Threaded Joints – Course: Techniques of Fitting and Assembling Component Parts to Produce Simple Units. Methodical Guide for Instructors

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Threaded Joints – Course: Techniques of Fitting and Assembling Component Parts to Produce Simple Units. Methodical Guide for Instructors

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1. Objectives and Contents of the Practical Training in the Techniques of Making Threaded Joints

Trainees who have completed the course are supposed to have a good command of the techniques of making threaded joints. To achieve this, the following is required:

Objectives of training

– The trainees will have a ready knowledge of the purpose and the types of threaded joints and the stresses in these joints.

– The trainees will master the various techniques of making direct and indirect screwed joints for fastening purposes.

– The trainees are in a position to select those joints which serve an intended purpose.

– They can choose the right type of tools, auxiliaries and aids and use them properly, strictly keeping to all regulations on health and labour safety as well as fire protection.

To meet these requirements the instructor or teacher should emphasize the following points of content:

Content of training

Know–how

– Purpose and types of bolts, screws, nuts, locking devices, washers and threaded joints

– Stresses in threaded joints

– Types of tools and their uses

– The technological steps of making direct and indirect bolted and screwed joints for fastening purposes

– Undoing threaded joints

– Safety regulations

Abilities

– Preparing the component parts for assembly
– Assembling the component parts and inserting bolts, screws, nuts and locking devices
– Checking the component parts before and after assembly
– Undoing a threaded joint.

2. Organizational Preparations

Instructions, demonstrations and exercises should be prepared thoroughly and meticulously. This includes:

2.1. Planning the Practical Training in the Techniques of Making Joints

Set an approximately appropriate number of hours in which you want to complete the instruction in the individual techniques of making threaded joints. Plan an appropriate number of hours for the theoretical introduction into each technique, the practical demonstrations, the task–related instructions in preparation of the exercises, the proper execution of the exercises for recapitulations and controls.

When planning your time schedule, remember the level of knowledge attained by your trainees, the conditions of training, the future jobs which your trainees will take on, the degree of difficulty of this training.

The emphasis at each stage of training is always on the teaching of manual skills. They must be given the biggest chunk of time in your schedule.

2.2. Preparing Labour Safety Instructions

A short labour safety instruction should precede any practical exercise, where the major points of the safe handling of all working tools are explained to avoid injuries. The details of the safe handling of drills, countersinks and thread cutting dies will be explained.

These main points should be repeated serval times:

– Make sure that the tools are of the right type and size and in proper working order.

– Make sure that the workpiece is clamped tightly and safely. Do not use excessive force in clamping a workpiece as it will cause damage.

– Use assembly tools of the right size for tightening or loosening bolted and screwed joints. Tools of the wrong size tend to damage the workpiece and may slip off causing injuries.

– Make sure that large parts cannot drop to the ground when the bolts and nuts or screws are removed.

– Always keep your workplace in order, storde all tools properly and place individual parts always together with their matching parts.

A notebook or file should be at hand to keep minutes of these instructions. All trainees are required to certify with their signature that they were instructed accordingly.

2.3. Teaching Aids and Materials

– Every trainee should be given a copy of the “Trainees’ Handbook of Lessons – Threaded Joints”.

– Surveys and tables should be prepared as blackboard drawings prior to the instructions.

– Different kinds of tools, bolts and screws, a number of threaded joints, as well as functional models of assemblies using threaded joints should be used in the demonstrations.

2.4. Working Tools

– Each trainee should have a copy of the “Instruction Examples for Practical Vocational Training – Threaded Joints” as a theoretical basis of the exercises.

– Make a sufficient number of component parts and joints always available for practical exercises, as described in the “Instruction Examples...”.

– Make sure that a sufficient number of tools, measuring and testing means as well as auxiliaries are available as specified in the “Instruction Examples... – Threaded Joints”.

The following basic stock of tools, measuring and testing means as well as auxiliary accessories is recommended:

– Marking gaugers, steel scribers, centre punches

– Locksmith’s hammers, flat chisels

– Vernier callipers, try squares

– Drills, countersinks, thread taps, die stocks, dies

– Screw drivers, wrenches and spanners of different types and sizes

– Cutting fluid, machine grease, tap wrenches

– Vice with protected jaws, suitable types of clamping devices.

– A bench–type drilling machine or column–type drilling machine and the required work–holding devices should be available for necessary preparatory work, such as drilling, boring and countersinking.

