2008 Prize of the Chairman of ECCJ

The "MOTTAINAI" Activities We Drove Forward for the Endurance Test Room

Denso Corporation, Daian Plant
Reliability Section 1, Functional Parts Quality Assurance Department
EDRC Circle

◎ Keywords: Others (Effective utilization of electricity)

◎ Outline of Theme

Denso Corporation and all of its employees has been making concentrated efforts together to reduce CO_2 emissions as one of their environmental activities, having "DENSO ECOVISION 2015" as a goal. Our section which performs reliability assessments on functional parts has also been working on energy conservation actively from the year 2000. As machines and equipment are getting larger due to transition to more systemized and modularized products, electricity consumption has been expanding. In such environment, we continued focusing on "MOTTAINAI" spirit (a sense of regret concerning waste when the intrinsic value of an object or resource is not properly utilized) and addressed on electricity savings of endurance test equipment by achieving:

(1) Improvements in equipment reservation system;
(2) Visualization of energy consumption; and
(3) Transition to inverter-controlled vacuum pumps.

This document describes details of the improvements for which we all worked together by carrying out cycle activities for energy conservation, citing some cases and examples.

◎ Implementation Period for the Said Example

March 2006 – March 2007

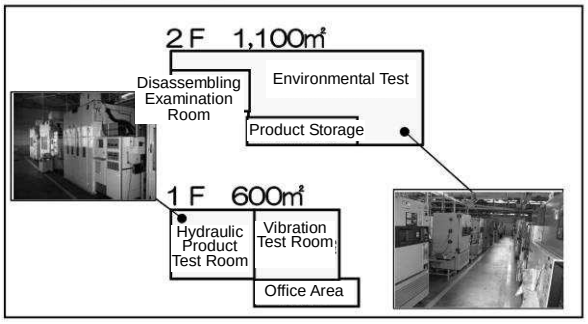
● Project Planning Period	March 2006 – July 2006	Total of 5 months
● Measures Implementation Period	July 2006 – January 2007	Total of 7 months
● Measures Effect Verification Period	July 2006 – March 2007	Total of 9 months

◎ Outline of Business Establishment

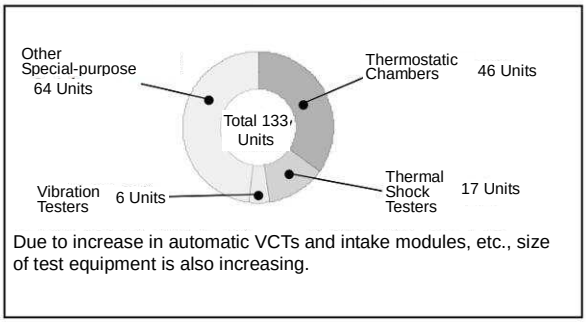
- Items Produced　Automobile electrical components (e.g. ignition devices, safety controllers, actuators, etc.)
- No. of Employees　4,000
- Type1 designated energy management factory

◎ Target: Endurance Test Room at Plant No. 602

[Floor Layout]



[Breakdown of Machines and Equipment owned]



Outline of Target Equipment

1. Reasons for Theme Selection

Our section is responsible for reliability testing on automobile electrical components, and carries out various tests including vibration and thermal shock tests, etc. We have a variety of equipment and instruments in endurance test rooms. In these days, larger and more complex testers have been installed due to recent trends toward more systemized and modularized products, causing substantial increase in electricity consumption (Fig. 1).

However, the CO_2 emissions which amounted to 475 tons in 2005 are forecasted to rise to 532 tons in 2010 with a projected annual increase by 12% based on the current pace of electricity consumption, and an electricity saving target for Quality Assurance (QA) department is getting more difficult to achieve. Furthermore, number of more complex and larger equipment is expected to increase. Considering the above, we determined to seek for reduction of electricity consumed by endurance test equipment, focusing on “MOTTAINAI” spirit (Fig. 2).

