

**RULES GOVERNING THE CERTIFICATION OF
NAMIBIAN MINE SURVEYORS**

Revision 18 - November 2006

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1. INTRODUCTION

There is a significant and urgent need for the training and certification of competent mine surveyors from within Namibia. Whilst there is a need to maintain the level of surveying standards within the Namibian mining industry, certification should not be placed out of the reach of potentially competent and skilled surveyors.

The Chamber of Mines of Namibia has, accordingly, through its Qualifications Subcommittee of Mine Surveyors, instituted a training and certification programme and awards the following Certificates:

1.1 Elementary Certificate in Mine Surveying

- a. Surface - only for open-cast operations
- b. Full - i.e. surface and underground operations

1.2 Advanced Certificate in Mine Surveying

- a. Surface - only for open-cast operations
- b. Full - i.e. surface and underground operations

1.3 Certificate of Competency in Mine Surveying

- a. Surface - only for open-cast operations
- b. Full - i.e. surface and underground operations

The Elementary Certificate concentrates essentially on written and practical survey subjects as these are the nucleus of the surveying profession. On attainment of this Certificate the candidate should be able to function as a surveyor and competently carry out the majority of survey tasks without direct supervision.

The Advanced Certificate and Certificate of Competency require the candidate to expand his / her knowledge to incorporate all the requirements needed by a Senior or Chief Surveyor to effectively take charge of a Survey Department on a mine or Sections thereof.

2. ADMINISTRATION

2.1 The Chamber of Mines of Namibia is responsible for :

- 2.1.1 The control and frequency of all Mine Survey Certificate examinations which, unless otherwise dictated by demand, will normally be held in May and November each year.
- 2.1.2 Advising all participating bodies of the exact dates and times of the examinations at least three months prior to the examinations.
- 2.1.3 Advising all participating bodies of the closing dates for applications for examinations.
Application forms (AE 1998) are available from the Chamber offices.
- 2.1.4 The approval of examination venues and appointment of invigilators for the examinations.
- 2.1.5 Setting examination fees and the collection thereof
- 2.1.6 The issue of examination papers and control of completed examination papers.
- 2.1.7 Notifying candidates of results and the issuance of all certificates

2.2 The Qualifications Subcommittee of Mine Surveyors is responsible for :

- 2.2.1 Making recommendations as to all aspects of the implementation and training of future Namibian mine surveyors.
- 2.2.2 Conducting all written and practical examinations
- 2.2.3 The preparation of training course materials and amendments thereto.
- 2.2.4 Updating and amending the “Rules Governing the Certification of Namibian Mine Surveyors”, as and when deemed necessary.
- 2.2.5 The appointment of examiners and moderators for both written examinations and the Trial Survey.
- 2.2.6 Ensuring that practical examinations are controlled by the relevant Chief Surveyor.

2.3 The Qualifications Subcommittee of Mine Surveyors will consist of :

- a Chairperson, approved by the Chamber of Mines
- a minimum of three (3) Chief Surveyors of Namibian Mines
- the Government Mine Surveyor
- any external examiners co-opted by the Subcommittee

N.B. If any member of the Subcommittee is unable to attend a Subcommittee meeting, then a designated alternate must attend in that member's place.

3. PREREQUISITES FOR MINE SURVEYING COURSES

3.1 Elementary Certificate :

- 3.1.1 Grade 10 certificate holders with either school or N1 mathematics
Candidates will be required to successfully complete a mathematics bridging programme.
- 3.1.2 Grade 12 certificate holders with either school or N3 mathematics
Candidates may apply for exemption from the mathematics bridging programme.

3.2 Advanced Certificate :

- 3.2.1 Possession of the Elementary Certificate, or equivalent certification acceptable to the Qualifications Subcommittee
- 3.2.2 Candidates shall have completed at least one (1) year's acceptable survey experience in the workings of a mine.

3.3 Certificate of Competency :

- 3.3.1 Possession of the Advanced Certificate, or equivalent certification acceptable to the Qualifications Subcommittee
- 3.3.2 Candidates shall have completed at least one (1) year's acceptable survey experience in the workings of a mine.

4. EXEMPTIONS

4.1 General :

Any person who possesses a valid survey qualification from an external authority may, within a period of one year from the commencement of that person's duties, make written application for exemption from part or all of the examinations for any particular certificate.

4.1.1 All applications for exemption must, where applicable, be accompanied by the following :

- 4.1.1.1 Certified copies of qualifications. The Chamber may require a detailed list of subjects comprising such certification.
- 4.1.1.2 Certified copies of certificates of service.
- 4.1.1.3 Certified schedule of practical survey work undertaken, listing all major surveys carried out since the start of the applicant's career.

4.1.2 The Qualifications Subcommittee may reject any application for exemption if :

- 4.1.2.1 Applications do not meet the standards acceptable to the Subcommittee
- 4.1.2.2 Applications are incomplete
- 4.1.2.3 Qualifications submitted are, in the opinion of the Subcommittee, not of a sufficiently high standard
- 4.1.2.4 Experience gained is, in the opinion of the Subcommittee, not of a sufficient variety or satisfactory standard or nature
- 4.1.2.5 There is any doubt as to the authenticity of a qualification or experience submitted, even if it is certified or signed by the applicant's previous Chief Surveyor.

The Qualifications Subcommittee may, but is not obliged to, give reasons for rejecting an application.

4.2 Exemption from the Elementary Certificate in Mine Surveying :

In order to be considered for exemption, the applicant must possess an acceptable equivalent to the Elementary Certificate in Mine Surveying from any other country and have worked as a Mine Surveyor for at least two (2) years in a Mine Survey Department. The candidate must also have worked in a non-directly supervised capacity, carrying out an acceptable variety of mine survey work.

N.B. A schedule of survey work undertaken (as defined in 4.1.1.3 above) must also be provided.

Notwithstanding the above, the candidate may, at the discretion of the Qualifications Subcommittee of Mine Surveyors, be required to carry out the practical tests and / or an oral test in Mining Law as defined in Clause 6.1.2.1(y) of these Rules.

