SLOVENSKI STANDARD
SIST-TP CEN/TR 16978:2016

01-december-2016

Železniške naprave - Infrastruktura - Pregled posameznih okvar

Railway applications - Infrastructure - Survey on isolated defects

Bahnanwendungen - Infrastruktur - Überblick von Einzelfehlern

Applications ferroviaires - Infrastructure - Étude relative aux défauts isolés

Ta slovenski standard je istoveten z: CEN/TR 16978:2016

ICS:

45.020	Železniška tehnika na splošno	Railway engineering in general
93.100	Gradnja železnic	Construction of railways

SIST-TP CEN/TR 16978:2016 **en,fr,de**

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 16978

October 2016

ICS 93.100

English Version

Railway applications - Infrastructure - Survey on isolated defects

Bahnanwendungen - Infrastruktur - Überblick von Einzelfehlern

This Technical Report was approved by CEN on 23 May 2016. It has been drawn up by the Technical Committee CEN/TC 256.

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Ref. No. CEN/TR 16978:2016 E

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European foreword

This document (CEN/TR 16978:2016) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

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Introduction

The Working Group CEN/TC 256 SC1/WG 28 "*Railway applications/Infrastructure/Track geometry quality*" conducted a European Survey on Isolated Defects (ESID) in order to support the process of the development of the EN 13848 series. The goal of the survey was to get an overview of certain thresholds of selected track geometry parameters in several European networks in terms of Isolated Defects (ID).

This Technical Report does not include urban rail matters.

1 Scope

This Technical Report describes the methodology used for the survey on Isolated Defects (ID) and gives the results.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13848-1, *Railway applications — Track — Track geometry quality — Part 1: Characterisation of track geometry*

EN 13848-5:2008+A1:2010, *Railway applications — Track — Track geometry quality — Part 5: Geometric quality levels — Plain line*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
decolouring
algorithm which converts one signal into a different signal

Note 1 to entry: It is used in EN 13848 series to convert a chord measurement signal into a *D1* or *D2* measurement signal.

3.2
Immediate Action Limit
IAL
value which, if exceeded, requires taking measures to reduce the risk of derailment to an acceptable level

Note 1 to entry: To reduce the risk of derailment can be done either by closing the line, reducing speed or by correction of track geometry.

3.3
isolated defect
part of the signal exceeding a given limit such as IAL with at least one sample (data break)

Note 1 to entry: The length of the exceedance is given by the number of samples exceeding the limit. A minimum length of exceedance may be applied to determine an isolated defect.

4 Symbols and abbreviations

For the purposes of this Technical Report, the following symbols and abbreviations apply.

Table 1 — Symbols and abbreviations

Symbol	Designation	Unit
AL	Alignment	mm
D1	Wavelength range 3 m < λ ≤ 25 m	m
D2	Wavelength range 25 m < λ ≤ 70 m	m
LL	Longitudinal level	mm
LoE	Length of exceedance	m
V	Speed	km/h

NOTE In this Report, *AL* stands for “alignment” and is not to be confused with *AL* standing for “alert limit” as defined in EN 13848–5.

5 Methodology

5.1 General considerations

The objective of the European Survey on Isolated Defects (ESID) is to get an understanding and an overview concerning isolated defects within European networks. In a first step it was ensured that at least 6 networks showed interest in participating in this study. The initial idea was to collect the number of isolated defects which exceed certain threshold levels. A discussion between the networks showed very different approaches concerning definition and counting rules of such isolated defects. In addition some networks had very limited availability of appropriate national databases and evaluation tools and concerns regarding costs and effort of a too detailed evaluation were raised.

So the experts of CEN/TC 256/SC 1/WG 28 worked out an alternative methodology which was more practical for most participating networks and less time consuming. First of all, the number of measurement parameters was limited to 8. For the next step, it was agreed to base the survey on cumulative frequency distributions of exceeding lengths. These cover at least the range of thresholds up to and above the IALs according to EN 13848-5. That means that for each threshold of a measurement parameter, the number of metres exceeding this threshold within the participating network were determined.

Finally each of the participating networks provided data for a representative part of their network according to the technical specification described below in 5.2. With the help of a standardised inquiry form, the cumulative frequency distributions of the data were determined and were sent to the CEN/TC 256/SC 1/WG 28 clearing office.

In order to make the data anonymous, the clearing office assigned a random network number to the data of each network and summarized the data in anonymous charts. These were supplied to CEN/TC 256/SC 1/WG 28 only.

