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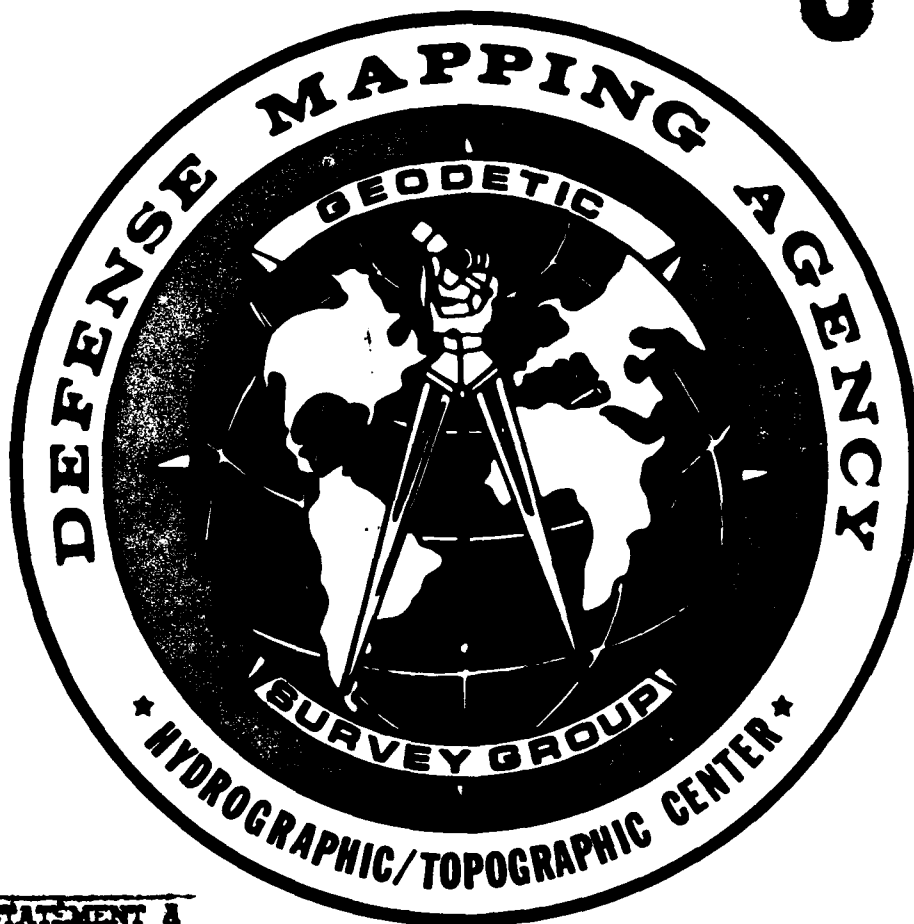
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GEODETIC SURVEY GROUP

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TRANSFORMATION VALUES

LOCAL DATUM TO WGS 84

EASTERN TEST RANGE AREA

November 1988

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TRANSFORMATION VALUES
 LOCAL DATUM TO WGS 84
 EASTERN TEST RANGE AREA

Prepared By:

Patrick J. Gilligan
 PATRICK J. GILLIGAN, GM-13
 Supervisory Geodesist

Approved By:

Richard M. Chapin
 RICHARD M. CHAPIN, Maj, USAF
 Commander GSS4

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REFERENCES

- a. DMA Technical Report 8350.2, Department of Defense World Geodetic System 1984, 30 Sep 1987.
- b. NGS Published NAD83 Geodetic Positions.
- c. GSS4 Report, Transformation Values, Local Datum to WGS84 for Eastern Test Range and AUTEC Areas, 15 Oct 1987.
- d. RCA Work Request 1988-2-G, Geodetic Position of Doppler Stations at Designated Sites, 18 Feb 88.