4.3 Exemption from the Advanced Certificate in Mine Surveying :

In order to be considered for exemption, the applicant must possess an acceptable equivalent to the Advanced Certificate in Mine Surveying from any other country and have worked as a Mine Surveyor for at least three (3) years in a Mine Survey Department. The candidate must also have worked in a non-directly supervised capacity, carrying out an acceptable variety of mine survey work.

N.B. A schedule of survey work undertaken (as defined in 4.1.1.3 above) must also be provided.

Notwithstanding the above, the candidate may, at the discretion of the Qualifications Subcommittee of Mine Surveyors, be required to carry out the written Mining Law examination and / or practical tests as defined in Clause 6.2.2.3 of these Rules.

4.4 Exemption from the Certificate of Competency in Mine Surveying :

In order to be considered for exemption, the applicant must possess an acceptable equivalent to the Certificate of Competency in Mine Surveying from any other country and have worked as a Mine Surveyor for at least five (5) years in a Mine Survey Department. The candidate must also have worked in a non-directly supervised capacity, carrying out an acceptable variety of mine survey work.

N.B. A schedule of survey work undertaken (as defined in 4.1.1.3 above) must also be provided.

Notwithstanding the above, the candidate :

1. will be required to carry out the written Mining Law examination as defined in Clause 6.3.2.3 of these Rules
and
2. may be required to carry out other written subject examinations where, in the opinion of the Qualifications Subcommittee of Mine Surveyors, insufficient competency exists.

5. EXAMINATIONS

No candidate will be allowed to sit any examination unless the requisite examination fee has been received by the Chamber of Mines.

The applicable examination fees are specified on the application form.

Individual companies or mines may make their own arrangements with respect to funding or reimbursement of examination fees for their candidates.

In principle, candidates for examinations should acquire their knowledge in the course of their normal duties, supplemented by study in their own time.

5.1 Elementary Certificate in Mine Surveying:

The subjects for the examination, time allowed for the examination, maximum marks, marks required for a pass and the marks required for indefinite exemption are as follows :

Theory Examination

Based on the syllabus as defined in -

- Clause 6.1.2 - Theory
- Clause 6.1.2.2 - Specimen Plan

Candidates must satisfy all the written examination requirements, as there will be no separate examinations distinguishing between underground and open-cast mining.

<u>Subject and Maximum marks</u>	<u>Time Allowed</u>	<u>Maximum Marks</u>	<u>Pass Marks</u>	<u>Exemption Marks</u>
Mine Surveying (includes Mining Law)	3 hours	100	60	75
Specimen Plan	No Limit	100	75	75
Hydrography I	3 Hours	100	50	75

N.B. A minimum of 50 % of the 25 marks allocated to the Mining Law question must be obtained.

Note: Hydrography is a specialization subject only and is not required for the Elementary Survey Certificate. Should the candidate pass the Hydrography subject as well, then the Elementary Certificate will be endorsed accordingly.

Practical Examination

Based on the syllabus as defined in -

- Clause 6.1.1 - Practical

1. 75 % must be obtained in each practical task.
2. The Chief Surveyor of the relevant mine will certify, in writing to the Qualifications Subcommittee of Mine Surveyors, that the candidate has obtained the required pass marks.

Note A Certificate will not be awarded until such time as

1. the practical examination has been successfully completed;

- and / or
- the candidate has had the necessary one (1) year's acceptable survey experience in the workings of a mine

5.2 Advanced Certificate in Mine Surveying:

The subjects for the examination, time allowed for the examination, maximum marks, marks required for a pass and the marks required for indefinite exemption are as follows :

Theory Examination

Based on the syllabus as defined in -
Theory - Clause 6.2.2

Candidates must satisfy all the written examination requirements, as there will be no separate examinations distinguishing between underground and open-cast mining.

<u>Subject and Maximum marks</u>	<u>Time Allowed</u>	<u>Maximum Marks</u>	<u>Pass Marks</u>	<u>Exemption Marks</u>
Mine Surveying I	3 hours	100	50	75
Mine Surveying II	3 hours	100	50	75
Mining Law	1.5 hours	100	50	75
Mining Economics I	3 hours	100	50	75
Geology	3 hours	100	50	75
Mathematics	3 hours	100	50	75
Hydrography II	3 hours	100	50	75

N.B. Candidates are required to specify which subjects they will be sitting at each set of examinations.

Credits will be given for each subject passed.

Note: Hydrography II is a specialization subject only and is not required for the Advanced Survey Certificate. Should the candidate pass the Hydrography II subject as well, then the Advanced Certificate will be endorsed accordingly. Candidates will not be allowed to enter for Hydrology II unless they have previously passed Hydrography I.

Practical Examination

Based on the syllabus as defined in -

- Clause 6.2.1 - Surface
- Clause 6.1.1 - Underground (for full Certificate)

- 75 % must be obtained in each practical task.
- The Chief Surveyor of the relevant mine will certify, in writing to the Qualifications Subcommittee of Mine Surveyors, that the candidate has obtained the required pass marks.

- N.B. 1.** A Certificate will not be awarded until such time as the practical examination has been successfully completed.
- 2.** A candidate without the required one (1) year's underground experience will only be issued with a Certificate endorsed for surface mines. Once the candidate has successfully completed the underground practical test, as per 6.1.1.2, a full Certificate will be issued.

5.3 Certificate of Competency in Mine Surveying:

The subjects for the examination, time allowed for the examination, maximum marks, marks required for a pass and the marks required for indefinite exemption are as follows :

Theory Examination

Based on the syllabus as defined in -
Theory - Clause 6.3.2

Candidates must satisfy all the written examination requirements, as there will be no separate examinations distinguishing between underground and open-cast mining.

<u>Subject and</u> <u>Maximum marks</u>	<u>Time</u> <u>Allowed</u>	<u>Maximum</u> <u>Marks</u>	<u>Pass</u> <u>Marks</u>	<u>Exemption</u> <u>Marks</u>
Mine Surveying III	3 hours	100	50	75
Mine Surveying IV	3 hours	100	50	75
Mining Law	1.5 hours	100	50	75
Mining Economics II	3 hours	100	50	75
Mineral Exploitation	3 hours	100	50	75
Management	3 hours	100	50	75
Hydrography III	3 hours	100	50	75

N.B. Candidates are required to specify which subjects they will be sitting at each set of examinations.

