Standards



Survey

Management System

GEMS SURVEY

STANDARDS

SURV-GEMS-20031027

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1 PURPOSE

This document describes a set of standards for surveying and should be used a guide for all surveying projects undertaken by GEMS members.

By clearly defining a set of standards to at minimum work towards, it provides a guide for establishing work practices and procedures that will enable the standards to be met and exceeded.

This document forms the main focus point of the survey management system.

When initially established in 2003, the purpose of this document is also to act as the guideline referred to in the WA DOME Safety Bulletin #57 dated 10/11/2000 by J M Torlach.

With the publication of the WA DIOR Codes of Practice – Mine Survey in 2005, this document has been slightly amended to incorporate what is deemed to be best effective mine survey practices and standards throughout Australia.

This includes, but is not limited to;

- West Australian Mining Act, Regulations, and Code of Practice.
- Australian Standards regarding Mine Plans and Geographical Feature Coding
- New South Wales Mineral Resources Survey and Drafting Directions for Mining Surveyors
- Victorian, Queensland, Tasmanian, and Northern Territory Mine Survey Regulations.

2 SCOPE

Unless a client has a set of documented standards and procedures that differ from these;

This document applies to any employees of Glockner Engineering & Mining Services (GEMS).

3 DEFINITIONS



4 STANDARD

4.1 Character and Attitude of the Mine Surveyor

- ✓ Endeavour to be of good, personable character.
- \checkmark Work in a safe manner.
- ✓ Be committed to the pursuit of high professional standards.
- ✓ Accept that a Mine Surveyors responsibility covers all facets of surveying within a mining lease, whether it is exploration, engineering, open cut, or underground works.
- ✓ Understand that it is how helpful and useful you can be to those around you that makes you important, not the experience or qualifications you have.
- Be useful and valuable to the client, it is your responsibility to add value to your position and make yourself invaluable.

4.2 Appointments

Mine surveyor are to request that the manager of a mine cause a record to be made in the record book, of the name of the mine surveyor(s) appointed to make or draw the survey or plan of the mine, and the day on which that person was appointed.

4.3 Equipment

- 4.3.1 All equipment, including vehicles, to be kept in a good, clean, working order.
- 4.3.2 All equipment used should be treated with the same care and respect, as if it were owned by the person themselves.
- 4.3.3 A capital equipment register is to be maintained. This list is to include purchase dates and serial numbers.
- 4.3.4 Instruments to be well calibrated and adjusted. Traverse equipment, optical zeniths and plummets to be included in equipment adjustments.
- 4.3.5 Instrument service schedule to be kept up to date. It is suggested that this be incorporated with the capital equipment register.
- 4.3.6 The instruments and equipment used are to be of a precision considered equal to best current industry standards and technology.



4.4 Data Collection - Measurements

- 4.4.1 Measurements to be taken so as to show true relative shape, volume, and/or location.
- 4.4.2 Every job done (both pickups and setouts) is to be recorded and noted in such a way that it could be easily recognized and re-processed many years later.

Sequential numbers are to be used as a name for each job to easily identify and track work.

- 4.4.3 All works done are to be annotated in a Chartwell (2647) style field book. As well as being used as a conventional field book, it is to be used as a log, a register of works done, this being also a cross-referencing tool for digital data.
 - (B) Ideally entries into the field book are to be:
 - Dated
 - Signed
 - Titled
 - Clear
 - Concise
 - Legible
 - In water-proof ink, black for original data, red for corrections.

• Cross-referenced to any relevant computer software files and plans, including the sequential numbering of setout/area and pickup/measure/job files.

4.5 Digital Data Storage

- 4.5.1 All data to be stored such that:
 - It is secure, safe from corruption. Suggest:
 - ✓ Survey data area have read-only access to non-survey personnel,
 - ✓ Data from the servers be backed up frequently and regularly,
 - ✓ Survey data to be written to a DVD or portable hard drive on a regular basis, such as monthly intervals.
 - The latest, most recent up to date information is readily on hand.





• Work folders to be compiled so as to present a log of daily works. Temp files are to be stored in the daily folders.