Without agreement of all participating networks neither the clearing office nor CEN/TC 256/SC 1/WG 28 may disclose or publish any of the data or the assignment between data and participating networks as a whole or in parts to anyone else.

5.2 Collected data

5.2.1 Scope of survey

The survey collected data for all main lines of the participating networks; main tracks in stations are included in the survey as well. Isolated switches or group of switches situated in plain line and run at line speed are included in the provided data, unless typical errors due to measuring systems occur. In the latter case, the respective data were excluded from the survey. In any case, all side tracks have been excluded. This prevents counting non-representative exceedances.

The survey was based on measurements of track taken typically at 0,25 m spacing. For a network length of 10 000 km track this would result in a cumulative frequency distribution comprising over 40 million measurements.

The survey was conducted using the most current measurement value for each location. This was summarized in a cumulative frequency distribution.

Where it was not possible for a participating network to do the calculation over their whole network, all data sets containing at least 10 % of the network were taken into account while the track layout and track quality considered in the sample had to be as representative as possible for the whole network. The track length considered for each speed class had to be quoted in the standardised inquiry form.

5.2.2 Speed classes

The survey was done in 5 speed classes according to the EN 13848 series:

1) 230 km/h < $V \leq$ 300 km/h;
2) 160 km/h < $V \leq$ 230 km/h;
3) 120 km/h < $V \leq$ 160 km/h;
4) 80 km/h < $V \leq$ 120 km/h;
5) $V \leq$ 80km/h.

Speeds higher than 300 km/h were not taken into account due to the lack of sufficient data.

In order to ensure anonymity of networks with high-speed tracks, the network lengths of the participating networks were not disclosed in the results. They were just used as weighting factors to calculate European exceedance lengths.

5.2.3 Parameters investigated

The survey was done on the parameters in the ranges given in Table 2.

Table 2 — Parameters and studied ranges

Parameters		Threshold range (min to max) for speed classes [km/h]				
		$V \leq 80$	$80 < V \leq 120$	$120 < V \leq 160$	$160 < V \leq 230$	$230 < V \leq 300$
1	Longitudinal level (*LL*) for domain *D1* according to EN 13848-1	(1 to 30) mm	(1 to 28) mm	(1 to 25) mm	(1 to 22) mm	(1 to 18) mm
2	Alignment (*AL*) for domain *D1* according to EN 13848-1	(1 to 24) mm	(1 to 19) mm	(1 to 16) mm	(1 to 14) mm	(1 to 12) mm
3	Mean Gauge (average over 100 m) narrow according to EN 13848-1	(−1 to −10) mm	(−1 to −9) mm	(−1 to −7) mm	(−1 to −7) mm	(−1 to −5) mm
4	*LL* for domain *D2* according to EN 13848-1	—	—	—	(1 to 35) mm	(1 to 30) mm
5	*AL* for domain *D2* according to EN 13848-1	—	—	—	(1 to 26) mm	(1 to 22) mm
6	Twist on a base of 3 m and expressed in mm/m according to EN 13848-1	(1 to 9) mm/m	(1 to 9) mm/m	(1 to 9) mm/m	(1 to 9) mm/m	(1 to 7) mm/m
7	Narrow gauge according to EN 13848-1	(−1 to −13) mm	(−1 to −13) mm	(−1 to −12) mm	(−1 to −9) mm	(−1 to −7) mm
8	Wide gauge according to EN 13848-1	(1 to 37) mm	(1 to 37) mm	(1 to 37) mm	(1 to 30) mm	(1 to 30) mm

Where the origin of the measurement data for *LL* and *AL* was chord based, they were decoloured to obtain *D1*.

5.2.4 Calculation of lengths of exceedances

For each of the parameters above, the length of exceedances (LoEs) were collected for all threshold levels in steps of 1 mm according to the range of values given in Table 2, except for twist where the LoEs were collected for threshold levels in steps of 1 per mille. All LoEs were collected in the units of [metres per 100 km] which means it was collected from the number of metres which exceed the threshold level related to a distance of 100 km.

For longitudinal level and alignment in domain *D1* as well as *D2* the exceedance lengths of left and right rail have been added.

5.2.5 Data processing

The tables of LoEs for all participating networks for the 5 speed classes were produced and a weighted average was calculated for each step of the frequency distribution. The line length of each participating network in the considered speed class was used as a weighting factor. In this way 'European Lengths of Exceedances' were determined for the 5 speed classes and all 8 parameters. These cumulative frequency distributions are shown in Clause 6.