1. Introduction

In the early 1980's the Defense Mapping Agency (DMA) in conjunction with other agencies developed a new World Geodetic System (WGS 84) to replace the existing WGS 72 which has been in use for several years. This new WGS 84 system has an improved Earth Gravitational Model (EGM) with orientation and scale changes from the WGS 72. The WGS 84 was developed using worldwide doppler derived station coordinates, laser satellite tracking data, satellite radar altimetry and gravity observations. Reference a. gives the unclassified information pertaining to the WGS 84 and it's relationship with various datums throughout the world. The following report provides transformation parameters to determine WGS 84 coordinates for geographical areas of interest to the Eastern Test Range (ETR). The delta values vary slightly ($< 2m$) from Reference a. due to direct satellite observation with doppler receivers in each area and reduction on the WGS 84 system which improves the accuracy of the results. The delta X Y Z values given in Table 2 supersede those values given in Reference c. for the applicable areas.

2. General

The WGS 84 Coordinate System is a Conventional Terrestrial System determined by modifying the Navy Navigation Satellite System Doppler Reference Frame (NSWC 9Z-2) in origin and scale and rotated to bring its reference meridian into coincidence with the Bureau International de L'Heure (BIH) Zero Meridian of 1984.0. During the time frame of the WGS 84 development, the National Geodetic Survey (NGS) developed a new Geodetic Reference System (GRS 80) to use in readjusting the North American Datum 1927 (NAD 27). For practical purposes the defining parameters for the WGS 84 and GRS 80 are the same. The NAD 27 has been readjusted and upgraded to NAD 83 using GRS 80 ellipsoid parameters and BIH Zero Meridian of 1984.0

3. WGS 84 for ETR Area

Table 1 gives the defining parameters for the WGS 84 and other ellipsoids associated with local datums in the ETR area. Table 2 gives the translation constants resulting from direct doppler observations in the various areas of the ETR. The delta values agree within 1 meter of the computed values given in Reference a. within CONUS and 2 meters for the downrange sites. The delta values given for NAD 83 to WGS 84 result from different observational and computational methods being used to determine the geodetic positions.

TABLE 1
Reference Ellipsoids of Geodetic Datums

Ellipsoid	Datum	a (meter)	b (meter)	f	e^2
Clarke 1866	NAD 27 OCD 64 Bermuda 1957	6378206.400	6356583.800	1/294.9786982	0.006768658000
International	Ascension Astro	6378388.0	6356911.946	1/297.0	0.006722670022
SAO C-7	SAO-67	6378142.0	6356757.138	1/298.255	0.006694429814
DOD WGS 72	WGS 72	6378135.0	6356750.52	1/298.26	0.006694317778
DOD WGS 84	WGS 84	6378137.0	6356752.314	1/298.2572236	0.006694379990
GRS 80	NAD 83	6378137.0	6356752.314	1/298.2572221	0.006694380023

TABLE 2
Translation Values
Local Geodetic System to WGS 84

Local Geodetic System	Reference Ellipsoid	Number of Doppler Stations Used	Translation Values		
			X (m)	Y (m)	Z (m)
OCD, 1964 (PAFB, OCAFS KSC, Malabar)	CLARKE 1866	9	- 3.00	157.35	178.06
OCD 1964 (JDIF)	Clarke 1866	1	- 2.05	158.16	178.54
NAD 1927 (Folly Beach, SC)	Clarke 1866	1	- 9.64	161.09	177.63
NAD 1927 (Richmond, FL)	Clarke 1866	1	- 2.86	154.54	180.01
NAD 1927 (Hiran Sol IV) (Antigua)	Clarke 1866	1	- 9.28	171.93	188.18
NAD 1927 (Hiran Sol IV) (Anguilla)	Clarke 1866	1	-12.23	172.53	183.76
Bermuda 1957 (Bermuda)	Clarke 1866	1	-71.85	215.86	295.88
Ascension Astro (Ascension)	International	2	-207.34	107.66	53.20
NAD 83 (PAFB, OCAFS, KSC, Malabar)	GRS 80	9	0.51	0.46	0.69
NAD 83 (JDIF)	GRS 80	1	0.61	0.58	0.91
NAD 83 (Folly Beach, SC)	GRS 80	1	0.94	0.49	0.50
NAD 83 (Richmond, FL)	GRS 80	1	0.43	0.45	0.78
PAFB, OCAFS, KSC & Malabar	NAD 83 to WGS 72 OCD 64 to NAD 83		-15.49 - 3.51	- 1.89 159.89	- 5.37 177.37

4. Addendum 1 contains the results of the individual station observations compared with local datum coordinates. The standard deviation of the shifts were computed using the standard formula

$$\sqrt{\frac{\sum v^2}{n-1}}$$

This is a measure of the consistency of the observations and should not be construed as an accuracy of the WGS 84 coordinates. The accuracy for WGS 84 coordinates given in Reference 1.a. of $\sigma_\phi = \sigma_\lambda = \pm 1\text{m}$ and $\sigma_H = \pm 1$ to $\pm 2\text{m}$ should be used.

