

Introduction of Products

Introduction of New Electric Forklift Truck Model FE25-1

Akio Ohta

Yoshihiro Dougan

Norikazu Nakazawa

The 2-ton class electric forklift truck, FE25-1, has been developed and introduced to the market.

This model, based on the electric-powered forklift truck, FB25-12, which was released in March 2013 and has had a favorable reception, is a new electric forklift truck equipped with an easy maintenance battery (to be described in Section 3.2.1) that does not require refilling of battery electrolyte and charged by a compact, stationary type quick charger system. This report describes its outline.

Key Words: FE25-1, Electric-powered Forklift Truck, Stationary Type Quick Charger, Opportunity Charge, Long-hour Operation, Easy Maintenance, Valve Regulated Lead Acid Battery, Improvement in Waterproof and Dustproof, KOMTRAX, Environment, Safety, ICT

1. Introduction

In recent years, clean machines and equipment that do not emit CO₂ and contaminants are required to reduce the environmental load such as global warming, air pollution, offensive smell and noise pollution, and in industrial vehicles and construction machinery, the emission control (Tier4 Interim, final) has begun to be introduced in succession in Japan, U.S. and Europe since 2011.

On the other hand, an increase in the initial cost of vehicle due to compliance with the regulations and an increase in running costs due to a steep rise in fuel costs oppress the management of users. In industrial vehicles, the number of users is increasing who study the conversion from engine type forklifts that have a high environmental load and mounting running costs to clean electric-powered forklifts running costs of which are low. 75% of the total demand for 1-ton class forklifts has already shifted to electric-powered forklifts. However, in 2-ton class forklifts that account for a majority of the total forklift demand, the battery ratio (ratio of electric-powered forklifts in total demand) still remains at about 30% for the following reasons.

- 1) As the capacity of a battery is limited due to the limited installation space, continuous operation time per full charge is short (4 - 6 hours).
- 2) It takes time to bring the battery to full charge (10 - 12 hours). The battery capacity cannot be restored with opportunity charge of short time.
- 3) The battery needs management of charging and refilling of water. If this management is neglected, unexpected deterioration or replacement (expensive repair) of the battery occurs.
- 4) As an electric-powered forklift operates by electric/electronics components, it is vulnerable to water and dust and is not suitable to operation and storage outdoors.
- 5) Compared to engine type forklifts, performance such as stability is inferior.

This vehicle has solved the above issues by developing new technologies in a chassis, battery system as a battery pack and key components such as a quick charger. The outline is explained below.



Fig. 1 External view of FE25-1



Fig. 2 Stationary type quick charger

2. Development Aim

We have tackled, with this vehicle, the issues described in the above 1-1) to 4) to reduce the environmental load and user running costs of the 2-ton class forklift truck that accounts for a majority of the demand. The main aim and items implemented are as follows.

- (1) Adoption of the quick charging system that enables long-hour operation without increasing the battery capacity
- (2) Adoption of an easy maintenance battery that does not require cumbersome refilling of water for a battery and preparatory work for charging
- (3) Adoption of the waterproof and dustproof structure that enables outdoor work/storage in the rain and work at a worksite where there is a lot of dust
- (4) Adoption of the latest ICT (Information Communication Technology) that grasps the operating condition of the vehicle and supports security and trust of customers

3. Main Features

The pursuit of “Environment”, “Safety” and “ICT” on a higher level based on Komatsu’s commitment to “Quality and Reliability” is the basic concept.

Based on this concept, the product competitiveness has been substantially enhanced by reducing the environmental load due to zero emission gas as well as reducing electrical power consumption, pursuing safety and utilizing the ICT technology.

Its outline and features are introduced below.