6 Participating networks and involvement

6.1 Participating networks

The following alphabetic list gives the 12 networks that provided data to the survey:

Austria	ÖBB-Infrastructure
Belgium	Infrabel
Czech Republic	SZDC
Denmark	Rail Net Denmark
France	SNCF / RFF
Germany	DB-Netz
Hungary	MÁV
Italy	RFI
Portugal	IP
Sweden	Trafikverket
Switzerland	SBB
United Kingdom	Network Rail

6.2 Coverage

The survey is comprised data for approximately 63 000 km of track. This represents a 41 % sample of the participating networks. The total track length of all participating networks is about 154 000 km, this is more than half of the track length of the European Union member states.

Some networks provided data for nearly all the lines, others provided smaller samples. In any case, they have been chosen carefully as representative for the speed class in the whole network. However, just in 3 out of 34 cases, data of one network had to be removed because of poor coverage. Therefore, in these cases, data of the concerned networks were simply not taken into account in 3 out of 34 charts.

Furthermore, the data set of 1 network was not taken into account, because of significant distortion of the European results.

Table 3 shows the coverage of the individual speed classes related to the respective track length.

Table 3 — Sample size of track data for each speed class (points)

Speed range	Network length	Sample size	Percentage
230 km/h < V ≤ 300 km/h	5 955 km	3 263 km	55 %
160 km/h < V ≤ 230 km/h	12 400 km	7 253 km	58 %
120 km/h < V ≤ 160 km/h	55 355 km	15 874 km	29 %
80 km/h < V ≤ 120 km/h	49 652 km	21 964 km	44 %
V ≤ 80 km/h	30 797 km	15 060 km	49 %

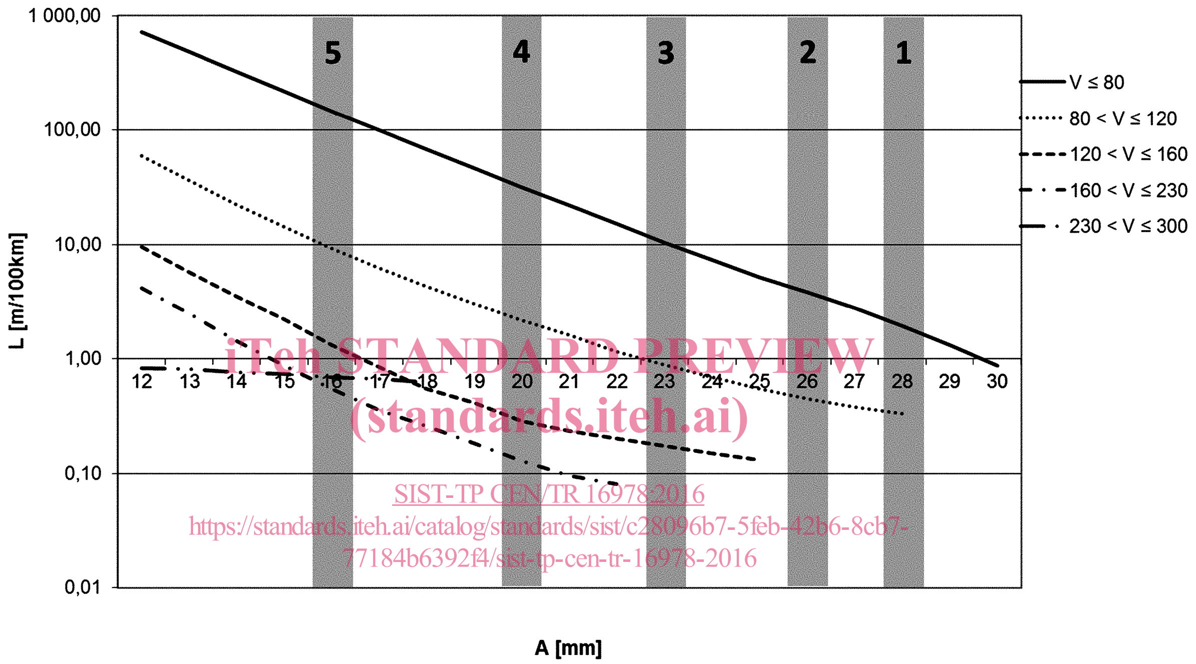
7 Results

7.1 General remarks

The following summary charts show for each parameter and all speed classes the most relevant parts of the European exceedance lengths. Each line in the charts represents the weighted averages of the LoEs of all evaluated networks for one speed class. In addition, the charts show the current IALs according to EN 13848-5:2008+A1:2010 for each speed class.

As the charts cover in most cases several decades of values; a logarithmic scaling on the ordinate is used. It has to be pointed out therefore, that values close to zero cannot be shown on this type of chart.

