

**Civil Aviation Advisory
Publication
March 1994**

Aircraft manual welding: approvals and qualifications

This publication is only advisory. It gives the preferred method for complying with the Civil Aviation Regulations.

It is not the only method, but experience has shown that if you follow this method you will comply with the Civil Aviation Regulations.

Always read this advice in conjunction with the appropriate regulations.

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The relevant regulations and other references

- Civil Aviation Regulations 33C - 33I. (Aircraft welding authorities)
- CAR 29A. (Interpretations <196> welding)
- CAA Syllabus Publication [29A] <196> *Aircraft Welding Examinations.*

Who this CAAP applies to

Anyone seeking:

- initial authorisation to carry out manual welding of aircraft, aircraft components or aircraft materials, or
- recognition of foreign or Australian Defence Force aircraft welding qualifications, or
- renewal of an existing aircraft welding authority for a further 2 years, or
- changes or additions to an existing aircraft welding authority.

Why this publication was written

Aircraft welding requirements have been reviewed and incorporated into new regulations issued in 1994.

The purpose of this CAAP is to give information on how to apply for approval to carry out aircraft manual welding and how to apply for renewal or additions to existing welding qualifications.

Status of this CAAP

This is the first CAAP to be written on the regulations relating to aircraft manual welding approvals and qualifications.

For further information

Contact the CAA District Office closest to you.

Qualifications needed

INITIAL APPLICATION

You must successfully complete practical and theoretical training in the particular type of manual welding and parent metal group qualification sought. This training is expected to:

- cover safety in welding, welding equipment, theory and application of welding processes, welded joints, welding metallurgy and welding practice and production;
- be based, as a minimum, on the Australian Standard 1796-1993 - SAA Welder Certification Code; and
- be carried out by a suitable training organisation, e.g., TAFE College.

You must submit documentary evidence, such as copies of the training course curriculum or syllabus and the completion certificate showing that you have successfully completed the particular training.

You must also pass the aircraft welding examinations appropriate to the qualification sought, which are specified in the CAA publication titled *Aircraft Welding Examinations*, (see copy attached to this CAAP).

RECOGNITION OF EQUIVALENT WELDING QUALIFICATIONS

The CAA currently recognises qualifications issued by the:

- Australian Department of Defence (RAAF Specification Engineering W5003 - Welders - Qualification for Aircraft, Missile and Aerospace Fusion Welding), or
- CAA U.K. (BCAR Subsection A8-10 - Approval of Welders), or
- FAA USA (FAA Repairmans Certificate endorsed with equivalent welding ratings).

The CAA will consider your equivalent welding qualifications for the issue of an aircraft welding authority without you having to complete the welding training and examination if:

- your qualifications are current/valid at the time of application; and
- you can provide appropriate supporting documentary evidence, such as your qualification document and authenticated associated employment records.

Your aircraft welding authority will take effect from the date of approval and will be issued only for the remaining validity



period of your existing (equivalent) welding qualification document.

(e.g. If your existing welding qualification document requires renewal in 6 months time, then your aircraft welding authority will be issued to expire at the same time. For renewal purposes you will be required to successfully complete the relevant welding examinations for the qualifications held.)

RENEWAL

If you wish to renew your aircraft welding authority for a further 2 years, you must successfully complete specified aircraft welding examinations within the 3 month application period.

If you are an independent aircraft welding authority holder, (i.e., you are not employed as a full-time welder by a CAA approved organisation), you must successfully complete the following aircraft welding examinations:

one Joint No. 1 in each parent metal group endorsement in any 'arc' welding process as determined by the CAA Materials Evaluation Facility (MEF), and

- one Joint No. 1 in each parent metal group endorsement in the 'gas' welding process (if applicable), and
- one Joint No. 4 in the most technically difficult welding type and metal group qualification held, as determined by the CAA MEF, if you have an 'unrestricted' endorsement.

If you are employed as a full-time welder in a CAA approved organisation, you are normally required to successfully complete the same aircraft welding examinations as that for an independent aircraft welding authority holder.

However, your employer (Certificate of Approval holder) may elect to implement documented quality control procedures whereby similar (renewal) welding examinations are carried out over the duration of the welding authority's 2 year validity period and analysed either in-house (where suitable/necessary testing equipment is held), or at a NATA approved testing facility. In this case you will be required to successfully complete, as part of the renewal requirements, at least:

- one Joint No. 1 in the most technically difficult welding type and metal group qualification held, as determined by the CAA MEF, and also

- if you hold an 'unrestricted' endorsement, one Joint No. 4 in the most technically difficult welding type and metal group qualification held, as determined by the CAA MEF, within the 3 month application period as mutually agreed and convenient to the employer and the CAA District Office.

All holders of an aircraft welding authority endorsed with a Type 2 - Braze Welding qualification(s), must successfully complete one Joint No. 2 in the most technically difficult metal group as determined by the CAA MEF.

The CAA MEF will, in making the welding type and parent metal group determination for each renewal requirement, take into consideration the material/alloy availability, the material form/composition, weldability factors and thickness criteria established from the American Society for Metals, 'Metals Handbook', (Ninth Edition), Volume 6 - *Welding, Brazing and Soldering*. The MEF determination will also take into account the applicant's welding activities over the entire validity period of the welding authority and will be representative of the welder's main day-to-day welding activity.

If you do not complete the renewal examinations before the expiry of your authority, you will be required to complete all the appropriate welding examinations necessary for the initial issue of the authority to retain your qualifications.

ADDITIONS

To qualify for any additional types of manual welding or parent metal groups, you must:

- pass the relevant aircraft welding examinations, appropriate to the qualification being sought, as specified in the *Aircraft Welding Examinations* publication, and
- successfully complete training covering the particular type of manual welding and parent metal group similar to the training required for the initial issue of an aircraft welding authority.

You should submit, with your application, copies of the training course curriculum or syllabus and the document/certificate showing that you have successfully completed the particular training.

Note that when you apply for an additional qualification the addition will not affect the validity period of your authority. You

will still be expected to meet the full renewal qualification requirements at the next renewal period.

How to apply

If you wish to apply for the grant, renewal or addition to an aircraft welding authority, you should complete the application form attached to this CAAP and send it together with the appropriate fee to the nearest CAA District Office.

The CAA District Office on accepting your application will:

- allocate to you or confirm your existing Aviation Reference Number (ARN) for future reference with you,
- arrange, in the case of renewal, the CAA's MEF determination of the welding process/metal group, and
- forward your application form to the person you nominated to conduct the examination who will then contact you to arrange the examination time/date/venue.

