Examination programs
Level 2 – Application sector « Land »

Theme 2 – Corrosion and materials

- Specific environments: soils, natural waters, sea water
- Corrosivity of grounds, relations with the resistivity and humidity, general knowledge of standard NF EN 12501-2
- Reviews about metals and alloys used for the structures in contact with the ground through cathodic protection: Carbon steels, cast iron, galvanized steel, stainless steels, lead, aluminium alloys, copper alloys
- Risks of stress corrosion cracking under separated coating

Theme 3 – General electricity

- Association of the batteries connected in series and parallel
- Batteries lifespan
- Diodes characteristic curves

Theme 4 –General theory of cathodic protection

- Reference electrodes and measurement electrodes used in soils and natural waters, influence of chlorides
- Cathodic protection criteria in soils and natural waters for carbon steels and cast iron
    - Influence of resistivity, temperature, bacterial developments
    - Criteria of cathodic protection concerning complex structures
    - Risks related to cathodic over-protection: hydrogen embrittlement, disbondment of coatings
    - Influence of alternating currents on the effectiveness of cathodic protection
- Cathodic protection criteria in soils and natural waters for other metals and alloys
    - Stainless steels
    - Copper and alloys
    - Lead
    - Aluminium and alloys
    - Galvanized Steel
    - Risks related to the cathodic over-protection of amphoteric metals (alkaline corrosion)
- Cathodic protection systems
    - Comparison of different cathodic protection systems
- Effectiveness and operational limits of cathodic protection
    - Risks of corrosion related to the use of isolating joints
    - Influence of the distance anode/protected structure

Theme 5 – Cathodic protection systems

- Design and sizing of cathodic protection systems
    - Determination of cathodic protection current
    - Calculation of the anodes resistance according to the shape and the layout of the elements (horizontal anode beds, vertical wells, wire mesh, etc...)
    - Anodic mass to be installed according to the required lifetime
- Protection system by galvanic anodes

  - Available anodic materials, chemical compositions and electrochemical characteristics (potential, electrochemical efficiency, practical mass consumption and practical mass energy)
  - Selection criteria of anodic material
  - Regulating mixtures
  - Constructive arrangements (lifetime, numbers of anodes to be installed, distribution, coupling factor)
- Impressed current protection system
  - Usable materials (characteristics, voltage, anodic medium)
  - Selection criteria of anodic material, conditions of use
  - Constructive arrangements (lifetime, number of elements)
  - Regulating mixtures (ionic conductor and electronic conductor)
  - Various types of impressed current protection stations: transformer-rectifiers, batteries, piles, photovoltaic panels, power generator sets, thermogenerators
  - How to control protection stations: impressed intensity, impressed voltage, impressed electrode potential (servo-control systems using a pilot reference electrode)
- Auxiliary equipment: cables, isolating joints, potential test points, discharge intervals, polarization cells, devices for influence currents flow, etc
- Constructive arrangements concerning the crossings under sleeve (roads, railways), directional drillings, river crossings, proximities to high voltage lines, pipes crossings, corbelled constructions along the structures, etc
- Startup and monitoring of the installations
  - Cathodic protection systems, sleeves, isolating joints, AC or influence currents flow systems, electrical influences, etc.)
  - Startup procedures
  - Maintenance and monitoring procedures
  - Monitoring and measurements periodicity

Theme 6 – Protection against the external electrical influences

- DC railway traction system (reviews)
  - Operating principle
  - Constructive arrangement (power, insulation, railways...)
  - Applicable regulations
- Protection against stray currents
  - Localization of origins
  - Means of protection (drainage, impressed currents stations, pipes sectionalizing, actions on the influence source, groundings)
  - Current drainage: composition, functionning, regulation means
  - On-site tests
  - Electrical protection system
  - Influence of the protection systems against stray currents on close structures
  - Administrative procedures in force
- Startup and monitoring
  - Checking of devices and their components before startup
  - Monitoring of devices performance after startup
  - Potentials measurement on the structure to be protected (instantaneous potential, average potential, maximum and minimum potentials, recordings, measurements on removable and permanent metal indicators)
  - Measurement of potentials concerning the source of the continuous stray currents
  - Startup procedure

  - Maintenance and monitoring procedure
  - Monitoring and measurements periodicity
- Influences generated by other cathodic protection systems in the vicinity: protection means, direct connection, polarized connection, resistant connection, coating and mechanical protection, potential measurements, maintenance and monitoring procedure, monitoring and measurements periodicity

- Influences generated by the proximity of high voltage structures (conduction, induction, capacitive effect, means of protection, regulation)
  - Overhead high-voltage power lines
  - 50 Hz railway traction power systems
  - Buried electric cables that transport high voltage energy
  - Corrosions generated by the 50 Hz alternating currents (origin, risks evaluation, solutions to be implemented)
  - Startup and monitoring of protection devices performance
  - Monitoring and maintenance procedure
  - Monitoring and measurements periodicity
- Influences generated by lightning
  - Different type of discharges
  - Characteristics of lightning shocks
  - Direct and indirect lightning strikes (electromagnetic coupling, conduction)
  - Keraunic level, lightning strikes density
  - Factors influencing drillings of burried pipes
  - Safety Device (insulating connection, lightning protector, equipotentiality of work stations)
  - Startup and monitoring of protection devices performance
  - Monitoring and maintenance procedure
- Prevention of workers against electrical risks
  - Prevention of risks
  - Protection materials
  - Regulation

