NB Rail	**LOGBOOK ITEM** **NB-RAIL RST SG**

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TITLE / QUESTION	
REPRESENTATIVE WHEEL PROFILES DURING TESTING ON STRAIGHT TRACKS	
ORIGINATOR	**SUBJECT**
NoBos Italcertifer and …	- TSI LOC & PAS (1302/2014) - EN14363:2005 - ERA/TD/2012-17/INT v3.0, 17/12/2014 - ERA-REC-120-2015 Annex I - EN14363:2016 - FprCEN/TR 17039

DESCRIPTION

The aim of this question is to clarify the interpretation of the word *representative* used by EN 14363:2016 (and ERA/TD/2012-17/INT v3.0 of 17/12/2014) referring to the wheel profiles for the tested vehicle during on track test on test zone 1 (straight tracks).

Background:

TSI HS RST (232/2008) §4.2.3.4.8 "In service values of equivalent conicity"

"Assessment of this clause is the responsibility of the Member State(s) where the rolling stock is operated. This clause is excluded from the assessment made by a notified body.

[…]

For a novel bogie/vehicle design, or for operation of a known vehicle on a route with relevant different characteristics, then the development of wear of a wheel profile, and therefore the change in equivalent conicity, is usually not known. For this situation a provisional maintenance plan shall be proposed. The validity of the plan shall be confirmed following monitoring of the wheel profile and equivalent conicity in service. The monitoring shall consider a representative number of wheelsets and shall take into account the variation between wheelsets in different positions in the vehicle and between different vehicle types in the trainset."

These sentences are no more present in the new TSI LOC&PAS (1302/2014).

TSI LOC & PAS (1302/2014) §4.2.3.4.3.2 "*In-service values of equivalent conicity*"

"The combined equivalent conicities the vehicle is designed for, as verified by the demonstration of conformity of the running dynamic behaviour specified in clause 6.2.3.4 of this TSI, shall be specified for in-service conditions in the maintenance documentation as set out in point 4.2.12.3.2, taking into account the contributions of wheel and rail profiles."

TSI LOC & PAS (1302/2014), instead of TSI RST HS 2008, asks the NoBo to specify the EC values *for* in-service conditions (worn condition) in the maintenance documentation.

EN 14363:2016 provides the following:

1. *Requirements for wheel rail contact geometry* (ref. table 2) only for test zone 1:
   a. *The majority of conditions shall be representative of normal service*
   b. *Avoid a narrow range of contact geometry conditions (equivalent conicities)*
   c. *Possibly exclude track sections with exceptional values of conicity outside the expected range of operation*
   d. *Some sections with tanye < 0,05 and (TG-SR)≥ 7 mm shall be included in the statistical assessment to cover low frequency body motions*
2. Requirements for the *Description of the test routes (ref. clause 7.7.4):*
   a. *if available: equivalent conicity for each track section of test zone 1 evaluated with measured rail profiles and representative wheel profiles for the tested vehicle*
3. *Details for Stability (ref. clause 7.7.7.4):*
   a. *the available equivalent conicity data (at minimum in the high equivalent conicity sections) evaluated with measured rail profiles and measured representative wheel profile(s) of the tested vehicle.*
4. General provisions to perform on-track tests (ref. clause 7.3.1):
   a. *[…] NOTE As it was found in the DYNOTRAIN project that the nominal rail inclination has no influence on test results, testing on two networks is no longer necessary, if profiles representative for the service of the vehicle are used during testing. In that case the range of contact conditions varies sufficiently for the statistical evaluation due to variations of gauge and rail shape on test lines.*
5. Annex W
   a. *stability testing is now handled as a separate "test zone"*
   b. *on-track tests are reduced to testing in one rail inclination. Therefore, representative wheel profiles need to be used and extreme low equivalent conicities need to be included in the evaluation. High conicities need to be included in the stability proof.*
6. Table 2 defines the following *objectives* for the tests:
   a. for test zone 1: *testing in the area of vehicle admissible speed*
   b. for stability test zone: *testing the vehicle running stability*
7. Table 2 defines the following *anticipated vehicle behaviour* for the tests:
   a. for test zone 1: *There are no or only low quasi-static guiding forces or accelerations, but larger dynamic content in all assessment quantities*
   b. for stability test zone: *highest probability of unstable running behaviour.*

