AD-A039 201 FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO F/G 17/8
A UNIVERSAL LASER SURVEYING INSTRUMENT. PART II.(U)
DEC 76 S PACHUTA, R KOSCIELEWSKI, A GUTKOWSKI
UNCLASSIFIED FTD-ID(RS)I-1322-76 NL

1 OF 1
AD A039 201

END
DATE FILMED
6-77

FTD-ID(RS)I-1322-76

FOREIGN TECHNOLOGY DIVISION

A UNIVERSAL LASER SURVEYING INSTRUMENT /Part II/

By

S. Pachuta, R. Koscielewski, A. Gutkowski

EDITED TRANSLATION

FTD-ID(RS)I-1322-76 29 December 1976

FTD-77-C-000017

A UNIVERSAL LASER SURVEYING INSTRUMENT /Part II/

By: S. Pachuta, R. Koscielewski, A. Gutkowski

English pages: 19

Source: Przeglad Geodezyjny, Warsaw, Vol 47, NR 5, 1975, PP. 203-206

Country of origin: Poland
Translated by: LINGUISTIC SYSTEMS, INC.
F33657-76-D-0389
A. Reymont
Requester: FTD/ETDO

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

ULIG KP-4 - A UNIVERSAL LASER SURVEYING INSTRUMENT /Part II/

Stanislaw Pachuta, Ryszard Koscielewski, Andrzej Gutkowski

4. A verification of geometric conditions and a rectification of the instrument

THEODOLITE GEOMETRIC CONDITIONS

The KP-4 instrument should satisfy the following conditions:

I/ The alidade levels axes (II) should be square with the instru--ment vertical turn axis (VV);

2/ The main surface of the round, spherical level (pg) should be square with the instrument vertical turn axis (VV);

3/ The collimation surfaces of the aim axis and the sight teles--cope level axis should be parallel to each other;

4/ The aim axis of the sight telescope should be parallel to the collimation level axis;

5/ When changing a position of the sight telescope focusing device, the stability of the aim axis of the telescope should be presser--ved.

6/ When changing a focusing position of the transmitting telescope, the stability of the laser light beam symmetry axis should be presreved;

7/ The symmetry axis of the laser light beam should be coaxial with the optical axis of the transmitting telescope;

8/ The collimation surface of the laser light beam symmetry axis should go through the instrument vertical turn axis;

9/ The laser light beam symmetry axis should be square with the la-
-ser head level turn axis;

IO/ The laser head level turn axis should be square with the istru-
-ment vertical turn axis;

II/ The collimation surfaces of the sight telescope aim axis and
the laser beam symmetry axis should overlap;

I2/ The laser light beam symmetry axis should be parallel to the
sight telescope aim axis;

I3/ The axis of the optical vertical should be coaxial with the in-
-strument vertical turn axis;

I4/ When having a level symmetry axis of the laser light beam, the
reading taken from the vertical circle should be equal to zero;

When checking the instrument, one has to make sure the above geo-
-metric conditions have been satisfied. The checking procedure is performed according to the order described above. A failure to sa-
-tisfy these conditions may result in instrumental errors. If any of the instrumental errors exceeds admissible values, an adjuste-
-ment /rectification/ of the instrument is necessary.

A VERIFICATION AND A RECTIFICATION OF THE ALIDADE LEVELS PERPENDI-
-CULAR AXIS IN RELATION TO THE INSTRUMENT VERTICAL TURN AXIS

a. One of the alidade levels is placed pamallel to a line joining
two accomodational screws.

By turning the two screws simultaneously in opposite directions, the middle of the blow-hole of the level is being reduced to the main point. By turning the third accomodational screw, the middle of the blow hole of the other alidade level is being brought to the main point.

b. The alidade is being turned by 200^g, exact to +1g If the posi--tion of the blow-holes does not change, the conditions of perpen--dicularity of the alidade level to the instrument vertical turn axis have been satisfied.

The admissible deviation of the blow-holes from the main points of the level is 0.3 of the level scale. If the blow-hole of any level deviates by more than 0.3 of the scale, a rectification of the level is needed.

When rectifying the first level, the first half of a deviation is corrected by means of two accomodational screws, and the second half of it is corrected through the use of the adjustment screws of the level.

