T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Science

Occupational specialism assessment (OSA)

Metrology Sciences

Assignment 2 - Pass

Guide standard exemplification materials

v1.1: Specimen assessment materials
September 2021
603/6989/9

Internal reference: SCI-GSEM-19

NCFE CACHE

T Level Technical Qualification in Science
Occupational specialism assessment

Guide standard exemplification materials

Metrology Sciences

Assignment 2

Contents

Introduction **3**
Task 1 ..... **4**
Task 2 ..... **6**
Task 3 ..... **11**
Examiner commentary 14
Overall grade descriptors 15
Document information **17**
Change History Record 17

Introduction

The material within this document relates to the Metrology Sciences occupational specialism sample assessment. These exemplification materials are designed to give providers and students an indication of what would be expected for the lowest level of attainment required to achieve a pass or distinction grade.

The examiner commentary is provided to detail the judgements examiners will undertake when examining the student work. This is not intended to replace the information within the qualification specification and providers must refer to this for the content.

In assignment 2, the student must write a measurement plan, undertake the measurement of sample parts and analyse the results.

After each live assessment series, authentic student evidence will be published with examiner commentary across the range of achievement.

Assignment 2

Task 1 - writing a metrology plan

Scenario

The company you work for need to produce large volumes of simple steel machined parts, produced by CNC turning machines. They operate a Six Sigma lean manufacturing system and are testing CNC machining centres using statistical process control to establish which machines are compliant for these parts. The parts are tensile test specimens to BS EN ISO 6892 for Hounsfield/TQ tensometers.

You will be provided with a sample (minimum 25) of 100 parts from a production run on the same machine using the same materials and tooling. All measurements are in millimetres.

Task

From the above drawing, create a working instruction detailing your plan. Your plan should include:

- how you will inspect every critical feature
- your sampling method to ensure all aspects are recorded
- the data collection method selected
- creation of a suitable uncertainty budget
- how you will ensure calibration of equipment selected
- appropriate tooling and equipment selection, with justification, taking into consideration the relative uncertainty of measurement of the equipment selected for each measurement
- how you will ensure environmental factors are dealt with
- how you will be minimising the impact of hazards and complying with relevant health and safety law and legislation
- any other relevant inclusions

Student evidence

For the inspection of the part, I will use different equipment for different features. I will use a steel ruler to measure the 25mm length and the 5mm length because this is already calibrated and doesn't change so it will be reliable. I will measure once and write this down straight after I have measured it then I'll put that part to one side so I don't measure it again by accident. I'll put all my measurements on a piece of paper so I can use them later. I will measure the internal and external diameter of the ends with a vernier caliper. I can use the same tool and different sides of the blades to do the measurement, so this will be the best tool because it can do both.

I will need to be careful as the steel ruler is sharp so it may cut me. Therefore, so that I do not get cut I will be very careful when using the ruler and I will not walk around when holding it. I also need to be careful I don't bend the blades of the caliper when I am measuring, so I need to be careful not to press the blades against the inside or outside diameter too strongly.

I might be uncertain about the measurement if I can't read it properly. If the part is dirty, then I may not be able to see the edges very well so to stop this from happening I will clean the part first. I will make sure that I wear my glasses so that I can see the ruler properly. Also, I will make sure that the room is not dark so that I am able to read the result from the ruler.

I have put the equipment I can use to measure the features below, and a vernier caliper can be used most of the time, so this is what I plan to use for most of the measurement. I might have to use some different pieces of equipment for the radius of the piece because the caliper won't be very reliable there.