FprCEN/TR 17039
13.1.3 Changes in EN 14363:2016
The test conditions specified in UIC 518:2009 were used as a starting point for the specification of the requirements regarding the contact geometry wheelset/track. The requirement to achieve the equivalent conicity distributed between 0,15 and 0,25 for a minimum of 50 % of the track sections together with the requirements for the distribution of the radial steering index values would on one hand require to equip the test trains with a costly measuring system, and on other hand restrict the number of test sections which

fulfil all test condition requirements and are thus suited for the evaluation.
The discussions about the pros and cons resulted in the agreement, that the only important requirement regarding the contact geometry wheelset/track which is relevant for the result of vehicle acceptance test is the equivalent conicity value during the stability test in test zone 1. This minimum requirement reduces the required amount of rail profile measurements and can be checked also using manual measurements of rail profiles if no other possibilities are available.
[…]
The specification of the requirements regarding the wheel profile to be used during the testing turned out to be difficult, because a high conicity is required for the stability test, while an average conicity value of about 0,2 is required for other tests. Finally, it was agreed that the testing should be carried out using wheel profiles providing the contact geometry conditions wheelset/track representative of normal service. As the running stability is tested separately according to revised EN 14363, the high conicity for the running stability test can be covered by selecting suitable sections of track with high conicity. Alternatively, the required high conicity condition for the stability test can be achieved by a modification of the wheel profile on a running gear without instrumented wheelsets while keeping the normal profiles on the instrumented wheelsets.

[…]
Hence, the limit curve of equivalent conicity (red line in Figure 17) was adopted from TSI Loc & Pas for the target test conditions given in Table 2 of EN 14363:2016. If the target test conditions are met, additional tests on different rail inclinations and a study about the evolution of wear of the wheel profile are no longer necessary.

13.2 Background information about investigations carried out in the DynoTrain project
[…] In the framework of the DynoTrain project, rail profile measurements were conducted in Germany, France, Italy and Switzerland with a vehicle based optical measurement device. In addition, the project partners provided rail profile measurements of track sections which were considered as representative of their network.
[…] The result of the UIC study is confirmed except for Italy where the values of equivalent conicity for the track are very low. The corresponding wheel profile (S1002 or EPS) is indicated for each country.

Table 1 — 50 %, 95 % and 99 % value of equivalent conicity (y = 3 mm countries [13]

	Germany			France		
	Equivalent conicity S1002			Equivalent conicity S1002		
Speed class [km/h]	50 %	95 %	99 %	50 %	95 %	99 %
0–120	0,15	0,60	0,90	0,10	0,25	0,45
120–160	0,15	0,50	0,85	0,10	0,15	0,25
160–230	0,15	0,30	0,60	0,10	0,35	0,55
> 230	0,10	0,20	0,30	/	/	/

	Italy			Switzerland		
	Equivalent conicity S1002			Equivalent conicity S1002		
Speed class [km/h]	50 %	95 %	99 %	50 %	95 %	99 %
0–120	< 0,05	0,15	0,20	0,20	0,45	0,65
120–160	< 0,05	0,15	0,20	0,20	0,30	0,50
160–230	< 0,05	0,10	0,15	/	/	/
> 230	< 0,05	< 0,05	0,05	/	/	/

It is worth to mention that, even for a worn-worn condition, the mean equivalent conicity values are in the range between 0,1 and 0,25 which is similar to the UIC study and confirms the requirement in UIC Leaflet 518:2009