4.6 Mine Datum

- 4.6.1 A datum station is to be established in the general vicinity of the mine, to which a coordinate system is related for survey and plan reference.
- 4.6.2 The position of the datum station must be established in terms of the Map Grid of Australia 1994 co-ordinate system and the Australian Height Datum (AHD).
- 4.6.3 If a local grid system is used for mine surveying and management the relationship between that grid system and the Map Grid of Australia 1994 in terms of distance and with respect to true bearing is established.
- 4.6.4 In addition to the above: Local mine grid values, based off the main control stations, are to be transferred to at least two surrounding, near-by SSM's, or other published government survey control marks. Having the local values on surrounding SSM's will permanently establish the relationship between local mine grid and all national grid systems (AMG66, AMG84, and MGA94).
- 4.6.5 A plan of the lease or tenement in which the mine is situated showing —

 (i) the datum station established as the origin of the survey;
 (ii) the relationship to the Map Grid of Australia 1994; and
 (iii) the relationship to the local grid system;

Is to be kept up to date in both digital and hard-copy formats.

4.6.6 If a new mine grid system is to be established; to avoid confusion between positive and negative figures in reduced levels, it is recommended that a constant be added to the AHD value. AS 4368-1996 recommends that the constant be based on an assumed datum of 10000m below AHD.



4.7 Surface Topography and Quarries

4.7.1 A person must not make or draw a survey or plan of a quarry unless the person —

(a) holds the equivalent of a West Australian authorised mine surveyor's certificate
(either grade 1 or grade 2); or

(b) is acting under the control and supervision of a person who holds the equivalent of a West Australian authorised mine surveyor's certificate (grade 1 or grade 2).

It is not encouraged that only one authorised mine surveyor's certificate holder be employed on a site. If only is employed, when that person is off site, managers are to be made aware that this may be considered a breach of the strictest mine management standards. For example; in Western Australia, depending on ones interpretation, this could even be considered as a breach of Act.

- 4.7.2 Survey control to be of a high order of precision and checked.
- 4.7.3 A hardcopy folder and plans detailing the surface control to be kept up to date on site.
- 4.7.4 Station summaries within this folder to indicate each points location, general construction, description of order of precision, as well as its co-ordinates.
- 4.7.5.1 GPS site calibration is to be carried out which establishes the relationship between WGS-84 points collected by GPS receivers, and local grid positions on a local map grid.
- 4.7.5.2 The local map grid includes elevations above sea level, and the GPS data includes WGS-84 heights. Published coordinate systems and geoid models do not usually allow for local variations in the projection. A GPS site calibration can reduce these variations and obtain more accurate local grid coordinates. This provides a good check on the integrity of the survey control precision.
- 4.7.5.3 Once a site calibration has been established from the mine survey control points, obtain mine grid co-ordinates of the SSM's. This will provide the transformation parameters between various grid systems and height datums.
- 4.7.5.4 An N value geoid separation model is to be compiled based off the published values on surrounding SSM's.
- 4.7.6.1 Control points are to be of sturdy permanent form of construction. Dumpy pegs and spikes in the scrub are not to be considered as suitable permanent survey marks.

Pillars to be constructed and used as control around a pit.



Revision:

- 4.7.6.2 Where possible, permanent level structures, such as concrete slabs and bitumen roads, are to be used to place aerial photo control marks.
- 4.7.7.1 Digital data to be coded as per:
 - ✓ Australian Standards AS 2482-1989 Geographic information systems-Geographic data-Interchange of feature-coded digital mapping data. And where not covered by the above,
 - ✓ The GEMS standards document: MIN-GEN-AS2482-1989 SSI String Numbering.
- 4.7.7.2 Topographical digital data for each site to be separated into six folders or categories:
 - Survey Control Stations including aerial photo marks
 - Contourable Data Data with real 3D values such as crests, toes, roads. •
 - Non-contourable Data Boundaries, area demarcations. •
 - Contours
 - Spot Heights Levels
 - Services Such as buildings, fences, powerlines, and various buried services.
- 4.7.8.1 An A4 or A3 booklet of plans showing site layouts to be kept up to date. These plans to act as a location, travel guide, and to facilitate emergency responses. These plans to show:
 - The general infrastructure,
 - Phones, fire extinguishers, muster areas, and other essential emergency response items,
 - high voltage electrical system.
 - major mains for compressed air and water supply systems and other essential services on the surface; and
 - all buried services.
- 4.7.8.2 In addition, digital and hardcopy plans showing the surface topography and infrastructure, are to be kept up to date.
- 4.7.8.1 Mine plans are to comply with Australian Standards AS 4368-1996 Mine plans-Preparation and symbols.
- 4.7.8.1 The following particulars must be contained in the plans:

(a) Surface plans should include all offices, buildings, concentrators, workshops and any other permanent structures.

