INTERNATIONAL UNION
OF RAILWAYS

Supporting document to UIC CODE 930 "Exchange of data for cross-border railway energy settlement"

Final edition, January 2010

Supporting document 2:
Estimation systems for un-metered trains

References

[1] UIC Leaflet 930R Exchange of data for cross-border railway energy settlement

CONTENT

Summary

Equipping trains with meters including a location system will be the only accurate way to split the energy consumption between different Railway Undertakings (RU) and Infrastructure Managers (IM).

Nevertheless there will be traction units without or with defective meters or metered data cannot be received or used by Infrastructure Managers for other reasons. In such cases the Infrastructure Managers also need to be able to account for the costs of traction energy. Since metered data is missing, estimation systems are used to evaluate the approximated energy consumption of traction units.

Therefore within the Railway Energy Billing project, a separate Work Group “Estimation System unmetered trains” (WG2) was built from Oct 2008 to June 2009 to deal with the demands of estimation separately.

The following key issues were handled in this Work Group:

- input data needed to estimate consumption
- estimation methods
- recommendations for estimation systems

In this document the results of WG2 are recorded in order to establish a framework for the application of estimation systems for unmetered trains.

1 Purpose

This appendix to the UIC Leaflet 930[1] sets out a framework for the application of estimation systems for unmetered trains to be used within the traction energy settlement framework by Railway Undertakings and Infrastructure Managers for cross border traffic. By respecting existing national systems, the identification of common rules and practices is intended to contribute to an improvement in European railway sector interoperability and settlement.

The purpose of this appendix is:

- to describe the basic contents for input data for energy estimation delivered from Railway Undertakings to Infrastructure Managers.
- to outline common estimation methods in order to get an overview of existing methods to estimate energy consumption and to understand applied estimation rules.
- to present a list of best practice and recommendations for estimation systems in order to improve existing estimation systems or in order to keep special aspects of railway energy estimation in mind while designing future estimation systems.

This framework is intended to help establish estimation systems with approved estimation routines so that the approximate energy consumption of each train can be used for billing and pricing. It is based on the status quo of contributing European Infrastructure Managers in 2009.

It is at the moment not possible for one estimation system to fulfil the demands of estimation and invoicing of all European Infrastructure Managers. National requirements and distinctions have to be taken into account; nevertheless some common necessities and principles of estimation systems can be identified and are collected in this document.

2 Brief description of input data

The quality of an estimation system depends to a great extent on the quality of the input data; therefore an exchange of accurate and appropriate input data is essential as a basis for accurate estimation, invoicing and settlement that is also transparent for Railway Undertakings as well as for Infrastructure Managers.

The following list of attributes resembles the information the IM needs for estimation. Attributes in bold print are minimum requirements for the IM. The RU is required to provide any of these items of information on request of the IM.

If the RU realizes that the meter is defect or missing, he has to inform the IM actively and send the input data for the estimation system to each concerned IM. In order for the RU to detect problems actively, the RU should get access to the raw data as soon as possible.

#	attributes	common usage	special usage/comments
1	**train number**	**metered + unmetered**	
2	**operational mode (e.g.train run/service)**	**metered + unmetered**	**categories can differ from country to country;** e.g. categories for train runs, shunting, preconditioning, special purposes
3	**used energy source (electric, diesel)**	**metered + unmetered**	**diesel (D) or electric (E). Information is specially needed for trains which can operate with diesel or electricity**
4	**Identification of operating Railway Undertaking (RU)**	**metered + unmetered**	**e.g. register- and company identifier** So far four number UIC-Code is not always related to each distinctive RU. Unique ID for RU and IM according to TSI should be defined and used.
5	transport category (e.g. more detailed information on train run/service)	optional (if relevant)	each IM can have different categories. For each category a different specific energy consumption can be defined. E.g. categories for local passenger trains, long distance passenger trains, cargo trains
6	**mass (ton) of train & locomotive**	**metered + unmetered**	Infrabel: total mass (ton), locomotive included; DB Energy: RU transmit tons of locomotive and hauled load separately. France: Using the maximum weight of the train (hauled load without the weight of the locomotive)
7	**distance of train run (km)**	**metered + unmetered)**	
8	scheduled maximal speed (of the train , km/h)	optional (if relevant)	this can be used to define supplementary categories (e.g. higher specific consumption for fast cargo

