UDC 669.141.25-4 : 61.74.002.6 : 620.1

January 1991

Technical delivery conditions for castings of metallic materials

Supplementary requirements for steel castings used for heavy-duty valves

DIN 1690 Part 10

Technische Lieferbedingungen für Gußstücke aus metallischen Werkstoffen; ergänzende Festlegungen für Stahlguß für höher beanspruchte Armaturen

The symbol • denotes items which shall, the symbol •• denoting items which may, be agreed upon at the time of ordering.

1 Scope and field of application

This standard specifies requirements for the pressure-containing components of heavy-duty valves (cf. subclause 2.2) made from steel castings. Such requirements are intended to supplement those given in DIN 1690 Parts 1 and 2.

Note. It is up to the purchaser to decide whether valves must be designed for heavy-duty service.

2 Concepts

In comparison with DIN 1690 Part 1, this standard specifies additional concepts (cf. subclauses 2.1, 2.2 and 2.4 to 2.8) and defines one concept differently (cf. subclause 2.3).

2.1 Quality levels

Table 1 specifies four quality levels to which castings may be assigned, as a function of the required freedom from defects. Castings complying with a certain quality level shall also comply with the corresponding severity level as specified in DIN 1690 Part 2, which deals with the internal and external condition of castings.

Table 1. **Quality levels**

Quality level	Severity level as in DIN 1690 Part 2	
	External	Internal
A	MS 1 or ES 1	RV 1 or UV 1
B	MS 2 or ES 2	RV 2 or UV 2
C	MS 2 or ES 3	RV 3 or UV 3
D	MS 3 or ES 4	RV 4 or UV 4

Factors relating to manufacture or service conditions, or a particular casting design (e.g. thick-walled) may necessitate that different combinations of severity levels be selected (e.g. higher levels where surfaces are in contact with chemicals or aggressive media).

2.2 Heavy-duty valves

For the purposes of this standard, heavy-duty valves are those which, should they not function properly, present a hazard to persons or property. The body of such valves is understood to include all components subject to internal pressure, even where such loading does not act on all parts of those components.

2.3 Production weld

A production weld is a weld carried out by the casting or valve manufacturer during production, the object of which is to ensure the required quality of the casting.

2.4 Acceptance batch

An acceptance batch is comprised of all castings that were produced under specified conditions and that were submitted for and subjected to testing. Where an acceptance batch is comprised of products originating from different casts, test pieces from each cast shall be tested.

2.5 Purpose-made castings

Purpose-made castings are castings of unique design (i.e. not intended for series production).

2.6 Prototype

For the purposes of this standard, a prototype is the first casting produced under the conditions specified for series production, on which no production welds are made until the results of non-destructive testing are established.

2.7 Pilot lot

A pilot lot is comprised of a representative number of castings (5 to 10) which, after prototype approval, are produced under specified conditions.

2.8 Castings in series production

Castings in series production are those produced under specified conditions (as for the pilot lot), it being possible to carry out such production at any time.

3 Ordering

3.1 • The required quality level or severity level combination (including scope of testing) of pressure-containing components made from steel castings shall be stated on the order.

