	98.1	97.0	95.2	92.6	89.2	83.3	80.7	75.5	69.6	63.3	56.5	49.3	41.7	33.7	25.5	17.1
	LATERAL	17.3	17.1	16.8	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0
15°	LONG.	96.2	95.2	93.3	90.8	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8
	LATERAL	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5
20°	LONG.	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6
	LATERAL	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9
25°	LONG.	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8
	LATERAL	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4
30°	LONG.	86.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.6	29.6	22.4	15.1
	LATERAL	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7
35°	LONG.	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3
	LATERAL	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9
40°	LONG.	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3
	LATERAL	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2
45°	LONG.	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.3	45.5	40.6	35.4	29.9	24.2	18.3	12.3
	LATERAL	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3
50°	LONG.	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2
	LATERAL	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3
55°	LONG.	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9
	LATERAL	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3
60°	LONG.	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7
	LATERAL	86.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.6	29.6	22.4	15.1
65°	LONG.	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4
	LATERAL	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8
70°	LONG.	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9
	LATERAL	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6
75°	LONG.	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5
	LATERAL	96.2	95.2	93.3	90.8	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8
80°	LONG.	17.3	17.1	16.8	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0
	LATERAL	98.1	97.0	95.2	92.6	89.2	83.3	90.7	75.5	69.6	63.3	56.5	49.3	41.7	33.7	25.5	17.1
85°	LONG.	8.7	8.6	8.4	8.2	7.9	7.5	7.1	6.7	6.2	5.6	4.9	4.4	3.7	2.9	2.3	1.5
	LATERAL	99.2	98.1	96.2	93.6	90.2	86.3	81.6	76.3	70.4	64.0	57.2	49.8	42.1	34.1	25.8	17.3
90°	LONG.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	LATERAL	99.6	98.5	96.6	93.9	90.6	86.6	81.9	76.6	70.7	64.3	57.4	50.0	42.3	34.2	25.9	17.4

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Annex B (PERCENTAGE RESTRAINT CHART) (Vertical) To Advance Sheet

HELICOPTER TACTICAL LOADING

INSTRUCTIONS: To find the effectiveness of the device, estimate the angle between the device and cargo floor; then read percentage on the chart under that estimated angle.

ANGLE BETWEEN DEVICE AND CARGO FLOOR

	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°
VERTICAL	8.7	17.4	25.9	34.2	42.3	50.0	57.4	64.3	70.7	76.6	81.9	86.6	90.6	93.9	96.6	98.5

NOTES

DEPARTMENT OF TACTICS
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File No. 597-1
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STUDENT OUTLINE

HELICOPTER TACTICAL LOADING

1. Types of cargo. *Prepared cargo. (cargo with tie down provision)*

    miscellaneous or (loose cargo)

2. Weight.

3. Forces affecting the cargo.

    1. weight
    2 forces acting on cargo during flight

4. Directions of movement.

    a. *forward*

    b. *aft*

    c. *vertical*

    d. *lateral*

5. Restraint criteria. *based on flight characteristics based on*

    a. *manufactured*

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b.   Restraint criteria for UH-1.

    (1)   4 Gs forward.

    (2)   2 Gs aft.

    (3)   2 Gs vertical

    (4)   1.5 Gs lateral

(AR 705-35)

6.   Means of restraining cargo.

a.   Tiedown fittings in aircraft. 1250 pounds of tie down onap force allowed each ring.

b.   Tiedown devices.

    (1)   A 1 A (a strap with 1 stationary hook one slide hook cotton strap.

    (2)   M C-1 nylon hook + strap 5000 lt tineal strength

    (3)   New MC-1 on air force

    (4)   points of attachment on the cargo its self

c.   Tiedown provisions on cargo.

7.   Holding power of tiedown provisions.

a.   Angles of tie. 30° - 30°

b. Percent effectiveness. $30°-30°$

~~fwd~~ aft 75°   vertical 50%
                  lateral 43%

8. The lashing formula.

$$\frac{\text{Weight} \times \text{restraint criteria}}{\text{TENS. Strgth} \times \% \text{ of EFF.}} = \text{number of devices needed}$$

9. Lashing cargo with tiedown provisions.
1 use 30°-30° if possible.
2 use corresponding points of tie down.
3 use tie down devices in pairs
4 apply = tension to all devices

10. Lashing cargo without tiedown provisions.

use corresponding tie down
points on the different sides

625 #
UH-1
MC-1
30°-30°

$$FWD \quad \frac{625 \times 4}{1250 \times .75} = \frac{2500}{938} = 2.7$$

$$AFT \quad \frac{625 \times 2}{1250 \times .75} = \frac{1250}{} = 2$$

vertical
$$\frac{625 \times 2}{1250 \times .50} = \frac{1250}{} = 2$$

lateral

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NOTES

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PERFORMANCE CHECK NO. 1

HELICOPTER TACTICAL LOADING

1. The major difference between prepared type cargo and miscellaneous type cargo
    is —

2. The restraint criteria for helicopters of the UH-1 types are —

    a. Forward.

    b. Aft.

    c. Vertical.

    d. Lateral.

3. The capacity of the tiedown rings in the UH-1 is _____.

4. The percent effectiveness of the 30/30-degree angle of tie in each of the four basic
    directions of movement is —

    a. Forward.

    b. Aft.

    c. Vertical.

    d. Lateral.

5. Write the formula used to determine the number of devices required to secure
    cargo.

    $$\text{Number of devices} = \frac{x}{x}$$

6. List two differences in applying lashing formula to prepared cargo and
    miscellaneous cargo.

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NOTES

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PERFORMANCE CHECK NO. 2

HELICOPTER TACTICAL LOADING

(Programed Text)

1.   List four of the planning considerations concerning external loading of helicopters.

   a.

   b.

   c.

   d.

2.   List the most important advantage of the space method for determining aircraft requirements.

3.   The four major elements of the briefing received by transported troops prior to helicopter operations are—

   a.

   b.

c.

d.

4.   Write the formula for computing center of gravity using the station method.

PRACTICAL EXERCISE

HELICOPTER TACTICAL LOADING

1.   Situation:

    a.   You are to carry a 106mm recoiless rifle in your UH-1 during an airmobile operation. The rifle weighs 485 pounds. The only tiedown devices available are Air Force-issue items with a tensile strength of 5000 pounds. You can secure the cargo using the technique for cargo with tiedown provisions approximately a 30/30-degree angle of tie.

    b.   From the class on tactical loads, you recall that the restraint criteria for the UH-1 are 4 G's forward, 2 G's aft, 2 G's vertically, and 1.5 G's laterally. The capacity of the UH-1-tiedown rings is 1250 pounds.

2.   Requirement: Determine the number of devices required to secure the cargo.