



SLOVENSKI STANDARD
oSIST prEN 50641:2014
01-oktober-2014

Železniške naprave - Stabilne naprave - Zahteve za ocenjevanje simulacijskih orodij za snovanje elektroenergetskih napajalnih sistemov električne vleke

Railway applications - Fixed installations - Requirements for the validation of simulation tools used for the design of traction power supply systems

Bahnanwendungen - Ortsfeste Anlagen - Anforderungen für die Validierung von Simulationsprogrammen für die Auslegung von Bahnenergieversorgungssystemen

Applications ferroviaires - Installations fixes - Exigences relatives à la validation des outils de simulation utilisés pour la conception des systèmes d'alimentation de la traction

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ICS:

29.280 Električna vlečna oprema Electric traction equipment

oSIST prEN 50641:2014

en

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EUROPEAN STANDARD
NORME EUROPÉENNE
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English Version

Railway applications - Fixed installations - Requirements for the validation of simulation tools used for the design of traction power supply systems

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This draft European Standard is submitted to CENELEC members for enquiry.
Deadline for CENELEC: 2015-01-30.

It has been drawn up by CLC/SC 9XC.

If this draft becomes a European Standard, CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CENELEC in three official versions (English, French, German).
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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

45 This document [prEN 50641:2014] has been prepared by CLC/SC 9XC “Electric supply and earthing
46 systems for public transport equipment and ancillary apparatus (Fixed installations)”, of Technical Committee
47 CLC/TC 9X “Electrical and electronic applications for railways”.

48 This document is currently submitted to the Enquiry.

49 This document has been prepared under a mandate given to CENELEC by the European Commission
50 and the European Free Trade Association, and supports essential requirements of EU Directive(s).

51 For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this
52 document.

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53 1 Scope

54 This European Standard specifies requirements for the acceptance of simulation tools used for the
55 assessment of design of traction power supply systems.

56 The simulation results allow the calculation of quality index(es) requested by EN 50388.

57 This European Standard is applicable to the simulation of a.c. and d.c. traction power supply systems,
58 including conventional and high speed lines defined in the TSIs.

59 This European Standard does not deal with validation of simulation tools by measurement.

60 NOTE The minimum required functionalities are described in this European Standard (Clauses 5, 6, 7 and 8). The previous
61 statement is valid regardless how many additional functions the simulation tool has, e.g. energy efficiency, advanced regenerative
62 braking, calculation of load angles, ...

63 It can also be applied to subway, tram and trolley bus systems.

64 Additionally, the application of the standard ensures that the output data among different simulation tools
65 are consistent when they are using the same set of input data.

66 This European Standard only applies to traction power supply systems at their nominal frequency for a.c.
67 or d.c. systems. It does not apply to harmonic, electrical safety or EMC studies over a wide spectrum.

68 This European Standard does not mandate the use of a simulation tool in order to validate the design of a
69 traction supply system.

70 2 Normative references

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

74 EN 50163:2004, *Railway applications – Supply voltage of traction systems*

75 EN 50388:2012, *Railway applications – Power supply and rolling stock – Technical criteria for the*
76 *coordination between power supply (substation) and rolling stock to achieve interoperability*

77 EN 50122-1, *Railway applications – Fixed installations – Electrical safety, earthing and the return circuit –*
78 *Part 1: Protective provisions against electric shock*

79 3 Terms and definitions

80 For the purposes of this document, the terms and definitions given in EN 50163:2004 and EN 50388:2012
81 and the following apply:

82 3.1

83 **assessor**

84 independent third party which undertakes conformity assessment

85 Note 1 to entry: In the TSI context, it is named a Notified Body (NoBo).

86 **3.2**
87 **simulation accuracy**
88 indicators dedicated to the characterization of the accuracy of the simulation output regarding a reference
89 (measure or theoretical model) for a given case

90 **3.3**
91 **simulation method**
92 construction and solution of a numerical time-step or space-step model of train movement and traction
93 power supply performance

94 **3.4**
95 **simulation tool**
96 software implementing a simulation method(s)

97 **3.5**
98 **traction power supply system**
99 railway electrical distribution network used to provide energy for rolling stock

100 **3.6**
101 **train set**
102 combination of vehicles

103 **3.7**
104 **train set model**
105 model describing the electrical and mechanical characteristics of the train set

106 **3.8**
107 **train traffic model**
108 model of the train mission and the timetable over a given time period

109 **3.9**
110 **track layout model**
111 model describing the physical characteristics of the track such as curves, tunnels and gradient description

112 **3.10**
113 **validation**
114 confirmation by examination and provision of objective evidence that the product, system or process is
115 suitable for a specific intended use

116 Note 1 to entry: Whilst the general term in standard is conformity assessment, validation is commonly understood in the
117 assessment of models and data analysis and its use is more specific than the general term conformity.