Similarly, the first half of a deviation of the blow-hole of the second level is corrected by turning the third accomodational screw, and the second half of the deviation is corrected by turning the adjustment screws of the level.

The procedure described above must be repeated.

A VERIFICATION AND A RECTIFICATION OF THE PERPENDICULARITY OF THE MAIN, ROUND, SPHERICAL (BOX) LEVEL TO THE INSTRUMENT VERTICAL TURN AXIS

Upon careful levelling of the alidade levels by means of accomoda--tional screws, the blow-hole of the round, spherical level should occupy a centric position. Any possible deviation of the blow-hole should be corrected by means of the adjustment screws of this level.

A VERIFICATION AND A RECTIFICATION OF A RECIPROCAL PARALLELISM OF THE COLLIMATION SURFACES OF THE AIM AXIS AND THE SIGHT TELESCOPE LEVEL AXIS

a. It is necessary to position the alidade in such a way that one of the accomodational screws lie exactly under the sight teles--cope.

b. A levelling staff should be set up in the distance of 30-40 meters from the instrument, on the way of the aim axis of the sight teles -cope.

c. It is necessary to achieve a coincidence of images of edges of the sight telescope level blow-hole through turning a vertical move--ment micrometer of the transmitting telescope /2I/ , and after--wards read the levelling staff indications.

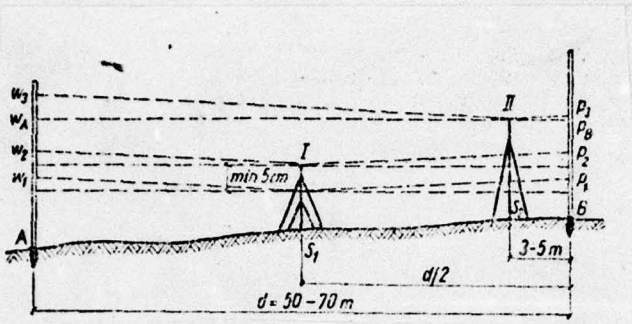

Fig. I2: A verification of the condition of parallelism of the aim axis to the levelling level axis:
I - the first position of the instrument,
II - the second position of the instrument

d. The accomodational screw located on the left hand side of the telescope should be turned by I80°, and the screw located on the right hand side should be positioned in such a way that the previous reading be obtained in the telescope for the se--cond time. If the collimation surfaces of the aim axis and the sight telescope level axis are parallel, the blow-hole of the sight telescope level should remain in the middle position.

e. When the blow-hole of the level deviates from the middle, it is necessary to loosen a little the upper adjustment screw of the level and make coincide the images of edges of the blow-hole by means of the level /horizontal/ adjustment screws of the level.

A VERIFICATION AND A RECTIFICATION OF THE SIGHT TELESCOPE AIM AXIS AND THE LEVELLING LEVEL AXIS PARALLELISM

The verification is performed by means of the so-called double

levelling in the following order:

a) Two pegs, distant 50-70 ~~metres~~ meters from each other (points A and B) should be set into the ground in a possibly darkened, wind-free area;

b) The vertical levelling staffs should be set up on the pegs, and the instrument should be placed in the middle of the section (position #I), exact to I meter.

In the position #I /with two, at least 5 cm different horizons of the instrument/ a difference in heght (h) betweem points A and B is twice determined by taking the readings from the levelling staffs w_1 and p_1 and also w_2 and p_2. The difference:

$$h_1 = \frac{(w_1 - p_1)\ (w_2 - p_2)}{2}$$

does not carry the axis non-parallelism error. The values conta-ined in parentheses cannot differ by more than $\pm$ 2 mm .