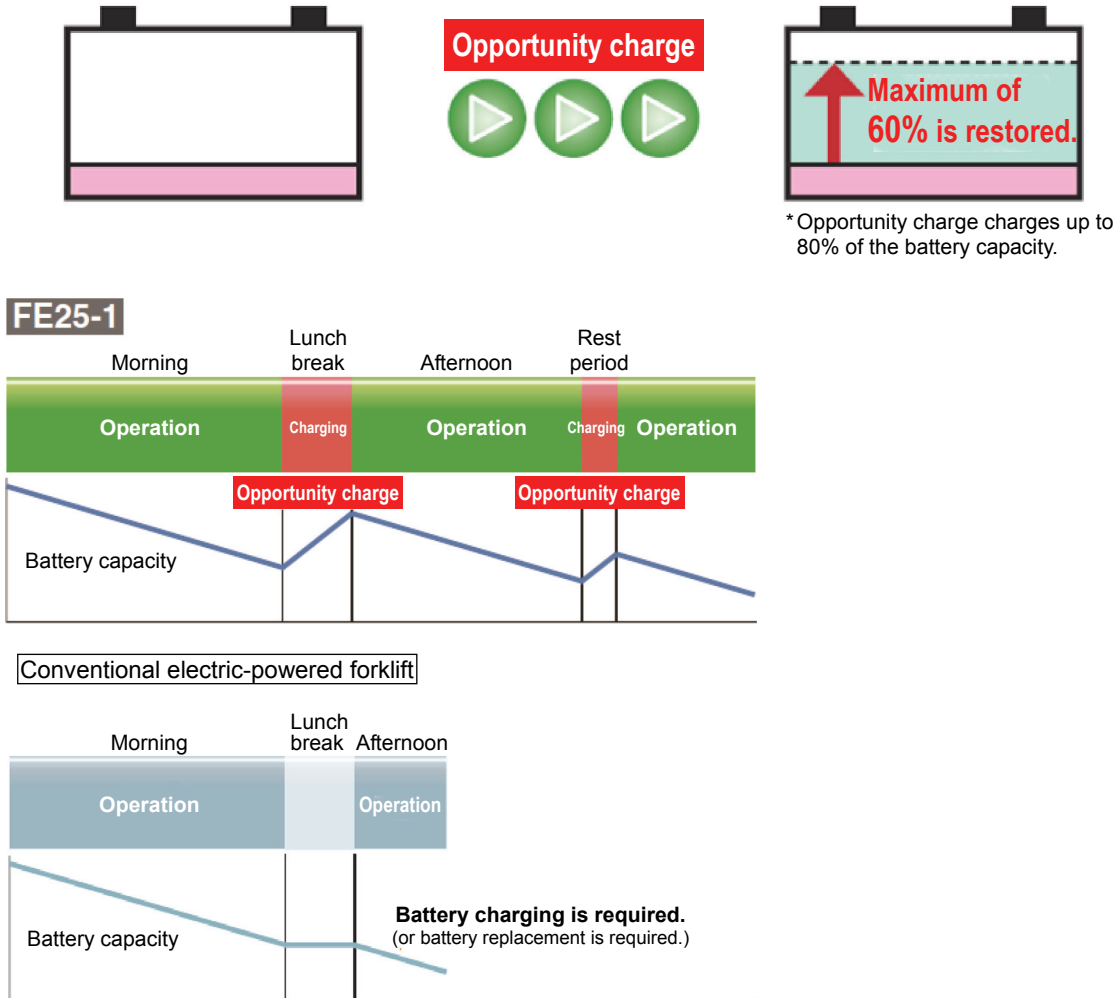
3.1 Environment

- The gas emission is zero, and besides, opportunity charge for a short time enables long-time operation.

The newly developed, high-output stationary type quick charger has enabled opportunity charge that restores the battery capacity to the maximum of 60% in a short time of one hour.

As operation hours per day can be substantially extended by opportunity charge utilizing lunch break or rest period, it is possible to cope with an increase in an amount of work during a busy period or sudden overtime work.