118 **3.11**
119 **verification**
120 confirmation by examination and provision of objective evidence that the specified requirements have
121 been fulfilled

122 **4 Symbols and abbreviated terms**

123 For the purposes of this document, the following symbols and abbreviated terms apply:

124 AT Autotransformer

125 BT Booster-transformer

126 CLS Contact Line System (overhead contact line or third rail)

127	EMU	Electrical Multiple Unit
128	FR	Freight Train set
129	F_{res}	Running resistance
130	HS	High speed Train set
131	I	Current
132	I_{aux}	Current for train auxiliary (air conditioning for example)
133	NoBo	Notified Body
134	PP	Paralleling post
135	SS	Substation
136	SUB	Suburban Train set
137	U_0	No load voltage at a substation for a given electrical supply system
138	$U_{mean\ useful}$	Mean useful voltage
139	U_n	Nominal voltage for a given electrical supply system
140	U_p	Current collector Voltage
141	v	Speed in km/h
142	v_{max}	Max allowed speed along the line in km/h
143	Z_{TR}	Transformer impedance
144	η	Mechanical or Electrical efficiency

145 5 General

146 The theoretical study of the interactions between the operation of rolling stock and the power supply
 147 system by means of computer simulation is generally used to obtain detailed information about the
 148 system, to minimise the costs of live tests, and as a consequence to optimize the investment to be made
 149 for a given performance of the electrical railway system.

150 Depending on the type of the supply system (for example: a.c. or d.c. system), the simulation tools
 151 require different data and different system description. Therefore, the scope of the simulation should be
 152 defined in advance, taking account of possible supply systems (see Figure 1).

153 The application of software quality management is the precondition for the application of this European
 154 Standard.

