

Cambridge **NATIONALS LEVEL 1/2**



# ***ENGINEERING MANUFACTURE***

**R110 Preparing and planning for manufacture**

**J832/J842**

## **Schemes of work**

Version 1

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## INTRODUCTION

This teaching resource, which we've developed with Nationals Engineering teachers, contains two types of schemes of work.

- A **longer term** plan which covers the whole academic year over three terms and suggests the order in which each Learning Outcome (LO) could be taught. Links to other units and LOs within Nationals Engineering are also shown.
- A **medium term** plan which also covers the whole academic year over three terms and suggests the order in which each LO could be taught but also provides classroom activities and any links to other resources which might be useful. We've also included 'Have they got it?' linking to activities other LOs in this unit and/or other units and LOs within Nationals Engineering. This includes performing practical activities by which learners confirm their understanding.

### Link to qualification

<https://www.ocr.org.uk/qualifications/cambridge-nationals/engineering-manufacture-level-1-2-award-certificate-j832-j842/>

See our range of planning and teaching resources on the link below (including delivery guides, project approaches, teaching activities, teacher guides and resources lists).

<https://www.ocr.org.uk/qualifications/cambridge-nationals/engineering-manufacture-level-1-2-award-certificate-j832-j842/planning-and-teaching/>

See our range of assessment resources on the link below (including past paper, mark schemes, examiners' reports, candidate exemplars and set assignments).

<https://www.ocr.org.uk/qualifications/cambridge-nationals/engineering-manufacture-level-1-2-award-certificate-j832-j842/assessment/>

## Scheme of work (longer term plan – academic year)

	Learning Outcome	Topic area/theme (from R110 specification)	Links to other Cambridge Nationals Engineering units and LOs
Autumn Term	LO1	Interpreting 2D and 3D drawing.	<b>R107 LO2</b> – Know how to develop designs using engineering drawing techniques and annotation.
	LO1	Understanding standard drawing conventions – part 1.	<b>R107 LO2</b> – Know how to develop designs using engineering drawing techniques and annotation.
	LO1	Understanding standard drawing conventions – part 2.	<b>R107 LO2</b> – Know how to develop designs using engineering drawing techniques and annotation.
	LO1	Production planning – flowcharts.	<b>R108 LO1</b> – Know how to plan the making of a prototype.  <b>R110 LO3</b> – Be able to modify a production plan for different scales of production.
	LO1	Production planning – tabular.	<b>R108 LO1</b> – Know how to plan the making of a prototype.  <b>R110 LO3</b> – Be able to modify a production plan for different scales of production.
	LO1	Production planning – Gantt charts.	<b>R108 LO1</b> – Know how to plan the making of a prototype.  <b>R110 LO3</b> – Be able to modify a production plan for different scales of production.  <b>R111 LO1</b> – Be able to plan the production of components on CNC machines.
	LO1	Production planning – Health and Safety considerations.	<b>R109 LO2</b> – Understand engineering processes and their application.
	LO1	Production planning – risk assessment.	<b>R109 LO2</b> – Understand engineering processes and their application.
	LO1	Production planning – quality control considerations – part 1.	<b>R110 LO3</b> – Be able to modify a production plan for different scales of production.  <b>R112 LO1</b> – Understand the importance of quality control.  <b>R112 LO2</b> – Be able to assess product quality from inspection and quality control techniques.
	LO1	Production planning – quality control considerations – part 2.	<b>R110 LO3</b> – Be able to modify a production plan for different scales of production.  <b>R112 LO1</b> – Understand the importance of quality control.  <b>R112 LO2</b> – Be able to assess product quality from inspection and quality control techniques.