– Check the safe and reliable operations of these machines before your trainees use them.

3. Recommendations for the Practical Training in the Techniques of Making Threaded Joints

The following paragraphs make suggestions for the theory instructions, the demonstration of the techniques of bolting and screwing as well as for checking and assessing the trainees’ newly acquired know–how.

3.1. Introductory Instruction

The trainees should be instructed on the fundamentals of the subject. For this, use a room where they can sit down and take notes, or answer the questions in the “Trainees’ Handbook...”. The trainees are supposed to have a good command of the techniques of boring, drilling, countersinking and thread cutting before they are instructed in the techniques of making threaded joints. The essential details of these techniques should be explained occasionally.

The contents of the “Trainees’ Handbook...” follow the system of the introductory demonstration and instruction. The main points in that “Handbook” can be discussed in the order given there.

Purpose, Types of Bolts, Screws, Nuts, Locking Devices, Washers and Joints

To start with, explain to your trainees the advantages of joining component parts by bolting or screwing. Use demonstration models to explain the mechanical details and functions of the different kinds of threaded joints.

From this, your trainees will understand the uses of the different joints discussed. Discuss with them the various kinds of joints and their uses. Explain the designations of all bolts and screws to enable your trainees identify the right type of bolt or screw from a piece list. They should be able to identify the nominal diameter and the length of engagement in order to select the right kind of drill and know the depth of the hole to be drilled. Where no original bolts, nuts, screws or joints are available, use the figures in the “Trainees’

Handbook...” to make your trainees familiar with them.

Stresses in Threaded Joints

Make frequent use of the blackboard drawings to explain the stresses in threaded joints. Your trainees should understand that in order to make a properly bolted or screwed joint, they must choose two component parts, one having an external thread, the other with an internal thread, and screw them together by turning in opposite directions.

Illustrate the details of positive and non−positive joints and what they have in common. Explain to them the details of all stresses that may occur in a threaded joint and make them understand how to take them into account when assembling the component parts. Discuss and compare the various ways stresses can act in a joint, i.e. prestressing, service stress, tensile and compressive stresses as well as shearing stress. Say why there is a self−retaining effect in threads for joints that are made for fastening purposes.

Tools

Introduce the tools and explain their uses. Your trainees will have some knowledge of that from the instruction in techniques of manual material working. Discuss these points again with your trainees. Ask them questions to find out what they remember.

Explain the following tools to your trainees:

- Drills, countersinks, thread taps, die stocks, dies
- Screw drive for screws with cross slots and intersecting slots.
- Open ended wrenches, ring spanners, box spanners
- Hexagon pin−type wrenches, adjustable wrenches
- Torque spanners, electrically actuated wrenches

Use the figures in the “Trainees’ Handbook...” to illustrate your points.

When you describe the tools, always tell your trainees how to use them properly and safely: Tell them what may happen when they use the wrong type or size of tool, such as a screw driver, spanner or wrench. Show them damaged bolts, screws and nuts to reinforce their understanding. Do not forget to mention the bodily injuries that can be caused by slipping tools.

The Technological Steps of Making Threaded Joints

The differences in bolted and screwed joints lie mainly in the preparations for making them. It is recommended to illustrate these differences by examples.

Direct and indirect threaded joints should be dealt with separately.

A screwed pipe joint is a good example to illustrate a direct screwed joint. A detailed explanation of a screwed pipe joint is given in the section on the cutting of external thread in the “Trainees’ Handbook...”. The example of a pipe joint there will be understood clearly by your trainees. It is that of a simple screwed joint using a piece of pipe and joining it to another piece by a short thread. Another typical example of a pipe joint is joining pipes by a bell piece and a long thread. This technique is mainly used in permanent pipe installation systems whose position cannot be changed. The technique is practised in the example no. 33.4., but it is good to explain it now to give the trainees a full picture of all techniques.

Most parts that are made for fastening purpose are indirectly bolted or screwed. The details of indirect joints are explained in the “Trainees’ Handbook...”. The two examples are those of a joint comprising a bolt, component parts and a nut, and of a bolt, component parts and another component part with a receiving thread.

It is recommended to repeat the details of these joints when discussing the technique of thread cutting.

(A good time is when the calculation of the drill diameter and the bore depth from the available kind of screws is the topic.)

Give examples in figures. Use blackboard drawings on the basis of the respective diagram in the “Trainees’ Handbook...” and enter dimensions for the calculation. Require your trainees to describe by exactly calculated values the techniques of drilling, boring, countersinking and thread cutting. Then give them the most important details of the assembly operations.

