HOFMANN
ROAD MARKING SYSTEMS

INFO N° 424
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# ZTV M 13 (Extract)

**Additional Technical Contractual Conditions and Directives for Marking on Streets**

## 1. Scope of Application

The Additional Technical Contractual Conditions and Directives for Marking on Streets ("Zusätzliche Technische Vertragsbedingungen und Richtlinien für Markierungen auf Straßen"), issue 2013 (ZTV M 13) deal with final (white) … markings on streets that are produced with a marking system.

## 2. Definition of Terms

2.1 Marking Systems

Marking systems consist of marking materials and the associated additives...
Drop-on materials must be performed according to DIN EN 1423; premix beads must be performed according to DIN EN 1424.

2.2 Final Markings

Final markings are white markings in the specified final location.

2.3 Marking Systems **Type I**

Lane markings of type I are markings with a usually level surface that do not have any special retro-reflective properties at night or when wet. They are performed on the full area in any case.

2.4 Marking Systems **Type II**

Lane markings of type II differ from type I markings in that the markings are formed to have particularly strong retro-reflective properties at night and when wet. They must be indicated as type II systems in the test certificates of the Bundesanstalt für Straßenwesen (BASt). They are currently structured into the **following** groups.

2.4.1 Systems with Coarse Drop-on

In systems with coarse drop-off, the increased retroreflection at night and wetness is mostly determined by large reflex beads and/or reflex beads with increased refractory index (≥ 1.7). They are performed on the full area.

2.4.2 Systems with Coarse Contents

For systems with coarse contents, the addition of coarse parts produces a structured surface that interacts with the drop-on material to produce increased retro-reflection at night and when wet. They are performed on the full area.

2.4.3 Profiled Systems

For profiled systems, the marking material is shaped to produce a structured surface that interacts with the drop-on material to produce increased retro-reflection at night and when wet. They are performed on the full area.

2.4.4 Agglomerations

Agglomeration markings are coarsely structured lane markings made up of components. They are produced from regularly or irregularly placed different marking materials and the associated additives. They can be applied with or without full-area support (primer). The area coverage should be at least 60 % when viewed vertically.
Agglomeration markings must be visible in full from the point of view of a truck driver (approx. 2.20 m eye level) at a distance of 30 m.

## 3. Requirements

3.1 Daylight Visibility

The daylight visibility is determined by the light density coefficient at diffuse lighting $\mathbf{Q_d}$ … according to DIN EN 1436 (see appendix). The light density coefficient at diffuse lighting $\mathbf{Q_d}$ is determined on dry and clean marking surfaces and must correspond to the requirements of table 1.

**Table 1**: Minimum values of the light density coefficient at diffuse lighting $\mathbf{Q_d}$

| Final markings | **New** condition | | **Usage** condition | |
|---|---|---|---|---|
| | $mcd \cdot m^{-2} \cdot lx^{-}$ [1] | Class | $mcd \cdot m^{-2} \cdot lx^{-1}$ | Class |
| | 160 | Q 4 | 130 | Q 3 |

If markings are applied to a new or restored bituminous covering layer that has been subject to traffic for less than half a year, no demands for daylight visibility apply during the first year after application.

3.2 Night Visibility

The measure for night visibility is the light density coefficient at retroreflection $\mathbf{R_L}$.

The light density coefficient must be measured according to DIN EN 1436 (see Appendix) on dry, clean marking and correspond to the requirements according to table 2 for the final marking systems …

**Table 2**: Minimum value of the light density coefficient at retroreflection $\mathbf{R_L}$ for final marking systems

| Marking systems of **type I and II**, dry | | | |
|---|---|---|---|
| **New** condition | | **Usage** condition | |
| $mcd \cdot m^{-2} \cdot lx^{-1}$ | Class | $mcd \cdot m^{-2} \cdot lx^{-1}$ | Class |
| 200 | R 4 | 100 | R2 |
| Marking systems of **type II**, moist | | | |
| 50 | RW 3 | 25 | RW 1 |

3.3 Layer Thicknesses of Applied Markings

The layer thickness is distinguished by wet film thickness and dry film thickness.

3.3.1 Markings of Colours

The layer thickness of paints (wet-film thickness) is the height protrusion of the wet film over a level area (e.g. test sheet) without drop-on and without injected additives.

The minimum wet-film thickness
- → 0.3 mm for **type I** marking systems,
- → 0.6 mm for **type II** marking systems.

3.3.2 Markings of Reactive Substances and Thermoplastic Substances

The layer thickness (dry film thickness) is the height protrusion of the marking material without drop-on or injected additives above a level surface (e.g. test sheet).

The minimum layer thickness for sprayable systems of reactive materials is
- → 0.3 mm for **type I** marking systems,
- → 0.4 mm for systems with injected additives (**only** type II marking systems),
- → 0.6 mm for other **type II** marking systems.

The minimum layer thickness for sprayable systems of thermoplastic materials is
- → 0.6 mm for **type I** marking systems,
- → 1.2 mm for **type II** marking system.

The minimum layer thickness for non-sprayable systems is 2.0 mm.

