CERTIFICATION SCHEME FOR WELDING AND INSPECTION PERSONNEL

DOCUMENT No. CSWIP- DS-16-06

Requirements for the Certification of Personnel Engaged in the Inspection of Drillstem Components (Rotary Tool & Drillpipe)

1st Edition January 2007

Issued under the authority of the Governing Board for Certification
All correspondence should be addressed to:

TWI Certification Ltd
Granta Park
Great Abington
Cambridge CB21 6AL
United Kingdom

Tel:+44 (0) 1223 899000
Fax:+44 (0) 1223 894219
Email: twicertification@twi.co.uk
Web: www.cswip.com

CSWIP is administered by TWI Certification Ltd
The use of the UKAS Accreditation Mark indicates accreditation in respect of those activities covered by Accreditation Certificate No 25

FOREWORD

The Certification Scheme for Welding and Inspection Personnel (CSWIP) is a comprehensive scheme that provides for the examination and certification of individuals seeking to demonstrate their knowledge and/or competence in their field of operation. The scope of CSWIP includes Welding Inspectors, Welding Supervisors, Welding Instructors, Plant Inspectors, Underwater Inspection personnel, NDT personnel and Heat Treatment operatives.

CSWIP is managed by the Certification Management Board, which acts as the Governing Board for Certification, in keeping with the requirements of the industries served by the scheme. The Certification Management Board, in turn, appoints specialist Management Committees to oversee specific parts of the scheme. All CSWIP Boards and Committees comprise member representatives of relevant industrial and other interests.

ACCESS TO CERTIFICATION

Access to certification is not improperly restricted. The sole criteria for certification are given in the document (and any subsequent amendments) and no other criteria will be applied. Certification is not conditional on the candidate applying for other services or membership from TWI Certification Ltd, its parent, or any other groups or associations.

1 GENERAL

This document prescribes procedures by which personnel may be examined and, if successful, certificated for inspection of drillstem components (Rotary Tool & Drillpipe).

2 Scope

The certification of personnel under the current document covers the inspection of drillstem components (Rotary Tool & Drillpipe).

Certification is available in a number of different categories and levels. The categories are based on the NDT method used and the component being inspected.

The Levels are defined as follows:

2.1 NDT Level 2

An individual certified to NDT Level 2 is qualified to perform inspections in accordance with established or recognised techniques. The individual shall be competent to choose the test techniques to be used; to set up and calibrate equipment; to interpret and evaluate results in accordance with applicable codes, standards and specifications; to develop NDT instructions adapted to problems which are the subject of an NDT specification; and organise and report the results of inspections. The individual shall also be familiar with the scope and limitations of the method for which he/she is qualified, and be able to exercise assigned responsibility for on-the-job training and guidance of trainees.

2.2 NDT Level 3 personnel

An individual certified to NDT Level 3 shall be capable of assuming full responsibility for a test facility and staff; establishing techniques and procedures; interpreting codes, standards, specifications and procedures; and designating the particular test methods, techniques and procedures to be used. The individual shall have the competence to interpret and evaluate results in accordance with existing codes, standards and specifications and have sufficient practical background in applicable materials, fabrication and product technology to select methods and establish techniques and to assist in establishing acceptance criteria where none are otherwise available. The individual shall also have general familiarity with other NDT methods and have the ability to train Level 2 personnel.

2.3 Limited certification

As outlined within ISO 9712[1] an individual holding limited certification to NDT Level 2 or Level 3 shall be qualified to perform only specified inspections on defined component types in accordance with established or recognised techniques. The individual shall be competent to set up and calibrate equipment; to interpret and evaluate results in accordance with applicable codes, standards and specifications; to develop NDT instructions adapted to problems which are the subject of an NDT specification; and organise and report the results of inspections. The individual shall also be familiar with the scope and limitations of the method for which he/she is qualified, and be able to exercise assigned responsibility for on-the-job training and guidance of trainees.

When the certification sought is limited in application e.g. UT thickness measurement, experience and training duration may be reduced by up to 50 %. Experience duration shall not be less than one month.