7.2 Results for longitudinal level in *D1*



Key

1 IAL $V \leq 80$ km/h

2 IAL 80 km/h < $V \leq 120$ km/h

3 IAL 120 km/h < $V \leq 160$ km/h

4 IAL 160 km/h < $V \leq 230$ km/h

5 IAL 230 km/h < $V \leq 300$ km/h

A amplitude

L length of exceedances

Figure 1 — Longitudinal level (*D1*)

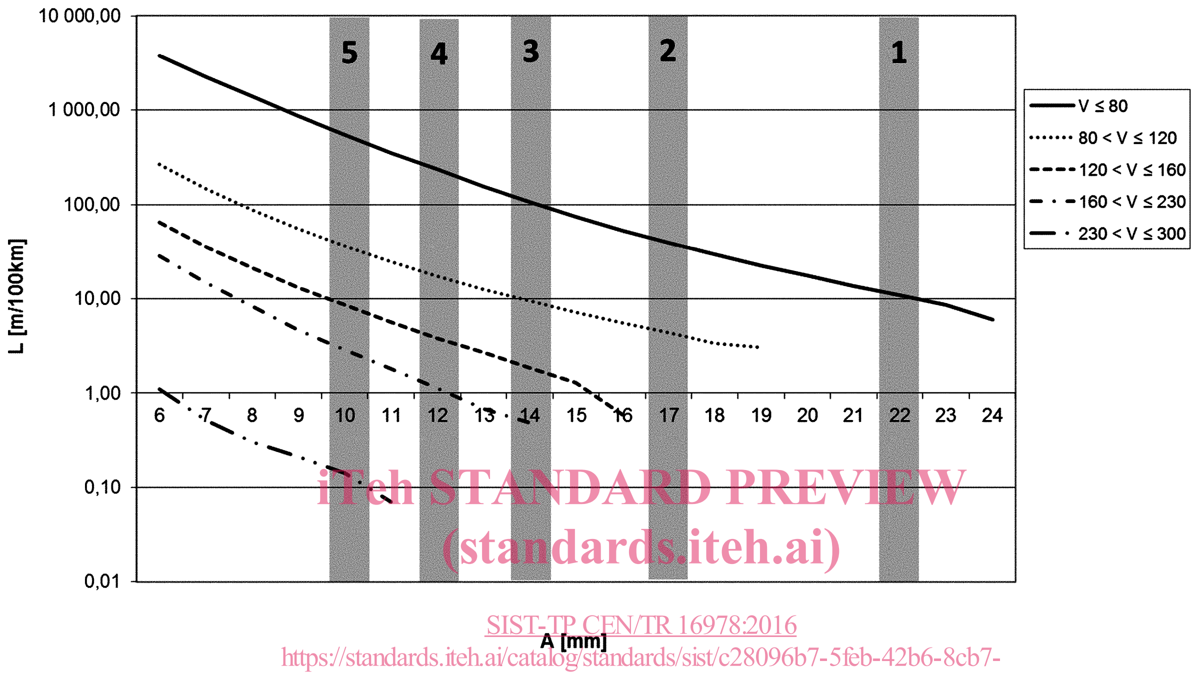
— The numbers of participating networks per speed class are: 9 ($V \leq 80$ km/h), 10 (80 km/h < $V \leq 120$ km/h), 11 (120 km/h < $V \leq 160$ km/h), 9 (160 km/h < $V \leq 230$ km/h) and 4 (230 km/h < $V \leq 300$ km/h).

— The curves for the different speed ranges show an important spread over more than two decades, indicating a strong dependence of the longitudinal level track quality on the line speed.

— The length of exceedance at the IAL values decreases with increasing speed except for the speed range 230 km/h < *V* ≤ 300 km/h which may be not representative enough because data from only 4 networks is available, thus increasing the effect of outliers.

— For all speed ranges, the length of exceedance at the current IAL value is in a range between 0,1 m/100 km and 2 m/100 km, indicating an appropriate choice of the IAL values.