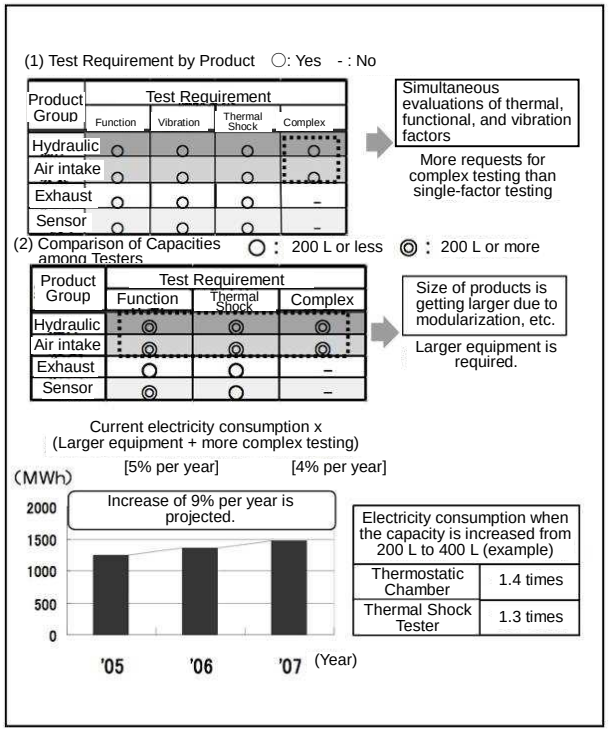


Fig. 1 Needs for Evaluation Equipment and Projected Changes in Electricity Consumption

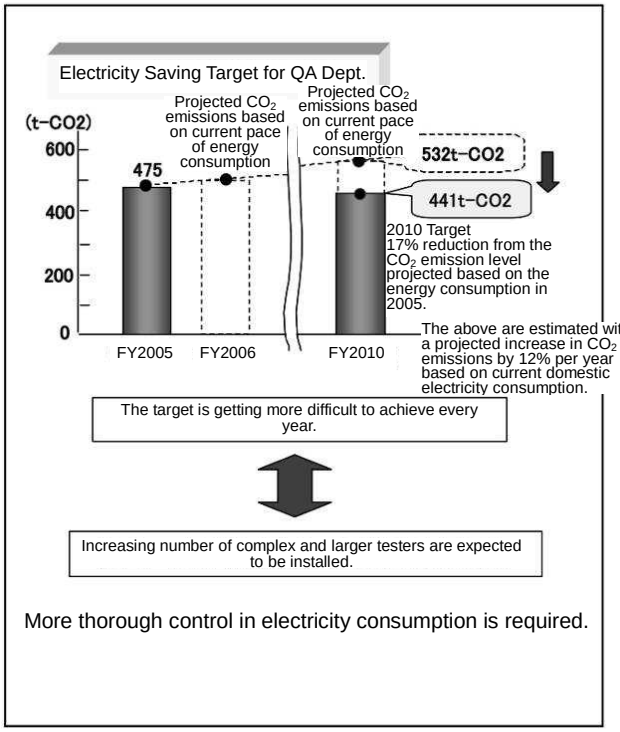


Fig. 2 Electricity Saving Target and Current Status in Quality Assurance (QA) Dept.

2. Understanding of Current Situation

(1) Past Energy Conservation Activities

Although the Reliability group is in a non-production department, we have been actively engaged in energy conservation activities by implementing improvement measures such as for ensuring energy conservation for target equipment, and achieving a result of being awarded Chairman Prize of ECCJ at National Competition for Energy Conservation in 2001 (Fig. 3).

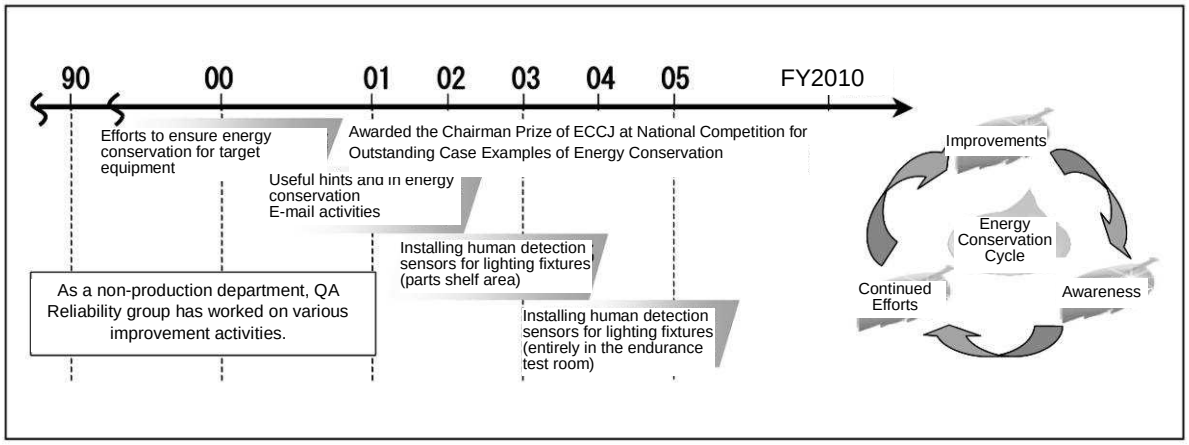


Fig. 3 History of Energy Conservation Activities by QA Reliability Group

(2) Understanding of Current Situation

Firstly, we measured electricity consumed by the machines and equipment owned by our section using a clamp meter. It was found out that endurance test equipment consumed 95% of its total consumption (Fig. 4).