In addition, the battery life is prolonged by multi-step constant current charging by inverter control according to the battery remaining capacity and temperature.



* Opportunity charge charges up to 80% of the battery capacity.

Fig. 3

- Operation time is extended by reducing electrical power consumption and vehicle weight.

20% compared to that of conventional forklift trucks because of the following improvements in (1) - (3).

FE25-1 has extended operation time by 1.2 times or longer while reducing the battery capacity by approximately 4%, by reducing electrical power consumption by more than

Operation time equivalent to that of a conventional forklift truck equipped with a large capacity battery is secured by performing one-hour opportunity charge.

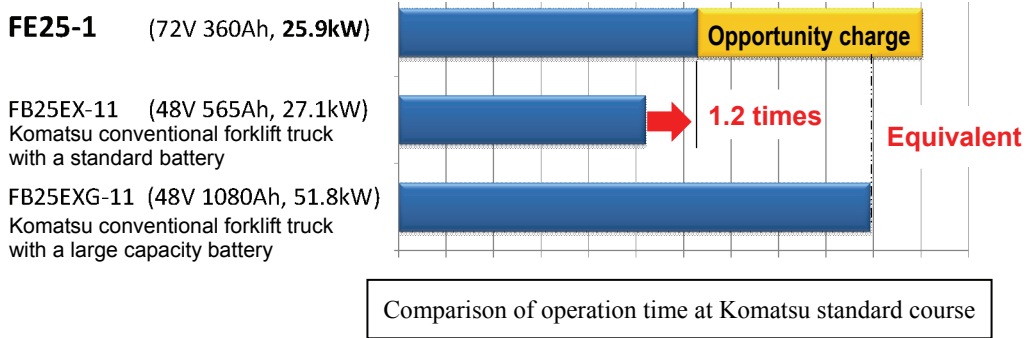


Fig. 4

(1) Adoption of PM motor

A highly efficient PM motor (permanent magnet synchronous motor) using a permanent magnet has been adopted for a travel motor and material handling motor.

As the “PM motor” uses a permanent magnet for the rotor of a motor, it does not need induced current (secondary current) necessary for the rotor of the conventional “IM” (induction motor), and can reduce energy loss.

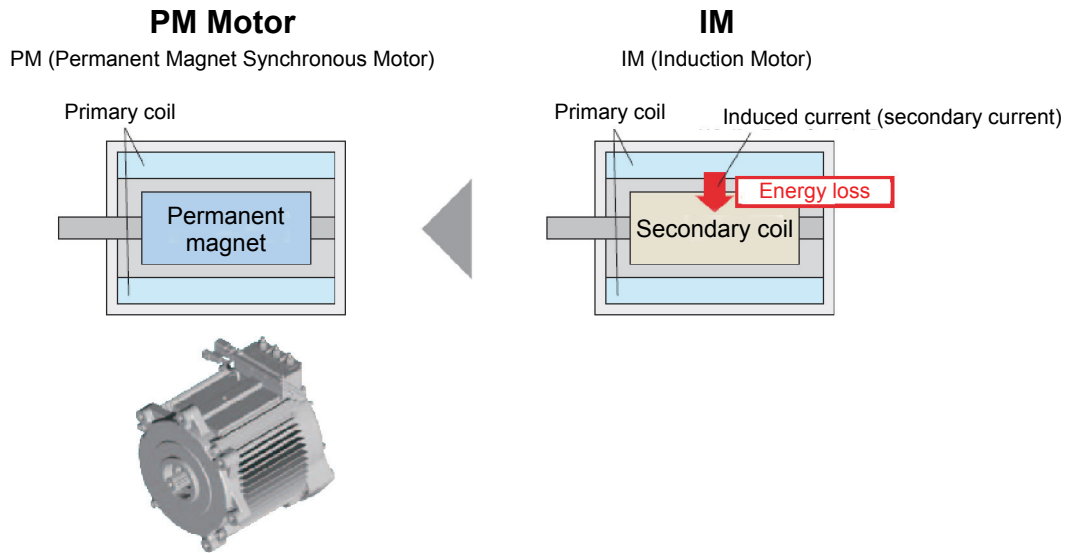


Fig. 5

(2) Adoption of new type motor control that reduces electrical power consumption

As the conventional forklift truck implemented control with reference to motor speed, torque more than necessary was generated during startup, acceleration and so on, and the

peak power tended to become large.