Your obligations as the holder of an aircraft welding authority

You can only carry out the kind of maintenance appropriate to the conditions and type of manual welding on a parent metal group that is annotated on your aircraft welding authority, and only in accordance with approved maintenance data as defined in CAR 2A.

WELDING OF AIRCRAFT

You can only carry out maintenance (manual welding), in accordance with approved maintenance data, on class A and class B aircraft within the scope of the authorisation.

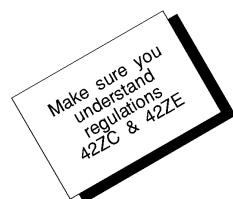
WELDING OF AIRCRAFT COMPONENTS/MATERIALS

You can only carry out maintenance (manual welding), in accordance with approved maintenance data, on aircraft components or aircraft material within the scope of the authorisation.

CERTIFICATION

You must certify for the maintenance (manual welding) carried out in accordance with approved maintenance data, in the documents kept for recording such maintenance under the requirements of CAR 42ZE.

Separate certification for the completion of maintenance on an aircraft will be made by an appropriately rated licensed aircraft maintenance engineer. This certification signifies that the maintenance (manual welding) has been carried out in



accordance with approved maintenance data by a suitably qualified person.

Note that certification of completion of activities other than maintenance (e.g., manufacturing) must be carried out in accordance with the Certificate of Approval holder's system of certification approved under the provisions of CAR 34.

NOTIFICATION OF YOUR NAME OR ADDRESS CHANGES

You should notify the Authority, as soon as practicable, of any changes in your name, business address or correspondence address to ensure CAA records are accurately maintained.

Maintaining standards

PROFICIENCY

You will be subject to surveillance checks by CAA officers who may be required, under the provisions of CAR 33, to ascertain your competency and diligence.

The CAA surveillance checks will take place with a view to assessing that:

- the welding being carried out is within the limits of any conditions of your authorisation;
- certification for the completion of the maintenance (manual welding) is being carried out correctly; and
- the quality of welds is maintained as shown by inspection records of production welds.

COMPETENCY

If the CAA has cause to question your competency as the holder of an aircraft welding authority, you may be required to demonstrate welding competency. The CAA may also recommend that you undertake some form of remedial training. If you do not achieve a satisfactory standard your authorisation may be suspended and you may be required to prepare and submit all the aircraft welding examinations that are necessary for an initial aircraft welding authority qualification.

FAILURE TO MEET WELDING EXAMINATION STANDARDS

If you fail an aircraft welding examination you may submit a further welding examination sample for assessment.

However, if you fail the re-examination, the CAA recommends that you undertake some form of remedial training and

demonstrate welding practice to the person conducting the examination in the particular type of manual welding and metal group before you re-attempt the welding examination again.

You will not be eligible for the issue or renewal of an aircraft welding authority or for additional type of manual welding or parent metal group unless you have satisfactorily completed the appropriate aircraft welding examinations.

CHARGES AND COSTS

You are responsible for the supply of all materials and equipment, the charges for the person conducting the aircraft welding examination and the costs for the welding test assessment by the weld testing agency.

CASA SYLLABUS PUBLICATION
AIRCRAFT WELDING EXAMINATIONS

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GENERAL

Under the provisions of Subregulation 29A (1) of the Civil Aviation Regulations, this publication sets out the requirements necessary for the preparation and assessment of aircraft welding examinations required by Civil Aviation Regulations 33D, 33G and 33H.

TYPES OF MANUAL WELDING

Satisfactory completion of aircraft welding examinations, made under one of the following types of manual welding processes, qualifies the welder with respect to that type of welding:

- Type 1 - Gas welding.
- Type 2 - Braze welding. [Note limitations apply]
- Type 3 - Manual Metal Arc Welding.
- Type 4 - Gas Tungsten Arc Welding (GTAW - TIG).
- Type 5 - Gas Metal Arc Welding (GMAW - MIG).
- Type 6 - Plasma Arc Welding (PAW).

PARENT METAL GROUPS

The parent metal groups for which qualifications may be obtained are:

- Group 1 - Aluminium Alloys.
- Group 2 - Magnesium Alloys.
- Group 3 - Carbon Steels and Low Alloy Steels.
- Group 4 - Corrosion and Heat Resisting Steels.
- Group 5 - Nickel Alloys.
- Group 6 - Copper based Alloys.
- Group 7 - Titanium Alloys.

DEFINITIONS

- All terms and definitions used in this publication are in accordance with Australian Standard AS2812 — “Welding, brazing and cutting of welds — Glossary of terms”.
- ‘**Tubular part**’, means a part of a primary structure not exceeding approximately 50 mm in diameter.

PART 1 - AIRCRAFT WELDING EXAMINATIONS

TYPES OF AIRCRAFT WELDING EXAMINATIONS

Dependent on the welding qualification sought, the aircraft welding examinations required to obtain qualifications are to be prepared as follows:

- Joint No. 1 - Sheet to sheet butt weld as specified in Diagram 1.
- Joint No. 2 - Tube to sheet fillet weld as specified in Diagram 2.
- Joint No. 3 - Sheet to sheet fillet weld as specified in Diagram 3.
- Joint No. 4 - Tube to tube test weld as specified in Diagram 4.
- Joint No. 5 - An aircraft part typical of the most difficult to be welded in production/repair by the applicant, e.g., repair/rebuild of engine nozzle guide vane; repair of gas turbine engine flametube or repairs to component castings, etc. (See Note below)

Note: A welding test joint which simulates the Joint No. 5 part may be prepared by the applicant at the discretion of the person conducting the aircraft welding examination. Where a simulated joint is prepared, the applicant must use the same materials, equipment, process, joint configuration, welding technique and maintenance data/specifications as that used for the production or repair part.

EXAMINATIONS REQUIRED FOR INITIAL GRANT OF AN AIRCRAFT WELDING AUTHORITY

For the purposes of regulations 33C and 33D of the Civil Aviation Regulations, an applicant for the grant of an aircraft welding authority, must satisfactorily complete at least 1 of the aircraft welding examinations set out in this publication. The aircraft welding examination must be completed in each of the types of manual welding and parent metal groups to which the application relates and relevant to the conditions of the authorisation sought.

Applicants for a braze welding type of manual welding qualification must satisfactorily complete at least the aircraft welding examination Joint No. 2 in the parent metal group to which the application relates.

Braze welding is restricted to tube-to-sheet Joint No. 2 and the type of weld joint prepared as Joint No. 5. There is no 'unrestricted' qualification or 'restricted to exclude tubular parts' qualification permitted for braze welding.

[Refer regulation 29A for types of manual welding and parent metal groups, regulation 33C for the application for an aircraft welding authority and regulation 33D for the grant of an authority.]