5. Addendum 2 contains the same WGS 84 results given in Addendum 1 but compared with the NAD 83 coordinates. These values should theoretically be the same but because of the different methods of observation and computation, there are minor differences of approximately 0.8 m in latitude and 0.6m in longitude as indicated. The geodetic heights for NAD 83 were assigned the WGS 84 observed value.

6. Readjustments of the local geodetic networks using the NGS NAD 83 coordinates as control has been accomplished for each of the applicable areas. The transformation to WGS 84 will be accomplished for all areas using the delta X Y Z values given in Table 2. The NAD 83, CCD 64 or Local Datum, WGS 72, and WGS 84 coordinates are currently available at GSS4, however, after 1 Jan 1989 the CCD 64 and WGS 72 data files will no longer be updated or maintained by GSS4. These coordinates can be furnished for an individual project only if specifically requested.

7. In addition to the geodetic latitude and longitude, deflection of the vertical components are often required for system operation. To determine these values in the ETR areas, astronomic positions were observed at various locations throughout the range from which direct comparison can be made or adequate interpolation accomplished. The meridional component (MC) is determined from the difference in astronomic and geodetic latitudes ($\phi_A - \phi_G$). The prime vertical component (PVC) is determined by $(\lambda_A - \lambda_G) \cos \phi$. Because of the non-coincidence of the longitude origins for the astronomic longitude and the NAD 27 and WGS 72 geodetic longitudes, a correction of +0.51 arc seconds (west longitude positive) was applied to the astronomic longitude before computing the PVC. The NAD 83 and WGS 84 longitudes of reference are coincident with the astronomic longitudes consequently this correction is no longer applicable. To compute the PVC relative to WGS 84 from existing WGS 72 PVC values use the following: $\eta_{84} = \eta_{72} + 0.244 \cos \phi_{84}$ (west longitude positive).

8. Observations in the AUTEC Range Area, Andros Island are scheduled for 2nd Quarter of FY89. The final shifts for this area should be available 1 Mar 89 and will be distributed in a separate letter.

ADDENDUM 1
TABULATION OF DATUM SHIFTS
LOCAL DATUM TO WGS84

DATUM SHIFTS (PAFB, OCAFS, KSC, Malabar)