Feature	**Tool**	**How will the tool be used**
Bobbin diameter	A micrometer or vernier calliper could be used	The bobbin diameter will be placed inside the micrometer. The micrometer will be then tightened until the thimble clicks
Shank diameter	A micrometer or vernier calliper could be used	The bobbin diameter will be placed inside the micrometer. The micrometer will be then tightened until the thimble clicks
Shank length	Vernier callipers	This measurement is hard to get. This is because this length is between the bottom of each radius and it is very difficult to tell where the radius meets the shank
Bobbin length	Vernier callipers	Vernier callipers would be placed on the flat end of the bobbin and the top of the radius
Radius between bobbin and shank	Radius gauge if a number was given on the drawing	A radius gauge would be used to check the radius

To reduce the uncertainty in the equipment I would make sure that the temperature of the workshop was the same, or I would use a heat plate or soak if it was available in the workshop. This is because the size of the material will change very slightly with changes in temperature due to thermal expansion of the material. To prevent this, I will make sure that the air conditioning in the workshop is set to 20 degrees and that no windows are opened. I have to be careful I don't hold the pieces too long, or the metal might expand which might affect the results.

Task 2 - conducting metrology measurements and basic repairs

Scenario

Your plan has been accepted by the company and is now used as the working instructions for measuring these parts. You have received the first batch of manufactured components to measure.

Task

Measure a sample (minimum 25) of the 100 parts supplied, using one of the methods planned.

Record all results in a suitable format.

Repair all possible errors or damage in equipment and produced parts.

While undertaking the measurement of each part, you should ensure the accuracy of your instruments by checking, maintaining, repairing and recalibrating them as you proceed.

Errors, faults and breakages beyond the reasonable expertise of the operator to repair or otherwise beyond SOPs should be quarantined as per company policy.

You must complete the following:

- prepare your sample and tooling appropriately
- maintain equipment throughout the process
- record all data making notes as appropriate, especially if you need to undertake unplanned activity
- update the plan if additional activity is required
- quarantine or disposal of faulty equipment beyond your scope

Student evidence

Criteria	**Essential criteria** (all essential criteria must be awarded to pass)	**Assessor check**	**Marks awarded**
Workspace is organised prior to the start of any measurement; this includes collecting any equipment planned to be used, all samples and any other equipment required.	No	Only the samples were collected when requested. The student collected any other equipment as needed, which shows a lack of planning.	1 mark 0 awarded
Cleaning of any sample parts.	No	No cleaning of samples took place.	1 mark 0 awarded

Criteria	**Essential criteria** (all essential criteria must be awarded to pass)	**Assessor check**	**Marks awarded**
Conducted any preparation tasks required for the measurement using the equipment available, for example, heat soak of machined components.	No	No preparation tasks were conducted on the sample. The student did not heat soak the parts to 20 degrees as required.	1 mark 0 awarded
Used an inspection grade surface plate where applicable to the plan, and in a suitable environment.	No	No preparation tasks were conducted on the sample. The student did not heat soak the parts to 20 degrees as required.	1 mark 0 awarded
Recorded their evaluation of available environment controls to control lighting, vibration, heat (20ºC) and dust.	No	No evaluation of environmental conditions other than moving equipment so light was suitable. No other controls taken, so not enough action to be awarded the mark.	1 mark 0 awarded
Taken suitable action to minimise any issues evident (including no action).	No	No evaluation of environmental conditions other than moving equipment so light was suitable. No other controls taken, so not enough action to be awarded the mark.	1 mark 0 awarded
Suitable equipment selected for accurate measurement of each key feature (guidance: suitable means suitable for the task).	Yes	A suitable piece of equipment was selected and used – metal rule.	1 mark 0 awarded
Equipment used is examined and cleaned prior to measurement.	No	Equipment selected was inspected and cleaned prior to use.	1 mark 1 mark awarded