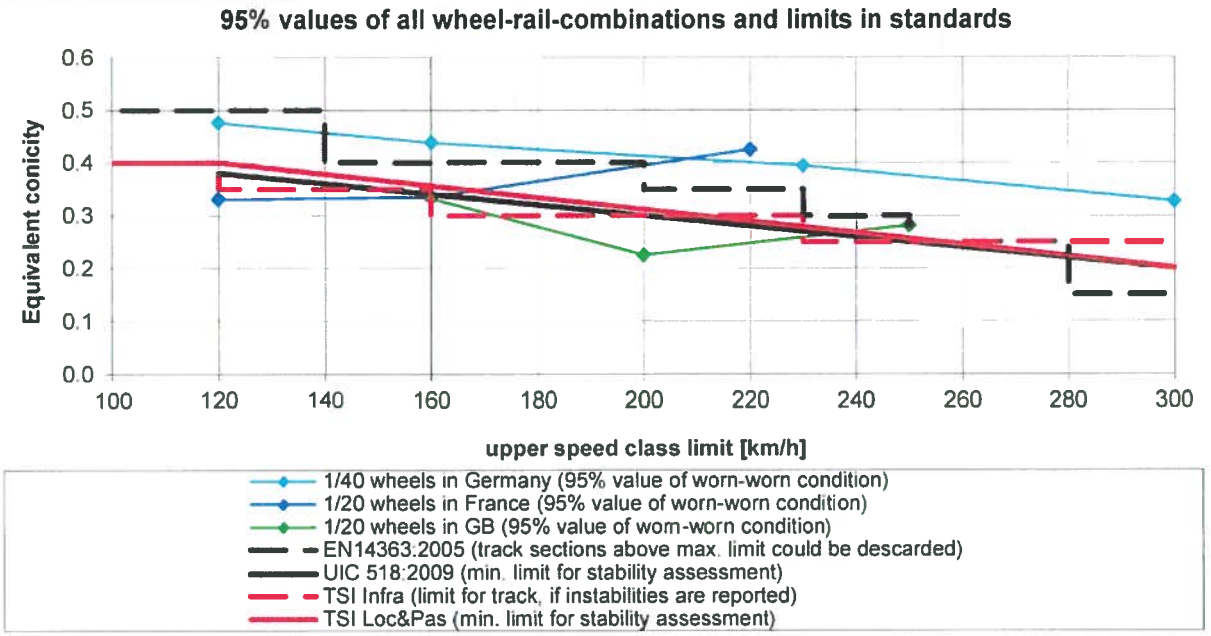

Figure 18 — 95 % values of equivalent conicity for the three networks and limits given in TSI, EN 14363:2005 and UIC 518:2009

Italian rail profiles were not used because the equivalent conicities for the track with the reference wheel profile S1002 are too small in order to obtain meaningful results.

Description of the Situation:
Up to now EN 14363:2005 provided/allowed to perform on-track test with new wheel profile and to study, after the first acceptance and authorisation of the vehicle, the evolution of the wear of the wheel profiles and of equivalent conicity.

The new EN 14363:2016 asks to test:

- with representative wheel profiles (only in test zone 1)
- extreme low equivalent conicities
- high conicities in the stability proof.

QUESTIONS

Question 1
For standard wheel profile S1002 and EPS is it allowed to test by wheel profile in new conditions and to perform only a separated stability test in 3 track sections of 100 m with worn wheel profile in order to experience during the separated stability test high equivalent conicities values?

Question 2

For wheel profiles other than S1002 and EPS, if the tests in test zone 1 are performed with new wheel profile is it needed a proof that they are *representative* of the normal service conditions?

SOLUTIONS

Considering contents of FprCEN/TR 17039.

The discussions in the CEN WG about the pros and cons resulted in the agreement, that the only important requirement regarding the contact geometry wheelset/track which is relevant for the result of vehicle acceptance test is the equivalent conicity value during the stability test in test zone 1. This minimum requirement reduces the required amount of rail profile measurements and can be checked also using manual measurements of rail profiles if no other possibilities are available. If the target test conditions are met, additional tests on different rail inclinations and a study about the evolution of wear of the wheel profile are no longer necessary.

Finally, it was agreed that the testing should be carried out using wheel profiles providing the contact geometry conditions wheelset/track representative of normal service.

In the framework of the DynoTrain project, rail profile measurements were conducted in Germany, France, Italy and Switzerland with a vehicle based optical measurement device. In addition, the project partners provided rail profile measurements of track sections which were considered as representative of their network.

