



REVISIONS

U I C CODE

897-4

Leaflet to be classified in Volumes:

V - TRANSPORT STOCK

VI - TRACTION

VIII - TECHNICAL SPECIFICATIONS

OR

2nd edition, 1-1-1987

Leaflet 897-4, 2nd edition, 1-1-1987

Amendment

Amendment

| No. | date | No. | date |
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TECHNICAL SPECIFICATION
FOR THE ACCEPTANCE AND SUPPLY
OF COMBINATIONS OF WIRE ELECTRODES AND FLUX
FOR AUTOMATIC SUBMERGED ARC WELDING
OF CARBON, CARBON-MANGANESE AND LOW-ALLOY STEELS (1)

(1) This leaflet is:

- *obligatory* for all technical documents prepared by the UIC and the ORE.
- *recommended* for technical documents of the UIC member Railways.

**NUMERISATION DANS
L'ETAT DU DOCUMENT**

NOTE

This leaflet is part of a set which also includes:

- Leaflets in sub-section 89 (897): Welding

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1 - PURPOSE

1.1 - This specification covers the acceptance of combinations of wire electrodes and flux for automatic submerged arc welding of carbon, carbon-manganese and low alloy steels used for the manufacture and repair of rolling stock.

It lays down the minimum conditions required, for acceptance purposes and for checking that the supplied items comply with the approved quality levels.

1.2 - Classification

The wire electrodes and the flux shall be defined in the order or its appended documents by the systems of symbols laid down in UIC Leaflet 897-5.

2 - CHARACTERISTICS

2.1 - Wire electrodes and flux

2.1.1 - Physical characteristics

2.1.1.1 - Wire electrodes

The wire electrode shall be of uniform quality, with no trace of segregation or oxides, flaws or other irregularities.

The surface of the wire electrode shall be completely clean, free from oil, grease, paint, etc.

The covering shall be uniform in thickness with no surface cracks or scaling.

The wire electrode shall have no defect making it difficult to unreel.

2.1.1.2 - Flux

The flux shall be granulated and flow easily in the feed tubes, valves and hoses of welding equipment in normal use.

It shall be absolutely dry and contain no foreign bodies.

Under normal conditions of voltage and current, there must be no difficulty in striking and re-striking an arc, nor any chance of accidental extinction of the arc.

The slag must be easily removable when cold by means of a hand tool.

2.1.2 - Chemical composition

The chemical composition of the wire electrode shall conform with that laid down in the order or its appended documents; if no indication is given on these documents the chemical composition shall comply with that given in UIC Leaflet 897-5.

2.1.3 - Geometrical characteristics

2.1.3.1 - Wire electrode

The tolerances allowed on the nominal diameter of the wire electrode shall conform to those laid down in the order or its appended documents; if no indication is given on these documents, the following tolerances shall be complied with:

| Nominal diameter (mm) d | Tolerance (mm) |
|-------------------------------|-------------------|
| $d \leq 1.6$ | + 0.01 - 0.04 |
| $1.6 < d \leq 3.2$ | + 0.01 - 0.05 |
| $3.2 < d$ | + 0.01 - 0.06 |

The wire electrode shall be coiled in one continuous length obtained from the same cast or from the same ingot, with no bends, corrugations or folds. The wire shall be wound so that the coils can unwind without becoming entangled or crossing each other.

The terminal end of the wire electrode shall be firmly and clearly fixed.

2.1.3.2 - Flux

The grain size shall conform to that laid down in the order or its appended documents.

If no indication is given on these documents, the grain size shall be that shown in document IIS-IIW-545-78.

2.1.4 - Marking

Each package must carry a label with the following information:

- name of the manufacturer,
- batch number
- symbols for the product in accordance with UIC Leaflet 897-5,
- diameter of the wire electrode (in mm),
- net weight of the wire electrode or flux, excluding packaging,
- type and minimum and maximum values of current to be used,
- special provisions for storage and use.

The date of manufacture or a code enabling this date to be determined, shall be indicated if required in the order or its appended documents.

2.2 - Weld deposit and welded joint

2.2.1 - Limits for permissible defects

During acceptance and quality control testing no defect in a test weld, due specifically to the electrode wire and flux combination, shall be accepted.

The limits for permissible defects are those in classes E15 and A1 in UIC Leaflet 897-12, Appendices 2 and 3.