EXAMINATIONS REQUIRED FOR RENEWAL OF AN AIRCRAFT WELDING AUTHORITY

For the purposes of regulation 33G of the Civil Aviation Regulations, the holder of an aircraft welding authority seeking renewal of the authority must, within the 3 month application period, satisfactorily complete aircraft welding examinations, as set out in this publication, that CASA considers necessary in the interests of the safety of air navigation.

Failure to satisfactorily complete the necessary renewal welding examinations before the expiry of an aircraft welding authority will result in the holder having to complete all the

appropriate welding examinations required for the initial issue of the particular welding authorisations held.

Where the required aircraft welding examinations under the following renewal options are to be determined on the basis of the most technically difficult welding type and metal group, the determination will be made by the CASA Materials Evaluation Facility (MEF).

The CASA MEF will, in making the welding type and parent metal group determination for the applicable renewal requirement, take into consideration the material/alloy availability, the material form/composition, weldability factors and thickness criteria established from the American Society for Metals, *'Metals Handbook'*, (Ninth Edition), *Volume 6 - Welding, Brazing and Soldering*. The MEF determination will also take into account the applicant's welding activities over the entire validity period of the welding authority and will be representative of the welder's day-to-day welding activity.

Renewal requirements for holders of an aircraft welding authority not employed as a full time aircraft welder in a CASA Approved Organisation

The holder of an aircraft welding authority who has not been employed in a CASA approved organisation as a full time aircraft welder, who is seeking renewal of the authority must, within the 3 month application period, satisfactorily complete:

- ◇ one Joint No. 1 in each parent metal group endorsement in any 'arc' welding process, and
- ◇ one Joint No. 1 in each parent metal group endorsement in the 'gas' welding process (if applicable), and
- ◇ where an 'unrestricted' endorsement is held, one Joint No. 4 in the most technically difficult welding type and metal group qualification held.

Renewal requirements for holders of an aircraft welding authority employed as a full time aircraft welder in a CASA Approved Organisation

The holder of an aircraft welding authority employed as a full-time welder in a CASA approved organisation, is required to successfully complete the same aircraft welding examinations as that for an independent aircraft welding authority holder.

However, the employer (Certificate of Approval holder) may implement and document procedures in the organisation's quality control system/procedures manual whereby similar (renewal) welding examinations are carried out over the duration of the welding authority's 2 year validity period and analysed either in-house (where the organisation has suitable/necessary testing equipment), or at a NATA accredited testing facility.

Where the employer implements procedures for examinations to be carried out and analysed in-house, the holder of the aircraft welding authority employed as a full-time welder must successfully complete, at least:

- ◇ one Joint No. 1 in the most technically difficult welding type and metal group qualification held, and (where applicable)
- ◇ for holders of an 'unrestricted' endorsement, one Joint No. 4 in the most technically difficult welding type and metal group qualification held.

Note that these examinations are not additional to the basic renewal requirements, but are necessary for CASA objective assurance of welding competency. Such tests may

form part of the employer procedures but are to be conducted within the 3 month renewal application period mutually convenient to the organisation and CASA.

Holders of an aircraft welding authority employed by a Certificate of Approval holder must submit employer endorsed evidence of their practical experience and welding work carried out (such as an employer endorsed letter stating experience, or employment/job records, etc.), with their application for renewal.

Renewal requirements for holders of aircraft welding authority endorsed with Braze Welding

All holders of aircraft welding authority endorsed with Type 2 — Braze Welding qualifications must, within the 3 month application period, satisfactorily complete one aircraft welding examination Joint No. 2, as set out in this publication, in the most technically difficult parent metal group qualification held.

[Refer regulation 33F for duration of an aircraft welding authority and regulation 33G for renewal]

EXAMINATIONS REQUIRED FOR THE APPROVAL OF ADDITIONAL TYPE OF MANUAL WELDING OR PARENT METAL GROUP

Addition of a type of manual welding

For the purposes of regulation 33H of the Civil Aviation Regulations, if the holder of an aircraft welding authority is seeking to have a type of manual welding (other than Type 2 — Braze Welding) added to the authority, the holder must satisfactorily complete at least 1 of the aircraft welding examinations, set out in this publication, in the type of manual welding to which the application relates in any parent metal group.

Addition of a parent metal group

For the purposes of regulation 33H of the Civil Aviation Regulations, if the holder of an aircraft welding authority is seeking to have a parent metal group added to the authority, the holder must satisfactorily complete at least 1 of the aircraft welding examinations, set out in this publication, in the parent metal group to which the application relates in any type of manual welding.

Addition of Braze Welding

If the holder of an aircraft welding authority is seeking to have Type 2 — Braze Welding added to the authority, the holder must satisfactorily complete at least the aircraft welding examination Joint No. 2 (as set out in this publication) in the particular parent metal group.

[Refer regulation 33H for changes to an aircraft welding authority]

EXAMINATION FAILURE

For the purposes of regulations 33D, 33G and 33H of the Civil Aviation Regulations, if an applicant fails a welding examination for the initial issue, renewal or additional qualifications of a welding authority, the applicant may submit a further welding examination sample for assessment.

If the applicant then fails the re-examination, CASA recommends that the applicant completes some form of remedial practical and theoretical training on the type of manual welding and parent metal group and demonstrate welding practice to the person conducting the welding examination prior to further examination.

Documentary evidence may be required by the person conducting the re-examination in support of any remedial welding training completed.

PARENT METAL THICKNESS LIMITATION/CONDITIONS

The welding examinations — Joints No. 1, No. 2, No. 3 and No. 4 specify that the weld must be carried out on a pre-determined representative parent metal thickness for the particular welding process (gas) or (arc).

Welders complying with the examination metal thickness specifications are authorised to carry out manual welding (using the particular process) on parent metals of a thickness up to that specified and greater. There will be no parent metal thickness limitation or condition endorsement made on the welding authority.

Welders who carry out welding examinations using parent metals of a greater thickness than that specified for the welding examination will be authorised to carry out welds on the parent metal of that thickness or greater. The welding authority will be endorsed with a parent metal thickness condition.

- e.g., If the welding examination specifies that the sheets to be arc welded must be 1.2 mm thick and the welder uses sheets of 1.5 mm thick, then the parent metal thickness condition endorsed on the welding authority will limit the welder to only carrying out welds on metals of 1.5 mm thickness or greater.