	Learning Outcome	Topic area/theme (from R110 specification)	Links to other Cambridge Nationals Engineering units and LOs
Spring Term	LO2	Measuring and marking out equipment – part 1.	<b>R108 LO3</b> – Be able to produce a prototype.  <b>R112 LO2</b> – Be able to assess product quality from inspection and quality control techniques.
	LO2	Measuring and marking out equipment – part 2.	<b>R108 LO3</b> – Be able to produce a prototype.  <b>R112 LO2</b> – Be able to assess product quality from inspection and quality control techniques.
	LO2	Safe working practices in a working environment.	<b>R108 LO1</b> – Understand safe working practices used when making a prototype.  <b>R111 LO3</b> – Be able to set up and use CNC equipment to manufacture components.
	LO2	Bench work and hand-held tools (including safe use).	<b>R108 LO3</b> – Be able to produce a prototype.  <b>R109 LO1</b> – Know about properties and used of engineering materials.
	LO2	Bench work and hand-held tools (including safe use).	<b>R108 LO3</b> – Be able to produce a prototype.  <b>R109 LO1</b> – Know about properties and used of engineering materials.
	LO2	Bench work and hand-held tools (including safe use).	<b>R108 LO3</b> – Be able to produce a prototype.  <b>R109 LO1</b> – Know about properties and used of engineering materials.
	LO2	Manually controlled machinery operations (including safe use).	<b>R108 LO3</b> – Be able to produce a prototype.
	LO2	Manually controlled machinery operations (including safe use).	<b>R108 LO3</b> – Be able to produce a prototype.
	LO2	Manually controlled machinery operations (including safe use).	<b>R108 LO3</b> – Be able to produce a prototype.
	LO2	Synoptic links from LO2 to other units.	<b>R109 LO1</b> – Know about properties and used of engineering materials.  <b>R109 LO2</b> – Understand engineering processes and their application.

	Learning Outcome	Topic area/theme (from R110 specification)	Links to other Cambridge Nationals Engineering units and LOs
Summer Term	LO3	Quality control checks – measurements of dimensions.	<b>R108 LO4</b> – Be able to evaluate the success of a prototype. <b>R112 LO1</b> – Understand the importance of quality control. <b>R112 LO2</b> – Be able to assess product quality from inspection and quality control techniques.
	LO3	Quality control checks – tolerances.	<b>R108 LO4</b> – Be able to evaluate the success of a prototype. <b>R110 LO1</b> – Be able to plan for the making of a pre-production product. <b>R112 LO2</b> – Be able to assess product quality from inspection and quality control techniques.
	LO3	Quality control checks – finish.	<b>R108 LO4</b> – Be able to evaluate the success of a prototype. <b>R110 LO1</b> – Be able to plan for the making of a pre-production product. <b>R112 LO2</b> – Be able to assess product quality from inspection and quality control techniques.
	LO3	Quality review of completed product.	<b>R108 LO4</b> – Be able to evaluate the success of a prototype. <b>R110 LO1</b> – Be able to plan for the making of a pre-production product. <b>R112 LO2</b> – Be able to assess product quality from inspection and quality control techniques.
	LO3	Scales of production – one off, batch and mass.	<b>R105 LO2</b> – Understand the requirements of design specifications for the development of a new product. <b>R106 LO1</b> – Know how commercial production methods, quality and legislation impact on the design of products and components. <b>R111 LO4</b> – Know about applications of computer control processes used to manufacture products.
	LO3	Impact of quantities of production – processes.	<b>R108 LO1</b> – Know how to plan the making of a prototype.
	LO3	Impact of quantities of production – sequence.	<b>R108 LO1</b> – Know how to plan the making of a prototype.
	LO3	Impact of quantities of production – timing of stages.	<b>R111 LO4</b> – Know about applications of computer control processes used to manufacture products.
	LO3	Impact of quantities of production – health and safety and quality control.	<b>R108 LO4</b> – Be able to evaluate the success of a prototype.
	LO3	Modifications to production planning based on scale of manufacture.	<b>R111 LO4</b> – Know about applications of computer control processes used to manufacture products.

