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System CL400

for inspection of fuel consumption in Diesel-electric locomotives

Aims and functions of the system

The system is intended for inspection of fuel consumption in fuel supplied devices in Diesel-electric locomotives, specifically for:
– controlling the actual consumption of fuel by comparing it with the technically justified fuel consumption level;
– detecting and recording fuel losses which may indicate theft;
– detecting and recording acts of interference into the recording system;
– evaluating the technical conditions of internal combustion engine as far as fuel consumption is concerned;
– evaluating the way in which the locomotive is operated in terms of fuel consumption;
– developing fuel consumption standards.

Characteristic features of the system

The flexible configuration of the system makes it possible to:
– use the system for short-term or continuous/long-term inspections of fuel consumption;
– install the system in all types of Diesel-electric locomotives which are used in Poland and are equipped with one or more fuel tanks;
– use the system in companies which employ a few or a few hundred locomotives;
– read data via the GSM, the Internet or – if it is needed – using a portable computer with an IrDA infra-red link, which can communicate with a recorder mounted on a locomotive;
– perform some extra functions, i.e.: locating locomotives, inspecting engineers' working hours, recording of confirmation that operating activities were performed.

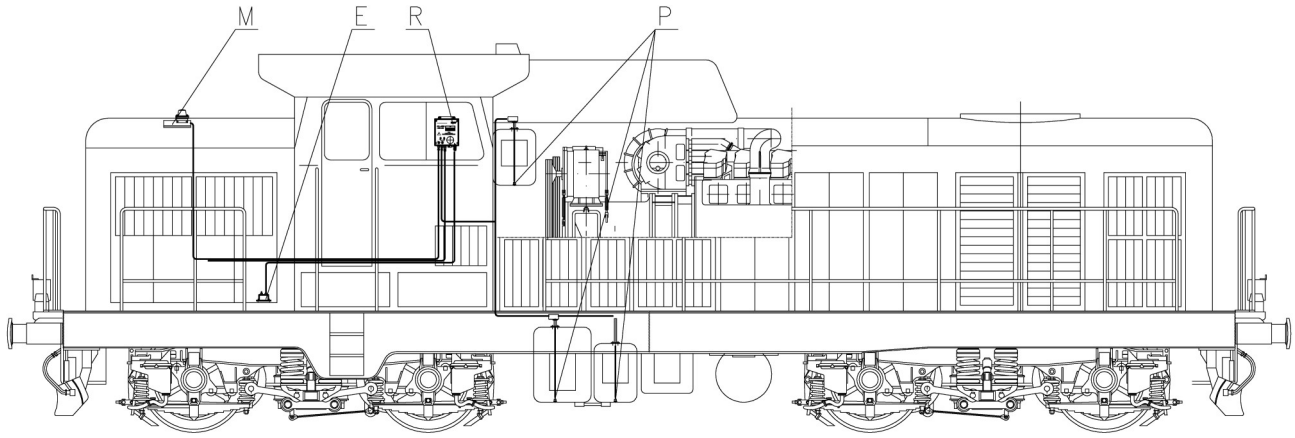
The unique solutions:
– a simple and effective method of fuel control useful in detecting groundless fuel losses;
– a very accurate way to measure the amounts of fuel in locomotive tanks; it can be applied due to very accurate sensors, individual tank calibration, compensation of differences in fuel properties and locomotive inclinations that may affect the measurement and to some other solutions;
– an ability of recognizing the technical state of a locomotive which may influences fuel consumption;
– an ability of recognizing intentional or accidental/unintentional interferences into devices and their circuits mounted on a locomotive;
– design and installation of system sub-assemblies adapted to specific locomotive environment;
– physical and programming/electronic methods of protecting data stored in a the system memory against their modification or deleting;
– a special procedure, which controls recording process and eliminates recording irrelevant data; the procedure simplifies data analyzing process and reduces amount of information stored;
– storing the exploitation/operation data in the system memory for approx. six months; this feature allows comparing past fuel consumption with data copied or achieved via teletransmission;
– a user friendly program, which analyzes the recorded data and allows some standard analyses of fuel consumption, of working parameters and exploitation/operation conditions which may influence the fuel consumption;
– data conversion enables any analysis done in Microsoft Excel.

Other advantages:
– favourable price,
– three year guarantee,
– after-guarantee service.