WELDING IDENTIFICATION AND WELDING POSITION CODE

On completion of the welding examination, the person conducting the examination must stamp, etch or permanently mark each welding examination sample with the applicant's Aviation Reference Number (ARN) and the appropriate welding position code letter, as follows:

- F — Flat (fillet or butt), where the face of the weld is approximately horizontal;
- H — Horizontal (fillet or butt), where the line of weld root is approximately horizontal;
- OH — Overhead (fillet or butt), where the weld is performed from the under-side of the joint;
- HV — Multiple Position (fillet only), where the axis of the tube is approximately horizontal and the tube is not rotated during welding; or
- V — Vertical (fillet or butt), where the line of the weld root is approximately vertical.

EXAMPLES OF EXAMINATION COMBINATIONS AND CONDITIONS

An aircraft welding authority will be granted subject to the qualification conditions or restrictions determined by the type and number of welding examination combinations selected and satisfactorily completed by the welder.

Examples of the conditions CASA may impose when particular aircraft welding examination combinations have been successfully completed are given below and apply to both the initial issue and additional qualification requirements for an aircraft welding authority:

Example #1

Welding Examination Carried Out	
Joint No. 1	
Condition Entered on Welding Authority — for each type of manual welding and parent metal group.	
“Restricted to Butt welds of ‘X’ mm thick sheets”	

This example is intended to show the flexibility of welding examination selection for welding authorisation whereby an applicant only requires one welding examination qualification.

The satisfactory completion of Joint No. 1 will authorise the welder to carry out manual welding ‘butt welds’ (using a particular process) on sheets of a specified thickness (for a particular parent metal).

Similarly, if, for example, a Joint No. 3 is selected and satisfactorily completed, the form of condition entered on the authority may read “Restricted to fillet welds of sheets ‘x’ mm thickness.” (for the particular process/metal group).

Example #2

Welding Examinations Carried Out	
Joint No. 2	Joint No. 5
Condition Entered on Welding Authority — for each parent metal group.	
“Braze Welding only - Restricted to particular parts or types of parts” (statement may include description of part(s) or approved procedures reference)	

With respect to Braze welding, the braze welding qualification is restricted for tube to sheet Joint No. 2 and the type of the weld prepared as Joint No. 5. There is no “Unrestricted” qualification or “Restricted to exclude tubular parts” qualification permitted for braze welding.

Example #3

Welding Examinations Carried Out	
Joint No. 1	Joint No. 5
Condition entered on Welding Authority — for each type of manual welding and parent metal group	
“Restricted to the particular parts or types of parts” (Statement may include description of part or approved welding procedures reference)	

The annotation “Restricted to particular parts or type of parts”, requiring Joints No. 1 and 5, applies where the only welds to be carried out are restricted to a particular joint configuration on a specific part or types of parts, e.g., repair/rebuild of engine nozzle guide vanes, or repair of gas turbine engine flametube or repairs to component castings, etc. This may also apply where welds are carried out repetitively on a production line basis in accordance with particular procedural data.

The holder is only authorised to carry out manual welding of the particular part or type of parts described in the welding authority (e.g., butt joints in flame tubes of (type) engines, or edge welds on nozzle guide vane support Part No., etc.).

The welding carried out must be as specified in the approved maintenance data for the parent metal group and type of manual welding for which the “Restricted to part” annotation is granted.

Example #4

Welding Examinations Carried Out		
Joint No. 1	Joint No. 3	Joint No. 5
Condition Entered on Welding Authority — for each type of manual welding and parent metal group.		
“Restricted to exclude Tubular Parts”		

The annotation “Restricted to exclude tubular parts”, requiring Joints No. 1, 3 and 5 is intended to make provision for applications for metal groups other than aluminium or steel, which are generally not used in tubular form in aircraft primary structure or are not generally available in tubular form. e.g., magnesium, nickel or titanium. (As a tubular part is part of a primary aircraft structure not exceeding approximately 50 millimetres in diameter, then an exhaust manifold is not considered a tubular part since it is not primary structure)

The holder is authorised to carry out manual welding of any part (e.g., flat, horizontal and overhead butt welds and fillet welds for sheet-to-sheet), except for tubular parts, where welding is specified in approved maintenance data for the parent metal group and type of manual welding for which the “Restricted” annotation is granted.

Example #5

Welding Examinations Carried Out		
Joint No. 1	Joint No. 2	Joint No. 4
Condition Entered on Welding Authority — for each type of manual welding and parent metal group.		
“Unrestricted” or “Nil”		

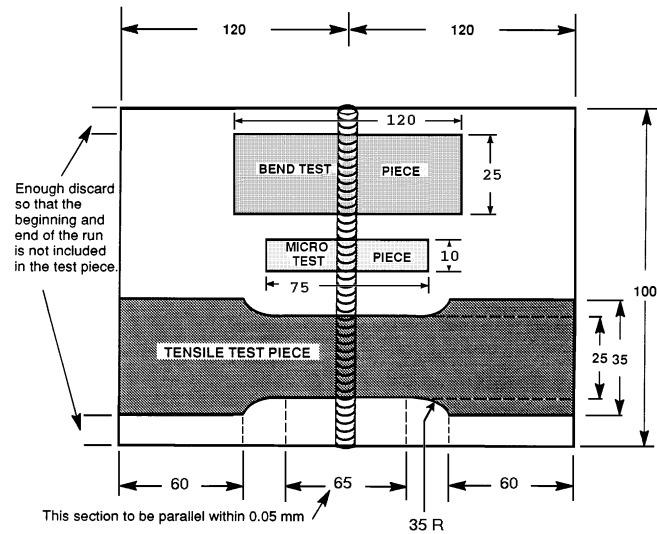
The “Unrestricted or Nil” annotation, requiring Joints No. 1, 2 and 4 is granted on the basis that the selection of joints is considered sufficiently searching of welding ability in the majority of cases (e.g., flat, horizontal, overhead, vertical and multi-position butt welds [sheet-to-sheet], fillet welds [sheet-to-sheet] [sheet-to-tube] and fillet and butt welds [tubular parts]).

It is intended to apply primarily to aluminium and steel metal groups and where structural tubing is in common use. Where more difficult welds are to be carried out to satisfy production, additional Joint No. 5 examination may be required.

The welder is authorised to carry out manual welds of any part where welding is specified in approved maintenance data, without restriction for the parent metal group and type of manual welding for which the "Unrestricted or Nil" annotation is granted.