DynoTrain results considering new wheel profiles and measured rail profile of track sections which were considered as representative of the networks, confirmed the result of the UIC study (0,15<EC< 0,25) *except for Italy where the values of equivalent conicity for the track are very low.*

Considering requirements of EN 14363:

- in clause 7.7.4 representative wheel profiles *for the tested vehicle*, the word representative can be interpreted as the selection of some axles, or an average profile, between all the axles of the vehicle, with representative profile(s) for which calculate the EC. As provided by TSI RST HS (232/2008) it is needed to take into account: a representative number of wheelsets, the variation between wheelsets in different positions in the vehicle and between different vehicle types in the trainset.
- in clause 7.7.7.4 *the available equivalent conicity data (at minimum in the high equivalent conicity sections) evaluated with measured rail profiles and measured representative wheel profile(s) of the tested vehicle, the word* representative can be interpreted as the selection of some axles, or an average profile, between all the axles of the vehicle, with representative profile(s) for which calculate the EC
- *NOTE As it was found in the DYNOTRAIN project that the nominal rail inclination has no influence on test results, testing on two networks is no longer necessary,*

if profiles representative for the service of the vehicle are used during testing. In that case the range of contact conditions varies sufficiently for the statistical evaluation due to variations of gauge and rail shape on test lines.

Considering *objectives* and *anticipated vehicle behaviour* described in the table 2 for test zone 1 and stability zone:

1. *objectives*:
   - *c.* for *test zone 1*: *testing in the area of vehicle admissible speed*
   - d. for *stability* test zone: *testing the vehicle running stability*
8. *anticipated vehicle behaviour*:
   - *a.* for *test zone 1*: *There are no or only low quasi-static guiding forces or accelerations, but larger dynamic content in all assessment quantities*
   - *b.* for *stability* test zone: *highest probability of unstable running behaviour*

Solution to question 1:

It is possible to consider standard wheel profile (S1002 and EPS) in new conditions as representative wheel profile for tested vehicle in test zone 1 because the range of contact conditions varies sufficiently for the statistical evaluation due to variations of gauge and rail shape on test lines, according to DynoTrain results. In this case the requirements for wheel rail contact geometry (ref. table 2) are satisfied performing tests with new wheel profiles in test zone 1 during the on-track tests because the majority of conditions are representative of normal service for the statistical evaluation due to variations of gauge and rail shape on test lines.

The stability test performed in test zone 1 with high conicities is the only further acceptance test needed to determine the maximum equivalent conicity value the vehicle was designed and tested for. This maximum value is the *in-service value of wheelset equivalent conicity* required by point 4.2.3.4.3.2 of TSI LOC&PAS (1302/2014). The equivalent conicity is the only relevant parameter for the result of vehicle acceptance test. *This minimum requirement reduces the required amount of rail profile measurements and can be checked also using manual measurements of rail profiles if no other possibilities are available.*

In order to support this interpretation Italcertifer is going to:

- collect some representative rail profiles, track gauges of the lines where usually on-track tests are performed
- calculate Equivalent Conicity values combining these measured rail profiles and track gauges with nominal wheel profiles or real wheel profiles in new conditions of the tested vehicles
- compare the calculated equivalent conicity values with those values provided by Dynotrain project
- collect some time history and post processed data concerning the stability tests performed in the same line with worn wheel profiles

- correlate the measured data with some track section of 100m each where instability conditions were measured
- compare the results of the assessment performed by the statistical evaluation performed in the past respect to the assessment in 3 sections (not overlapping) of 100 m each, in order to verify that, if the target test conditions in table 2 of EN 14363:2016 are met, additional tests on different rail inclinations and a study about the evolution of wear of the wheel profile are no longer necessary.

Therefore, is it allowed to test by standard wheel profile (S1002 and EPS) in new conditions and to perform only a separated stability test in 3 track sections of 100 m with worn wheel profile.

Solution to question 2

For wheel profiles other than S1002 and EPS, if the tests in test zone 1 are performed with new wheel profile it is needed a confirmation of the results of DYNO Train project. In this case a calculation of Equivalent Conicity values combining representative measured rail profiles and track gauges with the nominal new wheel profile, or real wheel profiles in new conditions of the tested vehicles, is enough for positive assessment.