AS 2346—1980

Australian Standard®

METHODS FOR THE DETERMINATION OF UNIFORM ELONGATION IN SHEET AND STRIP METALS

The following scientific, industrial and governmental organizations and departments were officially represented on the committee entrusted with the preparation of this standard:

- Aluminium Development Council
- Australian Institute of Metals
- Bureau of Steel Manufacturers of Australia
- Commonwealth Scientific and Industrial Research Organization
- Confederation of Australian Industry
- Department of Defence
- Federal Chamber of Automotive Industries
- Metal Trades Industry Association of Australia
- National Association of Testing Authorities
- Railways of Australia Committee
- Society of Automotive Engineers—Australasia
- University of Melbourne
- University of New South Wales
- University of Sydney

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PREFACE

This standard was prepared by the Association's Committee on Mechanical Testing of Metals at the request of the Metals Standards Board to provide standard methods whereby the formability of sheet and strip metals may be assessed by mechanical testing.

During preparation of this standard the committee considered other methods in use which call for multisectional test pieces, e.g. the 'circle arc' and the 'Sollac' methods, but decided against their inclusion because these methods are not in common use in Australia and because of problems associated with the preparation of test pieces which require unacceptably small tolerances for routine testing purposes, and further, because these methods are more sensitive to errors in parallelism and to errors caused by inhomogeneities in the metal than the methods included.

Methods that involve measurements between gauge marks on a parallel strip test piece which has been strained to the necking point or to the fracture point, have also been excluded because of inhomogeneity of strain causing unacceptable errors in the result.

Provision has been made at this stage for the use of a subsidiary gauge length for use in the testing of products. However, it is expected that the use of subsidiary gauge lengths will not be permitted when the standard is revised.

This standard requires reference to the following Australian standards:

AS 1391 Methods for Tensile Testing of Metals

AS 1545 Methods for the Calibration and Grading of Extensometers.

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FOREWORD

In the testing of metals in accordance with AS 1391 for their forming properties, the strain at maximum force in a tensile test provides valuable information on the formability of the metal, particularly where deformation is predominantly by tensile stresses, as opposed to a combination of tensile and compressive stresses.

The principal difficulty in making accurate measurements of strain at maximum force arises from the fact that, with most ductile metals, the force/extension curve has an extremely flat maximum, so that the strain at maximum force is not easily and precisely identified. This difficulty can be overcome either by using equipment with highly sensitive force measuring ability (direct method), or by using indirect methods which involve measurement of the slope of the tensile curve.

METHOD

1 SCOPE. This standard sets out methods for the determination of uniform elongation in sheet and strip metals. The standard specifically covers the following methods:

(a) Direct method.

(b) Indirect methods—

(i) Nelson-Winlock method*

(ii) Logarithmic-plot method.

2 DEFINITIONS. For the purpose of this standard, the definitions given in AS 1391 and the following apply:

Uniform elongation—the total extension at maximum force, expressed as a percentage of the original gauge length.

True stress—the force per instantaneous cross-sectional area.

True strain—the natural logarithm of the ratio of the deformed gauge length to the original gauge length.

3 SYMBOLS AND DESIGNATIONS. For the purpose of this standard, the symbols and designations given in AS 1391 and the following apply:

F_i = force at any instant 'i'
= force at e_i

L_i = gauge length at any instant 'i'

S_i = cross-sectional area of the test piece at any instant 'i'

e_i = nominal strain at any instant 'i'
= $(L_i - L_o)/L_o$

ε_i = true strain at any instant 'i'
= $\ln (L_i/L_o)$
= $\ln (1 + e_i)$

σ_i = true stress at any instant 'i'
= F_i/S_i

L_m = gauge length at maximum force

e_m = nominal strain at maximum force

ε_m = true strain at maximum force

A_m = uniform elongation
= $100 \times e_m$ percent.

4 PRINCIPLE.

4.1 Direct Method. A test piece is strained and changes in force and gauge length are recorded. The extension at maximum force is determined and the uniform elongation calculated.

4.2 Indirect Methods.

4.2.1 *Nelson-Winlock method.* The instantaneous value of the gradient in the $\ln \sigma_i/\ln \varepsilon_i$ curve, measured at the point of maximum force, is numerically equal to the true strain at that point (ε_m). The uniform elongation, A_m, can be calculated from the following formula:

$$A_m = 100 \, ([\exp \varepsilon_m] - 1)$$

The gradient of the curve, for some materials, is constant over a substantial portion of the curve up to and including the maximum force being reached. For these materials, the force at a value of strain which is less than the strain at maximum force and which lies within the region of the constant gradient curve is used to determine uniform elongation either by calculation or by the use of tables.

4.2.2 *Logarithmic-plot method.* The gradient of the $\ln \sigma_i/\ln \varepsilon_i$ curve is determined from a logarithmic plot of stress/strain values.

5 EQUIPMENT. The equipment shall be capable of performing tests in accordance with AS 1391. The grade of extensometer (if used) shall be Grade E or better.

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* 'Method of Determining the Percentage Elongation at Maximum Load in the Tension Test' by Paul G. Nelson and Joseph Winlock. *ASTM Bulletin*. January 1949.