AIRCRAFT WELDING EXAMINATION No. 1

JOINT No. 1 — SHEET TO SHEET BUTT WELD

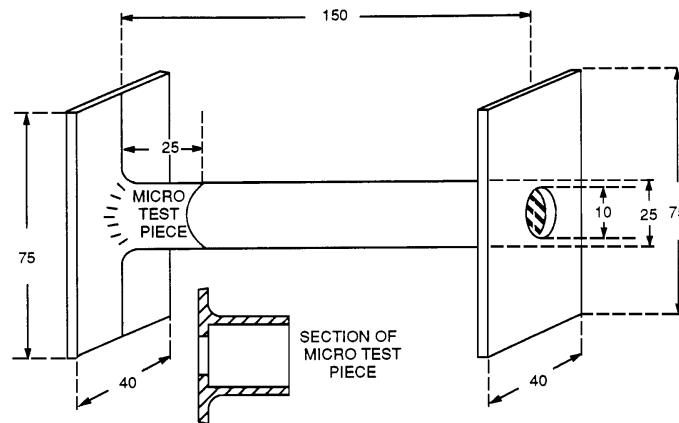


Weld for aircraft welding examination No. 1

- For the purposes of undertaking the aircraft welding examination No. 1, a person must carry out a Joint No. 1 - sheet to sheet butt weld in accordance with the specifications set out in diagram 1.
- All measurements are nominal and in millimetres (mm).
- The examinations must be carried out using parent metals of the same alloy type or grade procured to the applicable specifications referenced in the production procedure/maintenance data.
- For oxy-acetylene (gas), GTAW (TIG) and MTAW (MIG) welding processes, maximum thickness of sheets is 1.6 mm thick.
- For other arc welding processes, maximum thickness of sheets is 2.5 mm thick.
- Tack welds may be made from any position but shall be incorporated into the completed weld.
- Welding position - flat.
- The weld shall be performed by welding from one side only using correct filler rod, flux or shielding gas as applicable.
- The sheets to be welded shall be supported so that they do not contact the bench or other material that will form a backing bar in the welded joint.
- Completed welds may be cleaned by wire brush, but must not be dressed, hammered or sand blasted. (Light tapping with a hammer to remove scale deposits is not regarded as a dressing operation.)
- Weld residue (flux, slag) shall be removed from the weld in the usual way.
- Pre or post-weld heat treatments, if required, must be performed in a similar manner to that required for production weld procedures/specifications.

Note: The welding examination sample must be submitted to the Weld Testing Agency intact. The testing agency is responsible for the preparation of the particular test pieces.

AIRCRAFT WELDING EXAMINATION No. 2
JOINT No. 2 — SHEET TO TUBE FILLET WELD

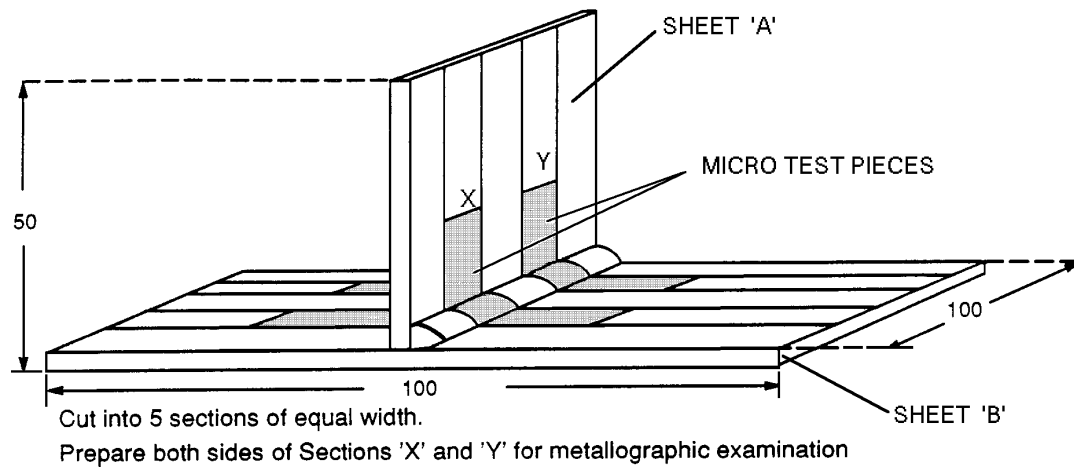


Weld for aircraft welding examination No. 2

- For the purposes of undertaking the aircraft welding examination No. 2, a person must carry out a Joint No. 2 - sheet to tube fillet weld in accordance with the specifications set out in diagram No. 2.
- All measurements are nominal and in millimetres (mm).
- The examinations must be carried out using parent metals of the same alloy type or grade procured to the applicable specifications referenced in the production procedure/maintenance data.
- For oxy-acetylene (gas), GMAW (MIG) and GTAW (TIG) welding processes, thickness for tube is 0.9 mm wall thickness and end plates of 1.6 mm thick.
- For other arc welding processes, thickness for tube is 1.6 mm wall thickness and end plates of 2.5 mm thick.
- If tubes and end plates of other thicknesses are used, the thicknesses should be kept in these proportions. (Note authorisation may be subject to thickness conditions.)
- Centre of end plates to be drilled with 10 mm diameter hole prior to welding.
- End plates may be positioned by tack welds.
- The first weld shall be completed by working around the tube with the end plate horizontal (flat) on the work surface and the tube in the vertical position.
- The second weld shall be completed by working under and over the tube with the tube in the horizontal position (as depicted in diagram 2) and not moved during the process of completing the weld. (Note that the micro test piece will be taken from the second weld area.)
- Completed welds may be cleaned by wire brush, but must not be dressed, hammered or sand-blasted. (Light tapping with a hammer to remove scale deposits is acceptable and is not regarded as a dressing operation.)
- Weld residue (flux, slag) shall be removed from the weld in the usual way.
- Pre or post-weld heat treatments, if required, must be performed in a similar manner to that required for production weld procedures/specifications.

Note: The welding examination sample must be submitted to the Weld Testing Agency intact. The testing agency is responsible for the preparation of the particular test pieces.