3 Non-destructive Testing methods

Qualification and certification of NDT personnel in magnetic particle, liquid penetrant and visual inspection of rotary tools and the visual, ultrasonic and electromagnetic inspection of drillstem equipment in accordance with this document is applicable to each of the following product groups

- CSWIP Level 2 - Magnetic Particle Inspector of Drillstem Components
- CSWIP Level 2- Liquid Penetrant Inspector of Drillstem Components
- CSWIP Level 2 – Ultrasonic Inspector of Drillstem Components
- CSWIP Level 2 – Electromagnetic (EMI) Inspector of Drillstem Components
- CSWIP Level 2 - Rotary Tool Inspector
- CSWIP Level 2 - Rotary Tool Inspection Supervisor
- CSWIP Level 2 – Drillpipe Inspector
- CSWIP Level 2 – Drillpipe Inspector Supervisor
- CSWIP Level 3 – Drillstem Senior Inspector

Notes

1. CSWIP Level 2 Rotary Tool Inspector, Rotary Tool Inspection Supervisor, Drillpipe Inspector and Drillstem Inspection Supervisor are limited certifications as defined in section 2.3.

2. Rotary Tool Inspector

   Personnel qualified to perform liquid penetrant, magnetic particle visual inspections and dimensional measurements upon rotary tool components.

3. Drillpipe Inspector

   Personnel qualified to perform ultrasonic, electromagnetic (EMI), magnetic particle, liquid penetrant, visual inspections and dimensional measurements upon drillpipe.

4 Examination Requirements

4.1 Qualifications

Candidates for Rotary Tool Inspector examinations must hold either CSWIP Level 2 Magnetic Particle and Liquid Penetrant Inspector of Drillstem components qualifications or EN 473[(2)] Level 2 Magnetic Particle and Liquid Penetrant Inspector.

Candidates for Rotary Tool Inspector examinations holding qualifications in accordance with SNT-TC-1A[(3)] but not holding EN 473[(2)] qualifications, may be eligible for examination subject to a full review of all documentation pertaining to their SNT-TC-1A examination and provision of verified evidence of relevant prior experience.

Candidates for Rotary Tool Inspection Supervisor examinations must hold a Rotary Tool Inspector qualification.

Candidates for Drillpipe Inspector examinations must hold a Rotary Tool Inspector qualification plus CSWIP Level 2 Ultrasonic Inspector of Drillstem components and Electromagnetic (EMI) Inspector of Drillstem components.

Candidates for Drillpipe Inspection Supervisor must hold a Drillstem Inspector qualification.

4.2 Training

To be eligible for certification the candidate shall provide evidence of successful completion of a training programme approved by TWI Certification Ltd in that method. The minimum, training hours required are:

NDT Method	Training Hours Level 2
Liquid Penetrant Inspector	40
Magnetic Particle Inspector	40
Ultrasonic Inspector	80
Electromagnetic (EMI) Inspector	40
Rotary Tool Inspector	40
Rotary Tool Inspection Supervisor	24
Drillpipe Inspector	80
Drillstem Inspection Supervisor	24

Notes:

1 Documented on the job training can account for one-third of the total training hours.
2. Drillpipe inspector is considered to be limited certification covering the application of a single manual ultrasonic technique and a single magnetic flux leakage technique. The training hours therefore represents a 50% reduction for the combined hours required for ultrasonic inspection and magnetic flux leakage.

Candidates must provide evidence of training. A certificate of successful attendance and a copy of the training syllabus, both authenticated by a senior responsible person in the candidate's employing organisation or by a major client, will normally suffice.

4.3 Experience

To be eligible for examination, the candidate shall have the minimum experience indicated below:

NDT Method	Months of Experience Level 2
Liquid penetrant Inspection	4
Magnetic particle Inspection	4
Ultrasonic Inspection	6
Electromagnetic (EMI Inspection	4
Rotary Tool Inspector	4
Rotary Tool Inspection Supervisor	12
Drillpipe Inspector	6
Drillpipe Inspection Supervisor	12
Drillstem Senior Inspector	

Notes:

1 Work experience in months is based on a nominal 40h/week (160 h/month). When an individual is working more than 40h/week, they may be credited with experience based on the total hours, but he/she shall be required to produce evidence of this experience.