Next, a meeting of Energy Conservation Circle was held to discuss these situations and measures against increased power consumption due to installation of more complex and larger equipment. As a conclusion, we determined to aim for saving of electricity consumed by endurance test equipment, having through focus on “MOTTAINAI” spirit (Fig. 5).

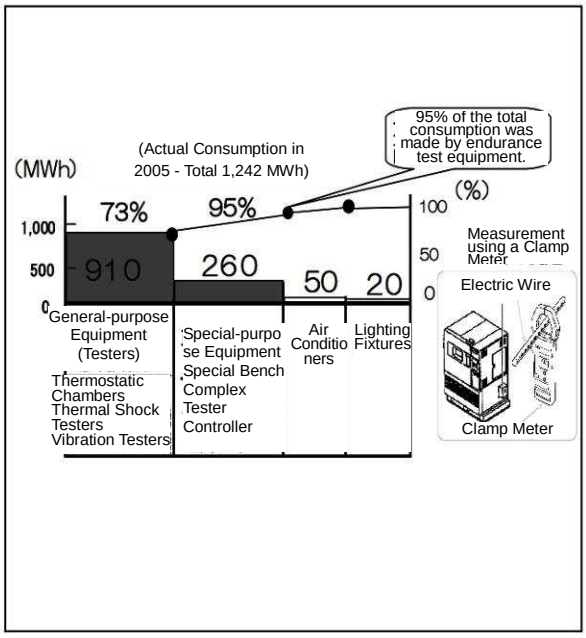


Fig. 4 Breakdown of Power Consumption in Reliability Group

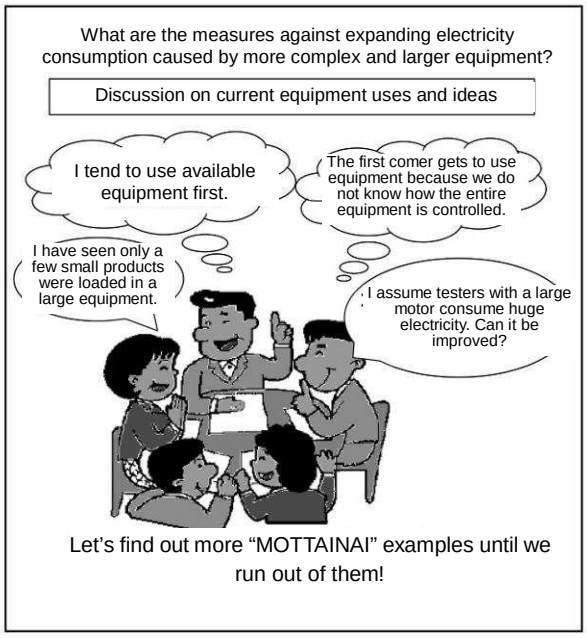


Fig. 5 Meeting of Energy Conservation Circle

3. Target Settings and Details of Activities

The target given to the QA department is CO_2 reduction for 19 tons per year. However, with an ambition to better contribute to environmental protection, we determined to set our target to 20% reduction, or to reduce 96 tons of CO_2 (4 million yen/ per year) (Fig. 6).

As we launched our efforts toward the target, we carried out PDCA cycle activities to combine our capabilities, and started to tackle on the challenges by following an action plan (Table 1).