AIRCRAFT WELDING EXAMINATION No. 3
JOINT No. 3 — SHEET TO SHEET FILLET WELD



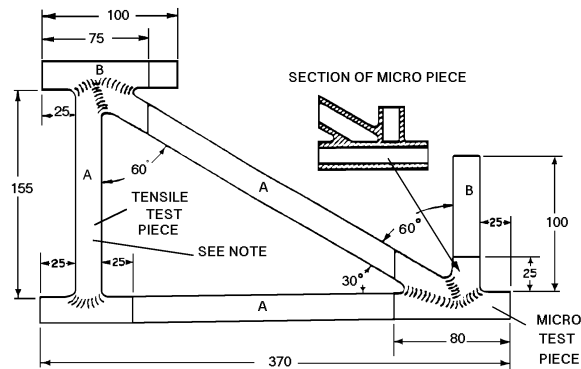
Weld for aircraft welding examination No. 3

- For the purpose of undertaking the aircraft welding examination No. 3, a person must carry out **2** Joint No. 3 - sheet to sheet fillet welds in accordance with the specifications set out in diagram 3.
- All measurements are nominal and in millimetres (mm).
- The examinations must be carried out using parent metals of the same alloy type or grade procured to the applicable specifications referenced in the production procedure/maintenance data.
- Thickness for both arc and gas welding processes are: Sheet 'A' - 1.2 mm and Sheet 'B' - 1.6 mm.
- If sheets of other thicknesses are used, the thicknesses of the sheets should be kept in these proportions. (Note authorisation may be subject to thickness conditions.)
- The plates should be positioned by tack welds on the opposite side to the weld and one weld shall be welded with Sheet 'A' in the vertical (as depicted in diagram 3).
- The second weld shall be with the weld joint in the overhead position.
- Completed welds may be cleaned with a wire brush but must not be dressed, hammered or sand-blasted. (Light tapping with a hammer to remove scale deposits is acceptable and is not regarded as a dressing operation.)
- Weld residue (flux, slag) shall be removed from the weld in the usual way.
- Pre or post-weld heat treatments, if required, must be performed in a similar manner to that required for production weld procedures/specifications.

Note: The welding examination sample must be submitted to the Weld Testing Agency intact. The testing agency is responsible for the preparation of the particular test pieces.

AIRCRAFT WELDING EXAMINATION No. 4

JOINT No. 4 — TUBE TO TUBE WELD



NOTE: Vent holes should not be drilled in the tensile test piece vertical tube 'A'.

Weld for aircraft welding examination No. 4

- For the purposes of undertaking the aircraft welding examination No. 4, a person must carry out a Joint No. 4 - tube to tube weld in accordance with the specifications set out in diagram No. 4.
- All measurements are nominal and in millimetres (mm).
- The examinations must be carried out using parent metals of the same alloy type or grade procured to the applicable specifications referenced in the production procedure/maintenance data.
- Each tube has a diameter of 19 mm. Thicknesses for oxy-acetylene (gas), GMAW (MIG) and GTAW (TIG) welding processes are: Tubes 'A' - 0.9 mm wall thickness and Tubes 'B' - 1.4 mm wall thickness
- For other arc welding processes substitute tubes of 2.0 mm wall thickness for 1.4 mm and 1.6 mm wall thickness for 0.9 mm wall thickness.
- If tubes of other thicknesses are used they should be kept in these proportions. (Note authorisation may be subject to thickness conditions.)
- The tubes shall be prepared assembled (in the manner shown in diagram No. 4) in a jig and tacked.
- The assembly is then to be removed from the jig and mounted in a vertical position with the longest tube horizontal and at the lowest point (as depicted in diagram 4).
- The assembly shall not be moved from this position during the process of completing the welds.
- The uppermost joint which is formed by the short horizontal, vertical and diagonal tubes shall be welded by the overhead technique and the remaining joints completed by working around the joints.
- Completed welds may be cleaned by wire brush, but must not be dressed, hammered or sand blasted. (Light tapping with a hammer to remove scale deposits is not regarded as a dressing operation.)
- Weld residue (flux, slag) shall be removed from the welds in the usual way.
- Pre or post-weld heat treatments, if required, must be performed in a similar manner to that required for production weld procedures/specifications.

Note: The welding examination sample must be submitted to the Weld Testing Agency intact. The testing agency is responsible for the preparation of the particular test pieces.

AIRCRAFT WELDING EXAMINATION No. 5
JOINT No. 5 — PRODUCTION/REPAIR PART WELD

Weld for aircraft welding examination No. 5

- For the purposes of undertaking the aircraft welding examination No. 5, a person must carry out a weld on:
 - ◇ an aircraft part that is no longer intended for use in an aircraft or as a part of an aircraft, or
 - ◇ a simulated aircraft part made of a metal of a type and grade that is the same as that metal to be used for the production or repair part,

using the procedures, joint configuration, welding positions, equipment and consumables specified for the production or repair weld.

Note: The welding examination sample must be submitted to the Weld Testing Agency intact. The testing agency is responsible for the preparation of the particular test pieces.

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PART 2 - EXAMINATION ASSESSMENT CONSIDERATIONS

ASSESSMENT STANDARD

Under the provisions of regulations 33D, 33G and 33H, for the grant, renewal or change of an aircraft welding authority CASA must be satisfied that an applicant has passed the aircraft welding examinations considered necessary in the interest of the safety of air navigation. Fundamental to passing an aircraft welding examination is the satisfactory assessment of the completed weld and welded joint.

To ensure that standardisation is maintained nationally, assessments of the aircraft welding examinations are to be conducted by an organisation accredited by the National Association of Testing Authorities (NATA) Australia to test metal welds.

Assessment of the weld is to be based on consideration of the entire test sample including visual examination, metallographic examination and mechanical tests where relevant. Where doubt exists as to the acceptability of a sample, or if it is thought that a defect may be of a local nature, further sections should be examined and the assessment of the sample based on all the sections examined.

The assessments required for each aircraft welding examination joint sample are as follows:

- Joint No. 1 – Sheet to Sheet Butt Weld: Visual Examination; Bend Test (AS 2205.3.1); Tensile Test (AS 2205.2.1); and Metallographic Test (AS 2205.5.1).
- Joint No. 2 – Tube to Sheet Fillet Weld: Visual Examination and Metallographic Test (AS 2205.5.1)
- Joint No. 3 – Sheet to Sheet Fillet Weld: Visual Examination and Metallographic Test (AS 2205.5.1).
- Joint No. 4 – Tube to Tube Weld: Visual Examination; Tensile Test (AS 2205.2.1) and Metallographic Test (AS 2205.5.1).
- Joint No. 5 – Aircraft Part or Part Typical of Production Weld: Visual Examination and Metallographic Test (AS 2205.5.1).

VISUAL EXAMINATION

The entire weld is to be examined. Inspection should be performed at magnification of up to 3 times for welds in parent metal up to 1.6 mm, and without magnification for thicker metals.

Features to be Examined:

The contour and weld dimensions should be examined for the following features:

- The transition from the surface of the parent metal to the weld face is to have a reasonably smooth blended contour, free from excessive undercut or an abrupt edge to the reinforcement at the toe of the weld. Some undercut in parent metal thicknesses of 1.6 mm and above is acceptable where it does not exceed the following amounts, 0.05T or 0.08 mm whichever is the lesser for butt welds and 0.1T or 1.6 mm whichever is the lesser for fillet welds.
- The weld face should be reasonably smooth, free from cavities and other surface defects. The ripple pattern should be regular, and the depth 'B' (Figure 2) of occasional depressions is not

to exceed $0.15T$, where 'T' is the thickness of the thinner parent metal. The weld and adjacent parent metal should be free from excessive weld spatter.