## Scheme of work (medium term plan – more detailed by academic term)

	Event	Learning Outcome	Topic area/subtopic Area (from R110 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Autumn Term	1	LO1	Interpreting 2D and 3D drawing.	Learners could be introduced to 2D and 3D drawings of engineered components. This includes isometric and oblique drawings (3D) and third angle orthographic projection (2D). They could identify key features from the drawings, including materials and dimensions.	<b>R110 LO1, LO2, LO3</b> – Learners will be able to interpret information from engineering drawings to be able to plan for, manufacture and quality check pre-production components and products.	Search for 'BBC Bitesize working drawings'.
	2	LO1	Understanding standard drawing conventions – part 1.	Learners will be introduced to standard drawing conventions including: title block, dimensions, tolerances, scale and materials. Learners could practice identifying these features from engineering drawings.	<b>R110 LO1, LO2, LO3</b> – Learners will be able to interpret key technical information from engineering drawings to be able to plan for, manufacture and quality check pre-production components and products.	A complete guide to technical drawings, including drawing types, dimensions, tolerances and conventions: <a href="http://www.design-technology.info/IndProd/drawings/">http://www.design-technology.info/IndProd/drawings/</a>  Search the Internet for 'BS8888' which is the drawing standard.
	3	LO1	Understanding standard drawing conventions – part 2.	Learners will continue to be introduced to standard drawing conventions including: sectional views, exploded drawings and detail views. Learners could practice identifying these features from engineering drawings.	<b>R110 LO1, LO2, LO3</b> – Learners will be able to interpret key technical information from engineering drawings to be able to plan for, manufacture and quality check pre-production components and products.	A complete guide to technical drawings, including drawing types, dimensions, tolerances and conventions: <a href="http://www.design-technology.info/IndProd/drawings/">http://www.design-technology.info/IndProd/drawings/</a>  Search the Internet for 'BS8888' which is the drawing standard.
	4	LO1	Production planning – flowcharts.	Learners will be introduced to flowcharts and flowchart symbols including: start and end symbol, process symbol and decision symbol. Learners will create a flowchart for general tasks and for simple manufacturing operations.	<b>R110 LO1, LO2</b> – Learners can identify the main areas of the flowchart and can produce a realistic flowchart from which a product could be manufactured.	See the following website for the history of flowcharts, and a guide to their production. Includes links to software tools to produce flowcharts: <a href="https://www.zenflowchart.com/flowchart/">https://www.zenflowchart.com/flowchart/</a>

	Event	Learning Outcome	Topic area/subtopic Area (from R110 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Autumn Term	5	LO1	Production planning – tabular.	Learners will be introduced to production planning in tabular format. Learners could be given a simple engineered product and try to identify the stages of production. Learners could identify the manufacturing stages and complete a simple planning table e.g. set up, marking out, materials, tools and equipment, health and safety considerations and quality control checks.	<b>R110 LO1, LO2</b> – Learners can produce and use a detail production plan that enables pre-production components or products to be manufactured.	
	6	LO1	Production planning – Gantt charts.	Learners could be presented with example Gantt charts for simple manufacturing operations to interpret. They could then be tasked with producing a Gantt chart for simple machining operation (e.g. drilling a hole using a pillar drill) focusing on how to set up and use the machine safely and correctly.	<b>R110 LO1, LO2</b> – Learners can set up and populate a Gantt chart using correct sequence of operations with realistic timings.	<a href="http://www.gantt.com">www.gantt.com</a> includes the history of Gantt charts, how they are produced and links to free software  <a href="http://www.technologystudent.com">www.technologystudent.com</a> search for 'planning time chart'.
	7	LO1	Production planning – Health and Safety considerations.	Learners could be introduced to the Health and Safety at Work Act (HASAWA) 1974 including the responsibilities of workers and employers for safety in a working environment. Learners could review a working area and identify specific warning signs used and areas that require improvement. Safety could then be related to its inclusion in the planning stages.	<b>R110 LO1, LO2</b> – Learners should be able to demonstrate knowledge of, and compliance with, the main areas of the HASAWA 1974 when planning and in the workshop. The shapes and colour of warning signs should also be readily explained.	Health and Safety at Work Act: <a href="https://www.hse.gov.uk/legislation/hswa.htm">https://www.hse.gov.uk/legislation/hswa.htm</a>  <a href="https://www.hse.gov.uk/pubns/books/l64.htm">https://www.hse.gov.uk/pubns/books/l64.htm</a> includes details of safety signs with a free booklet to download.
	8	LO1	Production planning – risk assessment.	Learners could be introduced to hazards and risks in a working environment, and the risk assessment process. They could undertake simple risk assessments, including the use of personal protective equipment (PPE). Again, this could be related to its inclusion in production planning.	<b>R110 LO1, LO2</b> – Learners will be able to identify hazards and risks in a working environment, together with methods they could adopt to reduce the level of risk. Risk assessment will be included in planning and enacted in the workshop.	The HSE website includes comprehensive guides to risk assessment including templates: <a href="https://www.hse.gov.uk/risk/">https://www.hse.gov.uk/risk/</a>  <a href="http://www.worksmart.org.uk">www.worksmart.org.uk</a> search for 'five steps to a risk assessment'.