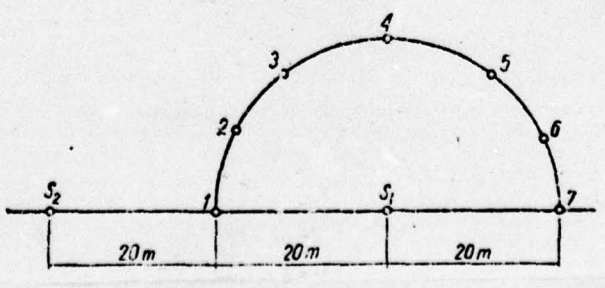

Fig.I3: A verification of the laser beam focussing device

Without changing the position of the staffs, it is now necessary to place the instrument near one of the staffs (for example B) in the distance of 3 - 5 meters (position #II), reading the indications of the staffs w_3 and p_3 and calculating the result of their substraction

$$h_{II} = w_3 - p_3$$

The condition of the parallelism of the aim axis to the level axis may be deemed satisfied, if the $h_{II} - h_I$ result does not exceed ± 3 mm.

If $(h_{II} - h_I) > 3$ mm,

provided that

$$P_B = p_3,$$

then it is necessary to calculate the reading

$$W_A = h_I + p_3$$

to which the aim axis of the telescope should be directed by turning the vertical movement micrometer of the transmitting telescope. A level blow-hole deviation, which occurred due to this, is corrected through turning vertical adjustment screws of the level.
The work on position #II is repeated until an accordance between the differences in height h_I and h_{II} within the range of $\pm (2 \div 3)$ mm is achieved.

A VERIFICATION OF THE STABILITY OF THE AIM AXIS OF THE SIGHT TELES-
-COPE AFTER CHANGING A POSITION OF THE FOCUSING DEVICE OF THIS TELE-
-SCOPE

This condition does not need to be verified, as the existing assembly error which remained after a manufacturing process of the sight teles--cope has practically no effect on the aiming exactitude.

A VERIFICATION OF THE STABILITY OF THE LASER LIGHT BEAM SYMMETRY AXIS AFTER CHANGING A POSITION OF THE SIGHT TELESCOPE FOCUSSING DEVICE.

a. In a flat area, within the radius of 20 meters away from the posi--tion of the instrument (S_1), a number of pegs should be set into the ground, one about 10 meters away from the other, in the way that they form a semicircle. Moreover, one peg should be put at the production of the line AB at the distance of 20 meters from the point B.

b. In the position S_1, with a levelled level and an unchanged position of the sight telescope focusing device, readings should be taken from the levelling staff set at the points I - 7, respectively. The highest reading value corresponds to the top of the lowest peg. The other pegs should be set the same way in order that the same readings on the staffs be obtained.

c. The instrument should be placed at the point S_2. At that place readings should be taken from the levelling staff set on the same pegs from I to 7, respectively at a variable distance (from 20 to 60 meters), which makes one change constantly the position

of the telescope focusing device.

As soon as all readings are equal within the range of exactitude ($2 \div 3$ m), the focusing device of the transmitting telescope will work properly, otherwise a correction in a repair shop is necessary.

A VERIFICATION OF THE COAXIALITY OF THE LASER LIGHT BEAM SYMMETRY AXIS TO THE TRANSMITTING TELESCOPE OPTICAL AXIS

a. Mark a geometry center of the transmitting telescope lens. To do so, it is necessary to draw on a sheet of paper a net of concentric circles at the spaces of 2 mm. Next the sheet should be put on the lens in such a way that the circle, whose diameter approximates the diameter of the lens, coincide with the cover of the lens. The center of the circles will mark a geometrical center of the lens.

b. The laser light beam symmetry axis (the center of the beam) sho--uld be in line with the center of the circles. If it fails to do so, it is necessary to unscrew the nuts (3) and bring the cen--ter of the beam to the center of the circles by means of the ad--justment screws of the laser head. If the laser beam is set pro--perly, a spot of the laser light of a maximum intensity should be obtained on the sheet.

A VERIFICATION OF THE PASSING OF THE LASER BEAM SYMMETRY AXIS COL--LIMATION SURFACE THROUGH THE INSTRUMENT VERTICAL TURN AXIS

The manufacturing factory guarantees the passing of the transmitting telescope optical axis collimation surface through the instrument ver--tical turn axis. By achieving the coaxiality between the laser beam symmetry axis and the transmitting telescope optical axis, a condition of the passing of the laser beam symmetry axis collimation surface through the instrument vertical turn axis will also be satisfied.