Continued on pages 2 to 7

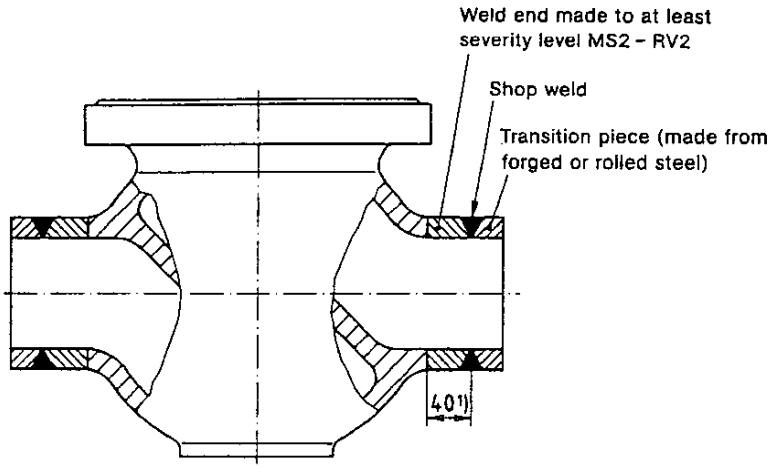

Figure 1. Valve with transition pieces

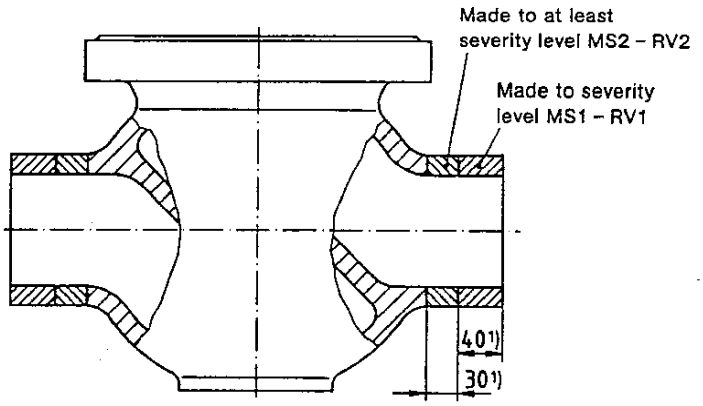

Figure 2. Valve without transition pieces

Where no specific quality level or severity level combination has been specified, the requirements of quality level D shall be complied with.

3.2 The manufacturer shall immediately check all pattern equipment supplied for its shape, dimensions, proper function, and suitability for producing the required number of castings, and inform the purchaser of any defects or deficiencies found.

4 Requirements

4.1 General

4.1.1 • Where valves are to be supplied with transition pieces made from rolled or forged steel, the weld ends shall comply with the severity level specified in figure 1, which corresponds to quality level B.

Where weld ends are of size DN 250 or greater, verification of compliance with the requirements of quality level B shall be provided. In the case of smaller welds ends, such verification may be dispensed with, provided the quality level of the valve body need not to be verified.

4.1.2 • Where valves are to be supplied without transition pieces made from rolled or forged steel, the weld ends shall be made to the severity level specified in figure 2, and proof of compliance with the relevant quality level shall be provided.

4.1.3 All other valve body parts (e.g. brackets, flanges, ribs) and other cast valve body components (e.g. obturators, levers) shall be produced to quality level D.

4.2 Valve production

4.2.1 Manufacturing process

Where a particular steelmaking process is not specified in the relevant material standard, the steel shall be made in an electric furnace or by means of an equivalent method.

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[1] • • Other values may be agreed at the time of ordering (e.g. in compliance with DIN 3840).

4.2.2 Production welds

All production welds carried out shall pass a welding procedure qualification test as specified in *Stahl-Eisen-Werkstoffblatt* (Iron and steel materials sheet) 110 or the equivalent.

Where such a test is carried out, it should be noted that, contrary to the specifications made in line 3 of tables 2.1 and 2.2 of that document, where welding is carried out using welding rod, an electrode or wire that is one size larger or smaller than the diameter specified, further testing must be carried out.

4.2.2.1 •• Unless otherwise agreed, production welds shall be carried out using filler metals which have been tested for suitability in accordance with *VdTÜV-Merkblatt* (VdTÜV Instruction sheet) 1153.

4.2.2.2 Where the results of the check for the surface condition or the internal soundness of pressure-containing components are unsatisfactory (cf. subclause 4.2.2.3), the procedure described in the flowchart overleaf shall be followed.

Production welds shall be checked for their surface condition and, where they are assigned to quality level A, B or C, for their internal soundness. In the case of holes in the valve body that are closed by welding, the surface condition of the weld shall be checked on both sides, along with radiographic or ultrasonic inspection.

The check for surface condition and, where required, ultrasonic inspection shall be carried out after final heat treatment, it being permitted to carry out radiographic inspection beforehand.

Where large zones have undergone extensive welding (i.e. over 40 % of the wall thickness, as defined in DIN 17 245), the documentation shall be as specified for procedure 2 in figure 3.

4.2.2.3 Where minor surface imperfections are detected after final heat treatment, and where such are to be remedied, the manufacturer and purchaser may reach agreement as to whether production welding is necessary, due consideration being given to the required design wall thickness.