2 Rotary Tool Inspection Supervisor candidates must have held Rotary Tool Inspection certification for a minimum period of 6 months and provide documented experience in accordance with the CSWIP log book.

3. Drillpipe Inspector is considered to be limited certification covering the application of a single manual ultrasonic technique and a single magnetic flux leakage technique. The training hours therefore represents a 50% reduction for the combined hours required for ultrasonic inspection and magnetic flux leakage.

4. Drillpipe Inspection Supervisor candidates must have held Drillpipe Inspector certification for a minimum period of 6 months and provide documented experience in accordance with the CSWIP log book.

5. Drillstem Senior Inspector must have held Drillpipe Inspector Supervisor certification for a minimum period of 6 months and produce documented experience in accordance with the CSWIP log book.

6. Credit for work experience may be gained simultaneously in two or more of the NDT methods with the reduction in total required experience as follows:

   a) two testing methods – reduction of total required time by 25%
   b) three testing methods – reduction of total required time by 33%
   c) four testing methods – reduction of total required time by 50%

   The candidate shall be required to show that, for each of the testing methods for which he/she seeks certification, they have at least half of the time required. Candidates must provide evidence of experience by providing relevant information authenticated by a senior responsible person in the candidate's employing organisation or by a major client.

4.4 Level 3

Level 3 responsibilities require knowledge beyond the technical scope of any specific NDT method. This broad knowledge may be acquired through a variety of combinations of education, training and experience. The table below details minimum experience related to formal education.

	Degree	Experience (Months)
Access to level 3 by a certified level 2 operator	Graduate of a four year accredited science or engineering college or university programme	12
	Successful completion of at least two years of engineering or science study at an accredited college, university or technical school	24
	No degree	48
Direct access to level 3 by a non-certified operator with experience equivalent to level 2	Graduate of a four year accredited science or engineering college or university programme	24
	Successful completion of at least two years of engineering or science study at an accredited college, university or technical school	48
	No degree	72
Note – If the college or university degree is issued in non-destructive testing the experience required for access to level 3 may be reduced by 50%		

4.5 Vision Requirements

The candidate shall provide documented evidence of satisfactory vision in accordance with the following requirements:

a) near vision shall permit reading a minimum of Jaeger number 1 or equivalent type and size letters (e.g. Times Roman N4.5), at not less than 30 cm on a standard Jaeger test chart for near vision, in at least one eye, corrected or uncorrected

b) colour vision shall be sufficient that the candidate can distinguish and differentiate contrast between the colours used in the NDT methods concerned.

The evidence must be in the form of a certificate issued by a medically recognised person within the previous 12 months, covering all the above points.

With all the above eligibility requirements the onus is on the candidate to provide the necessary evidence prior to examination. An examination appointment will not be confirmed until the evidence has been received. Subsequent to certification, tests of visual acuity shall be carried out annually.

5 Examination Format

All certification examinations comprise four parts:

- General Theory (multiple choice)
- Specific Theory (multiple choice)
- General Practical
- Specific Practical

5.1 Theory examinations

5.1.1 Level 2

Examination content will be as specified in section 6 and the number of questions will be according to the table below.

	Number of Questions	
NDT Method	**General Theory**	**Specific Theory**
Liquid Penetrant Inspection of Drillstem Components	30 *	30
Magnetic Particle Inspection of Drillstem Components	30 *	30
Ultrasonic inspector of Drillstem Components	40	30
Electromagnetic (EMI) Inspection of Drillstem Components	30*	30
Rotary Tool Inspector	50	30
Rotary Tool Inspection Supervisor	40	30
Drillpipe Inspector	50	30
Drillpipe Inspection Supervisor	40	30

- Candidates will be allowed 1.5 minutes per multiple choice question.
- Pass mark 70%

* Candidates holding EN 473 /ISO 9712 certification in Liquid Penetrant, Magnetic Particle, Electromagnetic (EMI) and Ultrasonic inspection will be exempt the relevant general theory section of the examination

** Questions will cover the practical application of liquid penetrant, magnetic particle and visual inspection.

*** Questions will cover both ultrasonic inspection and magnetic flux leakage inspection. Candidates holding EN 473/ISO 9712 certification in ultrasonic or magnetic particle inspection will be exempt the relevant general theory examination.