(b) in relation to quarry operations, a plan showing the true size and shape of all excavations and sufficient cross-sections showing advances made in the quarry operations and the areas reclaimed or again filled in;

(c) so far as is practicable, longitudinal sections or projections to a scale that accords with good engineering practice that shows all mining operations;



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(f) so far as is practicable, sufficient cross-sections or projections to a scale that accords with good engineering practice that clearly shows the ore bodies and the parts of ore bodies mined out;

- (g) the date when the plan was made; and
- (h) certification by the person who made the plan that the plan is correct.

as well as plans showing the location and details of all:

- (i) high voltage cabling and equipment installed at the mine;
- (ii) main switches provided at the mine; and
- (iii) low voltage and high voltage cables installed in the ground at the mine;
- 4.7.9.1 Prism monitoring of quarries and pits to be carried out such that these surveys are considered to be pro-active instead of re-active.
- 4.7.9.1 Surveying is the art and science of carrying out measurements, and as such, the mine surveyor is to actively participate in the decisions of prism placements, and the frequency of measurements.





4.7.9.1 Prisms are to be placed such that the most likely direction of movement is generally towards the monitoring station. Reference pillars are to be placed away from the active mining crest, and so that when measuring to it, it is through the same column of air as the target prisms.





- 4.7.10.1 When open cut surveys are carried out, digital models of the following are to be kept on hand:
 - Pre-mining, or natural surface details,
 - Total-cut model model of all excavations carried out, prior to any wall slips or backfilling.
 - Current void shape usually the "end of month" survey outlines.
- 4.7.10.2 Open pit and stockpile volumes are to have precision estimates calculated in conjunction with a confidence limit estimate.



4.8 Underground Surveys and Plans

4.8.1.1 A person must not make or draw a survey or plan of an underground mine unless the person —

(a) holds the equivalent of a West Australian authorised mine surveyor's certificate (grade 1); or

- (b) is acting under the control and supervision of a person who holds such a certificate.
- 4.8.1.2 A person who carries out a survey at a mine must ensure that the survey is carried out to a standard that accords with good engineering practice and is to an accuracy of not less than 1:5000.
- 4.8.2 A hardcopy filing system of field notes, traverse calculation sheets and traverse ledger to be kept in good order and up to date at all times.
- 4.8.3 Re-traversing or check surveys, plumbing through rises, spirit levelling, and gyro observations on underground control are to be carried out as a matter of course, and become part of the mine surveyors routine.
- 4.8.4 A hardcopy of the evidence of the above mentioned re-traversing, plumbing down rises, spirit levelling, and gyro observations to included in the current filing system. The Traverse Ledger is to act as the summary document of the above.
- 4.8.5 Prior to using resection survey observations as a primary form of underground survey control, a study of wall deformation over time should be carried out. It is even suggested that this be an on-going study, as a matter of course, whenever wall-resections stations are used as major control points.
- 4.8.6 Digital models of underground workings to be:
 - 3 dimensional
 - Show true shape, size, and locations
 - Be made into the form of 3dm (or triangle wireframes), not just left as string (breakline) data
 - Be kept up to date regularly
- 4.8.7 It is essential to have available a comprehensive and accurate hardcopy set of current working plans available at underground mines at all times, so that should a mine emergency arise, plans for emergency response (mines rescue) teams are immediately available.
- 4.8.8 An A4 or A3 booklet of plans showing the underground layout to be kept up to date. These plans to act as a location and travel guide, and facilitate emergency responses.
 - These plans to show:

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All main access, travel ways and openings

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- Refuge chambers, escape ways, phones, and other essential emergency response items
- The high voltage electrical system.
- the ventilation system underground;
- the geological structure;
- major mains for compressed air and water supply systems and other essential services on the surface and in underground workings of a mine; and
- all buried services and services in bore holes in underground mines.
- 4.8.9 A set of hardcopy "Pay Plans" to be updated regularly showing the location, size, and advances in the mine workings over time.
- 4.8.10 As well as the above, a digital and hardcopy of the "Underground Master Plans", are to be kept up to date.