- The weld width 'W' (Figures 1 and 2), should be reasonably uniform, and for butt welds the weld width is to be the minimum necessary for the weld metal to penetrate the joint as specified below.
- For butt welds the joint should have complete penetration evidenced by a penetration bead (see Figure 1), or the absence of an unfused joint line at the root of the weld (see Figure 3).
- Butt weld reinforcement 'R' (Figure 1) is to be present and should preferably be approximately $0.3T$, but should not exceed $0.5T$.
- For external corner welds, the actual throat thickness 'A' (Figure 10) is to be not less than 'T', weld width 'W' and reinforcement 'R' should be the minimum necessary to obtain complete penetration of the joint as evidenced by a penetration bead or the absence of an unfused joint line at the inside corner.
- The presence and extent of warping or misalignment.
- The presence of hard spots or cracking caused by stray arc strikes adjacent to, or on the weld

Unacceptable Welds:

Welds which exhibit any type of crack, incomplete joint penetration, underfill or overlap and stray arc strikes made on the parent metal in a position adjacent to or other than the weld preparation are unacceptable.

TENSILE TESTS

Method of Test:

The tensile test pieces shown in Joints No. 1 and No. 4, (Diagrams 1 and 4 of Part 1) are to be cut from the sample and tested to destruction in tension in accordance with the procedure specified in Australian Standard (AS) 2205.2.1 - Transverse Butt Tensile Test. The ultimate tensile stress (calculated on the minimum cross-sectional area of the sample neglecting the weld) and the position of the failure should be recorded.

Acceptable Features:

The weld is considered satisfactory when the failure occurs in the parent metal. Test samples failing at the toe of the weld or in the weld metal are satisfactory only when the fracture surfaces are free from defects and the weld conforms with all other requirements.

Unacceptable Features:

The fracture surfaces are to be examined at a linear magnification and the presence of defects such as cracking, large pores, lack of fusion and excessive porosity or inclusions are cause for rejection. Unless otherwise specified, the ultimate tensile strength should not be less than 90% of the strength of the parent metal.

BEND TEST

Method of Test:

The bend test piece (Diagram 1 of Part 1) is to be cut from the sample and tested with the weld lying along the centre line of the bend with the weld face (the side from which the welding was performed) on the outside of the bend in accordance with the procedure

specified in AS 2205.3.1 - Transverse Guided Bend Test Method. The test piece is to be dressed on both sides e.g., by filing or grinding, so that the weld metal is flush with parent metal. The edges of the test piece should be given a reasonable radius. Bending is to be carried out by the application of continuous pressure.

Extent of Bend Tests:

The test sample is to withstand bending through an angle of 180° over a radius of twice the nominal thickness, 'T', of the test sample without breaking or developing a crack visible to the unaided eye, except for the material listed in the following table and where the material specification for the parent metal specifies a less severe bend.

Material	Angle of Bend	Radius of Bend (degrees)
Magnesium Alloys	180	10T
Aluminium Alloys containing more than 6% Mg	180	5T
Aluminium Alloys of the 6061-6063 Type	180	8T
Cr-Mo Steels of the 4130 Type*90		4T
Titanium Alloys: Tensile Strength Less than		
516 Mpa	180	3T
516-827 Mpa	180	5T
827-965 Mpa	180	8T
965-1069 Mpa	180	10T
1069-1171 Mpa	180	14T
Martensitic and PH Stainless Steels and PH Nickel Alloys	Not Applicable	

* After any pre or post-weld heat treatments similar to production welds represented by the test samples.

METALLOGRAPHIC EXAMINATION

Method of Test:

The metallographic (macro) tests are to be carried out in accordance with the procedure specified in AS 2205.5.1 - Macro Test - Cross Section Examination Method. Sections are to be taken from each test sample at the following locations and prepared for metallographic examination as follows:

- Joints No. 1 to 4: At the approximate locations shown in the relevant joint sketches (Diagrams 1 to 4 of Part 1).
- Joint No. 5: At appropriate locations to cover each type of joint in the weldment.

An additional sample should be prepared and examined if doubt exists as to the acceptability of the sample. The sections are to be taken transverse to the direction of welding at locations where the weld quality appears poorest, except that the start and finish sections of the sheet samples should be avoided.

Weld Assessment Criteria:

The sections should be examined unetched and etched at magnification of up to 5 times and where appropriate, reported in accordance with the following requirements:

- The depth of fusion of fillet welds 'F' (Figures 4 to 7) shall be at least 0.15T, where 'T' is the thickness of the thinner parent metal.
- The size of fillet welds 'S' (Figures 4 and 5) are to be not less than the following values, where 'T' is the thickness of the thinner parent metal:

Parent Metal Thickness (mm)	Minimum Weld Size
0.254 - 0.635	2.4T
0.660 - 1.270	1.6T
1.295 - 2.285	1.3T
2.310 - 3.175	1.1T
3.200 and over	T

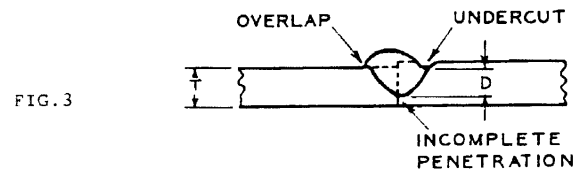
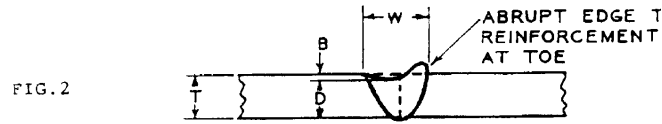
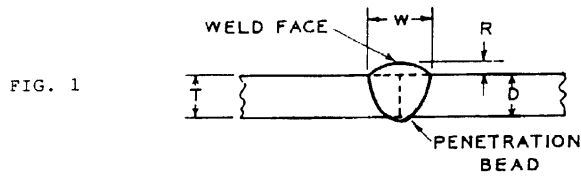
- The design throat thickness of fillet welds 'D' (Figure 4) should not be less than 0.7 x the minimum weld size 'S' as specified above.
- In fillet welds some lack of complete root fusion is acceptable where the following conditions exist. In all other cases complete root fusion is required.
 - ◇ For welds of approximately 45<198> included angle, the unfused distance 'X' (refer Figure 6) should not be greater than 1/3 of the distance 'Y'.
 - ◇ For welds of approximately 30<198> included angle, the presence of a cavity and an unfused section is permissible provided that the throat thickness 'D' is not less than the minimum weld size 'S' specified above (refer Figure 7)
 - ◇ For welds of 90<198> in sheets or tubes where the base metal thickness is equal to or less than 1.6 mm incomplete root fusion of either weld leg for a distance 'X' of not more than 0.3 times actual throat size 'D' is acceptable (refer Figure 8) provided that the actual throat thickness is not less than the minimum weld size 'S' specified above.

