ICAS Software Services		Systems: DDHDB	Project: PB2001
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To: Peter Clarke
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Re: Conversion of GRUM KA-coordinates to UTM and vice versa

1. KA-Coordinates to UTM

$$N_{UTM} = N_o + S*(N_{KA}*\cos\alpha + E_{KA}*\sin\alpha)$$

$$E_{UTM} = E_o + S*(-N_{KA}*\sin\alpha + E_{KA}*\cos\alpha)$$

2. UTM-Coordinates to KA

$$N_{KA} = ((N_{UTM}-N_o)*\cos\alpha - (E_{UTM}-E_o)*\sin\alpha)/S$$ ✓

$$E_{KA} = ((N_{UTM}-N_o)*\sin\alpha + (E_{UTM}-E_o)*\cos\alpha)/S$$ ✓

where N_{UTM}, E_{UTM} = UTM-coordinates of a point (DDH-collar)

N_{KA}, E_{KA} = KA-coordinates of a point (DDH-collar)

α = clockwise offset angle from KA-grid North to UTM-North

S = UTM distance scale factor

N_o, E_o = UTM-coordinates of KA-grid origin

My analyses indicate that the following values are adequate for use in the above formulae for the GRUM property

α = 1.5736111° $\cos\alpha$ = 0.9996229 $\sin\alpha$ = 0.0274612 (known value)

S = 0.99950853 (average value)

N_o = 6,894,007.169 E_o = 584,995.9084 (least-squares minimum)

J.R. Morton-Lambert.

$$\begin{Bmatrix} E_{UTM} \\ N_{UTM} \\ h \end{Bmatrix} = \begin{bmatrix} & T & \end{bmatrix}^{-1} \begin{Bmatrix} E_{NC} \\ N_{NC} \\ 1 \end{Bmatrix}$$

$$\begin{Bmatrix} E_{NC} \\ N_{NC} \\ 1 \end{Bmatrix} = \begin{bmatrix} & T & \end{bmatrix} \begin{Bmatrix} E_{UTM} \\ N_{UTM} \\ h \end{Bmatrix}$$

$$[T] = [A] * [B] * [C]$$

Scaling Translation Rotation.

$$\begin{Bmatrix} E_{UTMS} \\ N_{UTMS} \\ 1 \end{Bmatrix} = \begin{bmatrix} \frac{1}{s} & \cdot & \cdot \\ \cdot & \frac{1}{s} & \cdot \\ \cdot & \cdot & 1 \end{bmatrix} \begin{Bmatrix} E_{UTM} \\ N_{UTM} \\ 1 \end{Bmatrix}$$