Where castings made from GS-C 25, GS-C 25 N, GS-20 Mn 5 or GS-20 Mn 5 V steel have undergone welding in zones smaller than those specified in subclause 4.2.2.2, it may be agreed to dispense with stress-relieving, provided the other requirements specified in DIN 17 245 are complied with.

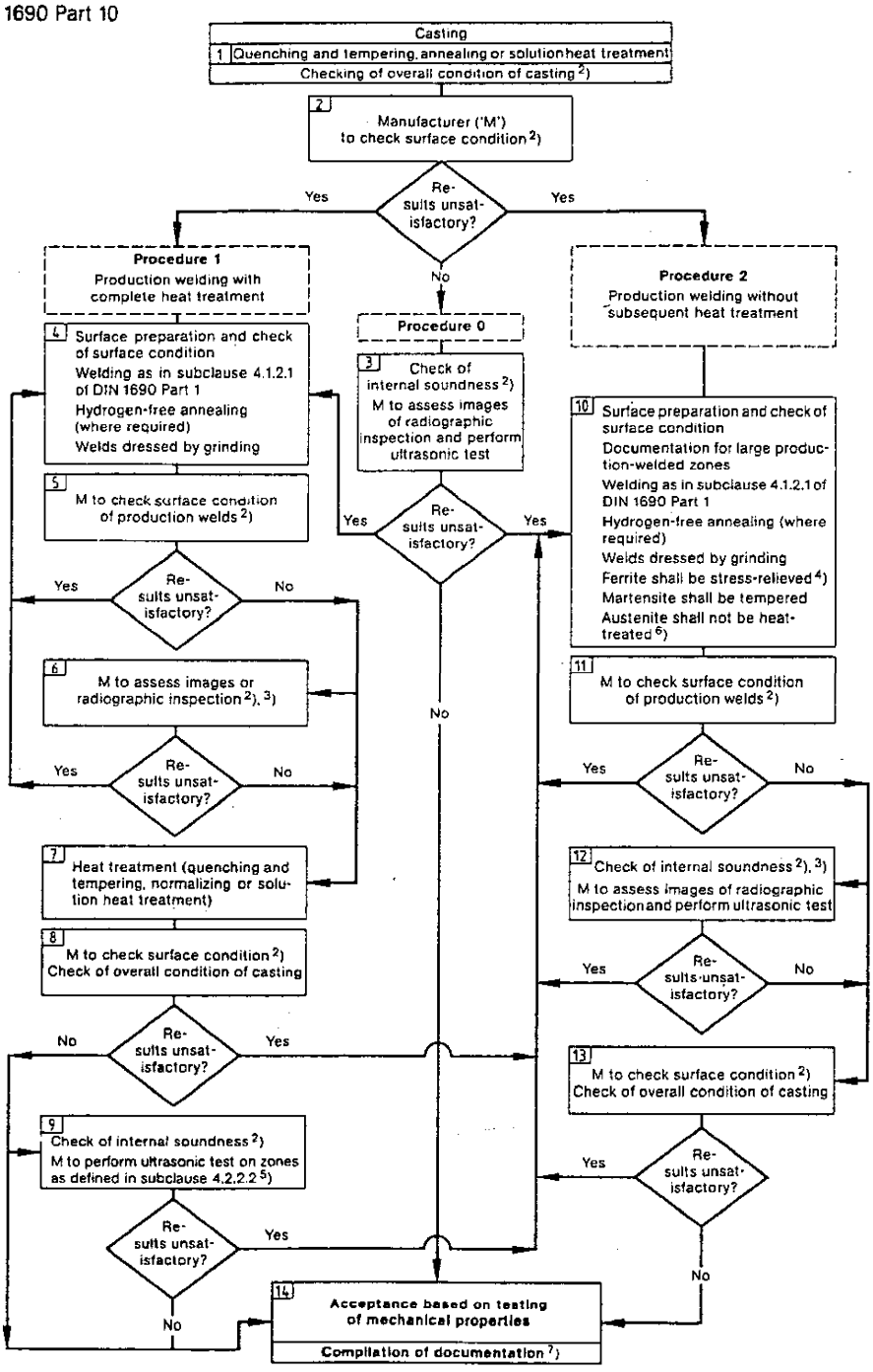

Figure 3. Flowchart for the production and testing of steel castings

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2) As specified in this standard.