A VERIFICATION AND A RECTIFICATION OF THE PERPENDICULARITY OF THE LA--SER LIGHT BEAM SYMMETRY AXIS TO THE LASER HEAD LEVEL TURN AXIS AND THE PERPENDICULARITY OF THE LASER HEAD LEVEL TURN AXIS TO THE INSTRU--MENT VERTICAL TURN AXIS

Since the turn of the telescope round the laser head level turn axis is impossible in the KP-4 instrument, the two conditions are being checked simultaneously in an indirect way by taking advantage of the influence of the errors on the level angle value.

Let be:

α - a real angle

α - an angle measured with the KP-4 instrument

c - a collimation error

i - an inclination error

h_i - a vertical angle of aim

Considering a global influence of the collimation and inclination errors on the angle (α), the following formula is obtained:

$$\alpha = a + c(\sec h_1 - \sec h_2) + i(\operatorname{tg} h_1 - \operatorname{tg} h_2)$$

By marking:

$$\sec h_1 - \sec h_2 = A$$

$$\operatorname{tg} h_1 - \operatorname{tg} h_2 = B$$

$$\alpha' - \alpha = \Delta\alpha$$

we will obtain the formula:

$$A_c + B_i + \Delta\alpha = 0$$

Since the above equation has two unknown quantities c and i, to cal-culate them it is necessary to formulate a system of two equations.

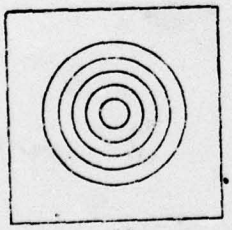

Fig.I4: A net for marking a geometrical center of the lens.

This is possible in the case of the measurement of two angles whose values are known. When measuring the level angle , it is necessary to read the values of vertical angles of the aiming points.

THE ORDER OF ACTION WHEN MARKING THE QUANTITIES c AND i:

a. It is necessary to chose 4 points in an area, two of which

should be near the horizon plane, and the other two should be above the horizon, at an angle of h.

b. Measure standard angles α_1 and α_2, exact to $m = \pm 15^{cc}$.

c. Measure the same angles with the KP-4 instrument.

d. Calculate the values of the collimation and the inclination (c and i). If $c'' \leqslant 50^{cc}$ and $i'' \leqslant 50^{cc}$, the geometric conditions may be considered satisfied.

When the collimation error exceeds a permissible value, it should be corrected by changing the laser beam symmetry axis. To do so, it is necessary to apply the following procedure:

— set the laser beam symmetry axis in the proximity of the horizon plane (set the transmitting telescope at level);

— set a control target in the distance of (d) from the position of the instrument and aim thereat.

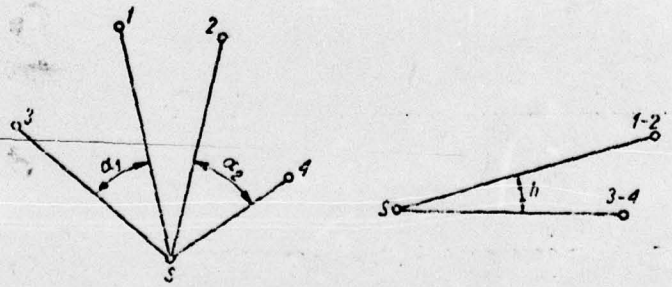

Fig. I5 : A schematic diagram of the arrangement of the points

— calculate the displacement value of the laser beam symmetric axis

$$l = d\frac{c''}{\rho''}$$

where;

l = a displacement value in the target plane;

d = a distance between the instrument position and the target;

c = a marked collimation value /in seconds/

— shift the beam symmetry axis by the segment (l) by means of the rear adjustment screws;

In the case of finding the inclination error exceeding a permissible value, it is necessary to have the instrument corrected in a repair shop. After being through with the adjustment of the instrument, it is advisable to repeat the check on the last two geometric conditions.

A VERIFICATION AND A RECTIFICATION OF THE OVERLAP OF THE COLLIMATION SURFACES OF THE SIGHT TELESCOPE AIM AXIS AND THE LASER BEAM SYMMETRY AXIS AS WELL AS A CHECKUP ON THE PARALLELISM OF THE LASER BEAM SYM-METRY AXIS WITH THE SIGHT TELESCOPE AIM AXIS

The above conditions are checked simultaneously. To this end, it is necessary to apply a control target with the marked square net which forms a local system of co-ordinates (Fig. I6).