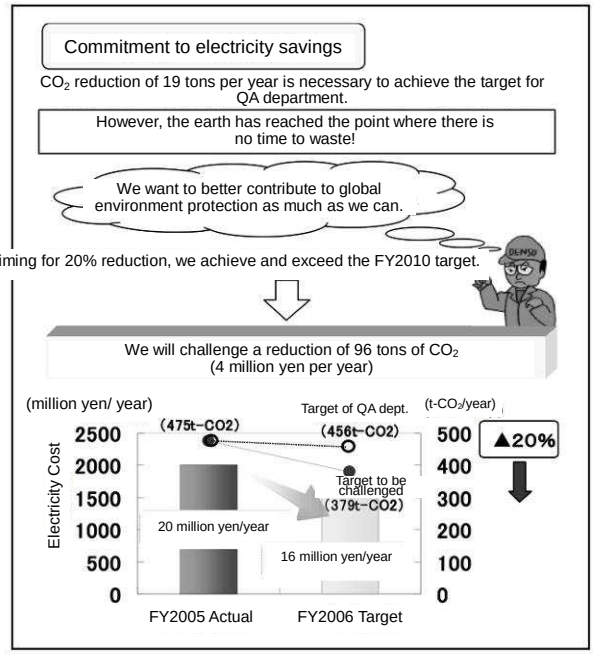


Fig. 6 Voluntary Activities Target for FY2006

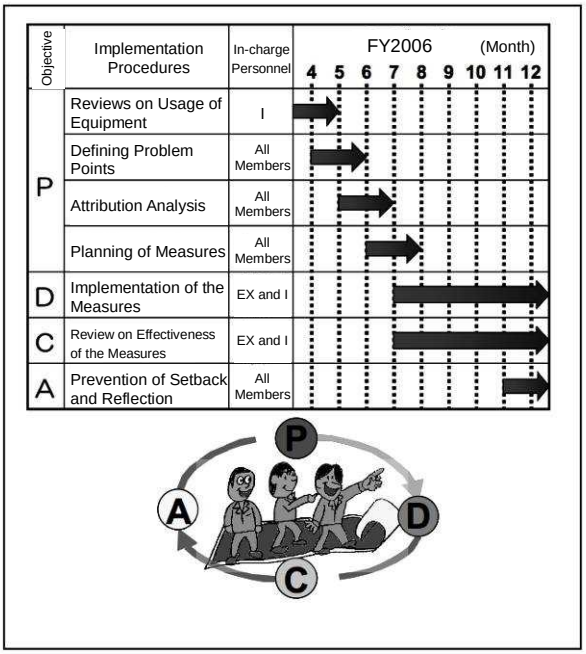


Table 1 Circle Activities Action Plan

4. Problem Points and Factor Analysis

(1) Reviews on Use of Testers

As we investigated for any “MOTTAINAI” practices in our use of existing testers, the following issues regarding thermostatic chambers and thermal shock testers were found.

1) Several chambers with the same temperature condition are found.
2) Only a small number of samples are loaded into a chamber with large electricity consumption.

Some problems were also found in vibration testers and vacuum pumps.

(2) Factor Analysis

Our analysis on factors attributable to the wasted electricity of testers has found the following problems (See Fig. 7).

1) Rules for equipment management have not been updated in order that increased number of larger equipment can be handled.

2) Tests are not carried out under appropriate operating conditions.

Details of measures to solve the above two problems are described in the Cast Study 1 and 2 below, respectively.

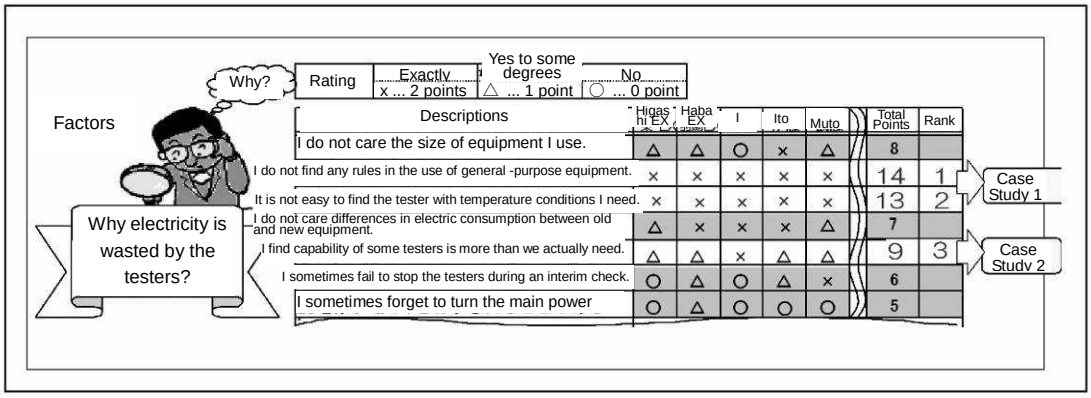


Fig. 7 Factor Analysis

5. Examples of Measures

(1) Display Panel for Status of Equipment Use

Through discussions in circle meetings for developing better mechanism to handle increased number of larger equipment, it was determined that a display panel to show if equipment is currently in use, as a tool where we can see status and conditions of equipment use at a view (Fig. 8).

The display panel is designed to provide status of use in one view, having some energy conservation measures. They include a color coding system in red, yellow, and green, in accordance with level of electricity consumption, so that a chamber with lower electricity consumption can be preferentially used leading to energy conservation (Fig. 9).