2.2.2 - Mechanical properties

2.2.2.1. - Weld deposit (values recorded on test pieces covered by Appendix 1 to this specification)

The tensile test values must satisfy the values shown in UIC Leaflet 897-5.

Notched bar impact strength: the test temperatures are:

| First symbol for notched bar impact strength | Test temperature (°C) |
|--|-----------------------|
| 0 | - |
| 1 | + 20 |
| 2 | 0 |
| 3 | - 20 |
| 4 | - 30 |
| 5 | - 40 |

The average value (over 3 tests) of the absorbed energy for this first symbol for notched bar impact strength shall be greater than or equal to 28 J, no value being less than 20 J.

| Second symbol for notched bar impact strength | Test temperature (°C) |
|---|-----------------------|
| 0 | - |
| 1 | + 20 |
| 2 | 0 |
| 3 | - 20 |
| 4 | - 30 |
| 5 | - 40 |

The average value (over 3 tests) of the absorbed energy relative to this second symbol for notched bar impact strength shall be greater than or equal to 47 J, no value being less than 32 J.

2.2.2.2 - Welded joint (values recorded on test pieces covered by Appendix 2 to this specification)

The tensile strength shall be greater than the minimum value of the tensile strength of the parent metal.

Notched bar impact strength: see § 2.2.3.1 above.

Bending: bending through 180° in both directions over a former of a width equal to twice the thickness of the plate for steels in grades Fe 360 to Fe 430, and equal to three times the thickness of the plate for Fe 510 grade and low alloy steels must not reveal any cracking. Small superficial cracks which do not increase in depth when the bending operation is continued shall not be regarded as defects.

The presence of larger cracks in tests performed on receipt of materials shall give rise to further examination including a final bend test.

3 - MANUFACTURE

The method of manufacture and preparation of the products is left to the discretion of the manufacturer.

At the request of the purchasing Railway, the manufacturer shall give details of the production method of the flux together with details of the main characteristics of the granulated flux.

The manufacturer shall not modify the manufacturing conditions without advising the purchasing Railway.

4 - INSPECTION

4.1 - General

The manufacturer shall provide a continuous product quality control. He shall have the necessary installations and apparatus for this purpose.

Before submission, each batch of the wire electrode and flux combination shall be subjected to the specified tests at the responsibility of supplier.

The representative of the purchasing Railway shall check the inspection carried out by the manufacturer. He is authorised, to this end, to select test pieces.

4.2 - Submission for approval

4.2.1 - Condition on submission

The wire electrode and the flux shall be submitted ready for delivery.

4.2.2 - Batching for inspection

The wire electrode and the flux shall be submitted grouped into batches, each batch containing only products from the same production batch, of the same nominal diameter and in the same grade. The size of the batch shall be laid down in the order or its appended documents.

4.2.3 - Advice of submission

The date of submission shall be advised to the representative of the purchasing Railway in writing.

The above advice shall indicate the quantity of wire electrode and flux submitted in each batch, together with the relevant order details. On submission, a certificate stating that the provisions of this specification have been complied with shall be handed to the representative of the purchasing Railway.

4.3 - Inspection and testing

The wire electrode and flux shall be subjected to the following inspection and testings:

4.3.1 - For approval

| Type of inspections or tests required | Number of inspections or tests |
|--|--------------------------------|
| A - Inspection and testing of wire electrodes and flux | |
| - chemical composition (1) | 1 |
| - geometrical characteristics | 1 |
| - physical characteristics | 1 |
| B - Deposition test: | 1 |
| C - Tests on weld deposit (Appendix 1) | |
| - X-ray test (1) | 1 |
| - Tensile test | 1 |
| - Notched bar impact test. | 6 |
| D - Tests on welded joint (Appendix 2) | |
| - X-ray test | 1 |
| - Tensile test | 1 |
| - Notched bar impact test. | 6 |
| - Bend test | 2 |
| - Macrographic test | 2 |
| (1) To be laid down in the order of its appended documents. Other non-destructive inspection methods may be applied (ultrasonic, etc.). The tests are to be carried out according to a written procedure, appropriate to the type of welded joint to be tested and approved by the Railway. The acceptance limits are to be specified in detail. | |

4.3.2 - On receipt

The type and number of tests or inspections shall be the same as those for approval purposes. The purchasing Railway shall lay down the nature and number of inspections and tests required.