3) Those parts of the casting and production welds which have already successfully undergone testing need not be retested.

4) The purchaser shall be consulted with regard to production welds required at a late stage of manufacture.
Cf. appendix B of DIN 17 245 with regard to castings made from GS-C 25, GS-C 25 N, GS-20 Mn 5 V or GS-20 Mn 5 N steel.

5) Ultrasonic testing of large production-welded zones shall also be carried out for castings made from GS-18 CrMo 9 10 (1.7379), GS-17 CrMoV 5 11 (1.7706), G-X 8 CrNi 12 (1.4107) or G-X 22 CrMoV 12 1 (1.4931) steel.

6) Provided the material, prior to heat treatment, is still resistant to intercrystalline corrosion (cf. table 5 of DIN 17 445) or such is achieved by reducing the carbon content.

7) Of the items given in the numbered boxes in the flowchart above, the following steps shall be documented, as a function of the relevant procedure (steps 2, 8 and 13 only where results are satisfactory):
procedure 0: 1, 2, 3 and 14;
procedure 1: 6, 7, 8, 9, 10, 12, 13 and 14;
procedure 2: 1, 10, 12, 13 and 14.

4.3 Mechanical properties

The requirements specified for the mechanical properties on which the particular design is based shall apply for all pressure-containing parts of the valve body.

4.4 Overall condition of casting

4.4.1 •• The surface of austenitic and ferritic-austenitic steel castings shall be blasted using, unless otherwise agreed, mineral or austenitic abrasives, use of ferritic abrasives not being permitted.

It may also be agreed that castings be pickled to have a matt finish which permits production welds to be recognized in the condition as supplied. The pickling solution used shall not contain hydrochloric acid.

4.4.2 Internal and external imperfections shall be remedied.

4.4.3 The surface appearance of castings shall be assessed on the basis of comparison with the sample images given in *Technische Empfehlung* (Technical Recommendation) 359-01, issued by the *Bureau de Normalisation de l'Industrie de la Fonderie* (Standardization Office of the Foundry Industry), as follows:

a) castings not subjected to non-destructive testing shall comply with at least sample image 4 S 1 or 4 S 2;
b) castings subjected to radiographic, magnetic particle or ultrasonic inspection shall comply with at least sample image 3 S 1 or 4 S 2;
c) castings subjected to liquid penetrant inspection shall comply with at least sample image 3 S 2.

4.4.4 •• Unless otherwise agreed, the information given in table 4, footnotes 2 and 4, of DIN 1690 Part 2 does not apply to the castings covered here, nor are chaplets or chills permissible.

4.4.5 The pressure-containing parts of the valve body shall be sound.

5 Testing

Samples shall be taken that are representative of the entire cross section of the pressure-containing part of the valve body. Where possible, samples shall be cast on.

5.1 Scope of testing

5.1.1 All parts of castings belonging to quality level A or B shall be checked for their surface condition and internal soundness by suitable means (cf. subclause 5.2).

Assuming the foundry is subject to quality control procedures, the scope of testing required for castings to comply with quality level C or D shall be as follows.

5.1.1.1 Quality level C castings

All purpose-made castings, prototypes and pilot lots shall be checked for their surface condition and internal soundness.[8]) All castings in series production need only be checked for their surface condition.

Samples taken at random shall be checked for their internal soundness, the following having been satisfied (see table 2 for number of test pieces).

a) A set of one to three samples shall be taken from the initial cast in the case of new designs, new pattern equipment, and whenever a change is made to production or design, or different materials are used.
b) The following particulars shall be documented for the samples taken as above:
   1. the results of the check for dimensional accuracy, material quality, surface condition, internal soundness and, where requested, condition of cut faces;
   2. a description of the casting process and the feeding and gating system;
   3. a description of production conditions (e.g. moulding plant, coremaking process, moulding material, coating/dressing, casting temperature, etc.).

   •• Such documentation shall be kept on file by the casting manufacturer for seven years after the end of production, unless otherwise specified.

After the prototypes have been properly documented, a pilot lot (cf. subclause 2.7) shall be checked non-destructively for surface condition and internal soundness. Checking the pilot lot is intended to reveal any casting zones that would be likely to pose problems during the casting process.

The conditions specified for production of the prototype shall be complied with for series production.