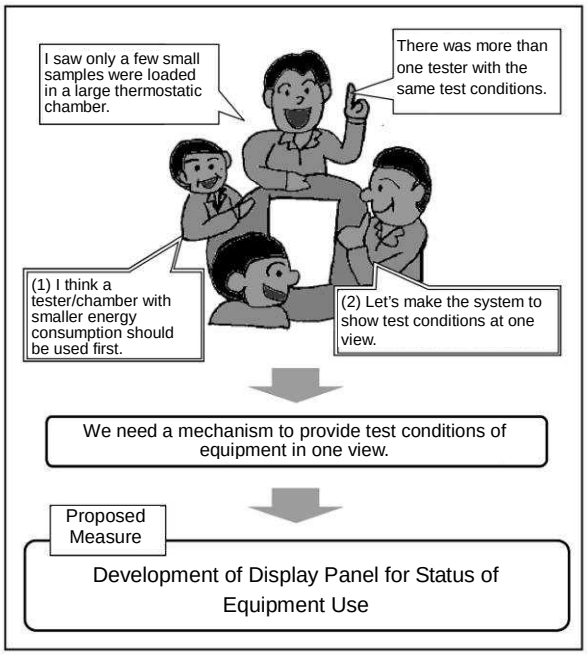


Fig. 8 Discussions on Measures against "MOTTAINAI" Behaviors and Practices

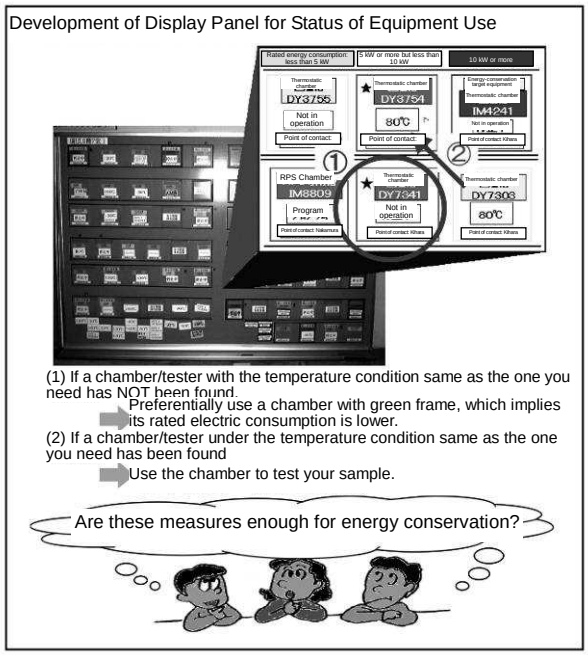


Fig. 9 Display Panel for Status of Equipment Use

(2) Case Study 1: Energy-Conserving Reservation System for Test Equipment

Our reviews made one month later found some specific problems which were summarized in "only current status is found on the display" and "owner of the products under the test is not identified". Based on those feedbacks, we decided to improve the Display Panel for Status of Equipment Use (Fig. 10).

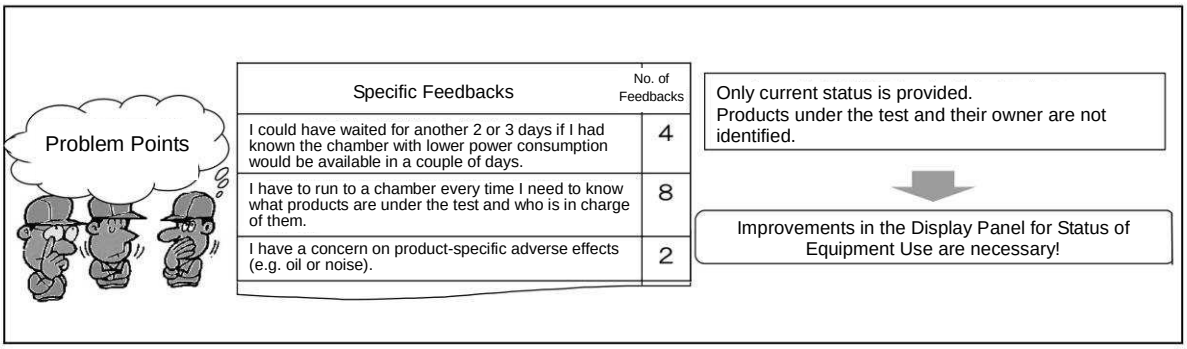


Fig. 10 Problem Points found in Display Panel for Status of Equipment Use

The system with an electronic display panel was improved by changing to the Energy-Conserving Equipment Reservation System. In order to solve the issue that "only current status is provided", we improve the system to show status of reservations in time-line and allow us to preferentially reserve a less power-consuming chamber/tester. By clicking

"In Operation" icon, you are able to obtain the information regarding the products under the test and their owners so that you can determine if your sample can be tested in the same chamber. Using a power-saving map, selection and reservation of a chamber with lower electricity consumption can be also made on the map (Fig. 11).