#	attributes	common usage	special usage/comments
			train)
9	**identification of traction unit(s) (including 12-digit-vehicle-id)**	**metered + unmetered**	**traction units will be identified by the same ID used for the transfer of Metered Data, i.e. the European Vehicle Identification (12 digits); consists with more than one meter will be treated according to CENELEC/TSI (possibility of 13th digit).**
10	**Starting and ending time of data set**	**metered + unmetered**	
11	**Starting and ending location of data set**	**metered + unmetered**	**GPS-coordinates or abbreviations; depends on the IM**
12	border crossing time and location	optional (if relevant)	only needed in case of border crossing not identified by starting and ending time of data set; also distance can be added
13	country of operation	optional (if relevant)	only needed in case of border crossing not identified by starting and ending location of data set
14	intermediate points (time & location)	optional (if relevant)	supplementary information regarding the trajectory in between two intermediate points (e.g. distance) might be added

The IM normally expects information only for the operations inside his country on his grid. For each change within the declared operation (e.g. change of train composition or mass) the IM needs a new complete data set. The end point and end time of the previous data set shall be the starting point and starting time (end time plus one minute) of the new data set.

The dates and mode of data transfer have to be defined bilaterally by IM and RU.

3 Outline of common estimation methods

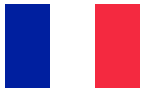
The following overview is the result of the input of the members of the REB Work Group in 2009. It gives an outline of existing estimation methods for railway energy consumption in Europe. Thereby it does not claim to be complete nor can each system be described in detail. The aim is to give an impression about key characteristics of each estimation method and to show the similarities and differences on a broad level. The intention is to show the common characteristics of estimation systems that are in use, if metered data is missing or incorrect. The definition of the rules of estimation is the responsibility of each IM.

Providing visibility of the processes and distinctive characteristics applied in different countries is intended to increase understanding and cooperation among the different Infrastructure Managers in Europe.

For further information, it is recommended to contact the Infrastructure Managers of the respective countries directly (see reference to web-links).