4.4 - Selection and preparation of the samples and test pieces

4.4.1 - Sampling

The representative of the purchasing Railway shall select

at random, from each batch submitted; the welding products for testing and shall mark the closed and sealed packages accordingly.

4.4.2 - Welding of samples

4.4.2.1 - General

The welded test pieces shall be produced by automatic welding using the selected products.

In accordance with ISO/R 630, the steel used shall be:

- Fe 360 to Fe 430 steel grades for combinations of wire electrodes and flux for which the tensile strength is between 430 and 510 N/mm²; these grades of steel shall be at least of quality B;
- Fe 510 grade or low alloy for combinations of wire electrodes and flux for which the tensile strength is between 510 and 610 N/mm² or 570 and 710 N/mm²; these grades of steel shall be at least of quality C;
- low alloy steel grades for combinations of wire electrodes and flux for which the tensile strength is \geq 650 N/mm²; these grades of steel shall be at least of quality C.

The dimensions of the samples shall conform to those laid down in Appendices 1 and 2.

The welding shall be carried out in accordance with the relevant code of practice. The direction of welding shall be reversed for each run.

It is recommended that the welds begin and terminate on separate run-on run-off plates attached to the main test plates.

The welding parameters (current and speed of welding) shall be kept within the limits recommended by the manufacturer.

Between each run, the weld shall be allowed to cool in still air to a temperature of 250°C at the surface at mid-length of the sample and at 30 mm from the edges of the weld.

No repair is allowed.

4.4.2.2 - Nature of the samples and test pieces

The samples shall conform with Appendices 1 and 2. They shall be welded for the approval tests with a wire electrode of 4 mm diameter of the same grade and the flux of the same manufacturer as the wire electrode and the flux to be tested.

4.4.3 - Preparation of the test pieces

4.4.3.1 - X-ray examination

The X-ray examination shall be carried out on the welded samples before sectioning takes place.

4.4.3.2 - General

Excess weld metal shall be dressed flush.

The cutting and final machining of the test pieces shall be carried out cold and with due precautions to ensure that no appreciable heating of the metal takes place.

The edges shall be dressed with a file or other suitable hand tool.

The samples and test pieces shall not undergo any heat treatment or mechanical working (1).

4.4.3.3 - Tensile, impact and bend tests

The various test pieces shall be selected as indicated in:

- Appendix 1 to this specification in the case of tests on weld deposits,
- Appendix 2 to this specification in the case of tests on welded joints.

(1) However, to accelerate the diffusion of hydrogen, the tensile test piece for the weld deposit test may, with the agreement of the purchasing Railway, be heated to a temperature of 250°C before the test for a period of at least 6 hours, but not exceeding 16 hours.

4.4.3.4 - Macrographic examination

The macrographic examination shall be carried out on sections of the cut-off ends.

4.5 - Inspection and testing

4.5.1 - Dimensional inspection

4.5.1.1 - Wire electrode

The diameter shall be inspected over a length of 1 metre.

4.5.1.2 - Granulated flux

The purchasing Railway may provide for an inspection of the grain size of the flux in the order or its appended documents.

4.5.2 - Deposition test

The deposition test shall be carried out at the same time as the welding of the samples for tests on the weld deposit or on the welded joints.

4.5.3 - X-ray examination

The X-ray examination shall be carried out on the welded joints; the order or its appended documents shall specify the image quality indicator for appraising the radiographic sensitivity.

The presence of at least one image quality indicator (I.Q.I.) is obligatory.

The parts subjected to X-ray shall be clearly identified on the print.

4.5.4 - Tensile test

The tensile test shall be carried out in accordance with the

provisions of ISO/R 82. The test piece used shall be "the proportional test piece" for which the ratio between the original gauge length (L_0) and the original cross-sectional area of the gauge length (S_0) is:

$L_0 = 5.65 \sqrt{S_0}$, the transverse dimensions of the gauge length being as follows:

4.5.4.1 - for the test on weld deposit:

diameter: 10 mm.

4.5.4.2 - for the test on a welded joint:

those given in Appendix 2 to this specification.

4.5.5 - Notched bar impact test

The notched bar impact test piece and its testing shall be in accordance with the provisions of Recommendation ISO/R 148.

4.5.6 - Bend test:

The bend test shall be carried out in accordance with the provisions of recommendation ISO/R 85.