7.3 Results for alignment in *D1*



Key

1 IAL *V* ≤ 80 km/h

2 IAL 80 km/h < *V* ≤ 120 km/h

3 IAL 120 km/h < *V* ≤ 160 km/h

4 IAL 160 km/h < *V* ≤ 230 km/h

5 IAL 230 km/h < *V* ≤ 300 km/h

A amplitude

L length of exceedances

Figure 2 — Alignment (*D1*)

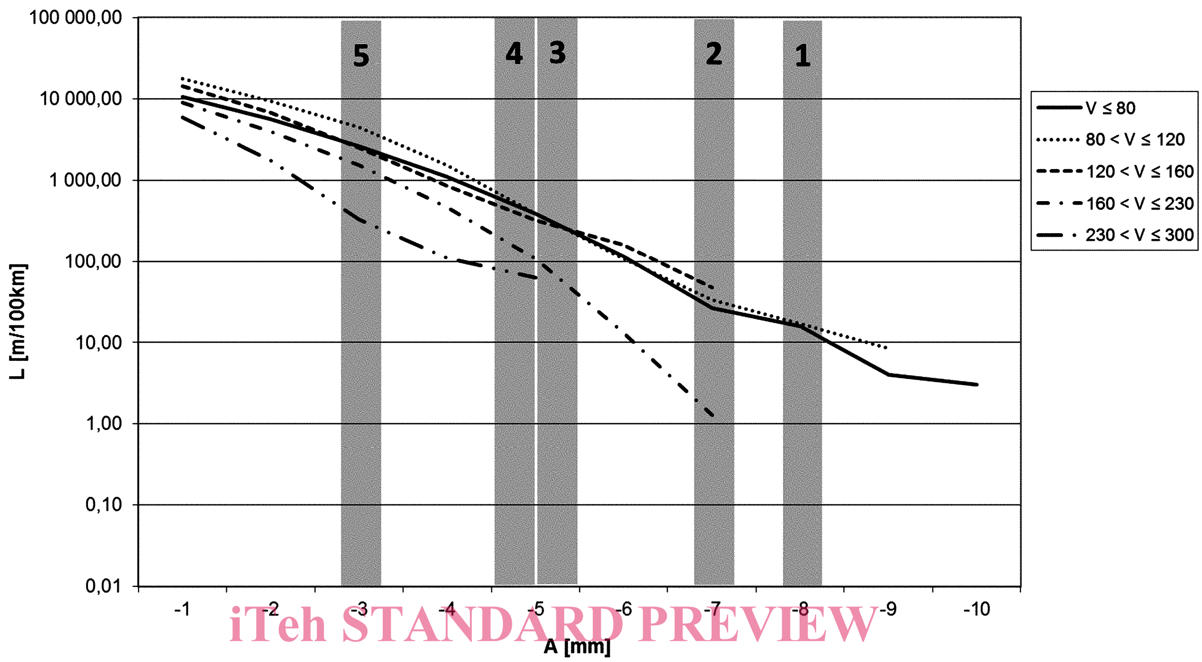
— The numbers of participating networks per speed class are: 9 (*V* ≤ 80 km/h), 10 (80 km/h < *V* ≤ 120 km/h), 11 (120 km/h < *V* ≤ 160 km/h), 9 (160 km/h < *V* ≤ 230 km/h) and 4 (230 km/h < *V* ≤ 300 km/h).

— The curves for the different speed ranges show an important spread over more than three decades, indicating a strong dependence of the alignment level quality on the line speed.

— The length of exceedance at the IAL value decreases monotonously with increasing speed in a range between 0,1 m/100 km and 10 m/100 km. The latter value corresponds to the speed range *V* ≤ 80 km/h.

— Taking the actual IAL values as reference, the alignment *D1* shows a worse track geometry quality compared to the longitudinal level. The current IAL values are appropriate.

7.4 Results for mean gauge over 100 m



Key

1 IAL $V \leq 80$ km/h

2 IAL 80 km/h < $V \leq 120$ km/h

3 IAL 120 km/h < $V \leq 160$ km/h

4 IAL 160 km/h < $V \leq 230$ km/h

5 IAL 230 km/h < $V \leq 300$ km/h

A amplitude

length of exceedances

Figure 3 — Track gauge over 100 m

— The numbers of participating networks per speed class are: 9 ($V \leq 80$ km/h), 10 (80 km/h < $V \leq 120$ km/h), 11 (120 km/h < $V \leq 160$ km/h), 9 (160 km/h < $V \leq 230$ km/h) and 4 (230 km/h < $V \leq 300$ km/h).

— The small spread of the curves indicates a relatively small influence of the line speed on the mean gauge over 100 m compared to longitudinal level and alignment. However, taking into account the logarithmic representation, the range 230 km/h < $V \leq 300$ km/h has a considerably lower length of exceedance.

— Consequently, the exceedance length at the IAL value increases with increasing speed. For $V \leq 80$ km/h it is at 10 m/100 km while it goes up to 300 m/100 km for the range 120 km/h < $V \leq 160$ km/h.