

# Level 2 Certification

## Introduction

The British Society for Strain Measurement holds personnel certification examinations leading to the award of the Strain Measurement Certificate at Level 1 and 2 and the Diploma at Level 3. This booklet gives details of the Level 2 examination. Corresponding details of the Level 1 and 3 examinations are given in booklets CSMP11<sup>(2)</sup> and CSMP13<sup>(3)</sup> respectively. Full details of the certification scheme are given in CSMP10<sup>(1)</sup>, which is supplied to all registered candidates.

The Level 2 Certificate provides a qualification for engineers and technicians who install strain gauges, supervise installations and make measurements. It shows that the holder has demonstrated a high level of skill in making strain gauge installations, is able to prepare detailed instructions for installing gauges and can use gauges to obtain accurate and reliable measurements of the strain in loaded components.

The Society publishes a Code of Practice CPI<sup>(4)</sup> for the installation of electrical resistance strain gauges, a copy of which is issued to everyone registered for the examination. Candidates are expected to observe this code and use it in conjunction with the instruction sheets provided by gauge manufacturers and suppliers. The Society also publishes Installation Record Sheets; copies are provided for use during the examination.

A list of scheduled examinations can be obtained from the Society Office. When there are several candidates from the same firm an examination can be held on the firm's premises.

A one-day seminar is held about two weeks before each examination, so that candidates can review procedures for typical gauge installations, make measurements, plan installation instructions and discuss written questions with an experienced engineer. It is normally held at the examination venue.

## Entry Requirements

All candidates should have received appropriate training and obtained relevant experience. The periods of time normally expected are given in the table. It is not necessary to obtain equal experience of installation, supervision and measurement.

Tertiary Education	Training (days)		Experience (months)	
	After Level 1	Direct Entry	After Level 1	Direct Entry
Degree/HNC in Engineering or Science	4	5	6	12
None	5	N/A	12	N/A

## The Examination

- (a) The objective of the examination is to enable candidates to demonstrate that they use procedures consistent with the Code of Practice CP1<sup>(4)</sup>, and are able to direct the installation of gauges, choose appropriate gauges, materials and methods, and make measurements using gauges.
- (b) The whole examination lasts 6.25 hours. It normally starts at 9.15 a.m., but candidates are allowed into the examination room at 9.00 a.m., so that they can become familiar with the room and the equipment and read through the question papers. A lunch break is taken at around 12.15 p.m. Since the examination is predominantly an assessment of practical skills and understanding, reference books and similar material, excluding the written examination question bank, can be taken into the examination room and used in any part of the examination. Personal written material may also be used but must be made available for inspection by the examiner.
- (c) The examiner will provide advice and assistance if this is necessary in order that candidates can fully demonstrate their competence. Problems or any difficulties with the question papers or the materials and equipment should be reported to the examiner as they arise.
- (d) The examination is divided into two parts:
- a practical test
  - a written test

The practical test forms the main part of the examination and contains four tasks:

- a gauge bonding and wiring installation
- a full-bridge wiring installation
- a measurement exercise using pre-installed gauges
- preparation of instructions for bonding gauges

The written test has two sections:

- a general section, containing questions based on general knowledge of strain measurement, solid mechanics and materials
- a section dealing with points which can arise when gauges are being installed and used

- (e) The various tasks involved in the examination can be done in any order. The time spent on each task is decided by the candidate. Normally the written test takes around 1 hour and the two installations take about half the remaining time.
- (f) In the bonding and wiring task the candidate is normally required to choose gauges and adhesive from a range provided and install the gauges, to satisfy specified objectives.
- (g) The full-bridge wiring task is usually based on an unwired version of the gauged body used for the measurement task.
- (h) The measurement task normally involves the design of a bridge circuit for load measurement, and a calibration exercise. A power supply, a voltmeter and a connection/balance box are provided.
- (i) Installation instructions are normally required for the gauge bonding task. The instructions are expected to be suitable for an experienced Level 1 operator, and cover objectives, materials and methods.
- (j) The marks awarded for the two installations will be based on the choice of gauges, adhesive and gauge locations, and factors such as bonding, wiring, soldering, electrical characteristics and documentation.

The measurement task will be assessed on the bridge design and on the calibration exercise.

Marking of the installation instructions will be based on the statement of objectives, the specification of materials, and the precision and clarity of the instructions for preparation, bonding, inspection and documentation. Excessive detail will not impress the examiner.

- (k) The written test contains questions consistent with the knowledge base outlined in CSMP10<sup>(1)</sup>. The general section of the test contains ten multiple-choice questions, all of which should be attempted. The section based on specific strain gauge techniques has four sub-sections, corresponding to the four installations described on page 7. There are thirty multiple-choice questions: ten for each of the two standard installations (a) and (b), five for installation (c) and five for installation (d). Candidates choose any fifteen questions.
- (l) All questions in the written test are allocated equal marks, although they may not take the same time to complete. Answers may come from the candidate's own notes and personal experience, but it may also be necessary to refer to documents such as the Code of Practice CPI<sup>(4)</sup>, and manufacturers' data sheets. Some answers may involve calculations.
- (m) If the tests have not been completed at the end of the standard period of time, a further period of up to 30 minutes will be allowed at the discretion of the examiner. The first 10 minutes can be used without penalty, but after that the aggregate mark for the Level 2 examination will be reduced by 10.