The dimensions of the test pieces shall be those given in Appendix 2 to this specification.

4.5.7 - Macrographic examination:

The order and its appended documents shall specify the quality of finish; the reagent used shall have the following composition:

- 3 g ammonium cupric chloride: $\text{Cu}(\text{NH}_4)_2\text{Cl}_4 \cdot 2\text{H}_2\text{O}$,
- 25 cc distilled water,
- 50 cc Hydrochloric acid (1.19),
- 15 g Ferric chloride.

4.6 - Results of tests

All unsatisfactory results shall cause rejection of the materials.

Where the results of visual examination, X-ray examination or macrographic examination are unsatisfactory, the sample shall be rejected.

A new sample shall only be welded with the prior agreement of the representative of the purchasing Railway.

5 - DELIVERY

5.1 - Preparation

The wire electrode may be supplied on a reel, bobbin or drum.

The dimensions, and the tolerances allowed on the dimensions of the reels, bobbins and drums shall conform with those laid down in the order or its appended documents. If no indication is given in these documents, the applicable dimensions shall be those laid down in document IIS-IIW-385-71.

5.2 - Protection

The packaging of the wire electrode and the flux must afford protection during transport or storage, against any damage, particularly that caused by dampness.

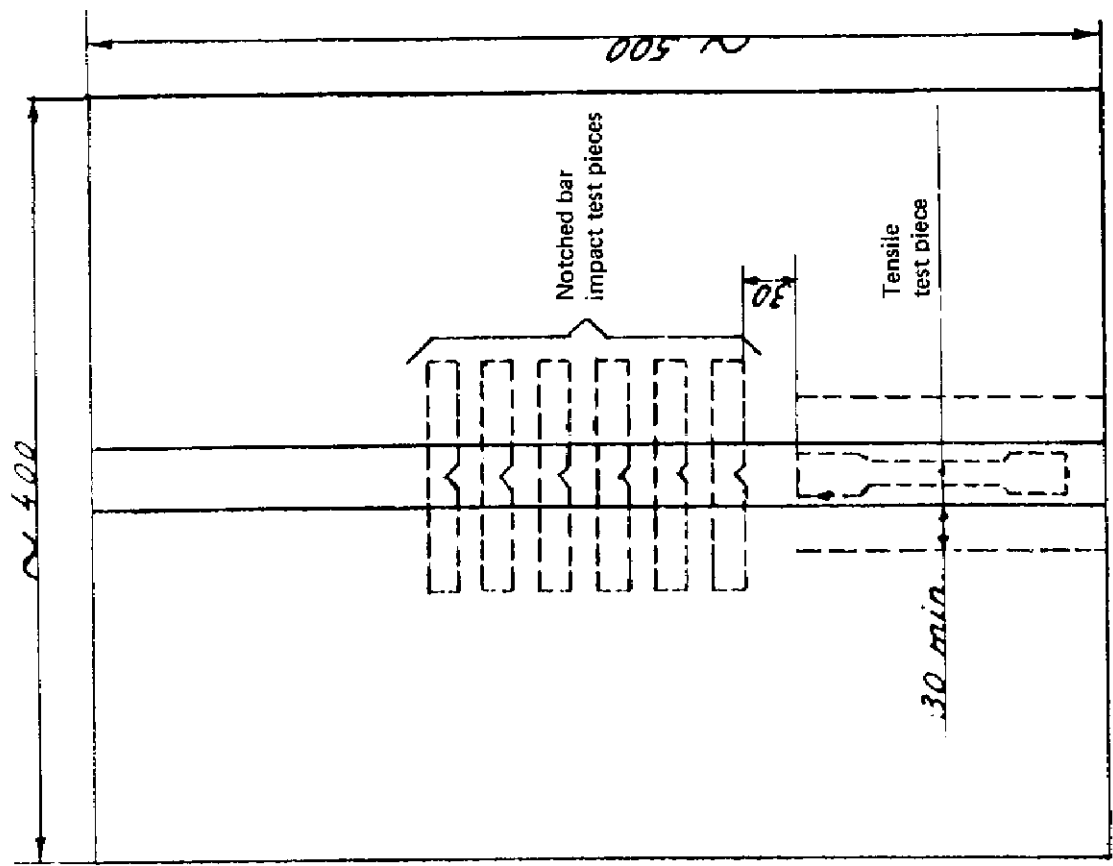
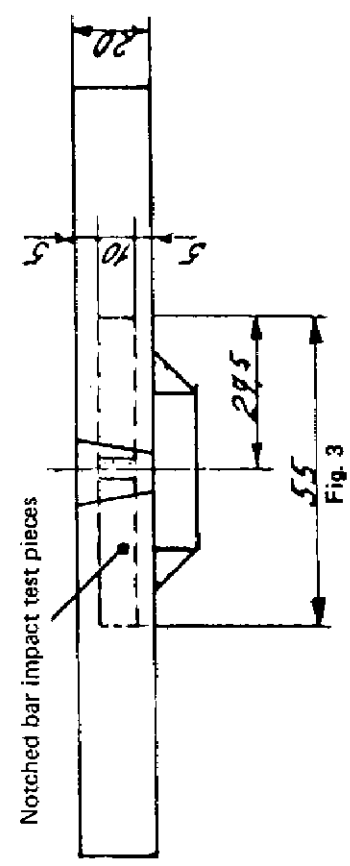
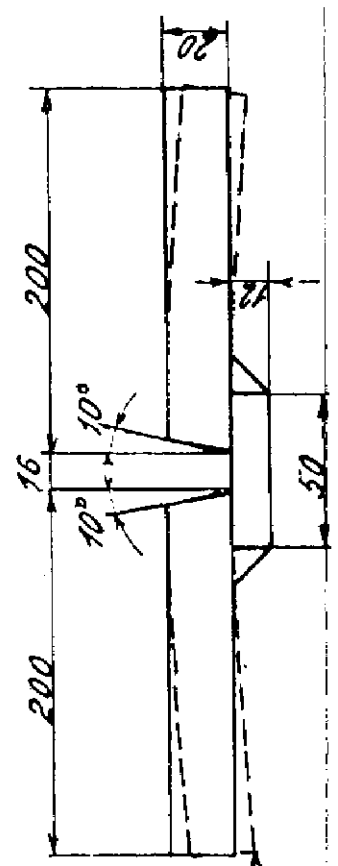