STATION	STA NO.	DATUM	LATITUDE(N)	LONGITUDE(W)	GEOID HEIGHT (m)	X	Y	Z	ELEV (m)
HANSON	11590	OCD64	28° 14' 16.801	80° 36' 40.601	9.71	917356.07	-5548076.07	2999605.58	1.756
		WGS84	28 14 17.861	80 36 39.771	-27.40	917352.92	-5547918.33	2999783.48	
		Deltas	1.060	-0.830		-3.15	157.74	177.89	
AFETR No1	10198	OCD64	28 15 17.049	80 36 20.117	25.71	917766.06	-5547132.90	3001246.93	17.823
		WGS84	28 15 18.111	80 36 19.262	-10.65	917763.67	-5546975.63	3001425.28	
		Deltas	1.062	-0.855		-2.39	157.27	178.35	
CX46 PED 187.5	NSWC	OCD64	28 27 24.632	80 31 43.844	12.76	923442.81	-5535394.75	3020951.08	4.903
		WGS84	28 27 25.643	80 31 43.021	-23.78	923439.32	-5535237.78	3021128.56	
		Deltas	1.011	-0.823		-3.49	156.97	177.48	
CID ASTRO	11644	OCD64	28 25 06.507	80 35 35.102	11.18	917566.83	-5538422.84	3017211.35	3.265
		WGS84	28 25 07.555	80 35 34.277	-25.92	917563.42	-5538264.91	3017389.46	
		Deltas	1.048	-0.825		-3.40	157.93	178.11	
NPF DOP STA	32029	OCD64	28 28 10.005	80 34 44.520	26.76	918486.82	-5535556.94	3022185.68	18.850
		WGS84	28 28 11.022	80 34 43.686	- 9.48	918483.79	-5535400.06	3022363.51	
		Deltas	1.017	-0.834		-3.03	156.88	177.83	
CX47 DOP STA	32044	OCD64	28 32 55.436	80 34 05.025	16.47	918857.97	-5531234.81	3029902.11	8.619
		WGS84	28 32 56.455	80 34 04.186	-19.66	918855.01	-5531077.80	3030080.28	
		Deltas	1.019	-0.839		-2.96	157.01	178.17	
NITRO	11635	OCD64	28 36 05.840	80 38 25.946	13.03	911403.89	-5529623.43	3035048.00	5.154
		WGS84	28 36 06.855	80 38 25.117	-23.54	911400.77	-5529466.03	3035226.00	
		Deltas	1.015	-0.829		-3.12	157.40	178.00	
CIGAR	11698	OCD64	28 27 50.453	80 39 15.116	13.75	911268.74	-5537028.92	3021650.36	5.794
		WGS84	28 27 51.494	80 39 14.273	-22.78	911266.06	-5536871.41	3021828.68	
		Deltas	1.041	-0.843		-2.68	157.51	178.32	
RML 3	11619	OCD64	28 01 28.544	80 41 05.754	16.36	912029.05	-5560259.83	2978753.42	8.073
		WGS84	28 01 29.639	80 41 04.922	-20.32	912026.26	-5560102.42	2978931.84	
		Deltas	1.095	-0.832		-2.78	157.42	178.42	
Mean Deltas (9)						-3.00	157.35	178.06	
						+0.35	+0.36	+0.30	

DATUM SHIFTS (JDIF)

STATION	STA NO.	DATUM	LATITUDE(N)	LONGITUDE(W)	GEOETIC HEIGHT (m)	GEOID HEIGHT (m)	X	Y	Z	ELEV (m)
J.D. PARK Deltas	11517	OCD64 WGS84	26° 58' 55" 315	80° 06' 31" 695	20.26	9.61	977056.82	-5603366.71	2876288.92	10.651
			26 58 56.548	80 06 30.783	-17.35	-27.85	977054.77	-5603208.55	2876467.46	
			1.233	-0.912		-37.46	-2.05	158.16	178.54	

DATUM SHIFTS (Folly Beach, SC)

STATION	STA NO.	DATUM	LATITUDE(N)	LONGITUDE(W)	GEOETIC HEIGHT (m)	GEOID HEIGHT (m)	X	Y	Z	ELEV (m)
MIKE Deltas	11786	NAD27 WGS84	32° 41' 07" 649	79° 53' 15" 681	7.36	4.75	943472.60	-5290041.12	3424473.41	2.611
			32 41 08.301	79 53 14.959	-31.44	-34.05	943462.96	-5289880.03	3424651.04	
			0.652	-0.722		-38.80	-9.64	161.09	177.63	

DATUM SHIFTS (Richmond, FL)

STATION	STA NO.	DATUM	LATITUDE(N)	LONGITUDE(W)	GEOETIC HEIGHT (m)	GEOID HEIGHT (m)	X	Y	Z	*ELEV (m)
TIMER Deltas	20038	NAD27 WGS84	25° 36' 49" 355	80° 23' 03" 433	14.05	10.05	961321.66	-5674210.98	2740384.94	4.002
			25 36 50.762	80 23 02.609	-20.90	-25.06	961318.80	-5674056.44	2740564.95	
			1.407	-0.824		-35.11	-2.86	154.54	180.01	

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DATUM SHIFTS (Antigua)

STATION	STA NO.	DATUM	LATITUDE (N)	LONGITUDE (W)	GEOIDETIC HEIGHT (m)	GEOID HEIGHT (m)	X	Y	Z	ELEV (m)
PAT	10005	HIRAN SOL IV (NAD27) WGS84	17° 08' 32.515	61° 47' 34.534	41.74	6.00	2881658.58	-5372677.66	1867793.77	35.739
	Deltas		17 08 35.512 2.997	61 47 32.061 -2.473	- 2.98	-38.72 -44.72	2881649.30 -9.28	-537 05.73 171.93	1867981.95 188.18	