Credits will be given for each subject passed.

Note: Hydrography III is a specialization subject only and is not required for the Certificate of Competency. Should the candidate pass the Hydrography III subject as well, then the Certificate of Competency will be endorsed accordingly. Candidates will not be allowed to enter for Hydrology III unless they have previously passed Hydrography II.

Practical Examination - Trial Survey

Based on the syllabus as defined in -
Clause 6.3.1

1. A minimum mark of 75 % must be obtained to pass the Trial Survey.

2. The Chief Surveyor of the relevant mine will ensure that the candidate is not given any practical assistance with the field work, calculations, and / or compilation of the plan.
3. The Chief Surveyor of the relevant mine will certify, in writing to the Qualifications Subcommittee of Mine Surveyors, that the candidate has not obtained any such assistance.
4. The candidate is required to make a declaration, in writing to the Qualifications Subcommittee of Mine Surveyors, that the Trial Survey is the candidate's own unaided work.
5. The Chief Surveyor of the relevant mine will ensure that the results of the candidate's Trial Survey is packaged and delivered timeously to the Chamber of Mines offices in Windhoek for the attention of the Qualifications Subcommittee of Mine Surveyors.

N.B.

1. A Certificate of Competency will not be awarded until such time as the Trial Survey has been successfully completed.
2. A candidate without the required one (1) year's underground experience, as required in 3.3.2, will only be issued with a Certificate endorsed for surface mines. Once the candidate has successfully completed the underground practical test, as per 6.1.1.2, a full Certificate will be issued.

5.4 General Conditions Relating to Examinations:

- 5.4.1 Written examinations will only be held at the appointed venue, at the times stated, and under the supervision of the appointed invigilator.
- 5.4.2 Examinations will be conducted in English.
- 5.4.3 Written examination papers will be only opened by the appointed invigilator, in the presence of the candidate(s).
- 5.4.4 The maximum time allowed for each written examination will be specified on each examination paper.
- 5.4.5 The appointed invigilator, or designated alternate, shall be present at all times whilst written examinations are taking place.
- 5.4.6 The use of any calculator will be permitted, providing all working steps and checks are shown in full. No computer processing will, however, be allowed.
- 5.4.7 Completed written examination papers will be sealed by the appointed invigilator, in the presence of the candidate(s), for dispatch to the Chamber of Mines offices for the attention of the Qualifications Subcommittee of Mine Surveyors.
- 5.4.8 The maximum time allowed for practical examinations will vary according to the type of examination being undertaken.

5.5 Right of Appeal:

- 5.5.1 Any candidate has the right of appeal against a decision made by the Qualifications Subcommittee of Mine Surveyors in respect of examination results.
- 5.5.2 Such appeal shall be directed in writing to the General Manager of the Chamber of Mines of Namibia within thirty (30) days of notification of examination results
- 5.5.3 The Appeals Committee, consisting of :

The Chairperson of the Qualifications Subcommittee of Mine Surveyors
The General Manager of the Chamber of Mines of Namibia
The Government Mine Surveyor
shall adjudicate the appeal and any decision reached will be final

6. SYLLABI

6.1 SYLLABUS FOR THE ELEMENTARY CERTIFICATE :

As stated in Section 3, Prerequisites for Mine Surveying Courses, all candidates without a recognised Grade 12 or N3 mathematics qualification must pass a mathematics entrance examination.

The requisite bridging course material is available from the Chamber of Mines.

6.1.1 Practical

6.1.1.1 - Surface

- a) Carry out a return rise and fall levelling exercise from one known elevation to another over a distance of at least 200 metres. At least three (3) change points must be established and then checked on the return run. Readings must be taken to three (3) decimal places of a metre. Elevations for the change points on the forward run must agree with those on the return run to within three (3) millimetres. Closure to the second known point will be within ten (10) millimetres and it will not be necessary to adjust intermediate elevations for this closure. All checks must be shown in the calculations.
- b) Carry out a collimation method levelling exercise with one change of setup. The start point (backsight) and foresight will have known elevations. There will be fifteen (15) intermediate sights whose elevations on the second setup will agree to within one (1) centimetre with the elevations of the first setup. The foresight elevation will close to within one (1) centimetre of the known elevation but intermediate sights need not be adjusted for this closure. Readings will be taken to two (2) decimal places of a metre. All checks must be shown in the calculations.
- c) Set up a theodolite accurately over a survey peg, both on level ground and on an awkward slope.
- d) From a given plan :
 - i) Calculate staking data for at least three (3) selected control points.
 - ii) Stake the control points from one survey station and carry out check staking from another survey station. Height of instrument and object must be measured together with vertical angles in order to calculate elevations of control points staked.
 - iii) Lay out selected points on the plan from the control points using a tape and optical square.
- e) Establish a grade profile on a level plane using one known elevation. All checks must be shown on the calculations.
- f) Carry out a resection observation to five (5) well spaced known beacons. Observe one arc with circles left and right, including the reference object. Mean circles left and right and adjust for R.O. An electronic field book may not be used.
- g) Carry out a tacheometric survey in the field using a tacheometer and staff. At least twenty (20) points must be observed. Make a neat field sketch of the area surveyed.
- h) Reduce the observations and construct a basic plan on the horizontal from the surveying above. Interpolate contours.

- i) Carry out a cut and fill exercise incorporating the surveys of a) or b) above.

6.1.1.2 - Underground

From a given development layout :

- a) Prepare for and carry out an underground survey to establish the position of the tunnel and to extend direction and grade control.
- b) Calculate the survey and grade chains in a calculation book, showing the required checks.
- c) Plot the survey on the relevant plan, section and vertical projection.
- d) Prepare a survey drawing giving the necessary instructions to the miner. Such instruction plan should show a minimum of one (1) breakaway from the surveyed tunnel.
- e) Carry out a month-end stope measuring exercise, including all plotting and the calculation of all the pertinent volumes.