Design and operation

The CL400 system is adapted to the constraints which originate from the locomotive design and accordingly to customers' requirements. The system consists of the following sub-assemblies and programs:
– sub-assemblies, which are mounted in a locomotive:
  ● recorder CL400;
  ● hydrostatic transducer CL411;
  ● electric accessories;
  ● optionally, module type GPRS/GPS with antenna;
– additional accessories and programs:
  ● isolated optical coupling, which connects the CL400 recorder with a computer;
  ● the CL400AN program, which analyses data recorded using the CL400 system;
  ● optionally, the service program named CL400_SERWIS.

For the system in which a transmission by the GSM net is used, data referring to the inspection of fuel consumption and to some extra activities, as well as visualization of these and selected analysis may be found on the Internet page belonging to the operator who realizes the transmission.



Elements of the CL400 system on the 6D (SM42) Diesel-electric locomotive
R – recorder CL400, P – hydrostatic transducer CL411, E - electric accessories,
M – telemetric module type GPRS/GPS and antenna

The recorder CL400 is the basic element of the system. Its design and the sub-assemblies used fit voltages, which occur in different locomotive circuits and fulfill the standards referring to rail-vehicles. The above statement especially refers to signals of voltage and current of the main electric generator. The recorder also meets the requirements, which refer to electromagnetic compatibility under the conditions occurring in traction vehicles. The recorder is a special micro-processing measurement and recording system. Any kind of the locomotive's working parameters – electric or non-electric – used for monitoring its devices and systems, especially those influencing fuel consumption, may be the recorder's input quantities. It is also possible to record parameters, which can explain reasons of repetitive damages, point at engineers' habits, etc.

Basic analogous quantities, which are measured:
– mass of fuel inside locomotive tanks;
– main generator voltage;
– main generator current;
– vehicle velocity;
– pressure, temperature and other analogous quantities, which are interesting for a user of the system (an option).

Moreover, the recorder achieves digital signals, which inform about switching on of the following:
– locomotive batteries;
– a Diesel engine;
– heaters of a Diesel engine;
– other devices which are interesting from the point of view of a system user (option).

The recorder has been equipped with a touchless card reader of RFID type, which may be used according to user's requirements.

The recorder is equipped with the following output devices:
– a LCD display, which shows fuel mass and fuel volume in locomotive tanks as well as other quantities agreed with a customer;
– an IrDA coupling, which enables two-way communication with an external computer;
– a coupling with a GPRS/GPS module (an option);
– a relay, which controls the operation of the device selected by a user (an option).

A unique mathematical model, realized by a program of the recorder's microcontroller describes the relationship between justified mass of fuel used and quantities and values of the recorder's input signals. The justified mass of fuel used is computed in an increasing manner since the moment, when the recorder was mounted in a locomotive. This mass is recorded simultaneously with other output quantities; its current value may be shown on the recorder's LCD display.

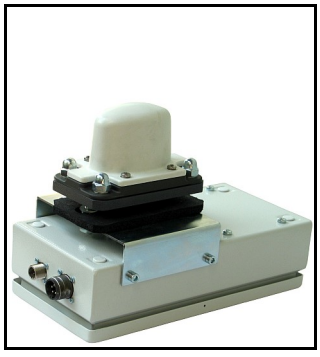
In the simplest version of the CL400 system, where the recorded data are not transmitted to an external computer, the total amount of fuel in a locomotive tanks (given in mass and volume units) and also the justified fuel mass consumption (computed in an increasing manner) used by the locomotive's devices are shown on the recorder LCD display. Thus, it is possible to compare the decrement of the fuel mass in the locomotive's tanks with the increment of the justified fuel mass consumption, which should be used by the locomotive. This comparison makes it possible to inspect any locomotive's working period. The refueled amount of fuel is taken into account in this computation.

The above described version does not permit analyzing locomotive engine's working time, including idle time, electric energy used by traction engines of a locomotive as well as other quantities, which may be used to decrease fuel consumption. A better solution consists in processing the recorded data by use of the CL400AN program and an external computer. The data may be copied to the computer by means of the IrDA coupling. The CL400AN program enables convenient data storage, visualization and printing as well as analysis of these and their conversion to the text format.