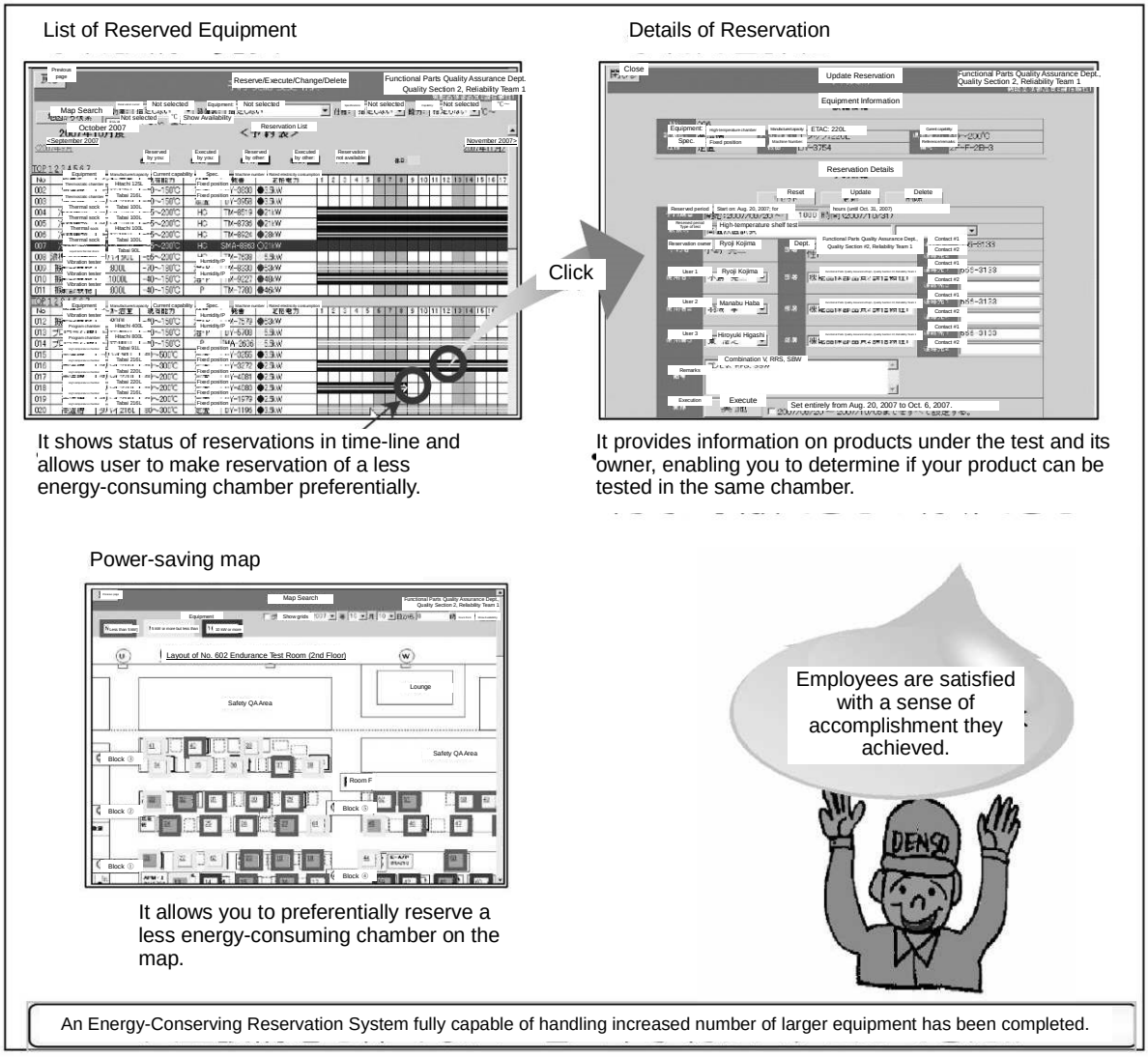


Fig. 11 Energy-conserving Reservation System

(3) Visualization by Energy Management System

In order to expand the improvements to raise employee awareness, it was necessary to have the employees realize how much effect they have achieved. Taking account of some inputs such as "the improvements seem only theoretical unless actual energy consumptions are visible" or "employees may be more motivated if they can clearly see how much effect they have achieved", a new energy management system, aiming at more steady and sustainable improvement activities, was implemented in the endurance test room (Fig. 12).