Criteria	**Essential criteria** (all essential criteria must be awarded to pass)	**Assessor check**	**Marks awarded**
Equipment is calibrated and checked against zero and a suitable standard.	No	No checks or calibration were performed on the equipment before use.	1 mark for calibration. 1 mark for checking against zero and a suitable standard. (**maximum 2 marks**) 0 awarded
Equipment checked throughout the measurement to ensure regular calibration and quarantine any unsuitable equipment.	No	No checks or calibration were performed on the equipment before use.	2 marks for consistent checks throughout. 0 marks for any omission. 0 awarded
All equipment has been calibrated before use against zero and a suitable standard (as applicable). Equipment is checked for calibration consistently, and all faults and errors corrected throughout.	No	No checks or calibration were performed on the equipment before use.	1 mark for calibration prior to use. 1 mark for recalibration and correction of faults and errors. (**maximum 2 marks**) 0 awarded
Conducted measurements of **each** feature using planned methods, maintaining the environment and safety as outlined in the plan.	Yes	3 features were measured and these were done while maintaining correct safety procedures.	2 marks for each feature measured. (**maximum 10 marks**) **Guidance:** there are 5 key features in the piece, 2 marks to be awarded for each feature. 6 awarded
The measurement is undertaken with appropriate equipment and taken relevant care to avoid damage.	Yes	All appropriate care and attention was taken to avoid damage or injury.	1 mark 1 awarded
Ensuring manipulation of the equipment, touch and feel, ensures the most accurate results.	Yes	Touch and equipment manipulation were used to inspect each measured feature.	1 mark 1 awarded

Criteria	**Essential criteria** (all essential criteria must be awarded to pass)	**Assessor check**	**Marks awarded**
Exercise relevant care to ensure the equipment and specimens are not over handled to keep heat gain to a minimum.	No	Samples were not inspected with due care to avoid over handling, and an inconsistent approach was used.	1 mark 0 awarded
Investigated all deviations to determine why results may have been inaccurate.	No	No further investigation was carried out to evaluate any errors.	2 marks 0 awarded
All samples repaired if possible, such as deburring. Parts that are not possible to repair are suitably quarantined.	Yes	Samples had repairs attempted and were suitably quarantined if repairs could not be completed.	1 mark 1 awarded
Correct procedure used when repairing any sample.	Yes	Correct and safe procedure used consistently.	1 mark 1 awarded
Suitable equipment selected for any repairs conducted.	Yes	Correct and safe equipment used, equipment was selected suitably, but only 1 piece of equipment was used throughout the repair.	1 mark 1 awarded
Applied safe handling requirements for equipment, including the use of personal protective equipment if required.	Yes	Safe handling of equipment was used throughout as well as eye protection during the repair process.	1 mark 1 awarded
Maintained health and safety of the workstation throughout, such as maintaining organisation of all equipment being used, safe use of any chemicals or electrical equipment, and appropriate handling of all equipment and tools.	Yes	All health and safety precautions were followed consistently throughout.	1 mark 1 awarded

Criteria	**Essential criteria** (all essential criteria must be awarded to pass)	**Assessor check**	**Marks awarded**
Cleaned up the workstation and appropriate surfaces following the completion of the inspection, returned all equipment to storage location, and disposed of any waste product appropriately.	No	Workstation was left with equipment on and surfaces had not been cleaned.	1 mark for cleaning workstation and surfaces. 1 mark for return/storage of equipment used and/or any disposal of waste. (**maximum 2 marks)** 0 awarded
Total marks			36 marks 14 Awarded

Task 3 - interpreting metrology measurement results

Scenario

You have completed the inspection of a sample of manufactured components. You must report on your findings to provide feedback on the current manufacturing process.

Task

Using the data sets created and tabulated from task 2, you should select 3 key features. For each of these features you must complete the following:

- determine the mean, mode and the standard deviation (SD) for each selected feature
- plot the standard bell curve normal distribution for each selected feature
- determine the six SD (1, 2 and 3 sigma) tolerance for each selected feature

Produce a report on the capability of the production method based on all of your results from task 2.

Your report should include:

- key data relating to accuracy of the machining process
- any errors encountered
- any recommendations for future improvement in the process, that will help increase the accuracy of the results, with justification
- any other relevant inclusions

Student evidence

When I measured the 25 parts I found out that they were not all the same, even though they should have been. This shows an inaccuracy in the manufacturing process that will be critical if any parts are made with critical tolerances. I would suggest a recalibration of the equipment used to manufacture these parts, as I have a concern about the performance of the machine.