The most advanced version of the system also includes the telemetric modem type GPRS/GPS which is used for localizing locomotives in motion and for data transmission using the GSM net. The data from the recorder and the localization unit are sent to a server, which is a property of a company enabling the transmission. Further, the data from the server, by means of the Internet, are sent to computers, which belong to the people who are responsible for locomotive disposal, supervision and fuel consumption. Then visualizations and analysis are performed using the CL400AN program and the Internet pages belonging to a company which transmits the data.

Recorder CL400

Hydrostatic transducer CL411



Telemetric modem and antenna

Technical specification

Measured analogous quantities		
Fuel mass		
Maximum fuel mass in locomotive fuel tanks	kg	8000
Measurement error – fuel tank <3000 l	kg	<5
Measurement error – fuel tank >3000 l	kg	<10
Fuel temperature		
Measurement range	°C	-40÷80
Measurement error (at the point where the CL411 is mounted)	°C	<0,5
Voltage of the main generator		
Maximum range	V	1000
Measurement error	V	<2
Nominal insulation voltage	kV	1
Current of the main generator		
Maximum range (set using locomotive shunt)	A	7200
Maximum input voltage	mV	90
Measurement error	A	<15
Nominal insulation voltage	kV	1
Locomotive speed		
Maximum range	km/h	120
Measurement error	km/h	<1
Maximum input voltage	VAC	165
Input resistance	kΩ	>1
Nominal insulation voltage	V	250
Digital signals		
Binary inputs (signaling)		
Number – signal type (function) determined by a program		2
Voltage of the state H (switching on)	Vdc	40÷165
Input resistance	kΩ	>22
Nominal insulation voltage	V	250
Computed parameters		
Diesel engine working time – incremented with the resolution of 1s		
Locomotive drive working time – incremented with the resolution of 1s		
Electric energy produced by the main generator – incremented with the resolution of 1 kWh		
Justifiable fuel mass consumption – incremented with the resolution of 1 kg		
Display		
Illuminated LCD – 2 rows, 16 alphanumeric signs each – character size 8 mm		
Identification card reader		
Type: RFID for UNIQUE cards		
Interface for the system calibration and service inspection purpose		
Type: serial IrDA		
GPRS/GPS module interface		
Type: serial RS422/RS485		
Parameter memory		
Type: EEPROM		
Memory for recording		
Type: battery back up RAM		
Design features		
Housing protection level		IP44
IEC protection class		I
Power supply insulation voltage	V	250
Temperature of work	°C	-25÷60
Relative humidity	%	20÷80
Supply voltage	Vdc	43÷170
Housing dimensions (without connectors) W × H × D	mm	260 × 280 × 80
Weight	kg	4,5

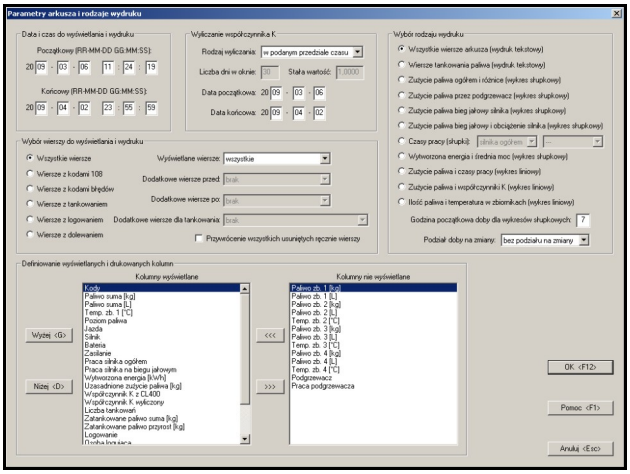
The CL400 recorder mounted in a locomotive