Should any changes be made during series production to the processes or materials used (e.g. to optimize the design or to correct errors), the valve manufacturer shall be immediately notified of such.

5.1.1.2 Quality level D castings

Quality level D is regarded as the customary standard of quality with which a competent valve castings works can be expected to comply. The scope of testing shall be as follows.

All prototypes shall be checked for their surface condition and internal soundness.[8])

All castings in series production, where the mass of a unit is greater than 50 kg, shall be checked for their surface condition. That of random samples from units weighing 50 kg or less shall be checked, if so recommended by the valve casting works. Subclause 5.1.1.1 shall be complied with in respect of random sampling.

The number of samples to be checked for their internal soundness shall be as specified in table 2.

5.1.2 All sides of all castings shall be visually checked for compliance with the relevant technical drawing and with the relevant sample image specified in subclause 4.4.3. It may be agreed to visually check random samples of castings in series production.

5.2 Test procedures

5.2.1 Check of internal soundness

Where castings made from ferritic, pearlitic or martensitic materials have a wall thickness up to 60 mm, the check of internal soundness shall preferably be made by radiographic inspection.

•• Use of ultrasonic testing for wall thicknesses up to 60 mm may be agreed at the time of ordering.

• In the case of wall thicknesses over 60 mm, the test method used shall be agreed at the time of ordering.

• Where ultrasonic testing is used, the assessment criteria specified in table 3 of DIN 1690 Part 2 shall be the subject of agreement.

Austenitic castings shall undergo radiographic inspection.

5.2.1.1 • The images with which castings checked by means of radiographic inspection are to comply shall be the subject of agreement.

Quality level A or B castings as specified here shall comply with test class B as specified in DIN 54 111 Part 2, except for valve bodies with a nominal size of not more than DN 150, where the minimum source-to-object distance may be in

[8]) •• Instead of the check for internal soundness, it may be agreed to make cuts through the valve body at different locations, their number and location also being the subject of agreement.

Table 2. **Scope of testing for the check of internal soundness for quality level C or D valves in series production** [1), 2)]

Line	Results of check of pilot lot [3)]	Quality level C	Quality level D
1	Pilot lot unsatisfactory.	All zones in which imperfections were detected, plus an internal soundness check of all surfaces of samples numbering 10% of an acceptance batch, or at least three.	All zones in which imperfections were detected, plus an internal soundness check of such zones complying with quality level D, on samples numbering 10% of an acceptance batch, or at least three.
2	Pilot lot satisfactory.	Internal soundness check of all surfaces of samples numbering 10% of an acceptance batch, or at least three.	Internal soundness check of zones where imperfections complying with quality level D were detected, on samples numbering 10% of an acceptance batch, or at least three.
3	Pilot lot complies with a least one level higher than that required.	Internal soundness check of all surfaces of samples numbering 3% of an acceptance batch, or at least one.	–

1) All casts comprising the acceptance batch should be represented for testing purposes.
2) Where the results of the check of internal soundness are unsatisfactory for one or more castings taken at random, the defective zone(s) of all castings making up the delivery shall be subjected to radiographic inspection.
3) All checks shall be carried out prior to any production welding.

accordance with test class A. The image quality of the radiographs shall be assessed in accordance with DIN 54109 Part 2.

Quality class C or D castings as specified here shall be permitted to comply with test class A and a less stringent image quality. Where the source-to-object distance is reduced (cf. subclause 8.1.2 of DIN 54111 Part 2), film complying with film G2 or the equivalent shall be used.

The radiographs shall be marked with a code number indicating the particular order and with a serial number. To indicate the particular film used, a grid shall be stamped on the valve body surface and included in the radiograph.

A photograph shall be taken, or a drawing made, of the points on the valve body subject to radiographic inspection, and submitted as part of the documentation. The results of radiographic inspection shall be included in a test report.

5.2.1.2 The test report shall include the particulars specified in DIN 54111 Part 2 (radiographic inspection) or in *Stahl-Eisen-Prüfblatt* (Iron and steel test sheet) 1922 (ultrasonic testing).

5.2.2 Check of surface condition

Magnetic particle inspection shall be used to check the surface condition of castings made from magnetizable steel.

•• It may be agreed to conduct penetrant inspection in addition.