**** Questions will cover the practical application of ultrasonic inspection and magnetic flux leakage inspection.

5.1.2 Level 3

The qualification examination for level 3 consists only of a written examination covering a specified test method.

The two sections of the examination are

a. Basic Examination: a minimum of 90 questions covering materials, processes and discontinuities; questions of a level 2 standard relating to other NDT methods (MT, PT, RT, UT, ET (Eddy current inspection), VT, AE (Acoustic Emission), TIR (Thermal Infra-Red inspection); requirements for the certification of NDT personnel as outlined in SNT-TC-1A and CP 189.

b. Method Examination: A minimum of 90 covering knowledge relating to the test method concerned and to the application of the method in the sector concerned. This maybe an open book examination where questions relating to codes, standards and specifications are concerned

Notes

1. Candidates must be successful in both the Basic and the Method examinations to be awarded certification.
2. If the candidate is not qualified to Level 2 at the time of application, then they shall also successfully complete the practical examination in the relevant NDT method.

5.2 Practical examinations

5.2.1 General practical

Candidates are required to conduct and report on a function or control test on visual, magnetic particle, electromagnetic (EMI), ultrasonic equipment or to carry out a visual inspection upon a minimum of 2 components.

- Time allowed 1 hour
- Pass mark 70%

5.2.2 Specific practical

Certification Sought	Specific Practical Content
Liquid penetrant inspection of Drillstem components	• To inspect a minimum of three components representative of drillstem components • Drafting a written instruction
Magnetic particle inspection of Drillstem components	• To inspect a minimum of three components representative of drillstem components • Drafting a written instruction
Electromagnetic (EMI) inspection of drillstem components	• To inspect a minimum of three components representative of drillstem components • Drafting a written instruction
Ultrasonic Inspection of Drillstem components	• To inspect a minimum of three components representative of drillstem components • Drafting a written instruction
Rotary Tool Inspector *	• To inspect 8 areas of components representative of rotary tool components, 2 each by liquid penetrant, magnetic particle, visual inspection and dimensional measurement • Drafting a written instruction
Drillpipe Inspector	• To inspect 8 areas of components representative of Drillpipe components, 2 each by Electromagnetic (EMI), Ultrasonic, Visual inspection and Dimensional measurement • Draft a written instruction

- Time allowed: 1 hour per specimen or 2 hours per case study
- Pass mark 70%

* Candidates holding CSWIP Liquid penetrant Inspection, Magnetic Particle Inspection, Electromagnetic (EMI) Inspection and/or Ultrasonic inspection of Drillstem components will be exempt the relevant section of the practical examination

6 Syllabi on Which Candidates Will Be Examined

The syllabi for the general and specific theory examinations are contained within Appendix A.

7 Examination Records

TWI Certification Ltd or their designated examination body will retain the following records

- Copies of theoretical examination and validated marking schemes
- Validated master reports of all practical samples utilised in practical
- Marking schemes
- Names of appointed examiners

- Name of certified individual.

8 Certification

8.1 Results notices

All candidates will be sent a results notice. This notice will also be sent to the organisation paying the examination fee, if not paid by the candidate.

a) The examination is evaluated by multiplying the mark achieved by the weighting factor for each component and then adding the components together to get an overall mark.

b) Results notices will indicate whether the candidate has achieved success or otherwise in the examination, the marks gained in each part of the examination, whether retests are allowable and brief reasons for failure of any part of the examination. The personal details recorded shall be those provided by the candidate.

8.2 Successful candidates

Two copies of a certificate of proficiency will be issued to the sponsoring organisation. Duplicate certificates to replace those lost or destroyed will be issued only after extensive enquiries.

8.3 Unsuccessful candidates

Candidates who fail to obtain a certificate may attempt one retest on those parts of the examination in which success was not achieved. The retest must be completed within one year of the initial test; otherwise candidates will have to repeat the complete examination.