I have plotted the key features of the parts lengths below and calculated the standard deviation of the parts. As you can see there is a lot of deviation in such as small measurement. This may be down to the accuracy of the manufacturing process or may be down to the tools used for the measurement of the pieces. I would suggest a calibration of the machine first, as it's probably the manufacturing that is off, because I used a consistent method when checking them.

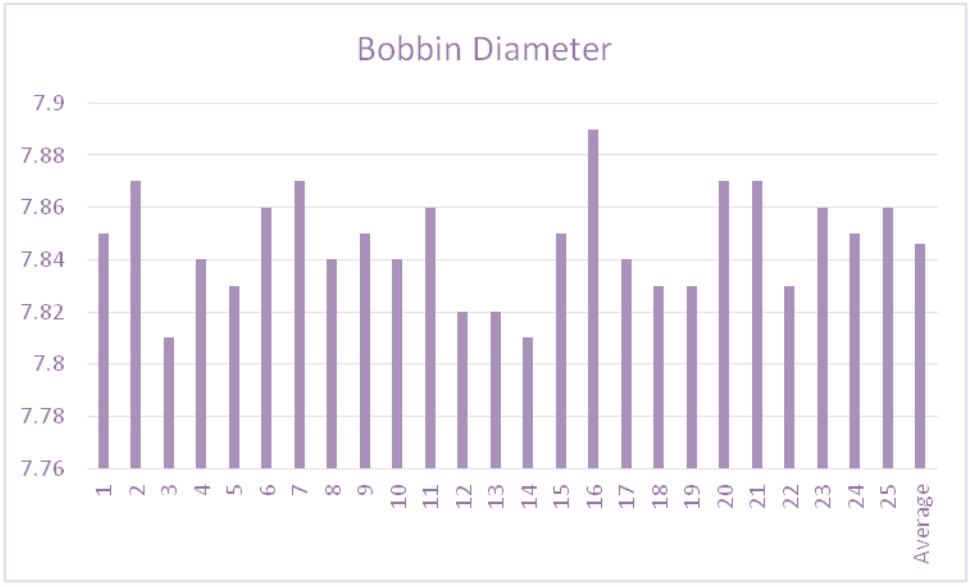
Part	Bobbin Diameter	Shank Diameter	Bobbin Length
1	7.85	5.04	4.99
2	7.87	5.03	4.98
3	7.81	5.02	4.99
4	7.84	5.06	5
5	7.83	5.06	4.98
6	7.86	5.05	5
7	7.87	5.09	5.02
8	7.84	5.07	5.01

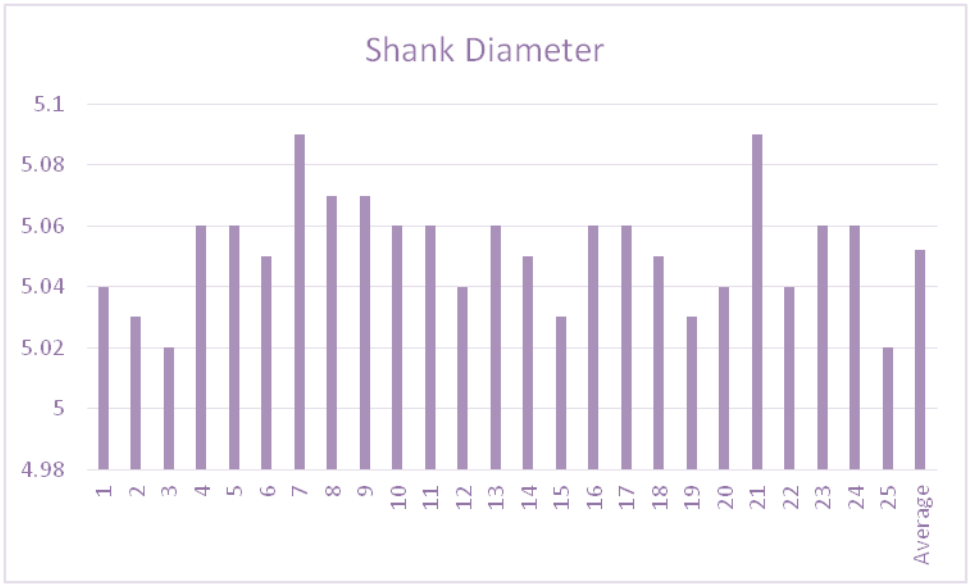
9	7.85	5.07	5
10	7.84	5.06	5.02
11	7.86	5.06	5
12	7.82	5.04	5.01
13	7.82	5.06	4.97
14	7.81	5.05	5.03
15	7.85	5.03	5.03
16	7.89	5.06	4.99
17	7.84	5.06	4.98
18	7.83	5.05	5.02
19	7.83	5.03	5.02
20	7.87	5.04	5
21	7.87	5.09	5.03
22	7.83	5.04	4.99
23	7.86	5.06	4.98
24	7.85	5.06	5.04
25	7.86	5.02	4.95
Average	7.846	5.052	5.0012