Telemetric system antenna

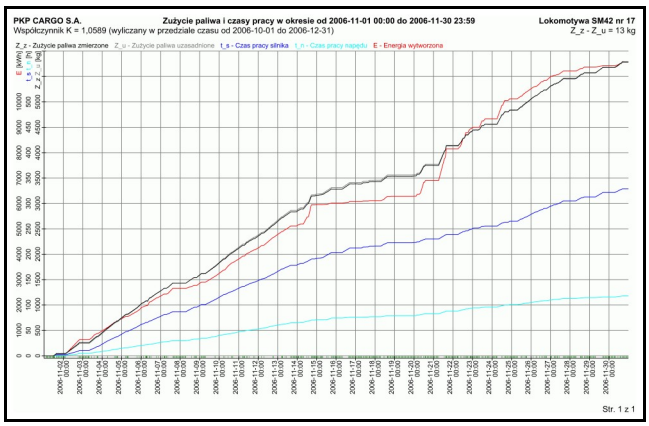
The CL400AN program and its features

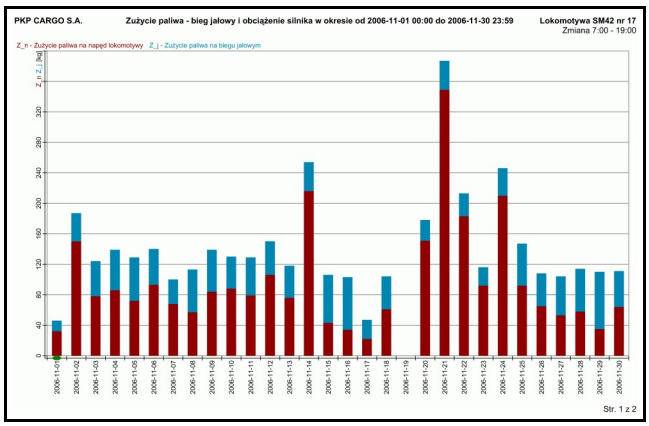
The CL400AN program is used for data storage, visualization and analysis. The program, which is installed in computers belonging to a user, enables data presentation on a computer screen as well as printing of the following information and diagrams:

– selected activities (e.g. refueling, engineer's logging on or off, switching on the Diesel engine, groundless fuel losses);
– information, which refer to refueling;
– bar chart of the actual and justifiable fuel consumption;
– bar chart of fuel used by a heater;
– bar chart of fuel used for idle run of a Diesel engine;
– bar chart of fuel used for idle or loaded run of a Diesel engine;
– bar chart of working times for: a Diesel engine (in total and during its idle run), locomotive driving system or a heater;
– bar chart of the electric energy produced and the average locomotive power;
– diagram of actual and justified fuel consumption, working time for a Diesel engine and for the locomotive driving system as well as the electric energy produced;
– diagram of actual and justified fuel consumption as well as of a coefficient, which defines an influence of locomotive technical condition on fuel consumption;
– diagram of mass, volume and temperature of fuel in locomotive tanks.



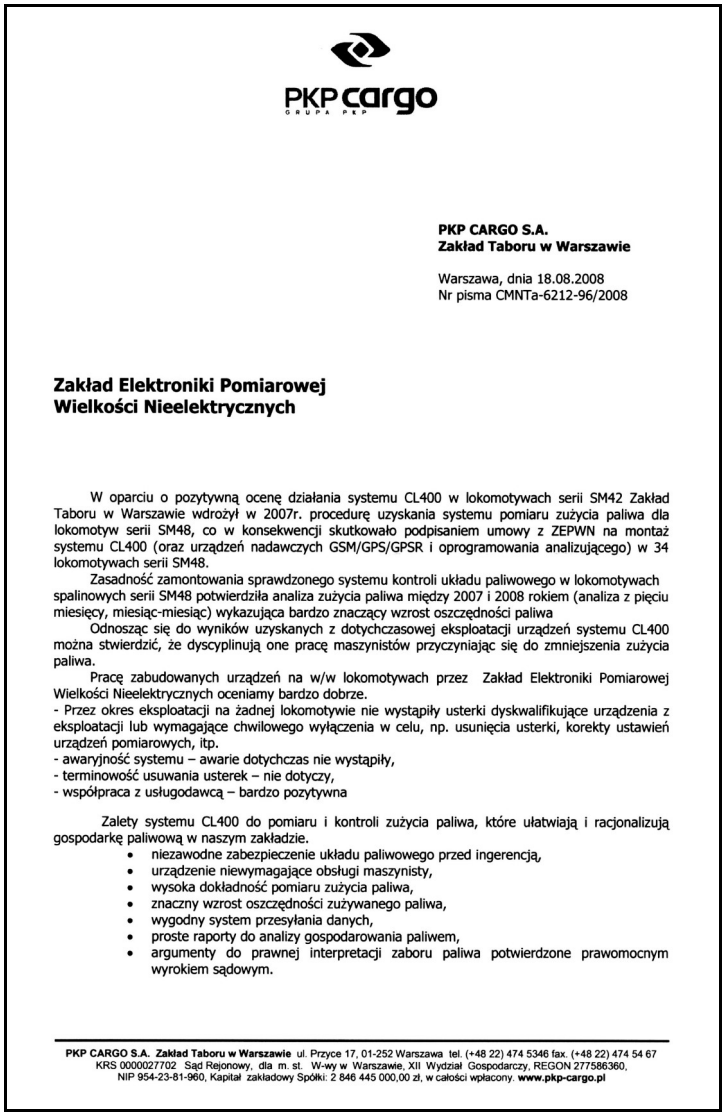
Examples of the windows created using the CL400AN program