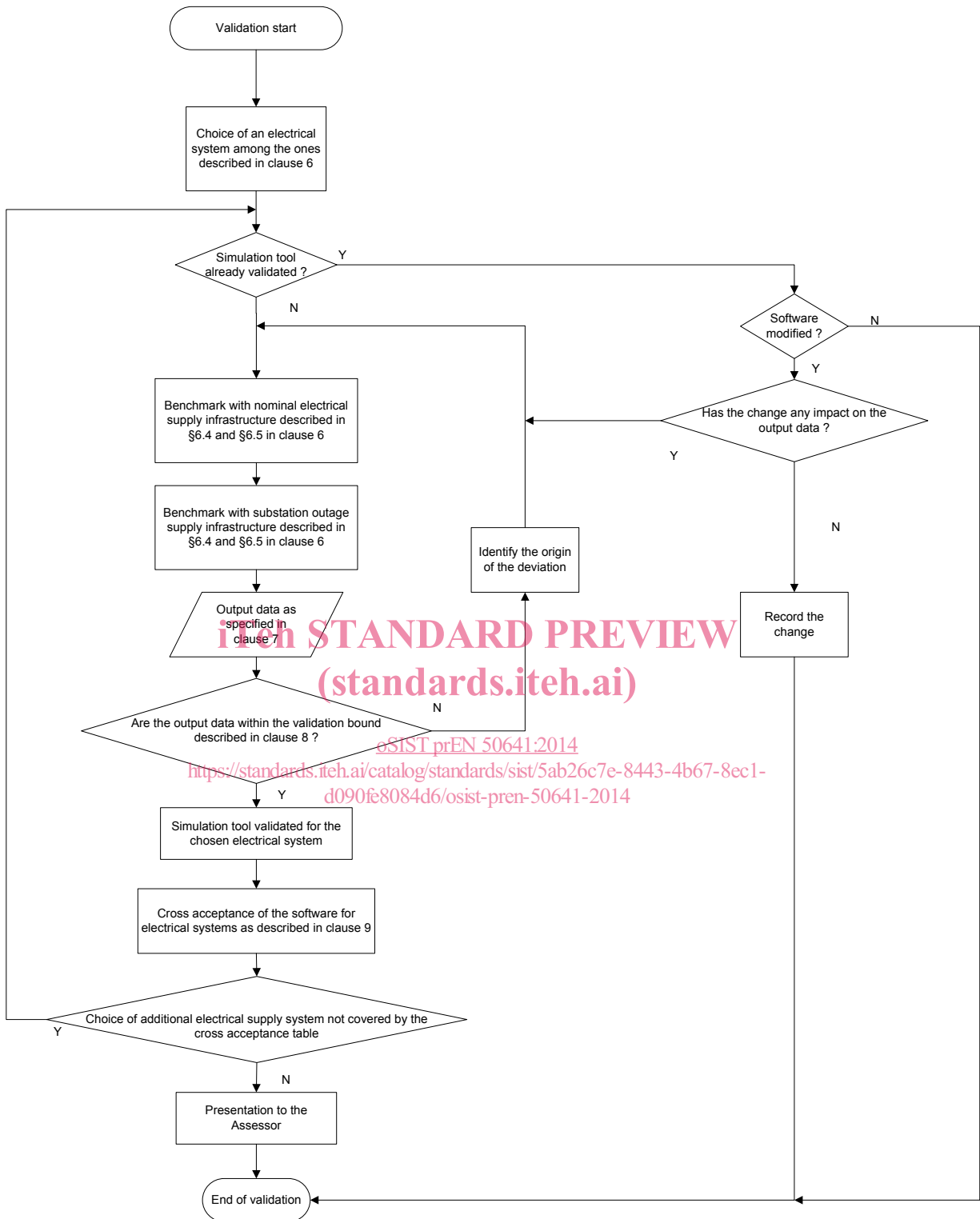
155 The validation process laid out in this European Standard is based on a verification using a defined
 156 benchmark example of a traction power supply system, and employing a common set of input data
 157 incorporating the infrastructure (including station locations, gradient, speed limit), types of train sets and
 158 timetable.

- 159 In order to obtain an acceptable validation of a simulation tool, the results of the simulation tool shall be
160 compared with the output results presented in this European Standard according to the criterion
161 described in Annexes A to D.
- 162 In order to use a simulation tool with confidence, it shall be validated initially and after each revision of the
163 software that has an impact on the simulation results. If the modification affects a core function, then a
164 new validation is necessary. The validation shall be done with steps shown in Figure 1.
- 165 Core functions are to
- 166 – solve the differential equations of train sets movement resulting in power demand at current
167 collector(s),
 - 168 – calculate the load flow (current-voltage) of electrical network with changing configurations caused by
169 moving loads.

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171

Figure 1 – Steps of validation

172 6 Test and models description

173 6.1 General

174 Common parameters for both a.c. and d.c. systems are given in 6.2 end 6.3. Parameters specific to d.c.
175 and a.c. systems are given respectively in 6.4 and 6.5.