6.1.2 Theory

6.1.2.1 - Mine Surveying

The candidate must be able to :

- a) give a definition of surveying, its objectives, the difference between geodetic and plane surveying, and describe the various survey methods.
- b) describe the various instruments used, the principles of operation, use and care, e.g. :

calculators	level and tacheometric staff
clinometer	optical square
compass	planimeter
computer	tacheometer
drawing instruments, etc	tapes
electronic distance measurer (EDM)	theodolite and gyro-theodolite
laser	total station (electronic theodolite)

- c) describe the meaning of the following terms :

areas	levelling
backsight	line of sight (collimation)
bench mark	long and cross sections
Bessel's Co-ordinate System	month-end measuring
contours	perimeter
datum plane	principles of resection, triangulation and tacheometry
foresight	reduced level (elevation)
grade and side grade	scales and other drawing instruments
grade peg	survey notes
gradient (slope), incline and horizontal plane	survey point and station
intermediate sight	tape surveying (tape offsetting)
International and German Legal Metre	volumes

- d)** describe the requirements of a good surveyor
- e)** describe the reasons why all a surveyor's work must be checked and why a rubber may not be used on field notes and calculations.
- f)** demonstrate a comprehensive knowledge of the principles of elementary plane trigonometry.
- g)** describe the process of location of points by offsetting and plotting results on plan.
- h)** give a description of surveying in a surface peg with a theodolite, including field book layout with correct headings.
- i)** give a description of placing a surface peg with a theodolite, including field book layout with correct headings.
- j)** define co-ordinates, co-ordinate systems, directions and angles.
- k)** describe rise and fall levelling, together with field book layout and calculations.
- l)** describe the collimation method of levelling, together with field book layout and calculations.
- m)** demonstrate an adequate knowledge of trigonometric levelling calculations.
- n)** demonstrate an adequate knowledge of join calculation and field book layout for staking.
- o)** demonstrate an adequate knowledge of polar calculations and calculation layout for a point surveyed by theodolite.
- p)** give a description of level grade profile, together with field book layout and calculations.
- q)** demonstrate an adequate knowledge as to plotting of survey pegs, directions and co-ordinates.
- r)** give a description of tape offsetting of side, hanging and foot walls in an underground development drive, including plotting results on plan and section.
- s)** give a description of surveying an underground peg with an optical theodolite, including field book layout with correct headings.
- t)** give a description of surveying a line peg and chains in a development drive.
- u)** give a description of polar calculation and layout for calculation of a peg surveyed underground, including calculation of elevation by trigonometric levelling.
- v)** give a description of the calculation of line peg and grade chains.
- w)** give a description of side grades, together with field book layout and calculations.
- x)** demonstrate an adequate knowledge of tacheometric reductions.
- y)** Answer questions on the practical application of the following Mines, Works and Mineral Ordinance Regulations :
25 (interpretation of selected definitions and terms), 28, 30, 39, 47, 52.7, 54, 100.7, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 143, 144, 157, 235, 236, 237, 246, until such time as the Namibian Mine Safety Regulations have been promulgated.

6.1.2.2 - Specimen Plan

The candidate must produce a specimen plan of a section of the candidate's Mine. The specifications for this plan are as follows :

- any scale
- size of plan must be a minimum of 300 mm by 300 mm
- must be drawn in conformity with the requirements of the Mining Regulations and must incorporate a declaration that the entire plan is the candidate's own work
- must contain a suitable heading and co-ordinate lines are to be constructed
- must contain sufficient detail to make the plan interesting

6.1.2.3 - Hydrography I (specialization subject)

a) Instruments and Survey Systems

Describe the purpose, principle of operation, care and use, adjustment, calibration techniques and effects of maladjustment of surveying instruments and equipment such as:

- Global Positioning Systems – DGPS, Static, RTK
- Single beam echo sounders
- Multi beam echo sounders
- Side scan sonars
- Sub bottom profilers
- Transceivers
- Transponders
- Motion sensors
- Gyros

b) Positioning

Describe the operational principles of:

- GPS
- SONAR
- LIDAR

Describe the effects on acoustic positioning due to:

- Salinity
- Temperature
- Pressure
- Thermoclines
- Haloclines
- Ray bending
- Multipathing
- Lloyd mirror effect
- Afternoon effect
- Slope
- Frequency, band width, pulse length

Knowledge of the basic sonar equations
Knowledge of LBL techniques and calibration
Knowledge of SBL techniques and calibration
Knowledge of USBL techniques and calibration

c) Survey Standards and Principles

Define and state the minimum limits of accuracy for Special Order, Order 1, Order 2 and Order 3 surveys.

State and give procedures on how to eliminate various error types.
Describe the different categories of Zones of Confidence.
Describe various types of map projections and demonstrate an understanding of the differences between various projections.
Describe ellipsoids, geoids and datums.

d) Tides

Knowledge of the relationship between MSL and tides.
Knowledge of tide raising forces.
Knowledge of tide prediction.
Effect of tide on survey results and necessary adjustments.

6.2 SYLLABUS FOR THE ADVANCED CERTIFICATE :

6.2.1 Practical

6.2.1.1 - Surface

- a) Establish a grade profile on an inclined plane using two (2) known elevations. Any suitable type of profile may be used.
- b) Carry out a triangulation exercise to one (1) unknown point. Set up at two (2) known points. The setup at the unknown point will include sights to three (3) check beacons. Observe two (2) full arcs with circle left and right with R. O. observations. Carry out a full adjustment of angles and a direction sheet calculation. The final point may be calculated by means of an error figure or by theory of least squares.
- c) Carry out a traverse between two (2) known stations. There must be two (2) unknown stations. One (1) arc with circle left and right is required, including R.O. observations. Carry out all adjustments, direction sheet and calculations and use the Bowditch method for final adjustments. Elevate the unknown points by means of trigonometric levelling. All checks must be shown.
- d) Carry out the two (2) peg levelling check and adjustment of a level.