The following particulars must be contained in these plans:

- (a) a general plan of any underground levels to a scale that accords with good engineering practice that shows, so far as is practicable, the true size and shape of all development openings, but a composite plan may be accepted if each level on that plan can be clearly seen;
- (b) ventilation system plan that shows the direction, course and volume of air currents, and the position of all air doors, stoppings, fans, regulators and ventilating devices, in the mine.
- (c) if any underground drill holes at the mine contain potentially hazardous services including electrical power cables, compressed air lines or diesel fuel lines, details of the location of those holes;
- (d) so far as is practicable, longitudinal sections or projections to a scale that accords with good engineering practice that shows all underground mining operations;
- (e) so far as is practicable, sufficient cross-sections or projections to a scale that accords with good engineering practice that clearly shows the ore bodies and the parts of ore bodies mined out;
- (f) the date when the plan was made; and
- (g) certification by the person who made the plan that the plan is correct.
- (h) In relation to a plan of West Australian underground mine operations, the certification referred to must be in the following form:

This is to certify that this survey has been done by myself (or by persons under my own supervision), subject to adequate inspection and field check, and is the actual result of the observations and measurements, and the survey and plan have been done in accordance with the requirements of the *Mines Safety and Inspection Act 1994* and the regulations made under that Act. DATED the day of 20

Authorised Mine Surveyor Grade . . . Certificate No.



- 4.8.11 Accurate survey control is required to maintain design line and grade in headings. The following survey controls are required;
 - All turnouts and stripping are to be marked up showing foresight and backsight marks. Lead strips are also to be marked up. The markup is to be issued on an Approval to Excavate (*ATE*) or Mining Instruction.
 - Pencil lasers class 3A are to be used where-ever possible for development line and grade control, to laser distance of 70 m (or longer where suitable).
 - Chainage markers, or measuring points, are to be installed every 20 to 30m.
 - A survey pickup is required of a development heading:
 - Every 20 to 30m of advance,
 - o Or every 4 weeks,
 - which-ever occurs first.
 - When-ever survey pickup a heading;
 - A pickup of the laser dot on the current face is to be carried out, to provide a quality assurance (QA) check on the laser alignment.
 - The grade line is to be marked up;
 - 1.5m above design floor,
 - At minimum on the left side wall, but preferably on both sides of the drive.
 - Hardcopy plans and sections;
 - o showing actual and design excavation,
 - o are to be compiled for all development,
 - o at duration intervals of no greater than 30m in crosscuts,
 - are to be submitted to the Development Superintendent in a timely fashion to provide a pro-active QA check on heading profile shapes and gradient.

4.9 Engineering Surveying

- Surveyors are to check Inspection and Test Plans (ITP's) prior to commencing work to fully understand the procedures and scope of the job.
- Issued for construction (IFC) drawings are only to be used for setout if the revision is 0 or above.
- A register of all construction plans is to be kept to ensure the latest information is being used.
- If a new revision of a plan is issued the plan register is to be updated. The old plan is to be stamped with 'Superseded' stamp and kept with the updated plan.
- All engineering drawings are to be given a Survey plan number and recorded in the Plan register.
- All important points (WP, TP and IP) are to be checked, verified and cross referenced between plans.
- All references to other plans are to be identified, investigated and reviewed from a surveyors perspective.
- The job (set out data) files created from IFC drawings are to be;
 - o Calculated by one surveyor,
 - o Checked by another,
 - Noted on the IFC drawings with the calc and checked surveyors names.
- Where ever possible a Centerline is to be established by using a transformation from a local grid and parameters recorded in job registers, field books and document registers.
- All control is to be transformed from Local grid to Construction Centerline.
- All setouts and pickups are to be done in reference to the Construction Centerline.
- All dimensions on plans are to be redline marked after construction (i.e. Ascon distances marked on design plans after construction)



4.10 Diary and Survey Logs

4.10.1 Survey Diary or Log Book

A diary and a survey job log is to be kept, which sets out more detailed information than is in the survey field books, and assists enabling a smoother transition or hand-over at roster change overs.