					
IM/ Country	**ÖBB-Infrastruktur Bau AG/ Austria**	**SBB Infrastruktur / Switzerland**	**DB Energie / Germany**	**Infrabel / Belgium (prospective)**	**jernbaneverket / Norway;**
use of estimation method in case of	missing metered data	always use of estimation method (so far no meters)	missing or incomplete metered data (for billing purpose); [metered data (for validation; preview; statistics)]	estimation system will always be used (also for validation of meters)	missing metered data (trains with defective meters or without meters)
automatic estimation system in use	no (computer-based manual procedure)	no (computer-based manual procedure)	yes (BPS)	not yet (planned in 2010;ERESS)	yes (NRESS)
estimation basis	actual operating performance data delivered by RU; train-based information	System timetable by IM (trainpath and timetable) plus input of Train Composition Data by RU (gross tonnes)	Train timetables by IM plus input of TU Operation Data by RU	input data from train management system (train composition data to be added) to be declared by RU to IM	input data of RU (incl. ton-km)
delivery of input data	data delivered by RU until 10th day of the month	data delivered by RU within 3 days, no later input accepted (otherwise use of default data according to catalog of services)	data delivered until 2nd day of the month for the previous month (exceptions with bilateral agreement possible)	not yet (planned in 2010)	15 days after report of damaged meters
estimation rules	a) calculation by comparable consumption of traction power for specific destinations and specific train load or b) calculation of traction power with specific parameter of overall consumption area (plain or different mountain routes) and specific train load c) billing on basis of operating performance data (€/km per 1000 t)	a) match data from IM and RU, find out responsible IM, b) calculate gr.Tkm, c) billing according to cost rate per train type	a) match data from IM and RU, identify general type of operation (train run, shunting, special services) and specific load classes (e.g. high speed passenger traffic) b) build load profiles, calculate gr.Tkm c) billing according to load classes and TU-categories	a) metered trains: consumption will be compared with ton-km's of that train run b) partially metered trains: data of TU with meter will be used to estimate consumption of TU without meter c) ton-km's for each train run will be calculated	train operators are invoiced on basis of ton-km's * key figure for energy consumption per gr.tkm
parameters used for estimation	in relation to relief of consumption area (e.g. plain or different mountain routes)	ten train types	load class parameters (related to TU-Categories); temperature scaling parameters	specific consumptions for a train category are used to calculate estimated consumption	key figures and profiles per train types (type of train, material, stop frequency)
billing interval	monthly billing plus annual closing statement	monthly billing	monthly billing plus annual closing statement	monthly billing	monthly billing
invoice recipient	train applicant	train applicant	train applicant (train runs); shunting station (shunting); contract applicant (contract runs); TU owner (other operations)	train applicant	train applicant
special features		- different IMs in Switzerland - weight control of train load with scales	estimation on basis of operation data for different kinds of operation (not only train runs)	location check (location of train compared with location of TU)	
prices	- €/MWh in relation to tariff time band (3 time bands and weekend tariff) - refund of recuperation	- train runs: €/gr.tkm in relation to tariff time bands (2 time bands) and train type (10 energy cost rates) - shunting: a) CHF/kWh; b)CHF per wagon and 1/2 hour - recuperation included in price	- €/kWh in relation to tariff time bands (3 time bands) - refund of metered recuperation	- tariff time bands (day, night plus peak hour charges) - possibly supplementary cost if data of RU contains many errors	- hourly prices related to energy profile of train type - key figures take into account recuperation

link for further information (e.g. prices)	http://www.oebb.at/bau/de/Servicebox/Bahnstromlieferung/index.jsp	http://www.onestopshop.ch	http://www.db-energie.de	http://www.infrabel.be	http://www.eress.eu

				
IM/ Country	**banverket / Sweden**	**RFF / France**	**Network Rail / UK**	**ADIF / ESP**
use of estimation method in case of	missing metered data (trains with defective meters or without meters)	missing metered data (trains with defective meters or without meters)	always use of estimation method (so far no meters for billing)	always use of estimation method (so far no meters for billing)
automatic estimation system in use	yes (NRESS)	no (computer-based manual procedure)	no (computer-based manual procedure)	no (computer-based manual procedure)
estimation basis	input data of RU (incl. ton-km)	input data from IM (timetable) and from train drivers; in the future also input data from RU	input data from IM and RU: route data (e.g. gradients, stations), timetable (incl. speed, number of stops), train characteristics	input data from RU (e.g. gross ton km)
delivery of input data	today 20 days after the month; in the future earlier	data of week before has to be delivered until Monday evening of the following week	train characteristics in advance of train running. Distance and time are recorded in real time	monthly
estimation rules	train operators are invoiced on basis of ton-km's * key figure for energy consumption per gr.tkm	a) estimation according to train type and train route; based on maximum tonnage, offered for the train path b) analysis of variations between forecast and consumption for each RU c) analysis of consumption at grid meter and amount of measured/estimated consumption plus losses	a) computer model used to generate mechanical energy from input data (route data, timetable, train characteristics) b) mechanical energy "converted" to electrical energy per km using default data and operation data	- estimation on basis of gross ton km; - formulas of David are applied (considers e.g. data of TU)
parameters used for estimation	key figures and profiles per train types (type of train, material, stop frequency)	- train types - train route types	- allocation of trains to Train Service Code (TSC, approx. 380) - passenger consumption rates (kWh/km) for each TSC; freight consumption rates (kWh/ton-km)	- train types - types of services
billing interval	monthly billing	monthly billing (about 10 days after the end of the month)	monthly billing plus annual reconciliation	monthly billing plus annual reconciliation
invoice recipient	signer of traffic agreement (RU, can be train applicant or operator)	train applicant	train applicant	RU (at the moment only one)
special features	total of ton km are checked by IM	each RU has to pay imbalancing based on the RFF declaration to the grid; imbalancing paid to responsible of balancing of the choice of the RU	- Train Service Codes define typical stopping pattern and rolling stock type - freight mostly diesel traction - annual reconciliation for each of 20 tariff areas (consumption at grid meter vs. estimated consumption) - estimation of recuperation between 16 and 20% according to type of train	tariffs have to be published and approved my ministery