6.2.1.2 - Underground

As per 6.1.1.2 - to obtain the full Certificate

6.2.2 Theory

6.2.2.1 - Mine Surveying I

The syllabus shall consist of the Elementary Certificate in Mine Surveying Syllabus and the following :

- a) a full range of area and volume calculations used in surveying
- b) all steel tape and EDM corrections and adjustments
- c) planimeter area calculations, including areas from co-ordinates
- d) calculation of simple and compound curves
- e) definitions
- f) instruments and adjustments
- g) the purpose and principles of the laser, EDM and gyro-theodolite observation

- h) transformations
- i) theory of errors (least square)

6.2.2.2 - Mine Surveying II

The syllabus shall consist of the Elementary Certificate in Mine Surveying Syllabus and calculations related to the following :

- a) tacheometry - staff, tape and EDM
- b) direction sheet, including t-T and scale correction
- c) resection, including error figure
- d) 2 and 3 point problems
- e) triangulation, including error figures
- f) traversing and Bowditch method of adjustment
- g) rise and fall levelling with all adjustments
- h) curve ranging
- i) longitudinal and cross – sections
- j) major and minor dips (Lauder theorem)
- k) tan ‘K’ formula
- l) shaft plumbing

6.2.2.3 - Mining Law

Describe the practical application and description of the following :

- a) from the Mines, Works and Mineral Ordinance of 1968, until such time as the Namibian Mine Safety Regulations have been promulgated :

Definitions :

accessory works	mining area
base mineral	mining commissioner
claim	owner
grant area	precious minerals
holder of a claim	private land
holder of a grant	prospector
inspector	prospecting
land surveyor	regulation
lessee	state land
mine	works
mineral	

- b) The syllabus will consist of the Elementary Mine Surveying Regulations (6.1.2.1 (y)) and the following :
31, 40, 45, 48, 49, 50, 51, 52, 53, 64, 68, 72, 101, 102, 103, 138, 145, 147,
until such time as the Namibian Mine Safety Regulations have been promulgated

6.2.2.4 - Mining Economics I

- a) Mine Sampling and Ore Valuation
 - a) theory of sampling
 - b) objects of sampling
 - c) importance of accurate sampling
 - d) mining and sampling terms
 - e) units of mass and measurements
 - f) methods of sampling
 - g) reducing size of samples
 - h) limitation of widths of samples
 - i) a sampler’s team and equipment
 - j) basic principles in sampling
 - k) false assay values and contamination
 - l) spillage or fraud and elimination
 - m) sampling intervals

b) Minerals

To enable the student to explain physical characteristics such as :

crystal form	colour	streak
lustre	density	hardness
cleavage	fracture	

and, through the above, identify such minerals as :

diamond	graphite	gold
copper	quartz	corundum
haematite	cuprite	cassiterite
uranite	malachite	azurite
pyrite	chalcopyrite	chalcocite
bornite	galena	garnet

c) Physical Geology

To enable the student to simply explain the effects of :

the atmosphere	rain	running water
lakes	groundwater	the ocean
ice	organisms	

and to identify and simply explain the origins of the following rock types :

Igneous	-	lava, local intrusives
Sedimentary	-	sandstone, shale, dolomite, conglomerate, grit
Metamorphic	-	quartzite, argillaceous, slates, coal, schist, quartzitic conglomerate

and to explain the following rock structures with the aid of sketches :

bedding plane features, such as ripple marks and cross bedding		
strata	folding	dip and strike faults
dykes and sills	normal and reverse faults	

and to be able to simply sketch and describe the local geological sequence and major structures.

d) Economic Geology

The syllabus covers the following :

1) The Formation of Economic Deposits

mineral deposits	magmatic deposits
contact metasomatism	pegmatites
hydrothermal deposits	vulcanogenic deposits
residual deposits	mechanical concentration deposits
chemically formed deposits	evaporites
metamorphic deposits	supergene enriched deposits
classification of deposits	

2) The Occurrence of Precious Metals

Gold - in the Swazian Erathem; the Witwatersrand goldfield; in the Transvaal Sequence
Gold production
Platinoids - in the Witwatersrand Conglomerates; in Dunite Pipes; deposits associated with the Merensky Reef
Diamonds - origins of diamonds; deposits in Kimberlites; alluvial deposits
Diamond production

3) The Occurrence of Base Metals

antimony	chromium	copper
iron	manganese	nickel
pegmatite minerals	rare earths and thorium	tin
titanium and zirconium	uranium	vanadium
zinc and lead		

- 4) The Occurrence of Non – Metallic Minerals
- | | | |
|----------------------------|----------|--------------------|
| andalusite and sillimanite | asbestos | building materials |
| clays | fluorite | limestone |
| phosphate | salt | vermiculite |
- 5) The Formation of Fossil Fuels
- Coal - the environment for formation; original constituents; coalification process; rank and types of coal
- The origin of Oil and Gas

- 6) Mineral Resources of adjacent countries
- | | | |
|--------------|----------|----------|
| South Africa | Botswana | Zimbabwe |
|--------------|----------|----------|

e) Prospecting Methods

metallogenic epochs	metallogenic provinces
target areas	ore traps
the geochemical anomaly	geochemical surveys
gravimetric surveys	magnetometric surveys
seismic methods	electric methods
radiometric surveys	photogeology and remote sensing
air photos	identification of structures
satellite imagery	drilling and sampling
evaluation of mineral deposits	ore grade and reserves

f) Structural Geology

the solution of structural problems	problems of strike and dip
completing outcrops	faults
intersecting lines and planes	the dip diagram
stratigraphic thickness	three borehole problems
general exercises	
plan to section and section to plan problems	
geological maps with a description of the sequence of events	

6.2.2.6 - Mathematics

The full syllabus is contained in *Mathematics for Mine Surveyors* First Edition, 1988, by G P Geldenhuys and is as follows :

1. Revision and Introduction
2. Factors of algebraic expressions
3. H.C.F. and L.C.M. and simplification
4. The Laws of indices and exponents
5. Logarithms
6. The manipulation of technical formulae
7. Solution of linear equations
8. Solution of equations of a higher degree
9. Solution of equations involving surds
10. Progressions
11. Interests

12. Trigonometry and trigonometric identities
13. Trigonometric proofs
14. Functions
15. Solution of triangles
16. Graphs
17. Geometry
18. Co-ordinate geometry
19. Solid co-ordinate geometry
20. The circle and concurrency
21. Areas
22. Volumes
23. Basic principles and formulae

6.2.2.7 – Hydrography II (specialization subject)

Calculation and interpretation of results in respect of hydrographical surveys with reference to:

- Sonar equations
- Triangulations
- Traversing
- Spirit and trig levelling
- Coordinate transformations
- Beam width and beam coverage
- Acoustic measurements
- Patch test calculations

In addition to the above, any portion of the syllabi in Hydrography I may be included in the examination.