Theme 7 – Measurement techniques – Equipment

- Equipment
  - Setting-up and implementation of mobile or permanent reference electrodes (copper – saturated copper sulfate) and of permanent measurements (zinc)
  - Metrological monitoring according to NF EN ISO 10012, monitoring of electrodes and of other devices of the measuring equipment
  - Metal indicators (coupons), associated or not with a reference electrode (setting-up and implementation)
  - Switchers
  - Grounding measurement (four stakes or quadripole, tellurometer)
  - Resistivity cell
- Potential measurements
  - “ON” current measurements on structures, punctual or with recording
  - Measurements of potential in the presence of alternative influences
  - Measurements of potential in the presence of stray currents
  - Ohmic drop related to the place of the reference electrode
  - “OFF” measurements with current switch-off on the structure, punctual or with recording

  - Factors influencing the results of measurements with current switch-off (compensation currents, stray or telluric current, influence of close cathodic protection systems)
  - Other factors that influence permanent current measurements and measurements with current switch-off (contact resistance of the reference electrode with the ground, contact resistance where the structure is connected, measurements carried out on a cable which conveys a current, galvanic coupling between the structures with strong insulation value and the reference electrode with current switch-off)
  - Measurements with shut down current on metal indicator, factors influencing the results
  - Close Interval Potential Survey ("CIPS")
  - Measurements of potential on complex structures
- Measurements of current intensity and density
  - Measurement of current circulating in a pipe (insulation connection with shunt, two-wire method, four-wire method, amperometric ring)
  - Determination of the current densities on structures or metal indicators. Detailed analysis of the factors that influence the results
- Measurement of soil resistivity and measurement of ground resistances
  - Measurements in laboratory (solid and liquid samples)
  - Four-point method (Wenner method)
  - Analysis of measurements of soil resistivity carried out on site at different depths (problems of stratified soils)
  - Analysis of measurements of the ground resistance of structures (tellurometer, variation of the current intensity emitted by a D.C. source)
  - Insulation values of buried structures
- Analysis of measurements and measurements series
- Supervision of research series about insulation surface-breaking defects
  - method to reduce an alternating signal,
  - method using alternating currents (Pearson),
  - method using DCs (" DCVG " and derived methods)
- Finalization of intervention reports
- Localization of the contacts between the protected structure and other metal elements. Case of sleeves

Theme 8 – Coatings

- Coating method of passive protection supplemented by cathodic protection (active)
- Non compatible coating with cathodic protection: heat insulators
- Main types of coatings (constitution, thicknesses)
  - Main coatings applied in factories on pipes: advantages and disadvantages of each one
  - Main coatings used for welded joints, shaped parts and repairs
  - Mechanical protection complementary coatings (anti rocks)
  - External coatings of buried tanks and storage tanks bottoms
  - Pipes sticking out of the ground
- Main properties of coatings
  - Keeping of adherence, main goal
  - Risks of corrosion through a shielding effect to the cathodic protection current under heat insulating and nonadherent coatings to steel. Practical importance (risks of corrosion or stress corrosion), mechanisms, main factors such as resistivity, incidence on the validity of the measurement methods
  - The detrimental effects of cathodic protection: blistering of paints, cathodic delamination
  - Physicochemical resistance of coatings: effects of temperature (application fields), pH, bacteria

- Resistance of coatings to mechanical aggressions (shocks, penetration under tension, bending)

Theme 10 – Knowledge of standards, procedures and official texts of regulation

- The various competence levels and application sectors according to NF EN 15257
- Procedures of certification of personnel according to NF EN 15257, examinations, period of validity
- Procedure CFPC PR4000: " Conditions of use of the certification and code of ethics "
- General knowledge of the following technical standards:
  - BS EN ISO 10012 " Requirements for measurement processes and measuring equipment "
  - BS EN 12954 " Cathodic protection of buried or immersed metallic structures - General principles and application for pipelines "
  - BS EN 13509 " Cathodic protection measurement techniques "
  - BS EN 12501- 2 " Protection of metallic materials against corrosion - Corrosion likelihood in soil - Part 2: " low alloyed and non alloyed ferrous materials "
  - BS EN 50162 " Protection against corrosion by stray current from direct current systems "
  - BS EN 14505 " Cathodic protection of complex structures "
  - BS EN 13636 " Cathodic protection of buried metallic tanks and related piping "
  - CEN/TS 15280 " Evaluation of AC corrosion likelihood of buried pipelines - Application to cathodically protected pipelines "
  - prEN 16299 " Cathodic protection of external surfaces of the bottom of aerial steel storage tanks in contact with the ground or the foundations "
  - NF EN 62305 " Protection against lightning ", Parts 1, 2 and 3
- Main official texts:
  - Decree of May 17 2001 " electric Power – Technical Conditions of Distribution (specific modifications made by the decree of April 26 2002 and the following ones"
  - Decree n° 88-1056 of 14 November 1988 " Protection of workers in establishments where electric currents are used "
  - Decree of 10 October 2000 " Inspection on electrical installations "
  - Decree of 22 December 2000 " Conditions and approval procedures of people or organisations for the monitoring of electrical installations "
  - Mining code
  - Decree of 13 July 2000 (modified) about safety regulations of combustible gas distribution through pipelines
  - Decree of 4 August 2006 about safety regulations of pipelines transporting combustible gas, liquid or liquefied hydrocarbons and chemicals