8.4 Period of validity

The certificate is valid for five years from the date of completion of the initial test and may be renewed for a further five years on application, provided evidence is produced in accordance with Clause 8.5.1. Certificates are only valid provided:

a) they are within date.
b) they are on standard cream CSWIP paper bearing the CSWIP logo in black on gold signed by an officer of CSWIP and embossed with the CSWIP stamp.
c) they have been signed by the individual to whom the certificate is awarded.
d) they are accompanied by a valid official CSWIP identity card.
e) the holder is still employed by the sponsoring organisation.

Photocopies are unauthorised by CSWIP and should only be used for internal administrative purposes.

8.5 Five year renewal procedure

Individuals whose certificates expire at the end of the maximum five year period may renew their certificates for a further five years if they are able to supply evidence of reasonably continuous work activity in the relevant method during the period of validity of the certificate.

At the end of a further five years, a renewal examination will be required consisting of the practical part of the initial examination.

A candidate unsuccessful in any section of the examination will be allowed one further attempt in the section or sections failed. If the candidate is unsuccessful in this second examination no certificate will be awarded and, to obtain a certificate, the procedure for a new candidate will have to be followed.

8.5.1 General requirements

In all cases, the individual applying for renewal must meet the following criteria:

a) provide evidence at least every second year of satisfactory vision examination (see Clause 3.3)
b) provide evidence of continued satisfactory work activity without significant interruption

A significant interruption means an absence or a change of activity which prevents the certified individual from practising the duties corresponding to his/her level in the method and the industrial sector(s) for which he/she is certified, for one or several periods for a total time exceeding one year.

It is recommended that renewal examinations (see below) are carried out between six and one month prior to the five year expiry of the original certificate as failure to do so may affect the continuity of their certification. Candidates failing to take the renewal examination before the expiry date of their certificate will be treated as initial candidates.

It is not possible to combine five year renewal examinations with supplementary examinations for additional groups not included in the original certificate.

Any previous certificate is invalidated upon issue of the result of the five year renewal examination.

9 References

1. ISO 9712, 2005, 3rd Edition Non-destructive testing- Qualification and certification of personnel
2. EN473, 2000 Qualification and Certification of NDT Personnel – General Principles
3. Recommended Practice Guideline to Personnel Qualification and SNT-TC-1A, 1996 Certification in NDT

4. Appendix A – Examination Syllabus

1. Liquid Penetrant Inspection of Drillstem Components

General Theory

a. Principles of Penetrant Testing Methods
General principles, capillary action, applications, fluorescence.

b. Testing Techniques
Method selection. Method of application, spraying, brushing, immersion. Penetrant contact time. Application of Emulsifier, contact time, removal, drying. Application of developer, immersion, brushing, spraying, powder storm. Development time. Viewing conditions, white and black light and their assessment.

c. Stages of a Penetrant Inspection
Surface dressing, cleaning methods.

d. Equipment and Materials
Static installations, portable kits, auxiliary equipment. Dye (solvent removable), fluorescent (water washable) and fluorescent (post-emulsifiable) penetrants. Emulsifiers. Developers, dry powder, water suspended, solvent suspended.

Specific Theory

a. Methods of Assessing Sensitivity
Chromium plated, aluminium test blocks. Defective components.

b. Interpretation and Reporting of Indications
Types of discontinuity and their identification. Non-relevant indications. Recording: transparent tape transfer, lacquer transfer, photographic (fluorescent and non-fluorescent). Reporting.

c. Standards and Specifications
The standards and specifications to be used will be relevant to the region in which the examination is to be conducted and to the employment of the candidate.

d. Manufacture Procedures
Forging, Friction Welding, Design, Yield & Tensile loading, Inspection

e. Environmental Conditions
Well Configurations, Corrosion Factors, Stress Factors

f. Fatigue & Failure Modes
Chemical Attack, Tensional & Compression Forces, Cycling Loading, Erosion, Temperature Ranges, Mechanical

g. Marking
Area Identification, Classification, Colour Coding, Stencilling

h. Reporting
Recording, Dimensional Data, Abbreviations

2. Magnetic Particle Inspection of Drillstem Components

General Theory

a. Principles of Magnetism
General principles, magnetic poles, magnetic field, lines of force, longitudinal magnetisation, horse-shoe magnet, vector field, consequent poles, distorted field, leakage field.