6.3 SYLLABUS FOR THE CERTIFICATE OF COMPETENCY :

6.3.1 Practical - Trial Survey

6.3.1.1 Initial Requirements

1. The Chief Surveyor of the relevant mine will ensure that the candidate is not given any practical assistance with the field work, calculations, and / or compilation of the plan.
2. The Chief Surveyor of the relevant mine will certify, in writing to the Qualifications Subcommittee of Mine Surveyors, that the candidate has not obtained any such assistance.
3. The candidate is required to make a declaration, in writing to the Qualifications Subcommittee of Mine Surveyors, that the Trial Survey is the candidate's own unaided work, compiled from the candidate's own original field notes and calculations.

6.3.1.2 Requirements for the Survey

- a) Area - approximately ten (10) hectares
- b) Unit of measurement - metres
- c) Datum - mean sea level
- d) The area chosen must have sufficient man-made surface features to make the plan interesting

e.g. buildings, roads, railways, trenches, shafts, powerlines, pipelines, etc.
The ground must slope sufficiently to enable at least ten (10) contours to be drawn.

- e) Calculations will be carried out to three (3) decimal places.
- f) An electronic distance measurer (EDM) may be used as follows :
 - i) The EDM must be calibrated both at the beginning and the end of the Trial Survey and the mean constant and / or scale corrections applied to all EDM measurements.
 - ii) The following corrections must be applied to all measurements :
 - a) height above mean sea level
 - b) conversion from International to German Legal Metre where necessary
 - c) slope distance
 - iii) A base line must be established as follows :
 - a) it must be at least 150 metres long
 - b) the coordinates and elevations of one end of the base line will be determined from trigonometric observations using either Trigonometric or Mine beacons. A full triangulation with error figure, or a least squares adjustment, is required. The elevation obtained must be checked by spirit levelling from a Mine Bench Mark or other well-constructed point with known elevation. The difference between the two levelling surveys shall not be greater than 100 millimetres.
 - c) the direction of the baseline will be determined either by gyro-theodolite or by polar observations from the point determined in b) above.
 - d) the coordinates and elevation of the other end of the base, together with a line point will be determined by means of polar observations from the initial point determined in b) above.
 - e) at least three (3) additional points must be coordinated and elevated by means of triangulation and trigonometric levelling from the baseline stations. Error figure adjustment, or least squares adjustment, is required as above.
 - f) coordinates and elevation of one (1) point must be determined by resection using two different combinations of the above baseline and triangulated stations. Final adjustment must be by error figure or least squares. The difference between the two sets of coordinates must be within acceptable limits. The two values must be meaned.
 - g) at least six (6) tache stations, reasonably distributed around the area chosen, must be fixed. Of these, at least two (2) must be fixed by traversing with full Bowditch adjustment, whilst the others may be fixed by double polars with good angular 'cuts'. Elevations must be determined by means of trigonometric levelling. The coordinates and elevations obtained from traversing shall be within acceptable limits of accuracy and the difference between the values obtained for each set of polars shall not be greater than five (5) millimetres. The values obtained must be meaned.

The elevations obtained must be checked by means of a closed level survey with an automatic level, the starting point for the levelling being the initial baseline station triangulated.

The allowable error between the two sets of elevations shall not be greater than twenty (20) millimetres. Both sets of elevations must be shown on the plan.

The traverse should, as far as possible, not double back on itself and start and end stations should be at opposite sides of the area chosen.

Curvature and refraction corrections must be applied to trigonometric levelling calculations.

- h) the method used to locate surface objects will be left to the discretion of the candidate but such method must be unmistakably recorded in the field book.
- i) the method used to carry out a tacheometric survey of the area is also left to the discretion of the candidate but such method must be unmistakably recorded in the field book.
- j) a peg register, containing all surveyed stations and conforming to the Regulations, will be submitted. A single sheet will be sufficient.
- k) survey field work and calculations must conform to standard survey practices; all field notes and calculation pages must contain the correct headings, and limits of accuracy must be in conformity with the Mines, Works and Mineral Ordinance Regulations and any Amendments made thereto, until such time as the Namibian Mine Safety Regulations have been promulgated.

N.B. A candidate may receive assistance as to how to carry out surveys, but not actual assistance with the survey itself.

6.3.1.3 Requirements for the Plan

- a) the scale of the plan will be 1 : 1000
- b) it shall be drawn in conformity with the Mines, Works and Mineral ordinance Regulations and any Amendments made thereto, until such time as the Namibian Mine Safety Regulations have been promulgated.
- c) provided that the mine has been granted the necessary dispensation to draw its mine plans using CADD, it will be acceptable for the candidate on that mine to draw his trial survey plan using CADD.

6.3.1.4 Plan, Field Notes and Calculations

The original field notes and calculations used in the compilation of the plan will be submitted with the original plan. These notes and calculations will contain no erasures and any mistakes will be neatly crossed out. All calculations will be carried out in ink.

These field notes, calculations and plan become the property of the Chamber of Mines of Namibia and will not be returned to the candidate.

6.3.1.5 Check Survey

The Qualifications Subcommittee of Mine Surveyors, or Examiners, reserve the right to ask the candidate, within a reasonable time from the submission of the candidate's plan,

to show the area of ground surveyed in order that a check survey may be carried out if deemed necessary.