3.3.3 Agglomeration Markings

For agglomeration markings, the minimum material amount without drop-on is relevant instead of the minimum layer thickness. A material amount of **2.2 kg/m²** must not be undercut. Additionally, it must correspond at least to the amount indicated in the BASt test certificate in the application.

3.3.4 Renewal

It is recommended to replace final markings when the minimum value for the classes of daylight visibility Q3, night visibility R2 or RW 1 is undercut by 20 % …. Explanations on the visibility of markings in darkness are made in the appendix (see below).

**Appendix**: Visibility at night depending on retroreflection

**Table A1**: Visibility S depending on the retroreflection on **dry** roads

| $R_L$ [mcd • $m^{-2}$ • $lx^{-1}$] | **Visibility** S (m) | | |
|---|---|---|---|
| | Lower limit | Average | Upper limit |
| 80 | 32 | 61 | 90 |
| 100 | 35 | 64 | 94 |
| 120 | 38 | 68 | 100 |
| 150 | 41 | 74 | 107 |
| 200 | 45 | 80 | 114 |
| 300 | 52 | 87 | 124 |
| 500 | 60 | 99 | 139 |
| 1000 | 73 | 112 | 155 |

**Table A2**: Visibility S depending on the retroreflection on **moist** roads

| $R_L$ [mcd • $m^{-2}$ • $lx^{-1}$] | **Visibility** S (m) | | |
|---|---|---|---|
| | Lower limit | Average | Upper limit |
| 25 | 34 | 47 | 60 |
| 30 | 39 | 54 | 68 |
| 35 | 44 | 60 | 76 |
| 50 | 53 | 71 | 88 |
| 75 | 66 | 87 | 107 |
| 100 | 74 | 96 | 119 |
| 150 | 85 | 111 | 136 |
| 200 | 94 | 122 | 148 |

**Explanation** of the tables:
Parameter: Dipped-beam headlights of a car, new H 4 headlights, straight road, no glare from other cars or external interfering lights, only one marking type (interrupted or uninterrupted longitudinal marking) present, maximum speed 80 km/h, observation by 40-year old driver.
The values of the above limit apply rather for continuous markings, e.g. edge markings of 30 cm width at very good visibility conditions, the values of the lower limit rather for interrupted markings, e.g. middle markings about 10 cm wide at bad visibility conditions and the average values e.g. for edge marking of 15 cm width at average visibility.
"Moist" means the road condition that occurs 5 minutes after rain stops. During rain, the reduced sight conditions give rise to expectations of lower visibility than according to table A2.

## 4. Selection of the Marking Systems

### 4.1 Traffic Classes

Marking systems are tested according to the Technical Test Conditions for Marking Systems and Elements ("Technische Prüfbedingungen für Markierungssysteme und –elemente") … on concentricity test facilities (Rundlaufprüfanlagen; RPA) … and assigned traffic classes P that reflect the number of the drive-overs that are achieved. Table 3 lists the … traffic classes.

**Table 3**: Traffic classes

| Traffic class | Number of wheel drive-overs on the RPA |
|---|---|
| P 2 | 100,000 |
| P 4 | 500,000 |
| P 5 | 1,000,000 |
| P 6 | 2,000,000 |
| P 7 | 4,000,000 |

According to the intended purpose, marking systems are tested under the traffic classes listed in Table 4.

**Table 4**: Traffic classes at the test for suitability

| Marking system | Final |
|---|---|
| Type I marking systems for brief use (< 14 days) | - |
| Colours, type I | P 4 and P 5 |
| Colours, type II | P 6 |
| Other sprayable marking materials | P 6 and P 7 |
| All other systems | P 6 and P 7 |

### 4.2 Areas of Use of **Type I**I Markings

Due to their **increased night visibility when wet**, type II markings are generally preferably to type I markings. Too-short sections must be avoided and longer sections (e.g. sections between two nodes) must be preferred.

Type II markings must be used on Federal Motorways. On other two-lane roads, Federal roads outside of towns and strongly frequented country and state roads, type II markings should be used as well.

In avenues and in the focus areas of the accident type "leaving the road", edge markings should be profiled markings with acoustic and/or haptic effects.

## 5. Execution

5.1 Equipment of Marking Machines

The total application technique must correspond to the purpose, the scope of work, the local situation and the state of the art in equipment and performance capacity … (preferably path-dependent/speed-proportional).

For work of a larger scope (section lengths of 1,000 m or more) for marking systems that are not prefabricated, use self-operated riding markers. They need to be equipped with a dash separation automatic and speed-proportionally (path-dependent/speed-proportional) controlled application aggregates for drop-ons.

Machines for sprayable systems also must be equipped and operated with a facility for continuous automatic documentation of the layer thickness.

The documentation must take place electronically and meet the following requirements:

- At least every 250 m, the average layer thickness of the respective section must be saved with date, time and GPS coordinates.
- It must be possible to display and read the data determined like this at any time.
- Data storage must be at least 7 days back.
- The data must be saved so that they can no longer be changed in the device.

The data are to be provided to the client on demand.

**HOFMANN GmbH**

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