prices	- hourly prices related to energy profile of train type - key figures take into account recuperation	- tariff time bands (price per hour, at the moment 7 time zones) -losses: price per month -if data is missing, RU pays RFF price - reconciliation	"Energy" prices: 5 time bands per month per RU. "Grid Distribution & Transmission" rates for each of the 20 tariff areas (i.e. geographic)	- tariff time bands (at the moment 6 time bands) - reconciliation at the end of the year
link for further information (e.g. prices)	http://www.eress.eu	http://www.rff.fr	http://www.networkrail.co.uk	

4 Recommendations for estimation systems

Given the differences in national laws, railway organisations and the extent of energy market deregulation in each country, the task of defining common invoicing business rules will remain the responsibility of each country or Infrastructure Manager. Nevertheless IMs face common tasks and difficult situations while collecting and handling data for estimating energy consumption. Therefore a collection of suggestions was developed by participants of the REB project that may help as a guideline while dealing with existing or upcoming special situations.

#	Task	Description	Suggestions/ Best Practise
1	match of TU-number(s) and train number	The train number is usually needed for billing, but not included in all sources of input data (e.g. metered data usually only contains TU-Number) --> different sources of input data need to be matched efficiently; esp. dealing with multiple units is difficult.	Receive all input data in time (incl. consist of the train), employ systems to check and validate data.
2	settlement of leased/hired traction units	The consumed energy of a TU cannot always be billed to one customer/user, but the TU can be leased/hired between several RUs. Input data of different RUs using the same TU can be conflicting.	Receive all input data in time, employ systems to check and validate data; invoice to the user if known, fallback solution: invoice to the owner, if user is not known and the owner is contract partner of the IM.
3	delivery of input data for the estimation not always in time	Data delivered by RU (or IM) are not delivered in time for billing.	Define procedures and consequences in the contract between RU and IM.
4	poor quality of input data	Data delivered by RU (or IM) are not complete or contain errors.	Estimation of energy consumption with risk factor.
5	handling of correction data	(Corrected) data is delivered after the billing process. Sophisticated correction methods are time-consuming and/or costly.	RU has to accept financial consequences for handling corrections, if RU is responsible for delay; in some countries rules are defined in national laws; IM has to examine with the RU/manager of rolling stock that data has been incorrect (more than once).
6	detection of border crossings	If metered location data is not available, informations about border crossings are inaccurate and delivered information can be conflicting.	Check all available information (from declaration data of RU, from traffic control center, from other IM …).

#	Task	Description	Suggestions/ Best Practise
7	detection of incorrect data (validation)	Input data for the estimation system can be wrong, how can the IM detect incorrect data ? Also input data from meters can be wrong, how can the IM detect that and when shall the estimation system be used for defective meters ? How to detect and deal with special cases (double traction, transfer of hauled locomotives) ?	Check of input data (format and content, e.g. TU and owner known in database of IM or other transport information systems); crosscheck of data from different sources (e.g. also crosscheck of location data); observation of output data over some time; compare consumption of similar vehicles and/or train runs/types of service over some time.
8	multiple units with incomplete metered data	For multiple units (esp. Passenger trains) with more than one meter, data can be missing or wrong for one meter, but data for another meter might be available.	If location data is missing, location data of the measured unit can be used. If consumption data is missing and the delivered consumption data of one unit seems to be correct, the data of the measured unit can be used as a basis to bill another unit of the same consist. Esp. in mountain areas the consumption of several meters on one multiple unit can differ considerably. Therefore in some countries estimation will be used for the whole multiple unit in case of missing or incorrect data for one meter.