6.3.2 Theory

The syllabus will consist of both the Elementary and Advanced Certificates syllabi but, in addition, the candidate must also be able to demonstrate an acceptable level of knowledge in the following :

6.3.2.1 Mine Surveying III

- a) define surveying, the main objective of mine surveying, and describe the fundamentals of three-dimensional rectangular coordinate systems and the various survey methods in use.
- b) describe the meaning of all the terms used in mine surveying.
- c) State the purpose, principles of operation, care and use of all the instruments commonly in use in mine surveying.
- d) Describe the method for checking the accuracy of all instruments and how to adjust, or apply corrections to, the following :

vernier theodolite + tacheometer (index and collimation error)	automatic level
electronic theodolite (index and collimation error)	optical plummet
electronic distance measurers	planimeter
gyro-theodolite	pantograph
- e) explain the use of the latest survey instruments such as :

sonic tape	profiler	GPS
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- f) perform all area and volumetric calculations and those with particular reference to :
 - levelling by rise and fall, collimation and trigonometry
 - cut and fill, earth work quantities (cross and long sections)
 - areas from coordinates
 - stockpiles
 - mine excavations (surface and underground)
 - planimetry
 - tape offsetting
- g) show field book and calculation page layout for all survey calculations
- h) carry out the following calculations with all checks and adjustments :

levelling (rise and fall, collimation, and trigonometry)	join
level and incline grade profiles on surface	polar
precise levelling	triangulation
side grades in development ends underground	trilateration
2 and 3 point problems and forward intersection	resection
traversing and adjustments thereof	error figure
direction sheet	
- i) prepare the following from field data and calculations :

surface and underground plans	stope sheets
cross and long sections	layouts

6.3.2.2 Mine Surveying IV

The candidate must be able to :

6.3.2.5 Mineral Exploitation

- 1) Introduction to mining
- 2) Origin of mining
- 3) Introduction to mineral exploitation
- 4) Introduction to Namibia's mining industry
- 5) Structure of the industry
- 6) The Private Sector
- 7) Government
- 8) Mining and economics
- 9) The role of mining in the economy
- 10) Basic general mining layouts and sequence of operation
- 11) Integrated environmental management
- 12) Explosives, drilling and blasting
- 13) General mining equipment and applications
- 14) Fundamentals of earthmoving
- 15) Rock engineering

6.3.2.6 Management

- 1) Management - an overview
 - Management and managers - levels of management - functional and general managers
 - Managerial functions and roles - what managers really do - time spent on managerial functions
 - Principal duties and principles of top, middle, and first-line managers
 - The changing world of work, nature of the work force, face of organisations, duties of management
 - Managerial skills - technical, conceptual, interpersonal, communicatory
 - The relative importance of managerial skills
 - Skills for managers in the year 2000
 - Management - a dynamic process
- 2) Integrated Management Systems
 - Key performance areas
 - Processes - strategic planning, business planning, controls
 - Designing and implementing planning, operational and management control systems
 - "some loose ends"
- 3) Human Resource Management
 - The staffing process
 - Recruitment, selection and engagement
 - Compensation and benefits
 - Training and development

Human resource planning
Orientation
Performance appraisals
- 4) Operations Management
 - The process
 - Productive system design : facility location, facility layout, materials handling flow

Operations as a system
- 5) Operations Planning and Control
 - The planning elements : demand forecasting, aggregate planning, material requirements planning
 - Inventory management, EOQ model, MRP and inventory management
 - Network planning and control, evolution, designing a network, using the network
 - Quality control, QC methods, risks

7. RECOMMENDED STUDY MATERIAL

7.1 Elementary Certificate in Mine Surveying

- a) The Amended Mines, Works and Mineral Ordinance, 1968
- b) The Amended Regulations made under the provisions of the Mines, Works and Mineral Ordinance, 1968, until such time as the Namibian Mine Safety Regulations have been promulgated.
- c) A modular course is available from the Chamber of Mines of Namibia

7.2 Advanced Certificate in Mine Surveying

- a) The Amended Mines, Works and Mineral Ordinance, 1968
- b) The Amended Regulations made under the provisions of the Mines, Works and Mineral Ordinance, 1968, until such time as the Namibian Mine Safety Regulations have been promulgated.
- c) Surveying for Mine Surveyors - T P Ritson
- d) Geology - Dr Jos Lurie
- e) Mathematics for Mine Surveyors - G P Geldenhuys
- f) Modules - Mine Surveying I and II - available from the Chamber of Mines
- g) Module - Mining Economics I - available from the Chamber of Mines
- h) Module - Geology - available from the Chamber of Mines
- i) Module - Communication Skills - available from the Chamber of Mines

7.3 Certificate of Competency in Mine Surveying

- a) The Amended Mines, Works and Mineral Ordinance, 1968
- b) The Amended Regulations made under the provisions of the Mines, Works and Mineral Ordinance, 1968, until such time as the Namibian Mine Safety Regulations have been promulgated.
- c) Surveying for Mine Surveyors - T P Ritson
- d) Modules - Mine Surveying III and IV - available from the Chamber of Mines
- e) Module - Mining Economics II - available from the Chamber of Mines
- f) Module - Mineral Exploitation - available from the Chamber of Mines
- g) Module - Management - available from the Chamber of Mines
- h) Integrated Management Systems - F G Schutte

8. CANCELLATION OR SUSPENSION OF CERTIFICATES :

Every person in possession of a Certificate in Mine Surveying, presented by the Chamber of Mines of Namibia, represents the mine survey profession and the mining industry in general and is, therefore, expected to conduct him- or herself accordingly.

The Chamber may cancel or suspend any person's Certificate or bar a person from receiving a Certificate, upon written recommendation of the Qualifications Subcommittee of Mine Surveyors that the person is guilty of improper conduct, including :

- bringing the profession or the mining industry into disrepute;
- committing an offence in the exercise of his or her profession;
- being sentenced to a prison sentence without the option of a fine and an appeal against this sentence is not upheld;
- carrying out, or allowing persons under his or her supervision to carry out, work contrary to the Laws and attendant Regulations governing the mining industry or laid down procedures at the person's mine;

Every person shall have the right to appeal to the Council of the Chamber of Mines of Namibia against the cancellation or suspension of that person's Certificate.