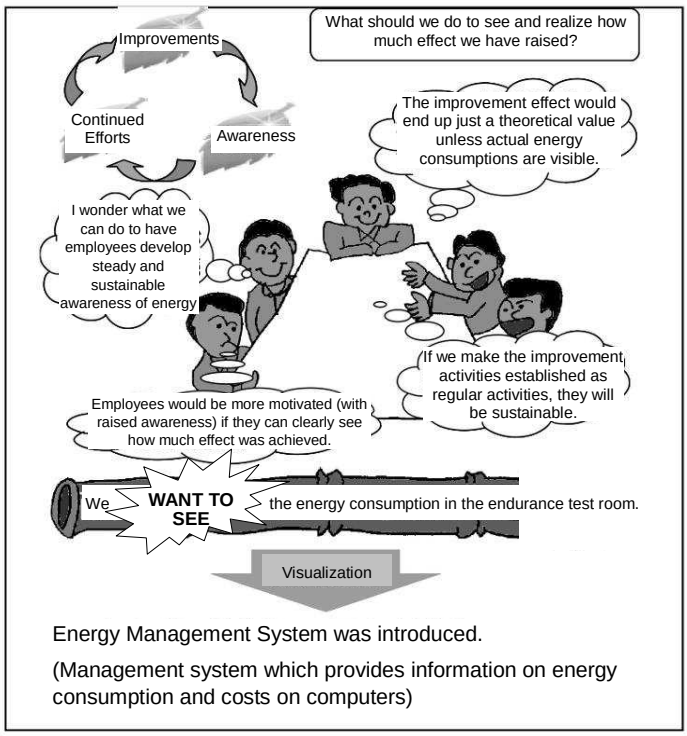


Fig. 12 Visualization of Energy Consumption Discussed in Energy Conservation Circle

Our analysis on testers by categories has shown that electricity consumption by vibration and thermal shock testers is higher than the others. And power-saving effect on each type of testers, compared to before implementing the Energy-Conserving Reservation System, has now been visible.

The effect was achieved by taking the measures such as preferentially using a chamber with lower electricity consumption, stopping operation of large-sized chambers, and reducing stand-by electricity, the efforts resulted in savings of 71.1 tons of CO_2 per year (3 million yen/year) (110,000 yen was invested to the new reservation system).

In addition, the analysis has shown us that large electricity consumption by vacuum pumps, which are not covered by the reservation system, had been overlooked (Fig. 13).

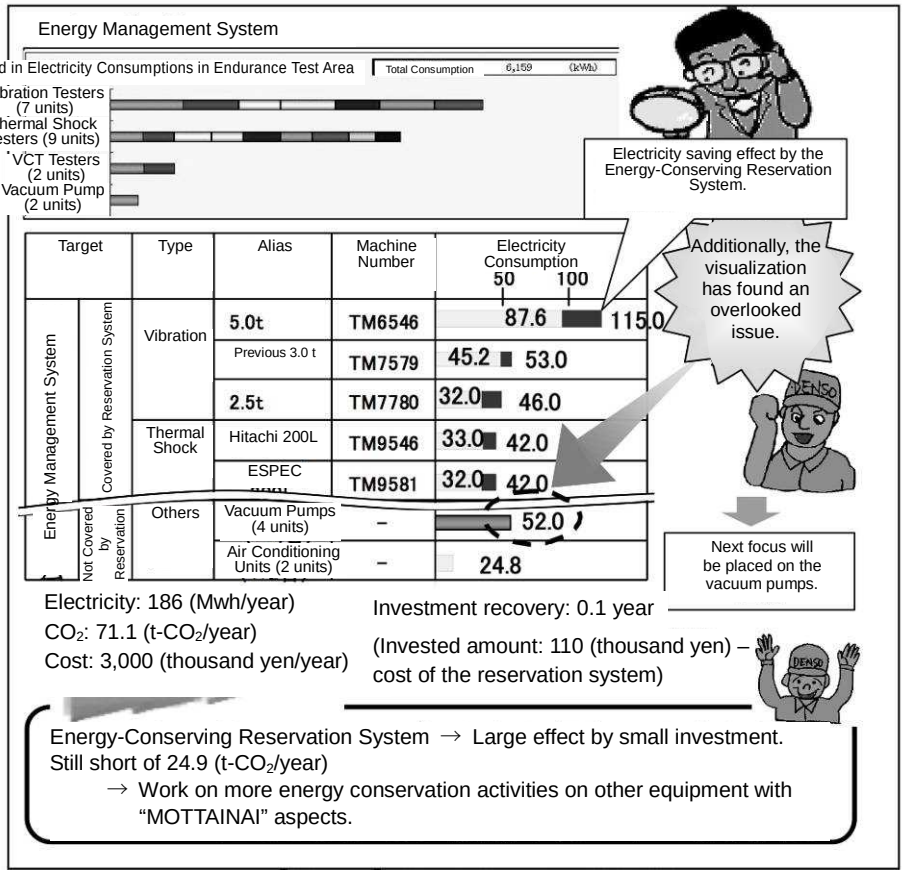


Fig. 13 Confirmation of Effects by Visualization

(4) Case Study 2: Transition to Inverter-controlled Vacuum Pumps

Following the visualization activities, a negative-pressure capacity analysis was made on the vacuum pumps which we determined to have a next focus on. As a result, it was found that they have a large performance margin rate. There are two types of pumps; the ones for measurement room which are used exclusively during measurements; and the ones for test areas which are used at any time. We measured the degree of vacuum to ensure high quality and the rotation speed to evaluate demerits to test equipment. It resulted in that the degree of vacuum was good enough, but the rotation speed decreased at the point around 30 Hz. The result left us an unsolved issue and concerns of possible troubles caused by decreased cooling capability of the pumps (Fig. 14).