The measurements are performed through aiming at the target placed at

the distances of 5, I0, I5, 20, 25, 30 meters respectively.

The measurement procedure is as follows:

a) After marking the points in given distances, it is necessary to set up the target on a stand at the first point (in the distance of 5 ~~metres~~ meters);

b) Aim at the center of the target with the sight telescope aim axis;

c) Read on the target the laser beam symmetry axis deviation values (Δx and Δy) ~~-/~~the center of the spot~~/~~;

d) Repeat the measurements taking the target readings at respective points;

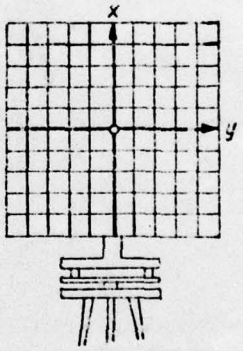

Fig. I6: A control target

e) Determine the occurrence of errors by analysing Δx_i, Δy_i values obtained from the measurement of the laser beam symmetry axis de--viation.

I. If the Δy values are equal at all distances quoted above, then the collimation surfaces of the sight telescope aim axis and the laser light beam symmetry axis are parallel; if, instead, $\Delta y = 0$, the collimation surfaces overlap each other.

The parallelism of the surfaces does not result in errors of the angles being measured, but may be inconvenient to an observer. In such cases, a rectification is unnecessary.

When Δy values are changing in a direct proportion to the distance, a rectification is needed (an intersection of the collimation surfaces occurs).

The rectification is achieved by shifting at a level plane the laser beam symmetry axis of the δy value calculated from the formula:

$$\delta_y = \frac{30(\Delta y_{30} - \Delta y_5)}{25}$$

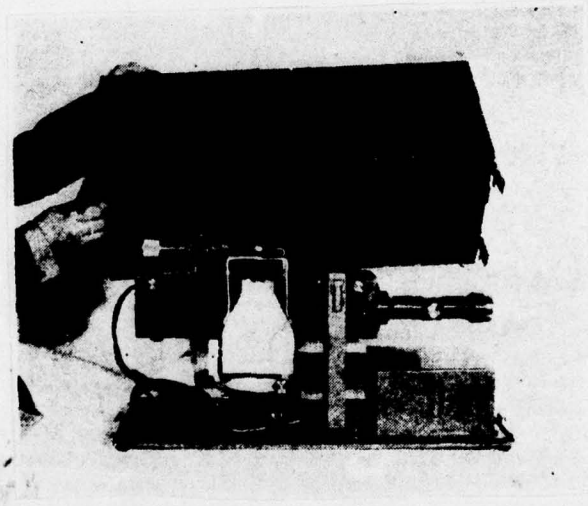

Fig. I7 : A picture of the theodolite in a transportation container

where $\Delta y, \delta x$ - the aim axis displacement measured on the target set at the distance of 30 ~~metres~~ meters;

$\Delta y_{30}, \Delta x_{30}$ - the laser beam spot deviation from the aim axis at the distance of 30 ~~metres~~ meters from the target;

$\Delta y_5, \Delta x_5$ - the laser beam spot deviation from the aim axis at the distance of 5 meters from the target;

In order to make a shift of the sight telescope aim axis at a level plane, it is necessary to unscrew (release) the screws which fasten the sight telescope bedplate (I0) and shift slightly the aim axis towards the laser light spot. Upon rectification it is necessary to check again the geometric conditions.

2. If the Δx values are equal at all distances, the condition of the parallelism of the sight telescope aim axis with the laser beam symmetry axis is satisfied.

   When Δx values are changing in direct proportion to the distance, a rectification is necessary. To do that, one must calculate the necessary shift of the sight telescope aim axis at a vertical plane, according to the formula:

$$\delta_x = \frac{30\,\Delta x_{30} - \Delta x_5}{25}$$

Then, by turning the adjustment screw of the sight telescope (I2) one must shift the sight telescope aim axis by the value of δx in the di-rection of the laser light spot.