Fig. 1



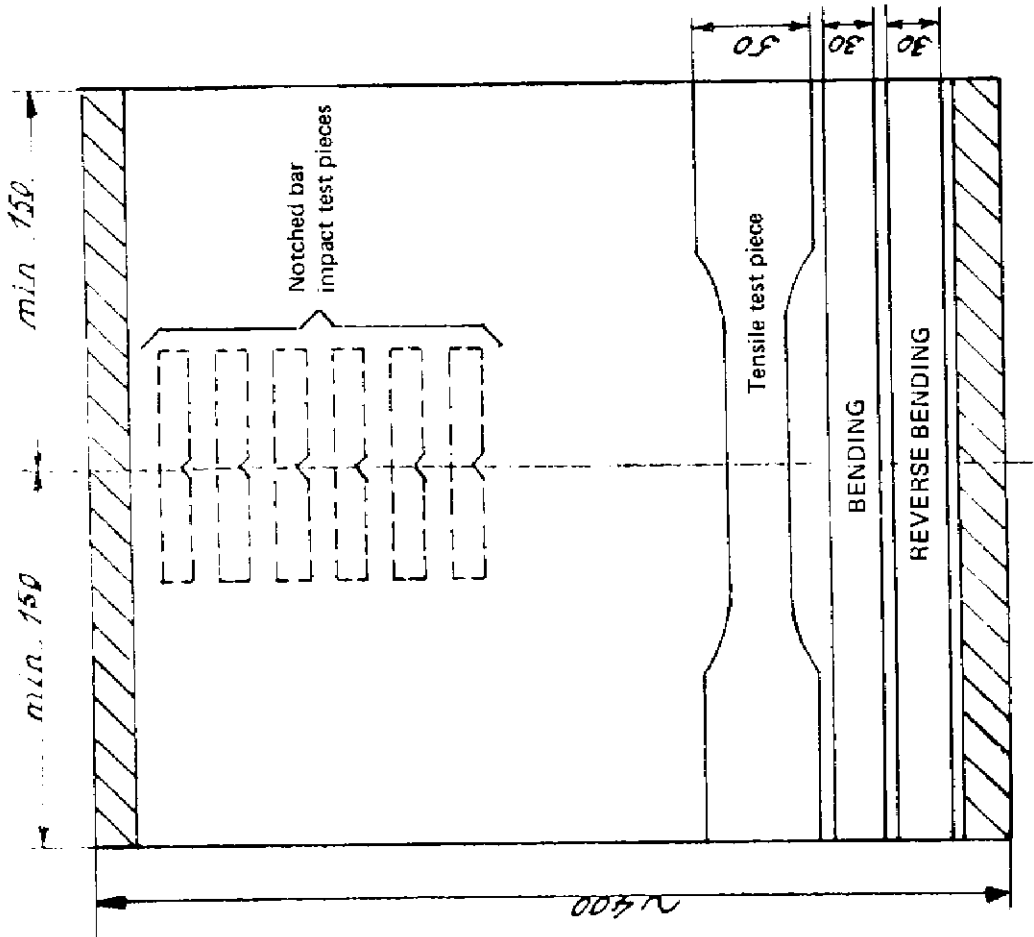


Fig. 2

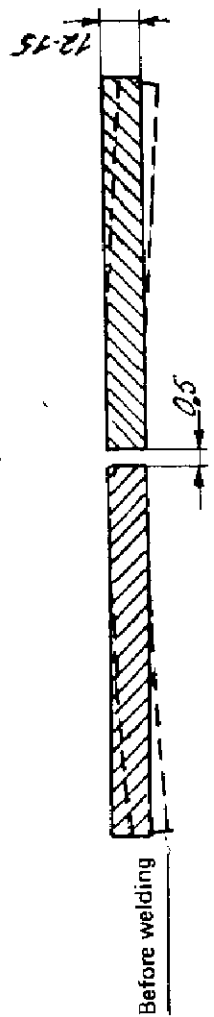


Fig. 3

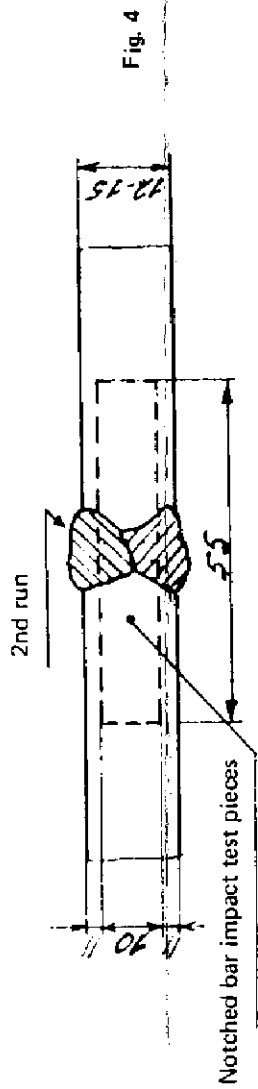


Fig. 4

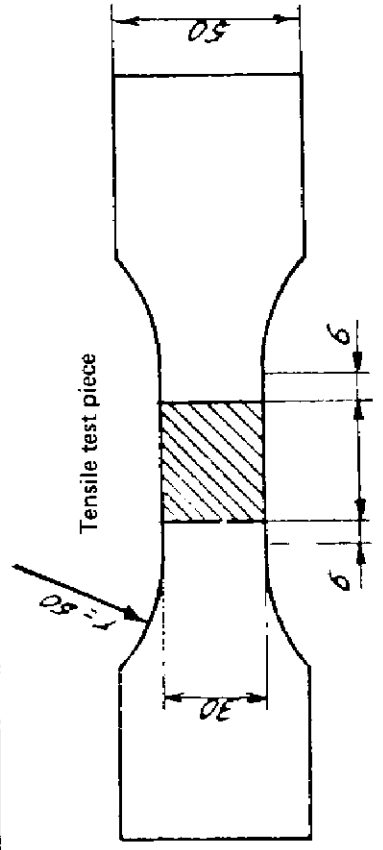


Fig. 5

APPLICATION

Effective from 1 January 1987.

All Railways in the Union.

RECORD REFERENCES

Heading under which the question has been dealt with:

- Question S/SA/FIC - Approval of revised leaflet 897-4
"Technical specification for the acceptance and supply of
combinations of wire electrodes and flux for automatic
submerged arc welding of carbon, carbon-manganese and low-alloy
steels".
(Traction and Rolling Stock Committee, Paris, June 1986).