- ◇ For lap welds the actual throat thickness 'A' (Figure 9) and the weld size 'S' should be not less than 'T'; depth of fusion 'F' should be not less than 0.15T.

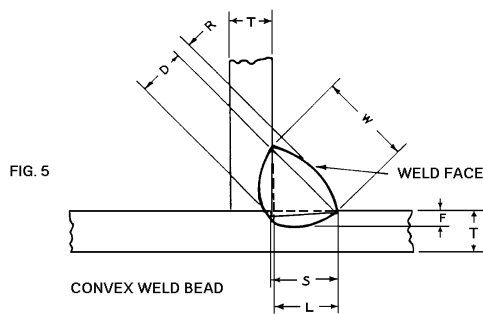
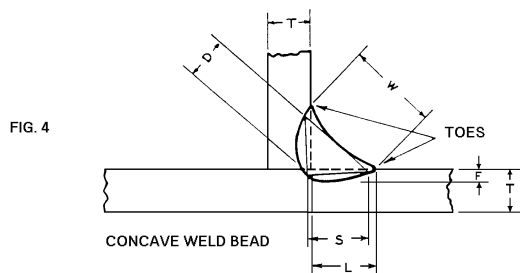
Unacceptable Weld Features:

Welds which exhibit any of the following defects are unacceptable.

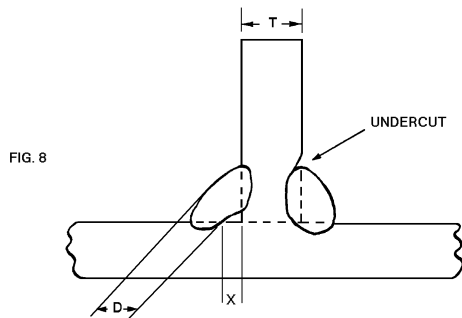
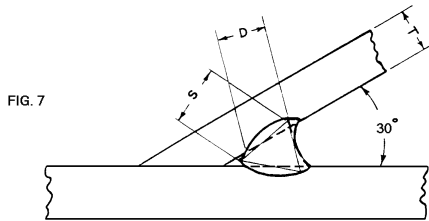
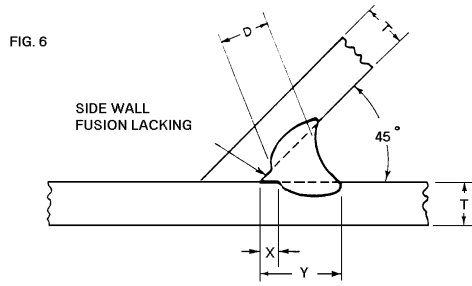
- Cracks.
- Incomplete fusion at the weld face except for the cases stated above.
- Undercut in excess of the amounts stated in the visual examination.
- Overlap.
- In fillet welds a ratio of the leg of the larger size to the leg of the smaller size of greater than 1.5 at any cross section.
- A leg length more than $6T$ or $T + 4.5$ mm whichever is the lesser for fillet welds in parent metal thicknesses equal to or less than 1.6 mm (where members differ in thickness 'T' are to be based on the thinner member).
- In convex fillet welds a convexity in excess of 0.1 times the average weld leg length at any location.
- In concave fillet welds, an actual throat size of less than $0.5T$ at any cross section. Where members differ in thickness 'T' are to be based on the thinner member.
- Excess penetration at the tube or sheet face opposite the weld bead in fillet welds of more than 1.6 mm thickness. In thickness up to and including 1.6 mm, excess penetration may extend for a distance of not more than the tube or sheet thickness 'T' beyond the tube or sheet wall.
- An individual pore size of $0.4T$ or 2.5 mm whichever is the lesser (where members differ in thickness 'T' is to be the thickness of the thinner member).
- Excessive porosity. Inclusions such as Tungsten shall be counted as porosity. All defects less than 0.05 mm size in parent metal thicknesses, up to 1.6 mm and less than 0.12 mm or $0.03T$ size, whichever is the lesser in parent metal thicknesses above 1.6 mm, are to be disregarded. Where porosity or the maximum pore size appears excessive, the weld is to be sectioned at other locations or broken open (nick-break) and a length of the weld examined. The assessment is to be based on the weld length of all metallographic sections.
- Any other defects which are attributable to unsatisfactory welding techniques or any unsatisfactory knowledge of welding consumables or the parent metals used.



B = DEPRESSION DEPTH
 D = DESIGN THROAT THICKNESS
 R = REINFORCEMENT
 T = THICKNESS OF THE THINNER PARENT METAL
 W = WELD WIDTH

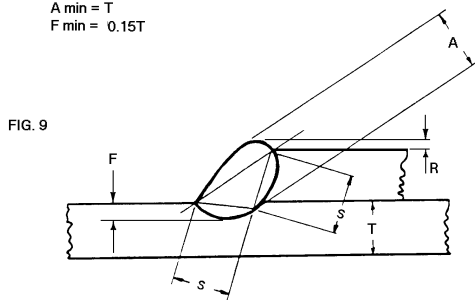


D = DESIGN THROAT THICKNESS
 F = FUSION DEPTH - MAXIMUM
 L = LEG LENGTH
 R = REINFORCEMENT
 S = SIZE OF WELD
 T = THICKNESS OF THE THINNER PARENT METAL
 W = WELD WIDTH

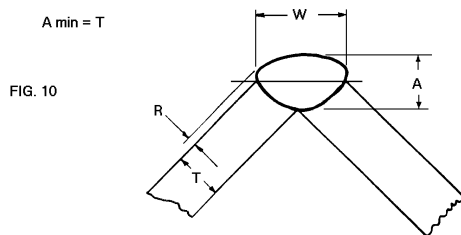


D = DESIGN THROAT THICKNESS
 T = THICKNESS OF THE THINNER PARENT METAL
 S = SIZE OF WELD

S min = T
 A min = T
 F min = 0.15T



A min = T



A = ACTUAL THROAT THICKNESS
 F = DEPTH OF FUSION - MAXIMUM
 R = REINFORCEMENT
 S = SIZE OF WELD
 W = WELD WIDTH