4.10.2 Job Register Book

A *Collins 3880 style account book* is to be used as a job register book. This register tables all setout and pickup files.

4.10.3 Plan Register Book

A *Collins 3880 style account book* is to be used as a job register book. This register tables all setout and pickup files.

4.11 Standing Order System

GEMS surveyors are to ensure that the <u>Standing Order</u> system within every site where we have a team (more than one CTM on site).

A **Standing Order** is an instruction that is to remain in place until it is superseded by another one, or by a procedure, or cancelled by someone with relevant authority.

The **Standing Order Folder** is a collection of printed Standing Orders, and other relevant safety notifications, handover instructions, stored in reverse chronological order (most recent on top).

During the course of our swing or panel at work, we will receive many instructions, notification of changes, that are relevant to our work and are not always part of a formal procedure and training package.

We are required to remember the instructions and even communicate these to our cross shifts to ensure safe and effective work.

Remembering <u>all</u> the instructions that are currently in place is virtually impossible for anyone.



Emails may help to communicate instructions and changes, but we have no real assurance that;

- they are getting to all those required?
- all read at start of each shift? or
- whether people store them for future reference?

Communicating <u>all</u> instructions and procedures to new starters is another issue.

The Standing Order System helps to overcome these issues;

- A folder is to be established and clearly labelled in the survey office,
- As notifications of instructions (emails and other formats) arrive, they are to be printed out and stored in the Standing Order folder, at the top of the folder. This ensures that the most recent instruction is always on top.
- If the new instruction supersedes an older one, the older one is to be stamped "superseded".
- We encourage that any hand over notes not in a survey dairy to be printed out and placed in this folder.
- As a person commences their panel swing they are to open this folder and familiarise themselves with all the instructions and changes that have been rolled out whilst they have been off site.

As the operation grows and we implement new infrastructure, without having something like the Standing Order system, the ability to keep up with all the changes will be even more difficult.

Hence the need to establish and embrace as system such as this before things get out of hand!

4.12 Archiving of Old Plans and Other Hardcopy Data

It is preferred that archive data be stored is separate, ventilated rooms, such as sea containers.

Archiving of old plans to be stored in verti-plan cabinets, not rolled up in bundles.

4.13 Plan of Scene of Fatal Accident

This applies if the Coroner or deputy Coroner or an inspector requires a survey to be carried out or a location plan to be prepared of the scene of any fatal accident at a mine (whether underground or elsewhere at the mine).

If this applies, the manager of the mine must ensure that a person is not engaged to carry out the survey or to prepare the location plan unless the person is the holder of an authorised mine surveyor's certificate.

5 **REFERENCES**

Mines Safety and Inspection Regulations 1995	WA Department of Minerals and Energy		
Safety Bulletin No 57 dated 10/11/2000 Mine Surveying – Risks in Loss of Accuracy and Integrity	WA Department of Minerals and Energy		
Mining Management Regulations 2001, No 50	NT Department of Business Industry & Resources Development		
AS 4368-1996 – Mine Plans	Australian Standards		
AS 2482-1989 - GIS	Australian Standards		
MIN-GEN-AS2482-1989	GEMS SSI String Numbering Standard		
Quikslope Users Manual v3	SoftRock Software		
Code of Practice - Mines Survey, 2005	WA Department of Industry & Resources		
Survey and Drafting Directions for Mining Surveyors	NSW Mineral Resources		

6 DOCUMENT REVISION HISTORY

Revision Events					
Rev.	Author	Changes	Date		
Draft A	OG	Word document	27/11/03		
Draft B	OG	Item numbering	4/12/03		
0	OG	Example of standards checklist	3/11/04		
1	OG	Appendices of several checklist-audit sheets	8/8/05		
2	OG	Underground Survey Control	30/3/06		
3	OG	Reference to WA Mine Survey Code of Practice	8/12/07		
4	TPM	Engineering Surveying Section	30/10/10		



7 APPENDICES

Examples of a standards checklist, or audit sheets:

- GEMS AUDIT Mine Survey Book 20050515
- GEMS AUDIT Surface Mine Plans 20050515
- GEMS AUDIT Surface Mine Emergency Plans 20050515
- GEMS AUDIT Underground Mine Plans 20050808
- GEMS AUDIT Laser use underground 20050426