b. Magnetic Materials
Ferromagnetic, paramagnetic and diamagnetic materials. Simple definitions of permeability and reluctance.

c. Electrically induced Magnetic Fields
Generation of circumferential flux and longitudinal flux. Flux density, residual magnetism.

d. Hysteresis Loops

e. Magnetisation Methods
Permanent magnet, electro-magnet, contact current flow (includes prod testing), threading bar, coils, induced current flow.

f. Equipment
Fixed, transportable and portable installations. DC battery, AC mains, DC rectified half wave, DC rectified full wave. Ancillary equipment. Inspection lighting (including white and black light). Viewing aids. Marking devices. Demagnetisers. Contrast aids. Calibration of equipment and the use of meters. Performance checks. Test pieces and 'portable cracks.'

g. Magnetic Detection Inks, Concentrates and Powders
Inks and concentrates: fluorescent and non-fluorescent. Water, hydrocarbon and quick drying based colours. Wetting agents and inhibitors. Dry powders: puffs, cabinets. Preparation and testing of materials: determination of solid content.

Specific Theory

a. Testing Procedures
Magnetising operation to be used, current or flux values, jigs or fixtures. Geometric shape of components. Methods of assessing sensitivity of techniques.

b. Interpretation and Reporting of Indications
Types of discontinuity and their identification (surface and sub-surface indications). Non-relevant indications. Recording: transparent tape transfer, lacquer transfer, photographic (fluorescent and non-fluorescent). Reporting.

c. Demagnetisation and Post Test Procedures
Reasons for demagnetisation, AC and DC methods. Testing for demagnetisation. Cleaning.

d. Standards and Specifications
The standards and specifications to be used will be relevant to the region in which the examination is to be conducted and to the employment of the candidate.

e. Manufacture Procedures
Forging, Friction Welding, Design, Yield & Tensile loading, Inspection

f. Environmental Conditions
Well Configurations, Corrosion Factors, Stress Factors

g. Fatigue & Failure Modes
Chemical Attack, Tensional & Compression Forces, Cycling Loading, Erosion, Temperature Ranges, Mechanical

h. Marking
Area Identification, Classification, Colour Coding, Stencilling

i. Reporting
Recording, Dimensional Data, Abbreviations

3. Rotary Tool Inspector

General Theory

a. Introduction
Definition and history of visual testing,

b. Factors Influencing visual Inspection
Vision, lighting, material properties, environmental, visual perception, surface preparation, direct and indirect inspection

c. Equipment
Mirrors, magnifiers, borescopes, fibrescopes, CC TV, gauges, templates, scales, automated systems, computer enhanced

Specific Theory

a. Manufacture Procedures
Forging, Friction Welding, Design, Yield & Tensile loading, Inspection

b. Environmental Conditions
Well Configurations, Corrosion Factors, Stress Factors

c. Fatigue & Failure Modes
Chemical Attack, Tensional & Compression Forces, Cycling Loading, Erosion, Temperature Ranges, Mechanical

d. Inspection Equipment & Application
Dimensional, Magnetic Particle, Penetrant Examination, Visual Examination

e. Inspection
Industry Standards, Product Standards, Client Based standards, Interpretation

f. Marking
Area Identification, Classification, Colour Coding, Stencilling

g. Reporting
Recording, Dimensional Data, Abbreviations

4. Rotary Tool Inspection Supervisor

General Theory

a. Introduction
Definition and history of visual testing,

b. Factors Influencing visual Inspection
Vision, lighting, material properties, environmental, visual perception, surface preparation, direct and indirect inspection

c. Equipment
Mirrors, magnifiers, borescopes, fibrescopes, CC TV, gauges, templates, scales, automated systems, computer enhanced

Specific Theory

a. Inspection Equipment & Application
Electromagnetic, Dimensional, Magnetic Particle, Penetrant Examination
Ultrasonic Examination, Wall Thickness Checks, Visual Examination

b. Inspection
Industry Standards, Product Standards, Client Based standards, Interpretation

c. Marking
Area Identification, Classification, Colour Coding, Stencilling

d. Reporting
Recording, Dimensional Data, Abbreviations

e. Written procedures and operational requirements
The Rotary Tool Inspection Supervisor shall be responsible for the compilation, review and implementation of the application of the NDT methods of inspection and dimensional measurement in accordance with the Contract conditions.

