Reference Frames in Practice Manual

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Seminars on Reference Frames in Practice
- 2012 FIG working week Rome [20],
- 2013 SE Asian Survey Congress Manila [40],
- 2013 FIG/UN-GGIM-AP Pacific Smalls Developing States Symposium Fiji [20].

- Manual addresses technical issues surrounding reference frames
- Provides a brief introduction to the use of Reference Frames in Practice.
- This presentation gives an overview of the Manual
1. Introduction

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- Addresses technical issues surrounding reference frames
- It is arranged as a series of short fact sheets
- Provide a brief introduction to the use of Reference Frames in Practice.
- It is intended for surveyors.
- It contains a number of technical terms and lists references where additional information may be found.
2. Geodesy and Global Reference Frames

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• This section gives an overview of the science of geodesy and use of global reference frames.
  – Surveyors increasingly use satellite positioning systems that provide position in terms of global reference frames.
  – Important for surveyors to understand these reference frames and how they relate to local reference frames.

3. Global Terrestrial Reference Systems and Frames

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• This section provides knowledge of global terrestrial reference systems and frames and transformations between them.
  – It is often necessary to transform between different global reference frames.
4. Regional and National Reference Frames

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• This section provides information for the surveyor on the different types of reference frames and datums and how crustal deformation can be accommodated in them.
  – Surveyors often make measurements in terms of regional or national reference frames.
  – We need to be concerned with accommodating the effects of crustal deformation in our datums.

5. Height Systems

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• This section describes the various height systems and how heights can be transformed between these systems.
  – Traditionally the surveyor is interested in determining heights in terms of sea level.
  – Satellite positioning systems determine heights relative to the ellipsoid
6. Transforming Between Datums

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• This section provides information on the commonly used transformation methods and some of the more specific cases
  – The surveyor is often required to transform data between different datums.

7. Transforming Between Datums in Non-static Reference Frames

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• This section details the specific case for transforming between these non static reference frames.
  – Surveyors are increasingly working in non-static reference frames, reference frames that account for the effects of crustal movements.
8. Reference Frame Parameter Estimation and Testing via the technique of Least Squares

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- This section focuses on the propagation of an international or regional reference frame onto national or local stations.
  - When making a set of measurements the surveyor will often be required to test the accuracy of those measurements and identify any outliers or errors.
  - This is most commonly carried out using the method of Least Squares.

\[ \hat{x} = (A^T V_m^{-1} A)^{-1} A^T V_m^{-1} m \]
\[ V_x = (A^T V_m^{-1} A)^{-1} \]


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- The section on Reference Frame Parameter Estimation and Testing via the technique of Least Squares gave a general overview of the topic.
- This section briefly reviews some basic concepts and techniques for the testing of geodetic measurements and least squares parameter estimates, and for estimating network reliability.

\[ \tau = \frac{\sigma_m}{\sigma_v} = \frac{\sigma_m}{\sqrt{\sigma_m^2 - \sigma_a^2}} \]

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- This section provides an overview of the various systems available and methods of making measurements.
  - Increasingly surveyors are using satellite based positioning systems to make their survey measurements.
  - A number of systems are now fully or partially operational and several regional augmentation systems are being developed.

11. GNSS CORS Networks and Linking to ITRF

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- This section details how to link information from a CORS to global reference frames.
  - More and more countries are building networks of CORS.
  - These provide services to the surveyor that can increase the efficiency
  - Real time positions may be generated in terms of local or global reference frames if required.
12. The International GNSS Service (IGS)

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- This section details the structure of the IGS and services provided by them.
  - Many of the commercially available GNSS software packages have options which enable the surveyor to download and utilize the IGS data and products in their processing.
  - This enables the generation of precise coordinates aligned to the latest version of ITRF.

13. Standards and Traceability of Terrestrial Reference Frames

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- Surveyors as professionals must fulfill certain legal, regulatory and/or accuracy requirements for their clients.
- Using internationally recognized standards such as the ISO series and ensuring traceability in measurement are two internationally and widely accepted ways of doing this.