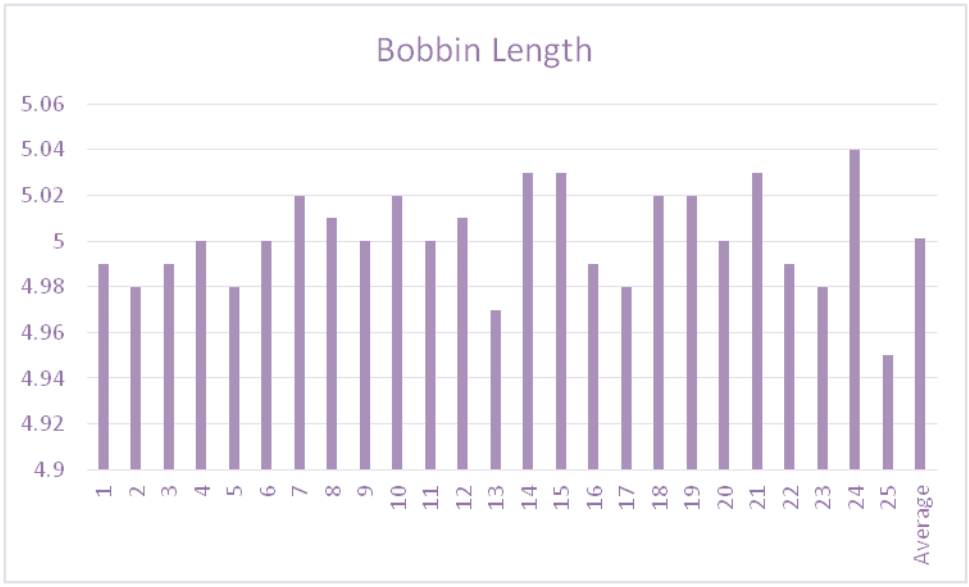
The mean is the average. To get the average I added them all together and divided by the number of parts.

$Mean\ bobbin\ diameter = \frac{196.15}{25}$ = 7.846mm

$Mean\ shank\ diameter = \frac{126.3}{25}$ = 5.052mm







The mode is the most common, the most common bobbin diameter was 7.85mm and the most common shank diameter is 5.06mm.

The standard deviation (SD) for each feature is:

	Bobbin Diameter	Shank Diameter	Bobbin Length
SD	0.02019901	0.01811077	0.021414014

Examiner commentary

The student has completed a basic plan that outlines some of the key equipment planned to be used and has some attempt to explain the key requirements of the task. There has been some consideration of the equipment used for different parts of the component to be measured, and this is evident in the plan.

The student has considered basic safety applicable to the set task and has demonstrated an awareness of the need to ensure the environment and condition of the samples are suitable.

The student has considered the accuracy of the equipment and the performance of the equipment, demonstrating an understanding of the key features of the item to be measured, and the different types of measurement equipment available.