DATUM SHIFTS (Anguilla)

STATION	STA NO.	DATUM	LATITUDE (N)	LONGITUDE (W)	GEOIDETIC HEIGHT (m)	GEOID HEIGHT (m)	X	Y	Z	ELEV (m)
ANGUILLA	10007	HIRAN SOL IV (NAD27) WGS84	18° 13' 02.433	63° 03' 56.401	71.86	5.00	2745258.45	-5403173.10	1981151.83	66.86
	Deltas		18 13 05.147 2.714	63 03 54.112 -2.289	24.16	-42.70 -47.70	2745246.22 -12.23	-5403000.57 172.53	1981335.59 183.76	

DATUM SHIFTS (Bermuda)

STATION	STA NO.	DATUM	LATITUDE (N)	LONGITUDE (W)	GEOIDETIC HEIGHT (m)	GEOID HEIGHT (m)	X	Y	Z	ELEV (m)
WELL	11819	BERMUDA 1957 WGS84	32° 20' 46.755	64° 39' 26.019	10.99	0.0	2308694.55	-4874659.22	3392762.92	10.991
	Deltas		32 20 51.820 5.065	64 39 24.970 -1.050	-20.04	-31.03 -31.03	2308622.70 -71.85	-4874443.36 215.86	3393058.80 295.88	

DATUM SHIFTS (Ascension)

STATION	S/A NO.	DATUM	LATITUDE(S)	LONGITUDE(W)	HEIGHT(m)	HEIGHT(m)	X	Y	Z	ELEV(m)
DEVIL	11652	ASC	07° 57' 17.880	14° 19' 39.610	537.99	0.00	6121437.91	-1563483.60	-876931.84	537.987
		WGS84	07 57 16.370	14 19 37.872	554.60	16.61	6121230.71	-1563375.74	-876878.42	
		Deltas	1.510	1.738		16.61	-207.20	107.86	53.42	
DOP	31846	ASC	07 57 05.959	14 24 45.230	88.91	0.00	6118732.91	1572453.85	-876506.98	88.914
		WGS84	07 57 04.464	14 24 43.518	105.34	16.43	6118525.44	1572346.39	-876454.00	
		Deltas	1.494	1.712		16.43	-207.47	107.46	52.98	
Mean Deltas (2)										
						+16.52	-207.34	107.66	53.20	
						+ 0.09	+0.19	+0.28	+0.31	

ADDENDUM 2
TABULATION OF DATUM SHIFTS
NAD83 TO WGS84

DATUM SHIFTS (PAFB, OCAFS, KSC, Malabar)