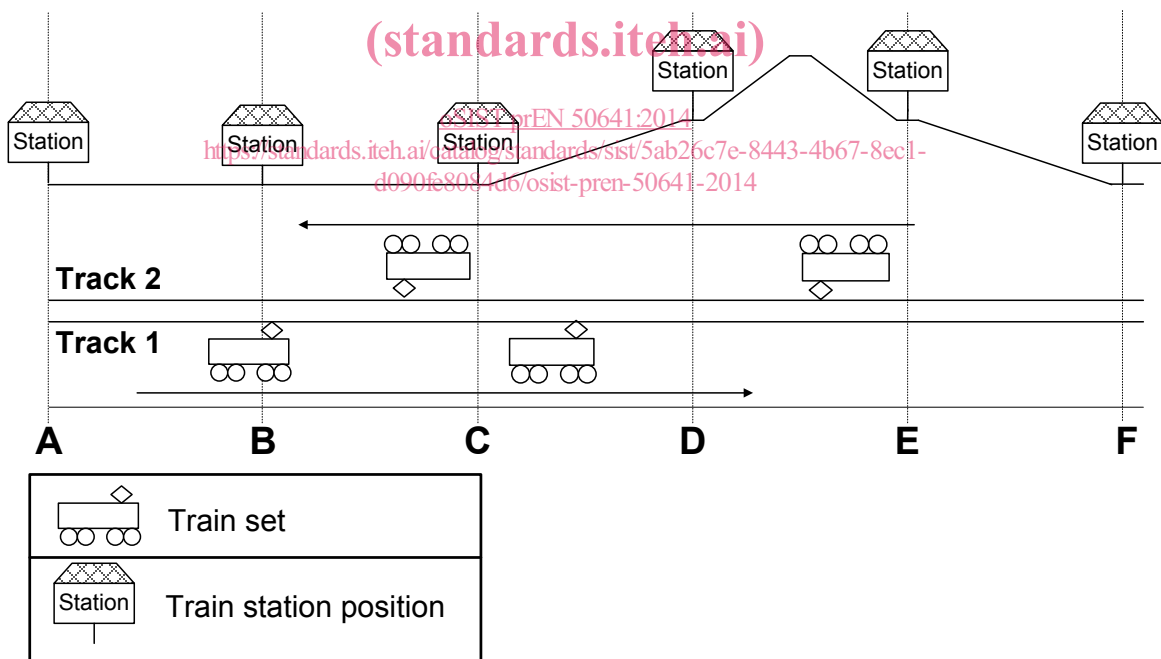
176 The test case configurations and data are used for the purpose of the standard only. They do not
177 represent typical applications for system design.

178 6.2 Common parameters

179 The test case describes a simple traffic along a given open air double track straight line. Although there
180 are some differences due to the different supply systems, some parameters remain identical among the
181 test cases:

- 182 – line gradient;
- 183 – traffic timetable;
- 184 – train set.

185 The general description of the case is described in Figure 2. Distances are indicated in Tables 2 and 6.



186

187 **Figure 2 – Test case general description**

188 3 different kinds of train sets are defined throughout the test case:

- 189 a) High Speed Train set (HS);
- 190 b) Suburban Train set (SUB);
- 191 c) Freight Train set (FR).

192 6.3 Train set descriptions

193 6.3.1 Type of train set and mechanical characteristics

194 The mechanical characteristics for the 3 different kinds of train set of this test case are provided hereafter:

- 195 a) High Speed train set (HS): locomotive and coaches;
 196 b) Suburban train set (SUB): EMU;
 197 c) Freight train set (FR): locomotive and wagons.

198 The parameters are defined in Table 1.

199 **Table 1 – Train set mechanical and traction characteristics**

Type	HS	SUB (2 units)	FR
Speed v_1 , km/h	110	50	80
Speed v_2 , km/h	180	140	140
Speed v_3 (max speed), km/h	220	160	160
Maximum Tractive effort F_m , kN	250	320	250
Tractive effort F_m at v_2 , kN	152,8	114,3	143
Tractive effort F_m at v_3 , kN	102	87,5	109,4
Total mass, t	580	400	1 580
Rotating mass, t	+10 %	+10 %	+10 %
Adhesion mass, t	80	400	80
Efficiency (η)	85 %	85 %	85 %
Power factor ^a (cos φ) at the pantograph (traction and auxiliaries)	0,96	0,96	0,96
Auxiliary power P_{aux} (at power factor 0,96) MW	0,5	0,4	0
A kN	9,23	3,351 6	24,3
B kN/(km/h)	0,015 8	0,008 208	0,084 7
C kN/(km/h) ²	0,001 23	0,000 66	0,004 03
Locomotive(s)	1	2 (EMU)	1
Coaches/wagon	10	-	25
Max permissible deceleration m/s^2	0,8	1	0,5
Length m	265	150	315
^a Applicable only to the a.c. cases; for d.c. cases, the power factor is 1.			

200

201 For the locomotives for the HS and FR train sets, the individual parameters are:

- 202 – mass : 80 t;
 203 – max. tractive effort : 250 kN;
 204 – length : 15 m.

205 The running resistance is defined using a formula: $F_{res} = A + B \cdot v + C \cdot v^2$ with v the speed in km/h. The A, B
 206 and C coefficients apply to the whole train set.