## Assessment Regulations

An aggregate mark for the examination will be calculated using 75% of the mark for the practical test and 25% of the mark for the written test.

The mark for the practical test will be determined by allocating:

- 30% for the gauge bonding and wiring installation
- 20% for the full-bridge wiring installation
- 20% for the measurement task
- 30% for the installation instructions

The mark for the written test will be determined by allocating:

- 40% for the general section
- 60% for the specific section

To qualify for the award of the Level 2 Certificate a candidate must obtain an aggregate mark of at least 70%; with 60% in the practical test and 60% in the written test.

A pass with Distinction will be awarded to a candidate who achieves an aggregate mark of 85% or higher.

A candidate who fails to achieve an aggregate mark of 70%, but has obtained 60% or more in the practical test and in the written test, may retake one of these tests once. A candidate who achieves the required aggregate mark, but scores less than 60% in either

the practical test or the written test, may retake the test with the low mark once, but the mark awarded will not exceed 60%. If a pass is not achieved in this way the candidate may retake the whole examination.

Marks are awarded by the examiner. Marking Record Sheets, scripts and samples are reviewed by a moderator. The Certification Committee confirms the result of the examination. Candidates are told the result by letter, usually within 5 weeks. The letter sent to candidates who fail will include the main reasons for the failure. A letter will also be sent to the employer.

## **Renewal of Certification**

The award is valid for 5 years.

At the end of each 5 year period, a practical test must be taken and a review of recent strain measurement experience must be submitted.

The practical test will involve design of gauge installations, installation of the gauges and wiring, and measurement using the gauges. It will not include the writing of instructions. Candidates will normally do the tasks at their workplace, under the supervision of a senior colleague, who will be required to confirm the candidate's experience and that the renewal tasks were done by the candidate. There will not be a limit on the time taken to do the tasks.

An examiner will assess the test samples and documentation, and note the type of work normally undertaken. The pass mark for the practical test is 70%.

## **Registration**

All new candidates for the examination must register using Form C121, and provide details of training and experience on form C122. Supporting evidence such as a copy of a certificate should be attached. Application to attend the pre-examination seminar should be made on form C123. Candidates applying to renew their certification should use form C124. All forms must be received by the BSSM office at least 5 weeks before the date of the examination.

Registrations are confirmed after a review by the Chairman of the Certification Committee. Each registered candidate is then provided with a copy of the Code of Practice CP1<sup>(4)</sup>, Installation Record Sheets, a sample practical examination paper, a sample written paper, and the bank of questions for the written examination CSMP12.2<sup>(5)</sup>.

## Materials and Equipment

Several types of strain gauges and adhesives will be provided. Candidates are expected to choose from these, but may use their own adhesive if this has been agreed with the examiner. The test bodies, loading devices and instruments required will be provided.

Candidates are expected to have calculators at the examination and the seminar. For the examination only they should also be equipped with all the usual materials and tools needed for the installation exercises. A list of equipment which may be required is given below. Any candidate who is unable to bring a comprehensive tool kit to the examination should advise the BSSM Office at an early date.

- silicone carbide papers (various grades)
- round-pointed rod or empty ball-point pen
- ruler
- degreaser
- cotton buds
- weak acid cleaning solution
- neutralising solution
- gauze sponge or paper tissue
- solder
- rosin solvent
- cellophane tape
- drafting tape
- Mylar tape
- P.T.F.E sheet
- silicone rubber pads and strips
- backing plates
- spring clamps
- terminal strips
- lead wire
- single conductor (lacquered)
- scissors
- screwdrivers
- blunt nosed tweezers
- scalpel
- wire cutters
- tools for wire stripping
- temperature-controlled soldering station
- safety glasses, gloves etc

## **Types of Installations**

### Standard Installations

- (a) Foil gauge for quarter-bridge operation at a temperature between 0°C and 50°C.
- (b) Full bridge of foil gauges for long life at a temperature between 0°C and 50°C.

### Other Installations

- (c) Foil gauge(s) for quarter-bridge or half-bridge operation at a temperature between -200°C and 250°C.
- (d) Gauges for operation at temperatures above 250°C.

## **References**

- (1) BSSM, Certification of Strain Measurement Personnel, CSMP10:2005
- (2) BSSM, Certification of Strain Measurement Personnel, Level 1 Examination, CSMP11:2005
- (3) BSSM, Certification of Strain Measurement Personnel, Level 3 Examination, CSMP13:2005
- (4) BSSM, Code of Practice for the Installation of Electrical Resistance Strain Gauges, CP1:2005
- (5) BSSM, Questions for Written Examinations in Strain Measurement, Level 2, CSMP 12.2:2005