The student has appropriately undertaken the practical measurement activity, meeting all of the essential criteria. The student selected suitable measuring equipment for each feature measured, undertook measurements safely, applying correct manipulation, and damaged samples were identified and repaired using suitable equipment.

The student demonstrated good manipulation of the equipment and the measurements undertaken were accurate and consistent, demonstrating effective skill. The learner has not explored any incorrect or inconsistent results.

The student has produced a basic report which articulates the results from 3 of the key features from the practical exercise and the student has produced graphs showing the feature measurements but has not progressed this to include normal distributions or six standard deviations. The student has commented on the errors encountered and recommendations for future improvements, however these conclusions are only basic and could be further explained.

The student has provided accurate data which is presented in a clear and easy to understand format. The student has accurately produced graphs showing the measurements taken and the mean values of each. The student has accurately calculated the standard deviation consistently throughout. All data is presented in a suitable format, with appropriate charts and tables provided with all key information present.

Overall grade descriptors

The performance outcomes form the basis of the overall grading descriptors for pass and distinction grades.

These grading descriptors have been developed to reflect the appropriate level of demand for students of other level 3 qualifications, the threshold competence requirements of the role and have been validated with employers within the sector to describe achievement appropriate to the role.

Occupational specialism overall grade descriptors:

Grade	Demonstration of attainment
Pass	The evidence is logical but displays minimal knowledge of basic metrological content in response to the demands of the brief.
	The student makes some use of relevant knowledge and understanding of how metrology informs practices in many sectors and demonstrates a limited understanding of perspectives or approaches associated with basic measurement tasks and principles.
	The student makes adequate use of facts/theories/approaches/concepts and attempts to demonstrate breadth and depth of metrological knowledge and understanding.
	The student is able to identify some metrological information from appropriate sources and makes use of appropriate information/appraise relevancy of information and can combine information to make decisions.
	The student makes minimal judgements/takes appropriate action/seeks clarification with metrological sources of guidance and is able to make limited progress towards solving non-routine problems in real life measurement activities/situations.
	The student attempts to demonstrate metrological skills and knowledge of the relevant concepts and techniques reflected in a measurement services role and generally applies this across different contexts and measurement skill sets.
	The student shows adequate understanding of unstructured measurement-related problems that have not been seen before, using limited knowledge to find solutions to problems and make justification for strategies for solving problems, explaining their reasoning.
Distinction	The metrological evidence is precise, logical and provides a detailed and informative response to the measurement related demands of the brief.
	The student makes extensive use of relevant knowledge and understanding of how metrology informs practices in many sectors and demonstrates an understanding of perspectives or approaches associated with basic measurement tasks and principles.

Grade	Demonstration of attainment
	The student makes decisive use of facts/theories/approaches/demonstrating extensive breadth and depth of metrological knowledge, understanding and selects highly appropriate skills/techniques/methods.
	The student is able to comprehensively identify metrological information from a range of suitable sources and makes exceptional use of appropriate information/appraise relevancy of information and can combine information to make coherent measurement decisions.
	The student makes well founded judgements/takes appropriate action/seeks clarification with metrological sources of guidance and is able to use that to reflect on real life measurement activities/situations.
	The student demonstrates extensive metrological skills and knowledge of the relevant concepts and techniques reflected in a measurement services role and precisely applies this across a variety of contexts and tackles unstructured problems that have not been seen before, using their knowledge and measurement skill sets to analyse and find suitable solutions to the measurement problems.
	The student can thoroughly examine metrological data/information in context and apply appropriate analysis in confirming or refuting conclusions and carrying out further work to justify strategies for solving problems, giving concise explanations for their reasoning.

Document information

The T Level Technical Qualification is a qualification approved and managed by the Institute for Apprenticeships and Technical Education.

Owner: Head of Assessment Design

Change History Record

Version	Description of change	Approval	Date of Issue
v1.0	Published final version.		June 2021
v1.1	NCFE rebrand		September 2021