A VERIFICATION OF THE COAXIALITY OF THE OPTICAL VERTICAL WITH THE INSTRUMENT VERTICAL TURN AXIS

In the instrument, the optical vertical built in the alidade has been applied. Upon exact levelling of the instrument it is necessary to mark

a point whose picture will be visible in the middle of the tick on the plate of the focal length of the optical vertical. The alidade should then be turned by 200^g. The picture of the point should be in the middle of the plate tick. When the picture of the point deviates by more than 3 millimeters, a rectification is necessary by shifting the optical vertical plate towards the point by $\frac{1}{2}$ of the deviation by means of the adjustment screws.

A VERIFICATION OF THE ZERO POINT OF THE VERTICAL CIRCLE

The order of action:

Level carefully the instrument by means of the alidade level. Then, set the transmitting telescope at level by means of the sight telescope level. Take the reading from the vertical circle, which is a zero point of this circle, when:

$$M0 > 0^g$$

the vertical angle

$$\beta = 0 - M0$$

if:

$$M0 < 400^g \ (0)$$

the vertical angle

$$\beta = 0 + M0 - 400^g$$

5. Transportation

The instrument is stored and transported at long distances in spe-

-cial containers (FIg.I7). There is enough room for the theodolite in such a container. The theodolite should be put into it cau-tiously, without the use of force, in a position indicated on the photo on the cover. The theodolite must not be transported on tough floors of any means of transportation.

The instrument can be transferred from one place to another, if fixed on a stand, only in a vertical position.

6. General principles of maintenance and utilization of the instrument

I. The laser radiation is harmful to the eyesight, therefore the light beam should not be directed into the eyes.

2. Upon completion of work it is necessary to clean the dust and the dirt off the theodolite.and the surfaces of the optical parts.

3. Fingers should be kept off the optical parts.

4. The outer surfaces of the optical parts are cleaned out by means of a cotton wool tampon reeled in a wooden stick soaked in a mixture of 50% of spirit and 50% of ether.

5. The mechanical parts of the instrument are cleaned out with a brush pencil and a dry, flannel wiper.

6. The instrument must be protected from occasional showers and a heavy insolation by means of a topographic umbrella.

7. The instrument must be stored in a dry, damp-proof place, away from corrosive substances.

8. The co-operating units should be oiled once in a year. In the case of discovering that the theodolite still turns with difficulty

round the vertical axis , despite a repeated strong turning, it is necessary to have the theodolite lubricated.

9. The theodolite may be taken to pieces only in a specialized sur-veying tools repair shop.

IO. The legs clearances of the levelling head and directing mechanisms are eliminated by tightening the nuts by means of the adjustment needle.

II. A replacement of the unloading pipe or the feeder elements as well as an aligning of the laser may be carried out only in a specialized maintenance shop.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FTD-ID(RS)I-1322-76 ✓	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A UNIVERSAL LASER SURVEYING INSTRUMENT /Part II/		5. TYPE OF REPORT & PERIOD COVERED Translation 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) S. Pachuta, R. Koscielewski, A. Gutkowski		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Foreign Technology Division Air Force Systems Command U. S. Air Force		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE 1975 13. NUMBER OF PAGES 19
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) 20		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION		MICROFICHE
A205	DMATC	1
A210	DMAAC	2
B344	DIA/DS-4C	8
C043	USAMIIA	1
C509	BALLISTIC RES LABS	1
C510	AIR MOBILITY R&D LAB/FIO	1
C513	PICATINNY ARSENAL	1
C535	AVIATION SYS COMD	1
C557	USAIIC	1
C591	FSTC	5
C619	MIA REDSTONE	1
D008	NISC	1
H300	USAICE (USAREUR)	1
P005	ERDA	2
P055	CIA/CRS/ADD/SD	1
NAVORDSTA (50L)		1
NAVWPNSCEN (Code 121)		1
NASA/KSI		1
544 IES/RDPO		1
AFIT/LD		1

ORGANIZATION		MICROFICHE
E053	AF/INAKA	1
E017	AF/RDQLR-W	1
E404	AEDC	1
E408	AFWL	1
E410	ADTC	1
E413	ESD	2
	FTD	
	CCN	1
	ETID	3
	NIA/PHS	1
	NICD	5