FE25-1 has changed the control reference from motor speed to necessary torque to suppress the peak power and to reduce electrical power consumption.

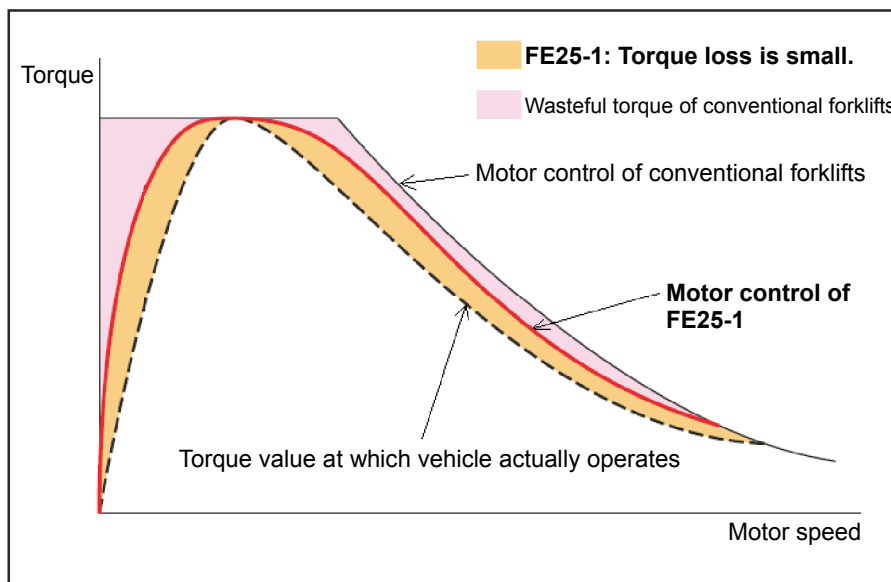


Fig. 6

(3) Reduction in vehicle weight

The center of gravity balance of the vehicle was fully reviewed and the battery installation position was laid out in the rear. As a result, weight reduction of approximately 200 kg has been achieved compared to the conventional forklift truck and electrical power consumption during operation has been reduced.



Fig. 7

3.2 Safety

3.2.1 Easy maintenance battery that does not require refilling of water

An easy maintenance battery, which is commonly called a VRLA (Valve Regulated Lead Acid) battery, is a battery that does not require refilling of water.

Compared to a conventional flooded lead-acid battery, an electrolyte of the easy maintenance battery is contained only in the liquid absorbing glassfiber separators of the positive and negative electrodes.

Hydrogen gas is less likely to be discharged outside because hydrogen gas generated during charging is absorbed by the negative plate and is recirculated in water.

These two factors have eliminated the need for cumbersome refilling of water that was required by a conventional flooded lead-acid battery and at the same time secure the safety.

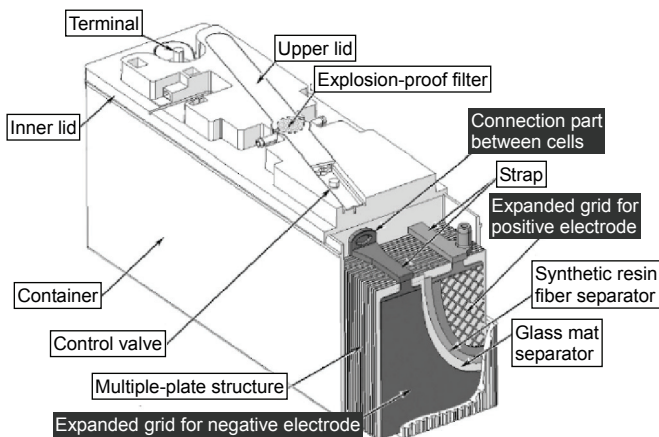


Fig. 8

3.2.2 Improvement in waterproof and dustproof

The structure has been changed so that outside air containing dust is not directly taken into electric equipment, by sealing the motor and controller and by changing the cooling system from the inside ventilation type to the heat sink type.