	Event	Learning Outcome	Topic area/subtopic Area (from R110 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Autumn Term	9	LO1	Production planning – quality control considerations – part 1.	Learners, through product investigation, could be introduced to the key quality control points for the product.  They could examine why quality control is carried out on products and how this is incorporated into production planning.	<b>R110 LO3</b> – Learners will be able to advise the reasons why quality control is an important part of the manufacturing process when reviewing pre-production products.	<a href="https://www.youtube.com/watch?v=18cN8MZvJRA">https://www.youtube.com/watch?v=18cN8MZvJRA</a> provides a short video introduction to quality control.
	10	LO1	Production planning – quality control considerations – part 2.	Learners could continue to investigate specific quality control techniques (e.g. visual inspection, taking measurements, application of tolerance) and how these are used to check the quality of a product during manufacture. These could also be related to their inclusion in production plans.	<b>R110 LO3</b> – Learners will be able to use measuring equipment and quality control techniques when reviewing pre-production products.	The following website introduces the top 10 measuring instruments, along with videos showing how they are used: <a href="https://gaugehow.com/2019/05/26/mechanical-measuring-instruments/">https://gaugehow.com/2019/05/26/mechanical-measuring-instruments/</a>

	Event	Learning Outcome	Topic area/subtopic Area (from R110 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Spring Term	1	LO2	Measuring and marking out equipment – part 1.	Learners could be introduced to a range of measuring equipment including: steel rule, digital Vernier caliper and micrometer. Learners could carry out a practical task of measuring out a specific object using the range of measuring equipment above and recording all measurements in table form.	<b>R110 LO2</b> – Learners will demonstrate that they can interpret a drawing and accurately measure and mark out prior to commencing manufacturing operations.	<a href="http://www.technologystudent.com">www.technologystudent.com</a> search for 'equipment and processes'.
	2	LO2	Measuring and marking out equipment – part 2.	Learners could be introduced to a range of marking out equipment including: scribing block, engineers try square, height gauge. This could also include 'engineers blue'. Learners could carry out a practical task of marking out an object using a given drawing with a range of measuring and marking-out equipment to select from.	<b>R110 LO2</b> – Learners will demonstrate that they can interpret a drawing and accurately measure and mark out prior to commencing manufacturing operations.	<a href="http://www.technologystudent.com">www.technologystudent.com</a> search for 'equipment and processes'.
	3	LO2	Safe working practices in a workshop environment.	Learners could be introduced to health and safety and safe working practices in a workshop area. Learners could identify hazards and risks in a workshop area, including the correct PPE required to safely carry out an activity.	<b>R110 LO2</b> – Learners will demonstrate that they can work safely in a workshop setting by undertaking simple risk assessments, selecting and wearing appropriate PPE and using tools and machines safely.	Health and safety in engineering: <a href="https://www.hse.gov.uk/engineering/">https://www.hse.gov.uk/engineering/</a> Includes a useful workshop guide booklet on to health and safety in engineering workshops.
	4	LO2	Bench work and hand-held tools (including safe use).	In the next series of lessons, learners could be shown a range of hand-held tools: hacksaw, junior hacksaw, hand files, needle file etc. A demonstration on how to use tools safely and correctly should be carried out on a range of materials. Learners will then practice using hand tools safely themselves.	<b>R110 LO2</b> – Learners will demonstrate that they can safely and correctly use processes, hand tools and equipment to make a product.	Range of videos on <a href="http://www.youtube.com">www.youtube.com</a> search for either: <i>hand sawing, hand filing or hand threading etc.</i>
	5	LO2	Bench work and hand-held tools (including safe use).	Learners will continue to safely use hand tools with a series of practice activities supplied by the teacher.	<b>R110 LO2</b> – Learners will demonstrate that they can safely and correctly use processes, hand tools and equipment to make a product.	
	6	LO2	Bench work and hand-held tools (including safe use).	Learners will continue to safely use hand tools with a series of practice activities supplied by the teacher.	<b>R110 LO2</b> – Learners will demonstrate that they can safely and correctly use processes, hand tools and equipment to make a product.	