Examples of the diagrams created using the CL400AN program

Opinion on the CL400 system and the award



PKP cargo
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PKP CARGO S.A.
Zakład Taboru w Warszawie

Warszawa, dnia 18.08.2008
Nr pisma CMNTa-6212-96/2008

Zakład Elektroniki Pomiarowej
Wielkości Nieelektrycznych

W oparciu o pozytywną ocenę działania systemu CL400 w lokomotywach serii SM42 Zakład Taboru w Warszawie wdrożył w 2007r. procedurę uzyskania systemu pomiaru zużycia paliwa dla lokomotyw serii SM48, co w konsekwencji skutkowało podpisaniem umowy z ZEPWN na montaż systemu CL400 (oraz urządzeń nadawczych GSM/GPS/GPSR i oprogramowania analizującego) w 34 lokomotywach serii SM48.

Zasadność zamontowania sprawdzonego systemu kontroli układu paliwowego w lokomotywach spalinowych serii SM48 potwierdziła analiza zużycia paliwa między 2007 i 2008 rokiem (analiza z pięciu miesięcy, miesiąc-miesiąc) wykazująca bardzo znaczący wzrost oszczędności paliwa

Odnosząc się do wyników uzyskanych z dotychczasowej eksploatacji urządzeń systemu CL400 można stwierdzić, że dyscyplinują one pracę maszynistów przyczyniając się do zmniejszenia zużycia paliwa.

Pracę zabudowanych urządzeń na w/w lokomotywach przez Zakład Elektroniki Pomiarowej Wielkości Nieelektrycznych oceniamy bardzo dobrze.

- Przez okres eksploatacji na żadnej lokomotywie nie wystąpiły usterki dyskwalifikujące urządzenia z eksploatacji lub wymagające chwilowego wyłączenia w celu, np. usunięcia usterki, korekty ustawień urządzeń pomiarowych, itp.
- awaryjność systemu – awarie dotychczas nie wystąpiły,
- terminowość usuwania usterek – nie dotyczy,
- współpraca z usługodawcą – bardzo pozytywna

Zalety systemu CL400 do pomiaru i kontroli zużycia paliwa, które ułatwiają i racjonalizują gospodarkę paliwową w naszym zakładzie.

- niezawodne zabezpieczenie układu paliwowego przed ingerencją,
- urządzenie niewymagające obsługi maszynisty,
- wysoka dokładność pomiaru zużycia paliwa,
- znaczny wzrost oszczędności zużywanego paliwa,
- wygodny system przesyłania danych,
- proste raporty do analizy gospodarowania paliwem,
- argumenty do prawnej interpretacji zaboru paliwa potwierdzone prawomocnym wyrokiem sądowym.

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KRS 0000027702 Sąd Rejonowy, dla m. st. W-wy w Warszawie, XII Wydział Gospodarczy, REGON 277586360,
NIP 954-23-81-960, Kapitał zakładowy Spółki: 2 846 445 000,00 zł, w całości wpłacony. **www.pkp-cargo.pl**

Wyróżnienie

w konkursie im. inż. Ernesta Malinowskiego

dla

Zakładu Elektroniki Pomiarowej Wielkości Nieelektrycznych

z Marek

za

system CL 400 do kontroli zużycia paliwa lokomotyw spalinowych

7. Międzynarodowe Targi Kolejowe

TRAKO 2007

Andrzej Spiker
Prezes Zarządu
Międzynarodowych Targów Gdańskich SA

dr Adam Wiekiek
Przewodniczący Jury

Gdańsk, 10.10.2007

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