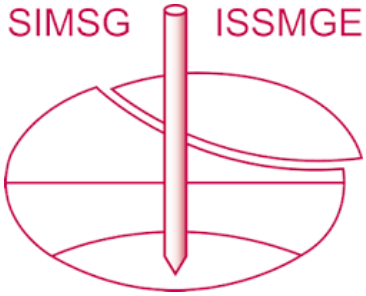
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Qualification criteria for technicians and enterprises performing ground investigation

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ABSTRACT: Many countries have no vocational training for technicians who perform geotechnical sampling, testing, measuring, monitoring and installing of equipment (e.g. piezometers, borehole heat exchangers, inclinometers and extensometers) for ground investigation purposes. Most of the operators are trained on the job (learning by doing) only. It is difficult for the clients to recognize and to compare the qualification of the operators in this field. The technical committee on geotechnics of the International Organization for Standardization (ISO/TC 182) has seen the need for setting the standards on the qualification.

Keywords: qualification, standardization, geotechnics, sampling, testing

1. Introduction

For almost 20 years the European technical committee CEN/TC 341 "Geotechnical investigation and testing" and the international technical committee ISO/TC 182 "Geotechnics" prepare standards on ground investigation according to the so-called Vienna Agreement.

First a set of standards on sampling, testing and monitoring were finalized:

- ISO 14688-1, Geotechnical investigation and testing - Identification and classification of soil - Part 1: Identification and description
- ISO 14689, Geotechnical investigation and testing - Identification and classification of rock - Identification and description
- ISO 17628, Geotechnical investigation and testing - Geothermal testing - Determination of thermal conductivity of soil and rock using a borehole heat exchanger
- ISO 17892 (all parts), Geotechnical investigation and testing - Laboratory testing of soil.
- ISO 18674 (all parts), Geotechnical investigation and testing - Geotechnical monitoring by field instrumentation
- ISO 22282 (all parts), Geotechnical investigation and testing - Geohydraulic testing
- ISO 22475, Geotechnical investigation and testing – Sampling of soil, rock and groundwater measurements
- ISO 22476 (all parts), Geotechnical investigation and testing - Field testing

These standards allow to compare the results of the ground investigation worldwide. This is a big benefit for enterprises and engineers performing ground investigation or using these results for their geotechnical design and other engineering purposes.

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

CEN, the European Committee for Standardization, is an association that brings together the National Standardization Bodies of 34 European countries.

In 2019 both technical committees decided to start a new project concerning the quality of the performance of ground investigation.

Therefore, a set of three standards are currently in preparation:

- ISO 24283-1 Geotechnical investigation and testing — Qualification criteria — Part 1: Qualified technician
- ISO 24283-2 Geotechnical investigation and testing — Qualification criteria — Part 2: Responsible expert**Error! Reference source not found.**ISO 24283-3 Geotechnical investigation and testing — Qualification criteria — Part 3: Qualified enterprise

2. Qualified technician

This standard will specify the qualification criteria for persons performing sampling, testing, measuring, monitoring and installation of equipment (e.g. piezometers, borehole heat exchangers, inclinometers and extensometers).

A qualified technician has documented competence regarding the following:

- basic knowledge of the purpose of geotechnical ground investigation, of

geological, soil and rock mechanical and hydrogeological fundamental principles;
- specified parts of sampling, testing, measuring, monitoring and installation of any equipment in boreholes (e.g. piezometers, borehole heat exchangers, inclinometers and extensometers) according to the relevant standard (see clause 2) in the framework of geotechnical investigation;
- preparation of records according to the relevant standard concerning ground investigation;
- the relevant health, safety and environmental regulations;
- the functioning, safe operation and maintenance of the equipment (including field checks);
- the quality assurance system of the enterprise.

Moreover, the standard will comprise an informative annex concerning the assessment procedures and prerequisites.

The prerequisites for admission to the qualification assessment are:

- Minimum age at the time of the assessment: 18 years;
- Sufficient knowledge of the assessment language;
- Completed vocational training of a relevant subject and proof of suitable work experience (see Table 1) in an enterprise that performs specified parts of sampling, testing, measuring, monitoring and/or installation of equipment in boreholes;
- Documented formal training in preparation of the assessment.

This is just a proposal; the users of this standard are free to change and to adapt these prerequisites to their purposes or legal conditions.

A vocational training means an on-the job or work place training based on a modular program for at least 3 years.

This standard will summarize the required work experience of various ground investigation methods.

Another informative annex will give a proposal for the scope and the duration of a training course and the preparation of the technician for the assessment.

This concept for a training course gives an overview about the assessment subjects and the time needed to prepare the technicians for the examination.