	Event	Learning Outcome	Topic area/subtopic Area (from R110 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Spring Term	7	LO2	Manually controlled machinery operations (including safe use).	Learners could be introduced to manually controlled machinery. This could include a pillar drill, lathe or milling machine (depending on centre resources).  A drawing of a simple object with a variety of holes in specific places could be produced. The use of a pillar drill would suit this activity.	<b>R110 LO2</b> – Learners will demonstrate that they can safely and correctly use processes, hand tools and equipment safely to make a product. For the pillar drill this could include: use of drill guard, drill gauge, machine vice, chuck key and safe machine operation.	Range of videos on <a href="http://www.youtube.com">www.youtube.com</a> search for either: <i>using a pillar drill, using a lathe or using a milling machine etc.</i>
	8	LO2	Manually controlled machinery operations (including safe use).	For turning work, a drawing of a round bar could be provided and using the lathe, machined to an alternate size. Specific tolerances could be included in the activity. Quality control techniques are covered in more detail in LO3.	<b>R110 LO2</b> – Learners will demonstrate that they can safely and correctly use processes, hand tools and equipment safely to make a product. For a lathe this could include: loading and centring material in the chuck, tool selection and mounting, use of centres if required, correct selection of speed and feeds and safe machine operation.	
	9	LO2	Manually controlled machinery operations (including safe use).	For milling work, a drawing of a block could be supplied, and a milling machine used to machine the block to a given shape. Again, dimensions could have tolerances to achieve to check accuracy of machining. Quality control techniques are covered in more detail in LO3.	<b>R110 LO2</b> – Learners will demonstrate that they can safely and correctly use processes, hand tools and equipment safely to make a product. For the milling machine this could include: work holding using a machine vice, selection and mounting of the milling cutter, correct selection of speeds and feeds and safe machine operation.	

	Event	Learning Outcome	Topic area/subtopic Area (from R110 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Spring Term	10	LO2	Synoptic links from LO2 to other units.	<p>In this session, learners could review work completed in LO2 of this unit and make links to other units in the specification (especially unit R109).</p> <p>They could produce a simple table documenting links from content covered in LO2 to R109, and other units.</p>	<p><b>R109 LO1</b> – Learners could relate selection of materials and manufacturing process for practical work to types, properties, characteristics and applications of materials.</p> <p><b>R109 LO2</b> – Learners could demonstrate how they have practically built upon theoretical knowledge of basic engineering machining processes and safe use of tools and equipment.</p>	