Tell them that these are “rules”. A summary of these rules is given in the “Trainees’ Handbook...”. The trainees should give the answers to the questions in their “Handbooks”.

Undoing Threaded Joints

The undoing of threaded joints should be explained with particular reference to safety aspects. Emphasize the need of using tools of the right type and size, the safe handling of all dismantled components and their identification for re–assembly. The loosening and dismantling of bolted or screwed joints is certainly a most requisite procedure. However, the fact should be stressed and repeatedly explained that bolts and screws and nuts which cannot be loosened despite the use of rust solvents, must be removed with a drill (bored out). This is in most striking contract to what the trainees were told about the specifics of bolted and screwed joints. It is a main point to make them understand that some way out of a given situation must always be found, even if by destruction.

It is most important that the component parts in the joint remain undamaged. The trainees should be told that this is the rule, and follow it.

Safety at Work

The main points of safe boring, drilling, counterboring and thread cutting should be discussed again. These main points can be taken from the “Trainees’ Handbook...”.

3.2. Exercises

Instruct your trainees to observe the labour safety regulations, before they start doing practical exercises. Then show every trainee his place of work and check that the machines and equipment in the workshop are in working order.

Begin each exercise by explaining the theoretical background and follow it with the practical execution of the exercise. Tell your trainees to go about their work with a sense of good craftsmanship. Also tell them where to expect difficulties. The practical exercises can be done in the order in which they are given in the “Instruction Examples...”.

Using the “Instruction Examples for Practical Vocational Training – Threaded Joints” the trainees can do four exercises in different techniques.

The “Instruction Examples...” contain lists of component parts (material), tools, measuring and testing means, auxiliary accessories and a workshop drawing. The trainees will find there the information they need to exercise the examples properly and thoroughly. The instructor is advised to make the trainees aware of the weak spots, where they may be facing difficulties, and enable them to assess the results of their own exercises correctly.

The instructor will do good to do the exercises himself, using the same tools his trainees will have to use, before he asks them to do the exercises themselves.

To make the instructor more aware of the major points which his trainees are to achieve in practice, we will now describe the exercises of the “Instruction Examples...”.

Instruction Example 33.1. Making a threaded joint

Different kinds of bolts and screws are screwed into two flat pieces of metal, the choice being open. The flat component part which is on top has through holes, the holes in the bottom component part are tapped. The purpose of the exercise is to practise the use of different types of tools for heads of different shapes. Further practice in the techniques of cutting internal thread is intended. (Figure 1)

Instruction Examples 33.2. Making a threaded joint with locking devices

Different kinds of bolts and screw with locking devices are screwed into two flat pieces of metal, the choice of the metal being open. The purpose of the exercise is to practise the proper use of different kinds of locking devices. Further practice in the techniques of cutting internal thread and making threaded joints is intended. (Figure 2)

Instruction Example 33.3. Making a container with lid

A container is made of 8 mm plate sections, the joints are made with countersunk screws. The lid is fitted on stud bolts and knurled nuts and can be screwed on the container. (Figure 3)

Instruction Example 33.4. Making a pipe joint

Two pieces of a 1–inch pipe are to be joined by a pipe bell on a long thread. The purpose of the exercise is to practise the use of the die stock for cutting pipe thread and making the joint of the two pieces of pipe by a pipe bell without turning the pipes. (Figure 4)

All trainees can do the exercises together if sufficient pieces of metal, bolts, tools, etc. are available.

This will give every trainee a chance of doing all exercises himself. Allow them as much time as they need to complete the exercises.

Where not enough component parts, bolts, tools, etc. are available, the trainees can work in groups. Each group should do one exercise at a time.

Other exercises can be done without prejudice to those suggested above. In that case the instructor should make sure that the techniques previously taught in this course can be practised extensivily.

Major Points for Practical Training

We recommend that the instructor selects certain aspects which he will give his particular attention. Here are a few suggestions:

- Do the trainees prepare their places of work with sufficient care and circumspection?
- Do they select the right type and size of tools for a particular assembly job?
- Will they do a job in the correct sequence of operation?
- Do they grease the bolts before they screw them in the metal component?
- Are the trainees able to meet the quality requirements?