The training course for the preparation of the examination may be divided into different parts:

1. Principles of geotechnical investigation and testing
2. Sampling of soil, rock and groundwater according to ISO 22475 including preliminary identification of soil and rock according to ISO 14688-1 and ISO 14689;
3. Field testing according to ISO 22476 series
   - Cone penetration testing according to ISO 22476-1 and ISO 22476-12
   - Standard-penetration testing according to ISO 22476-2
   - Dynamic probing according to ISO 22476-3
   - Pressuremeter testing according to ISO 22476-4
   - Field vane testing according to ISO 22476-9
4. Geohydraulic testing according to ISO 22282 series
   - Water permeability tests in a borehole without packer according to ISO 22282-2
   - Water pressure test in rock according to ISO 22282-3
   - Pumping test according to ISO 22282-4
   - Infiltrometer test according to ISO 22282-5
5. Installation of monitoring equipment in boreholes according to ISO 18674 series
   - Installation of extensometer equipment according to ISO 18674-2
   - Installation of inclinometer equipment according to ISO 18674-3
   - Installation of piezometer according to ISO 18674-4
6. Geotechnical monitoring according to ISO 18674 series
   - extensometer measurements according to ISO 18674-2
   - inclinometer measurements according to ISO 18674-3
7. Installation of geothermal heat exchangers according to ISO 17628
8. Geothermal response test in geothermal heat exchangers according to ISO 17628

3. Responsible expert

This standard will specify the qualification criteria for the person who is responsible for the performance of sampling, testing, measuring, monitoring and installation of equipment (e.g. piezometers, borehole heat exchangers, inclinometers and extensometers).

This person is responsible for the technical management and supervision of the performance of specified parts of sampling, testing, measuring, monitoring and installation of equipment.

The responsible expert has a documented competence:

- either college or university degree of a relevant subject and proof of relevant work experience of at least three years in an enterprise that performs specified parts of sampling, testing, measuring, monitoring and installation of equipment;
- or a completed vocational training of a relevant subject and proof of relevant work experience of at least five years in an enterprise that performs specified parts of sampling, testing, measuring, monitoring and installation of equipment;
- or proof of relevant work experience of at least ten years in an enterprise that performs

specified parts of sampling, testing, measuring, monitoring and installation of equipment.

The responsible expert has sufficient proven knowledge concerning

- the appropriate laws, health, safety and environmental regulations, technical rules and standards;
- the purpose of geotechnical ground investigation, about geological, soil and/or rock mechanical and hydrogeological principles;
- appropriate parts of sampling, testing, measuring, monitoring and installation of equipment according to the standards (see clause 2);
- reporting according to the relevant standards,
- the identification and description of soil and rock in each sample according to EN ISO 14688-1 and EN ISO 14689, if relevant;
- the quality assurance system.

Moreover, the responsible expert is able

- to understand the aim of the investigation programme;
- to supervise the work of the qualified operator;
- to ensure the completeness and quality of the report according to the relevant standards (see clause 2), especially divergences influencing the results of the investigation;
- to call for additional expertise if required.

The responsible expert supervises the geotechnical investigation, controls the correct performance of the geotechnical investigation in accordance with the relevant standards, checks and sign the test report(s) for which he is responsible.

4. Qualified enterprise

This standard will specify the qualification criteria for enterprises performing sampling, testing, measuring, monitoring and installation of equipment (e.g. piezometers, borehole heat exchangers, inclinometers and extensometers).

An enterprise is a public or a private organisation providing services. qualified enterprise. A qualified enterprise carrying out sampling, testing, measuring, monitoring and installation of equipment is able to demonstrate adequate competence and have:

- Experienced and qualified personnel and facilities to manage and to perform specified types of services complying with the relevant standards (see clause 2);
- items of equipment complying with the relevant standards (see clause 2);
- a health, safety and environmental system;
- liability insurance;
- a quality assurance system.

The qualified enterprise ensures that all specified equipment complies with the appropriate technical specifications, is correctly maintained, calibrated and used according to specifications and operating manuals.

It has a minimum of one responsible expert according to ISO 24283-2 and adequate numbers of qualified technicians according to ISO 24283-1 appointed for each project.

The qualified enterprise will appoint a responsible expert for each project. The enterprise complies with the actual bylaws, health, safety and environmental regulations and technical rules for the corresponding field of activity and follow them.

Moreover, it is covered for public liability.

The enterprise provides training of its personnel on a regular basis and maintain records of this training.

The qualification of external personnel and sub-contractors shall meet the same criteria and shall be verified by the enterprise.

The standard will also comprise an informative annex concerning the assessment procedures and prerequisites.

The prerequisites for admission to the assessment and re-assessment are:

- Name(s) of responsible expert(s) with records concerning education, training, experience and certificate(s) relevant to the assessment;
- Name(s) of the qualified technician(s) relevant to the assessment;
- List of machines and equipment relevant to the assessment subject;
- quality assurance system;
- health, safety and environmental system.

Arrangements will be made in advance for the assessor and enterprise to meet at the enterprise office and an investigation site to demonstrate its skills, knowledge and safe working according to the set standards and procedures of the conformity assessment body.

The duration of the assessment will be adapted to the complexity of the above techniques.

The assessed enterprise may choose the subjects individually according to its qualification.

5. Assessment and certification

The quality of these services can be proven by:

a) a declaration of conformity by a contractor (first party control);
b) a declaration of conformity by a client (second party control);
c) a declaration of conformity by a conformity assessment body (third party control).

Every enterprise or individual may decide, if and how they will prove the fulfilment of the technically related criteria: by first, second or third party control because no part the above mentioned standards require such a declaration.

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