	Event	Learning Outcome	Topic area/subtopic Area (from R110 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Summer Term	1	LO3	Quality control checks – measurements of dimensions.	Learners could be introduced to a range of quality control techniques using appropriate measuring equipment. They will already be familiar with the use of measuring equipment for marking out in LO2.  They could be provided with sample items to measure along with a technical drawing. They could also quality check items they have manufactured themselves.	<b>R110 LO3</b> – Learners could determine for products they have manufactured in LO2 which quality control methods are relevant and the reasons they are suited to checking quality of the product.	<a href="https://www.mitutoyo.co.uk/">https://www.mitutoyo.co.uk/</a> has details of engineering measurement (metrology) including free educational packs to order.
	2	LO3	Quality control checks – tolerances.	Learners will be introduced to tolerances on dimensions used for manufacture and production. Learners could be shown a drawing of an engineered product which shows dimensions with tolerances. A tolerance could be given with learners being asked to calculate the smallest and largest sizes that each part of the product can be. Learners could check if their own products meet given tolerances.	<b>R110 LO3</b> – Learners could undertake a practical quality control activity identifying the expected (nominal) value required, and the upper and lower limits for given tolerances.	<a href="http://www.wikipedia.org">www.wikipedia.org</a> search for ' <i>engineering tolerance</i> '.
	3	LO3	Quality control checks – finish.	Learners will be introduced to how surface finish is an important aspect of quality control checks on a product. This can be determined using visual inspection or more advanced techniques. They could then quality check the finish of supplied items, or ones they have manufactured themselves.	<b>R110 LO3</b> – Learners could undertake a practical activity where they visually inspect manufactured products to determine the quality of finish.	Search the Internet for ' <i>BINDT visual inspection</i> ' <a href="https://www.bindt.org/">https://www.bindt.org/</a>
	4	LO3	Quality review of completed product.	Learners could review a completed product against the specification and drawings supplied. Dimensions, finish, tolerances and appearance should be considered. Learners could also be given a mini project to review an item that has a number of inconsistencies, with learners identifying which are incorrect.	<b>R110 LO3</b> – Learners could use their own or others products manufactured in LO2 and perform a quality control check of these against the original drawing, to include: key dimensions, tolerances, and finish.	

	Event	Learning Outcome	Topic area/subtopic Area (from R110 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Summer Term	5	LO3	Scales of production – one off, batch and mass.	Learners could be introduced to scales of production including; one off, batch and mass production. Learners could be given a range of products from which they can then identify the category under which they have been produced. They could give reasons to clarify their answer.	<b>R110 LO3</b> – Learners could complete an activity identifying appropriate scales of production for given products.	Search for 'BBC Bitesize production methods' for a range of resources and videos covering scales of production.
	6	LO3	Impact of quantities of production – processes.	Learners could research and reflect on a range of processes used in manufacture, identifying the benefits and limitations of each. A range of products could be given to learners enabling them to explain which processes are most suitable for different scales of production. This could alongside the production plan already produced for one-off production.	<b>R110 LO3</b> – Learners could identify, for given products or ones they have manufactured, the impact of different manufacturing processes on its manufacture.	
	7	LO3	Impact of quantities of production – sequence.	Learners will continue by considering sequence of operations in production planning, and how these are impacted by different scales of production. They could review their one-off production plan produced in LO1 and consider how the sequence will change for batch or mass production. For example, for batch production individual stages of the plan could be performed on batches of products.	<b>R110 LO3</b> – Learners could return to manufacturing plans produced in LO1 and LO2 and make realistic amendments to the sequence to scale up product (e.g. for batch or mass production).	
	8	LO3	Impact of quantities of production – timing of stages.	Learners could continue by looking at the timing of stages of a production plan, and how these change with different scales of production. Again, they could return to their original one-off production plan and review its timings for scale production.	<b>R110 LO3</b> – Learners could return to manufacturing plans produced in LO1 and LO2 and, in addition to sequence, make realistic amendments to timings of operations to scale up product (e.g. for batch or mass production).	

	Event	Learning Outcome	Topic area/subtopic Area (from R110 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Summer Term	9	LO3	Impact of quantities of production – health and safety and quality control.	Learners could review their own production plan for making the one-off prototype and look at how healthy and safety consideration and quality control techniques can be amended to be suitable for scale production. This could include the use of jigs and fixtures, and enhanced quality control techniques such as templates and gauges.	<b>R110 LO3</b> – Learners could return to manufacturing plans produced in LO1, LO2 and above in LO3 and make enhancements to quality control techniques, and health and safety considerations relevant for scale production.	
	10	LO3	Modifications to production planning based on scale of manufacture.	Finally, learners could be provided a plan for one-off production of a product and, using knowledge from previous sessions, modify the plan in terms of: processes, sequence, timing of stages, health and safety and quality control techniques.	<b>R110 LO3</b> – Finally, learners could bring together knowledge of how to modify a 'one-off' production plan for scale production to produce a production plan to include: correct sequencing, realistic timings, enhanced quality control techniques, appropriate health and safety consideration.	

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