5. Ultrasonic Inspector

General Theory – Ultrasonic Inspection

a. Brief history of development of ultrasonic testing theory.

b. Ultrasonic capabilities in relation to other NDT methods.

c. Physical principles of sound
Nature of sound, relationship between wavelength, frequency and velocity. Wave motions and particle vibrations, velocities of sound in common materials.

d. Behaviour of ultrasonic waves
Reflection, refraction, diffraction. Snell's laws, attenuation, acoustic impedance, mode conversion, resonance, scattering from defects.

e. Production of ultrasonic waves
Piezo-electric effect. Types and properties of transducers, pulse width, near and far fields, effect of frequency and sound velocity on near field, far field and beam divergence. Dead zone, production of compression, shear and surface waves, critical angles, construction of single and twin crystal probes. Couplants.

f. Ultrasonic equipment
Block diagrams of flaw detector, functions of controls, amplifier and equipment performance characteristics. A-scan, B-scan and C-scan displays.

Specific Theory

a. Manufacture Procedures
Forging, Friction Welding, Design, Yield & Tensile loading, Inspection

b. Environmental Conditions
Well Configurations, Corrosion Factors, Stress Factors

c. Fatigue & Failure Modes

Chemical Attack, Tensional & Compression Forces, Cycling Loading, Erosion, Temperature Ranges, Mechanical

d. Inspection Equipment & Application
Electromagnetic, Dimensional, Magnetic Particle, Penetrant Examination
Ultrasonic Examination, Wall Thickness Checks, Visual Examination

e. Inspection
Industry Standards, Product Standards, Client Based standards, Interpretation

f. Marking
Area Identification, Classification, Colour Coding, Stencilling

g. Reporting
Recording, Dimensional Data, Abbreviations

5. **Electromagnetic (EMI) of Drillstem Components**

General Theory

a. Principles of Magnetism
General principles, magnetic poles, magnetic field, lines of force, longitudinal magnetisation, horse-shoe magnet, vector field, consequent poles, distorted field, leakage field.

b. Magnetic Materials
Ferromagnetic, paramagnetic and diamagnetic materials. Simple definitions of permeability and reluctance.

c. Electrically induced Magnetic Fields
Generation of circumferential flux and longitudinal flux. Flux density, residual magnetism.

d. Hysteresis Loops

e. Magnetisation Methods
Electro-magnet, contact current flow (includes prod testing), threading bar, coils, induced current flow.

f. Equipment
Fixed, transportable and portable installations. DC battery, AC mains, DC rectified half wave, DC rectified full wave. Ancillary equipment. Inspection lighting (including white and black light). Viewing aids. Marking devices. Demagnetisers. Contrast aids. Calibration of equipment and the use of meters. Performance checks. Test pieces and 'portable cracks.'

Specific Theory

a. Testing Procedures
Magnetising operation to be used, current or flux values, jigs or fixtures. Geometric shape of components. Methods of assessing sensitivity of techniques.

b. Interpretation and Reporting of Indications
Types of discontinuity and their identification (surface and sub-surface indications). Non-relevant indications. Recording: transparent tape transfer, lacquer transfer, photographic (fluorescent and non-fluorescent). Reporting.

c. Demagnetisation and Post Test Procedures
Reasons for demagnetisation, AC and DC methods. Testing for demagnetisation. Cleaning.

d. Standards and Specifications
The standards and specifications to be used will be relevant to the region in which the examination is to be conducted and to the employment of the candidate.