STATION	STA NO.	DATUM	LATITUDE (N)	LONGITUDE (W)	GEODETIC HEIGHT (m)	GEOID HEIGHT (m)	X	Y	Z	ELEV (m)
HANSON	11590	NAD83	28° 14' 17.836	80° 36' 39.786	-27.40	-29.15	917352.58	-5547918.76	2999782.80	1.756
		WGS84	28 14 17.861 0.025	80 36 39.771 -0.015	-27.40	-29.15	917352.92 0.34	-5547918.34 0.42	2999783.47 0.67	
		Deltas								
AFETR NO1	10198	NAD83	28 15 18.082	80 36 19.301	-10.65	-28.47	917762.69	-5546976.22	3001424.50	17.823
		WGS84	28 15 18.111 0.029	80 36 19.262 -0.039	-10.65	-28.47	917763.67 0.98	-5546975.63 0.59	3001425.30 0.80	
		Deltas								
CX46 PED NSWC 187.5		NAD83	28 27 25.638	80 31 43.026	-23.78	-28.68	923439.20	-5535237.87	3021128.42	4.903
		WGS84	28 27 25.643 0.005	80 31 43.021 -0.005	-23.78	-28.68	923439.33 0.13	-5535237.77 0.10	3021128.56 0.14	
		Deltas								
CID ASTRO 11644		NAD83	28 25 07.519	80 35 34.290	-25.92	-29.19	917563.16	-5538265.49	3017388.48	3.265
		WGS84	28 25 07.555 0.036	80 35 34.277 -0.027	-25.92	-29.19	917563.43 0.27	-5538264.92 0.57	3017389.45 0.97	
		Deltas								
NPF DOP STA 32029		NAD83	28 28 11.010	80 34 43.706	- 9.48	-28.33	918483.28	-5535400.32	3022363.18	18.850
		WGS84	28 28 11.022 0.012	80 34 43.686 -0.020	- 9.48	-28.33	918483.79 0.51	-5535400.05 0.27	3022363.52 0.34	
		Deltas								
CX47 DOP STA 32044		NAD83	28 32 56.431	80 34 04.212	-19.66	-28.28	918854.36	-5531078.27	3030079.63	8.619
		WGS84	28 32 56.455 0.024	80 34 04.186 -0.026	-19.66	-28.28	918855.01 0.65	-5531077.80 0.47	3030080.27 0.64	
		Deltas								
NITRO 11635		NAD83	28 36 06.828	80 38 25.138	-23.54	-28.69	911400.28	-5529466.52	3035225.27	5.154
		WGS84	28 36 06.855 0.027	80 38 25.117 -0.021	-23.54	-28.69	911400.76 0.48	-5529466.03 0.49	3035225.99 0.72	
		Deltas								
CIGAR 11698		NAD83	28 27 51.460	80 39 14.309	-22.78	-28.57	911265.17	-5536872.06	3021827.76	5.794
		WGS84	28 27 51.494 0.034	80 39 14.273 -0.036	-22.78	-28.57	911266.05 0.88	-5536871.41 0.65	3021828.69 0.93	
		Deltas								
RML 3 11619		NAD83	28 01 29.604	80 41 04.940	-20.32	-28.39	912025.86	-5560102.99	2978930.88	8.073
		WGS84	28 01 29.639 0.035	80 41 04.922 -0.022	-20.32	-28.39	912026.25 0.39	-5560102.41 0.58	2978931.84 0.96	
		Deltas								
Mean Deltas (9)										
							0.51 +0.28	0.46 +0.18	0.69 +0.28	

DATUM SHIFTS (JDIF)

STATION	STA NO.	DATUM	LATITUDE(N)	LONGITUDE(W)	GEODETIC HEIGHT(m)	GEOID HEIGHT(m)	X	Y	Z	ELEV(m)
J.D. PARK	11517	NAD83	26° 58' 56" 515	80° 06' 30" 808	-17.35	-28.00	977054.17	-5603209.12	2876466.55	10.651
		WGS84	26 58 56.548	80 06 30.783	-17.35	-28.00	977054.78	-5603208.54	2876467.46	
			0.033	-0.025			0.61	0.58	0.91	
		Deltas								

DATUM SHIFTS (Folly Beach, SC)

STATION	STA NO.	DATUM	LATITUDE(N)	LONGITUDE(W)	GEODETIC HEIGHT(m)	GEOID HEIGHT(m)	X	Y	Z	ELEV(m)
MIKE	11786	NAD83	32° 41' 08" 282	79° 53' 14" 998	-31.44	-34.05	943462.02	-5289880.52	3424650.54	2.611
		WGS84	32 41 08.301	79 53 14.959	-31.44	-34.05	943462.96	-5289880.03	3424651.04	
			0.019	-0.039			0.94	0.49	0.50	
		Deltas								

DATUM SHIFTS (Richmond, FL)

STATION	STA NO.	DATUM	LATITUDE(N)	LONGITUDE(W)	GEODETIC HEIGHT(m)	GEOID HEIGHT(m)	X	Y	Z	*ELEV(m)
TIMER	20038	NAD83	25° 36' 50" 734	80° 23' 02" 627	-20.90	-24.90	961318.37	-5674056.89	2740564.17	4.002
		WGS84	25 36 50.762	80 23 02.609	-20.90	-24.90	961318.80	-5674056.44	2740564.95	
			0.028	-0.018			0.43	0.45	0.78	
		DELTA								

* Feb 79 Elevation

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