In particular:

- Are all screws properly tightened?
- Have the locking devices been properly used?
- Will the threaded joint perform the intended task?
- Have the holes been tapped properly?
- Are the trainees able to asses their own work correctly?
- Have all labour safety regulations been observed?

3.3. Recapitulation and Controls

A list of questions has been compiled for this paragraph, which are to check the trainees' newly acquired knowledge. Most of these questions have been asked in the "Trainees' Handbook of Lessons...".

1. What is a bolted or screwed joint?

(Bolted or screwed joints are detachable joints where two or more individual component parts are joined by bolts, screws and nuts, directly with each other.)

2. What conditions must be satisfied by a threaded joint which is exposed to dynamic stress?

(Suitable locking devices are used where detachable joints have to be secured against accidental loosening due to the action of dynamic stress.)

3. Give uses of countersunk bolts and screws.

(They are used in industrial plant and machinery, where safety requires that no screw head projects from the surface of a component part.)

4. What is the difference in the length of engagement of a cheese head bolt or screw and a countersunk bolt or screw?

(As to cheese head bolts or screws the threaded shanks are inserted into a component part. As to countersunk bolts and screws the heads are flush with the surface of the part into which they are screwed.)

5. Where does the shape of a sheet metal screw differ from that of a wood screw?

(On sheet metal screws, there is thread on the entire cylindrical portion of the screw, with a tip, whereas on wood screws the thread is only as long as the tapered portion of the shank.)

6. What conditions must be satisfied by the materials of which nuts, bolts and screws are made?

(Bolts, screws and nuts must be made of the same material and have the same kind of coating.)

7. Identify uses of knurled nuts and wing nuts.

(Knurled nuts nad wing nuts are used for producing detachable joints of component parts by hand.)

8. Identify elements of locking devices which must be used once only.

(Cotter pins, spring rings and out–bent locking devices are used once only.)

9. Suggest an effective way of locking when the shank of a bolt projects the nut.

(The locking effect can be enhanced on bolts which have their shanks projecting beyond the nut by screwing a counternut onto the projecting portion of the shank. Both nuts must be screwed tight.)

10. Give uses for washers.

(Washers are used on bearing faces when the latter are not properly machined, where bolts, screws and nuts are to be tightened on oblong holes and where slopes of the bearing face must be compensated.)

11. Name different types of threaded joints.

(There are direct joints, indirect joints, fastening joints and adjustable joints.)

12. Identify a critical specification of a thread for fastening purpose.

(It must have a high self–retaining effect.)

13. Name different kinds of stress in threaded joints for fastening purpose.

(There are prestressing and service stress, which act as tensile or compressive forces, and shearing stress.)

14. What may happen when the blade of a screw driver is too narrow?

(The clearance between the blade and the slot is too big, the blade may slip and damage the screw head. Injuries can be caused.)

15. What may happen when an extension is used on an open ended wrench for tightening a bolted or screwed joint?

(The joint will be overly prestressed, the threaded bolt will fail either when being tightened or later, under the action of the service stress.)

16. Name applications of the torque spamnner.

(The torque spanner is used on high−strength bolted and screwed joints which require a specific torque or where there are several bolted or screwed joints on one component part and their prestressing is the same.)

17. Give details of making a tapped hole for a screw.

(For blind holes, consider the length of thread engagement and the run−out depth of the thread tap. The tap hole must be made deeper by that dimension.)

18. Where several component parts are to be joined by a screw, which part must have a receiving thread?

(The receiving thread must be in the part which is the last as seen from the head of the screw.)

19. How is a trainee to proceed in tightening a joint which comprises a bolt and a nut?

(Grip the bolt head tightly and tighten the nut.)

20. Where should the locking element be placed in a joint consisting of a bolt and a nut?

(At the side where the nut is applied.)

21. How will you proceed in tightening several screws or bolts in the lid of a container?

(Start from the middle and proceed outwards, crosswise.)

22. Give important details of dismantling component parts.

(Use a suitable support so that the parts cannot drop to the ground. Mark the parts for re−assembly. Loosen the joints before you dismantle the parts fully.)

23. What general requirements must be met by assembly tools?

(The tools must be of the right type and size for the job in hand, and they must be in proper working order.)

4. Teaching Aids

Use visual aids to reinforce the trainees' understanding of your instruction. Visual aids, or other illustrative material, can be bolts, screws, nuts, locking devices, threaded joints or component parts or assemblies of machines with threaded joints. Instructors are advised to use the sample joints made by the trainees during their practical exercises and illustrate good and bad joints.