Furthermore, improvement in waterproof and dustproof by adopting waterproof connectors and installing a waterproof cover has enabled outdoor work/storage in the rain, work at a worksite where there is a lot of dust and vehicle washing by directly splashing water using a hose.

Conventionally, the battery hood of an electric-powered forklift truck needed to be opened during charging in order to ventilate gas generated from the battery during charging, and therefore, charging outdoors was not possible. As described above, however, the easy maintenance battery has a structure that is less likely to generate hydrogen gas and hydrogen gas in the battery compartment is forcibly ventilated, thus eliminating the need to open the battery hood during charging and enabling charging outdoors.

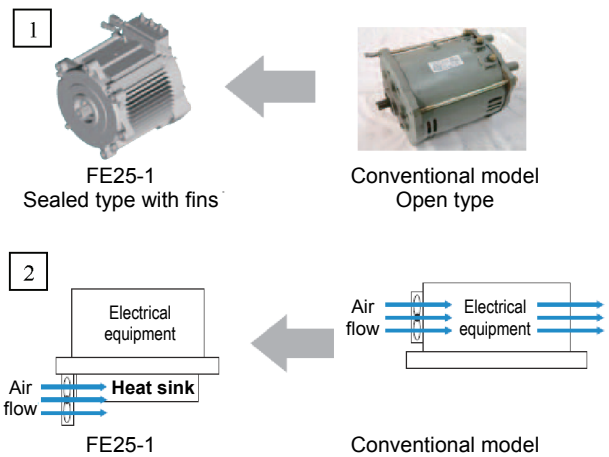
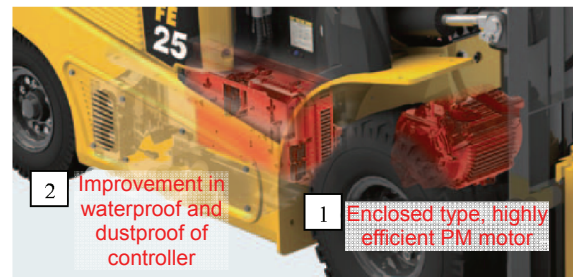


Fig. 9



Fig. 10

3.2.3 Waterproof outlet plug of charger that detects imperfect connection

FE25-1 has adopted an outlet plug of charger that detects imperfect connection to prevent a fire caused by imperfect insertion of an outlet plug of charger during charging. If charging is performed with outlet plug connected imperfectly, abnormal heat generation that may cause a vehicle fire can occur. To prevent this, this outlet plug of charger has a signal line that detects fitting of the plug and stops charging upon detecting an open-circuit in the signal line. Besides, charging outdoors and quick charging are made possible by improving the level of waterproof and dustproof to the body level and by increasing the capacity of the contact.



Fig. 11

3.2.4 Improvement in stability

Comfortability during travel and fore-aft stability during work have been improved by extending the wheelbase and increasing the front wheel tread width compared to those of the conventional forklift truck.

3.3 ICT

3.3.1 Color liquid crystal multi-monitor

A newly developed, large color liquid crystal multi-monitor has been installed under the common philosophy with construction machinery. The multi-monitor allows for grasping of vehicle conditions such as vehicle speed and remaining battery capacity and makes setup, such as travel/load handling power mode setting and vehicle speed limit, easy. Besides, various information can be obtained with button operation such as operations time, charged energy, electric charge and accumulated CO₂ emission amount.