9. REVISIONS

Revisions as deemed necessary and carried out by the Qualifications Subcommittee of Mine Surveyors of the Chamber of Mines of Namibia (see Clause 2.2.4)

Compiled :	11 January 1990
Revision 1 :	29 January 1990
Revision 2 :	17 – 19 July 1990
Revision 3 :	19 – 20 September 1990
Revision 4 :	5 – 6 February 1991
Revision 5 :	19 – 20 November 1991
Revision 6 :	16 – 17 March 1993
Revision 7 :	11 – 12 May 1993
Revision 8 :	16 – 17 November 1993
Revision 9 :	8 – 9 March 1994
Revision 10 :	17 – 18 May 1994
Revision 11 :	27 – 28 September 1994
Revision 12 :	15 – 16 November 1994
Revision 13 :	7 – 8 March 1995
Revision 14:	12 – 13 September 1995
Revision 15 :	8 – 9 September 1997
Revision 16 :	18 – 19 May 1998 (effective 1 June 1998)
Revision 17:	
Revision 18:	14 November 2006

10. ADDENDUM - 'Grandfather Clause'

This Clause is appended in its entirety but has been replaced by the Exemption provisions as per Revision 16, in May 1998.

'Grandfather Clause'

1. General Principles

Any person who has certain minimum or equivalent qualifications and / or practical experience acceptable to the Chamber, may within 1 year of commencement of acceptance of these rules (final date 6 February 1991) make written application for exemption from part or all of the examinations for any particular certificate. The general condition and requirements for exemptions are given in subsections below.

All applications for exemption must, where applicable, be accompanied by the following:

- a) Certified copies of qualifications. The Chamber may require a list of subjects for any qualification
- b) Certified copies of certificates of service
- c) Certified schedule of practical survey work carried out, listing all major surveys carried out since the applicant commenced his survey career

The Chamber may reject any application for exemption if:

- a) applications do not meet the standards of these proposals
- b) applications are incomplete
- c) qualifications submitted are, in the opinion of the Chamber, not of a sufficiently high standard
- d) experience gained is, in the opinion of the Chamber, not of a sufficient variety and of a satisfactory nature, or standard
- e) there is any doubt about the authenticity of a qualification or experience submitted, even if it is certified or signed by the applicant's previous Chief Surveyor(s). The Chamber may, but is not obliged, to give reasons for rejecting an application.

2. Provisions for the Elementary Certificate in Mine Surveying

The candidate must satisfy one of the following conditions :

- a) Possess an acceptable equivalent to the Elementary Certificate in Mine Surveying from any country and have worked as a Surveyor for at least 2 years in a Mine Survey Department. He / she must have worked unsupervised carrying out an acceptable variety of mine survey work, or
- b) Possess Standard 10 or acceptable equivalent with mathematics and have worked as a Surveyor for at least 5 years in a Mine Survey Department. He / she must have worked unsupervised carrying out a variety of acceptable mine survey work

He / she may at the discretion of the Subcommittee of Surveyors be required to carry out the practical tests and an oral test in Mining Law as defined in Clause 6.1.2.1(y) of these Rules.

A schedule of survey work as defined in 1(c) above must also be provided.

3. Provisions for the Advanced Certificate in Mine Surveying

The candidate must satisfy one of the following conditions :

- a) Possess an acceptable equivalent to the Advanced Certificate in Mine Surveying from any other country and have worked as a Surveyor for at least 3 years in a Mine Survey Department. He / she must have worked unsupervised during this period carrying out a variety of acceptable mine survey work, or
- b) Possess Standard 10 or acceptable equivalent with mathematics and have worked as a Surveyor for at least 7 years in a Mine Survey Department. He /she must have worked unsupervised doing a variety of acceptable mine survey work

He / she may at the discretion of the Subcommittee of Surveyors be required to carry out the written Mining Law examination and practical tests as defined in 6.2.2.3 above.

A schedule of survey work as defined in 1(c) above must also be provided.

4. Provisions for the Certificate of Competency in Mine Surveying

The candidate must satisfy one of the following conditions :

- a) Possess a full equivalent Certificate of Competency in Mine Surveying from any other country. He / she will be exempted from all examinations if he / she is the Surveyor of a Namibian Mine, appointed in terms of the Mines, Works and Mineral Ordinance Regulations. Otherwise he / she will be required to carry out the written Mining Law examination as defined in 6.3.2.3 above, or
- b) Possess an equivalent to the Certificate of Competency in Mine Surveying from any other country, e.g. a full 3 year National Diploma, or Government Registration as a Surveyor.

He / she will be required to have worked as a Surveyor in a Mine Survey Department for a period not less than 5 years and provide proof that he / she has carried out a satisfactory variety of survey work.

Unless he / she has been the Surveyor of a Namibian Mine, appointed in terms of the Mines, Works and Mineral Ordinance Regulations for a period not less than 1 year, or has been the Appointed Acting Surveyor for a period of at least 1 month during each of the preceding 5 years, he / she will be required to carry out the written Mining Law examination required in 6.3.2.3 above.

He / she must provide a schedule of his / her survey work as defined in 1 (c) above and provide proof that he / she is able to operate as a fully independent surveyor.

The candidate must provide certified proof of his / her appointment(s) as a Surveyor, or Acting Surveyor. Other applications must be accompanied by a letter from the Mine Manager stating that the applicant is able to take charge of the Survey Department at his / her Mine, or

- c) Possess Standard 10 or equivalent with mathematics and have been a Mine Surveyor for a period of not less than 15 years, carrying out a satisfactory variety of survey work

Unless he / she has been the Surveyor of a Namibian Mine, appointed in terms of the Mines, Works and Mineral Ordinance Regulations (until such time as the Namibian Mine Safety Regulations have been promulgated) for a period not less than 1 year, or has been the Appointed Acting Surveyor for a period of at least 1 month during each of the preceding 5 years, he / she will be required to carry out the written Mining Law examination required in 6.3.2.3 above, and at the discretion of a

Subcommittee of Surveyors, the written geology examination. He / she may also be required to carry out the Trial Survey if he / she has not served as the appointed Surveyor or acting Surveyor as above.

He / she must provide a schedule of his / her survey work as defined in 1 (c) above and provide proof that he / she is able to operate as a fully independent surveyor.

The applicant must provide certified proof of his / her appointment(s) as a Surveyor, or Acting Surveyor. Other applications must be accompanied by a letter from the Mine Manager stating that the applicant is able to take charge of the Survey Department at his / her Mine.