e. Manufacture Procedures
Forging, Friction Welding, Design, Yield & Tensile loading, Inspection

f. Environmental Conditions
Well Configurations, Corrosion Factors, Stress Factors

g. Fatigue & Failure Modes
Chemical Attack, Tensional & Compression Forces, Cycling Loading, Erosion, Temperature Ranges, Mechanical

h. Marking
Area Identification, Classification, Colour Coding, Stencilling

i. Reporting
Recording, Dimensional Data, Abbreviations

7. **Drillpipe Inspector**

General Theory

a. Introduction
Definition and history of visual testing,

b. Factors Influencing visual Inspection
Vision, lighting, material properties, environmental, visual perception, surface preparation, direct and indirect inspection

c. Ultrasonic equipment
Block diagrams of flaw detector, functions of controls, amplifier and equipment performance characteristics, A-scan, B-scan and C-scan displays.

d. Equipment
Fixed, transportable and portable installations. DC battery, AC mains, DC rectified half wave, DC rectified full wave. Ancillary equipment. Inspection lighting (including white and black light). Viewing aids. Marking devices. Demagnetisers. Contrast aids. Calibration of equipment and the use of meters. Performance checks. Test pieces and 'portable cracks.'

Specific Theory

a. Manufacture Procedures
Forging, Friction Welding, Design, Yield & Tensile loading, Inspection

b. Environmental Conditions
Well Configurations, Corrosion Factors, Stress Factors

c. Fatigue & Failure Modes
Chemical Attack, Tensional & Compression Forces, Cycling Loading, Erosion, Temperature Ranges, Mechanical

d. Inspection Equipment & Application
Electromagnetic, Dimensional, Magnetic Particle, Penetrant Examination
Ultrasonic Examination, Wall Thickness Checks, Visual Examination

e. Inspection
Industry Standards, Product Standards, Client Based standards, Interpretation

f. Marking
Area Identification, Classification, Colour Coding, Stencilling

g. Reporting
Recording, Dimensional Data, Abbreviations

8. Drillpipe Inspection Supervisor

General Theory

General Theory

a. Introduction
Definition and history of visual testing,

b. Factors Influencing visual Inspection
Vision, lighting, material properties, environmental, visual perception, surface preparation, direct and indirect inspection

c. Equipment
Mirrors, magnifiers, borescopes, fibrescopes, CC TV, gauges, templates, scales, automated systems, computer enhanced

Specific Theory

a. Inspection Equipment & Application
Electromagnetic, Dimensional, Magnetic Particle, Penetrant Examination
Ultrasonic Examination, Wall Thickness Checks, Visual Examination

b. Inspection
Industry Standards, Product Standards, Client Based standards, Interpretation

c. Marking
Area Identification, Classification, Colour Coding, Stencilling

d. Reporting
Recording, Dimensional Data, Abbreviations

e. Written procedures and operational requirements
The Rotary Tool Inspection Supervisor shall be responsible for the compilation, review and implementation of the application of the NDT methods of inspection and dimensional measurement in accordance with the Contract conditions.

9. Drillstem Senior Inspector

General Theory

a. Introduction
Definition and history of visual testing,

b. Factors Influencing visual Inspection
Vision, lighting, material properties, environmental, visual perception, surface preparation, direct and indirect inspection

c. Equipment

Mirrors, magnifiers, borescopes, fibrescopes, CC TV, gauges, templates, scales, automated systems, computer enhanced

Specific Theory

a. Inspection Equipment & Application

Electromagnetic, Dimensional, Magnetic Particle, Penetrant Examination
Ultrasonic Examination, Wall Thickness Checks, Visual Examination

b. Inspection

Industry Standards, Product Standards, Client Based standards, Interpretation

c. Marking

Area Identification, Classification, Colour Coding, Stencilling

d. Reporting

Recording, Dimensional Data, Abbreviations

e. Written procedures and operational requirements

The Rotary Tool Inspection Supervisor shall be responsible for the compilation, review and implementation of the application of the NDT methods of inspection and dimensional measurement in accordance with the Contract conditions.

In addition has the overall responsibility for the Operational and technical adherence of the application of the NDT methods and dimensional measurement of the Drillstem components.

Is responsible for the interpretation and correct implementation of the relevant standards and procedures being applied to the drillstem components.

Shall verify and ensure all contract conditions relative to NDT applications are being implemented in full.