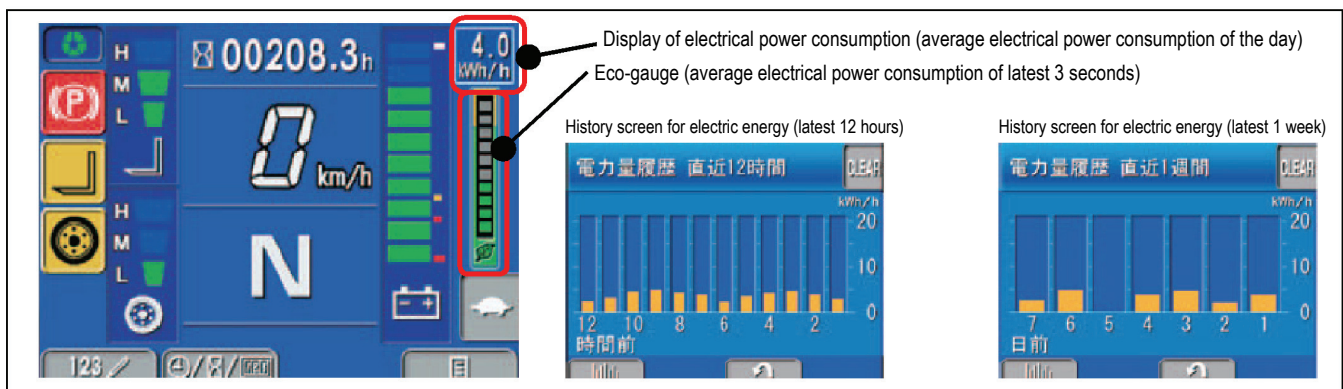


Fig. 12

3.3.2 “KOMTRAX” installed in electric-powered forklift trucks for the first time

The battery management information such as the charging history and charged energy has been added to “KOMTRAX” installed in electric-powered forklift trucks on top of the vehicle management system including the operating

condition, location information and failure history of the vehicle.

Such information allows not only grasping of electric energy used, CO₂ emission amount and running costs, but also the proposing eco-driving and rightsizing of the number of vehicles, and forecasting and prolonging the battery life.