In the case of non-magnetizable or not completely magnetizable materials (e.g. compound steels), only penetrant inspection shall be carried out.

Since the results of magnetic particle and penetrant inspection do not correlate with each other, the method selected shall not be changed in the course of production or further processing. Where a change occurs (e.g. in casting geometry) which necessitates that penetrant inspection be used instead of magnetic particle inspection, and where the maximum permissible indications specified in table 2 of DIN 1690 Part 2 are exceeded, the actual extent of imperfections shall be determined by measurement and compared with the maximum permissible values specified in table 1 of that standard.

The results of the check of surface condition shall be included in a test report in accordance with *Stahl-Eisen-Prüfblatt* 1935 (magnetic particle inspection) or *Stahl-Eisen-Prüfblatt* 1936 (penetrant inspection).

5.3 Documentation

The inspection certificate shall state the particular non-destructive test method used, and all relevant test reports shall be submitted.

6 Marking

6.1 All castings shall be marked with:

a) the casting manufacturer's mark and, where required, that of the valve manufacturer;
b) material designation or number in accordance with the relevant material standard;

Castings supplied with a DIN 50049 inspection document shall also be marked with:

c) the cast number or symbols indicating the date or period of manufacture, and symbols indicating that the test reports and the results listed in them are related to a particular test unit or casting (cf. clause 6 of DIN 1690 Part 1);
d) the mark of the inspector (who has either been selected in accordance with relevant regulations or commissioned by the purchaser).

6.2 •• In the case of small castings supplied with an inspection certificate and delivered in crates, it may be agreed to dispense with marking of the castings themselves with the cast number.

Standards and other documents referred to

DIN 1690 Part 1	Technical delivery conditions for castings of metallic materials; general information
DIN 1690 Part 2	Technical delivery conditions for castings of metallic materials; steel castings; classification into severity levels on the basis of non-destructive testing
DIN 3840	Valve bodies; design for resistance to internal pressure
DIN 17245	Heat resisting ferritic cast steel; technical delivery conditions
DIN 17445	Stainless cast steel; technical delivery conditions
DIN 50049	Inspection documents for the delivery of metallic materials
DIN 54109 Part 2	Non-destructive testing; image quality of radiographs; recommended practice for determining image quality values and image quality classes
DIN 54111 Part 2	Non-destructive testing; testing of metallic materials by X-rays or gamma-rays; radiographic examination of castings made from ferrous materials

Stahl-Eisen-Werkstoffblatt 110 *) *Verfahrensprüfung für Fertigungsschweißungen an Stahlguß* (Welding procedure qualification testing of production welds made on steel castings)

Stahl-Eisen-Prüfblatt 1922 *) *Ultraschallprüfung von Gußstücken aus ferritischem Stahl* (Ultrasonic testing of castings made from ferritic steel)

Stahl-Eisen-Prüfblatt 1935 *) *Oberflächenrißprüfung von Gußstücken aus Stahl; Magnetpulverprüfung* (Surface crack testing of steel castings; magnetic particle inspection)

Stahl-Eisen-Prüfblatt 1936 *) *Oberflächenrißprüfung von Gußstücken aus Stahl; Eindringprüfung* (Surface crack testing of steel castings; penetrant testing)

VdTÜV-Merkblatt 1153 *Richtlinien für die Eignungsprüfung von Schweißzusätzen* (Guidelines for suitability testing of welding filler metals) (obtainable from *Verlag TÜV Rheinland GmbH*, D-Köln)

Technische Empfehlung 359-01, issued by the *Bureau de Normalisation de l'Industrie de la Fonderie*, obtainable from *Editions Techniques des Industries de la Fonderie*, 12, Avenue Raphael, F-75 016 Paris.

Explanatory notes

This standard has been prepared by Technical Committee 11 *Stahlguß* of the *Normenausschuß Eisen und Stahl* (Steel and Iron Standards Committee).

In defining the term 'heavy-duty valves' the responsible technical committee had originally intended this to include only those valves used in plants subject to inspection. Subsequent discussion, however, revealed that it would be expedient to include valves which, should they malfunction, either present a health hazard to persons or result in expense to the user.

International Patent Classification

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*) Obtainable from *Verlag Stahleisen mbH*, Postfach 82 29, D-4000 Düsseldorf 1.