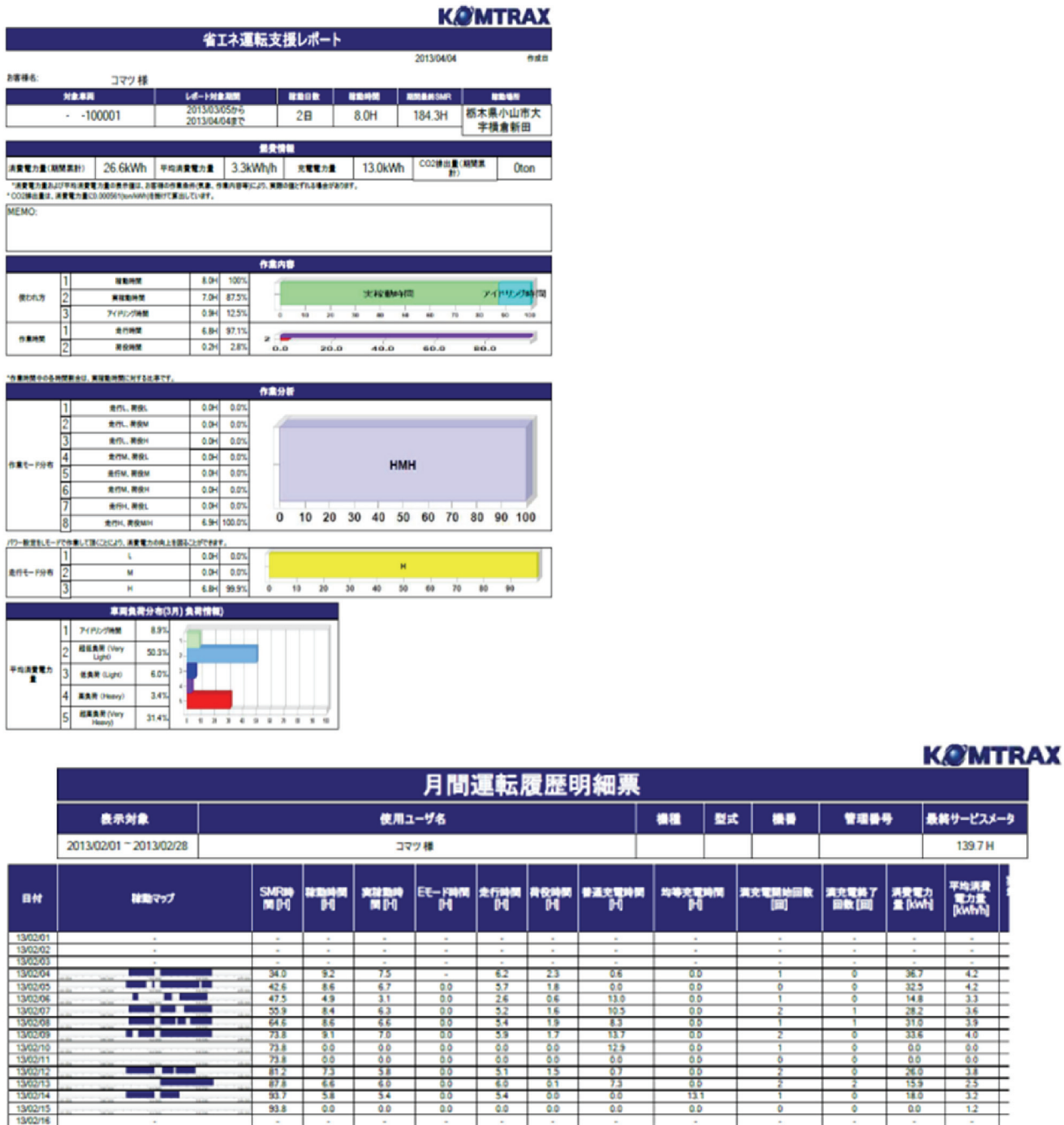


Fig. 13

4. Conclusion

We are confident that FE25-1 dispels anxiety, from the viewpoint of “Environment”, “Safety” and “ICT”, from users who want to use an electric-powered forklift truck but have uneasiness toward its use and that this new model will be accepted by users and markets that think they can use only engine type forklift trucks.

We are determined to make efforts to satisfy our customers by accumulating and analyzing operation and charging information of individual users that could not be obtained in the past but can now be obtained through KOMTRAX, and proposing various ideas acquired from analysis of such information to customers.

We would like to express our deep gratitude to Tochigi Plant and other production departments, each Component Development Center of System, ICT, Power Electronics and Powertrain, Test Engineering Center and partner companies, not to mention the customers and distributors who helped our researches.

Introduction of the writers



Akio Ohta

Joined Komatsu Ltd. in 1978.
Currently a member of Electric-powered Forklift Truck Development Group, Utility Technical Center, Development Division



Yoshihiro Dougan

Joined Komatsu Ltd. in 1989.
Currently a member of Electric-powered Forklift Truck Development Group, Utility Technical Center, Development Division



Norikazu Nakazawa

Joined Komatsu Ltd. in 2002.
Currently a member of Electric-powered Forklift Truck Development Group, Utility Technical Center, Development Division

[A few words from writers]

This model has adopted a lot of new technologies and new structures as a “DANTOTSU” product that changes the preconceived idea of an electric-powered forklift truck.

We conducted a quality check for many issues that occurred during development and could solve the issues without compromise.

We believe that we have developed a forklift truck that brings merits to our customers.