Our measurement of temperatures at some pump components at various frequencies has shown that the temperature of the components are all below 80℃ (Operational standard guaranteed by the manufacturer) and no temperature problem was found up to 25 Hz (Standard minimum frequency). Therefore, we assumed it was possible to improve them to

inverter-controlled pumps (Fig. 15).

In the new inverter system, an inverter main unit and a unit in the measurement room have a rotary switch, which require less capital investment than the device with PID variable control from a pressure sensor in the test room. Having such structure, the system can ensure high quality with less investment (Fig. 16).

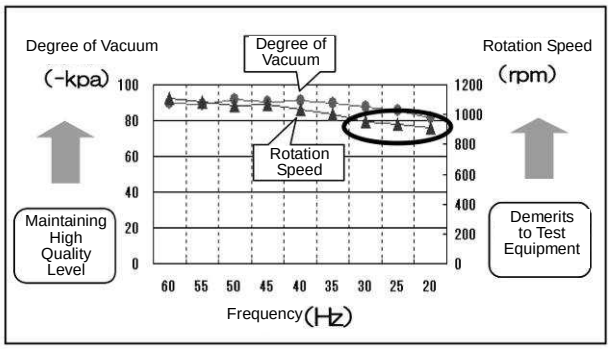


Fig. 14 Studies for Transition to Inverter-controlled Pumps

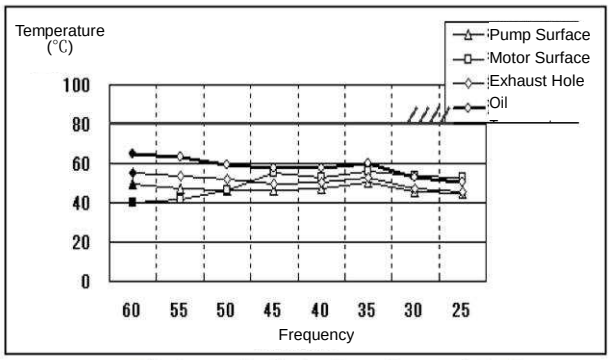


Fig. 15 Studies in Temperatures of Vacuum Pump

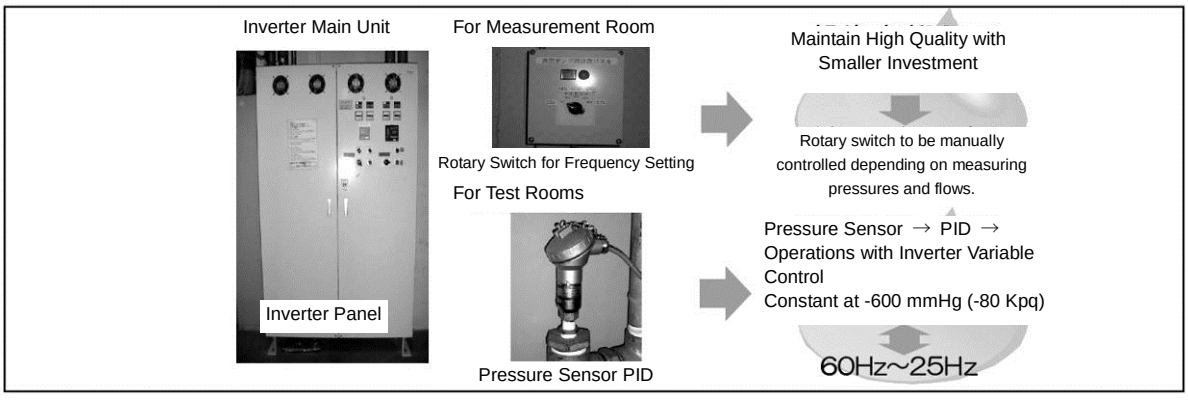


Fig. 16 Structure of New Inverter System where High Quality can be Maintained

The new inverter-controlled system brought an energy-saving effect of 25 tons of CO_2 per

year (1.08 million yen/year). We have successfully completed a transition to inverter-controlled vacuum pumps, with incidental improvements such as noise reduction and lower pump-oil temperature, resulting in longer interval between oil replacements due to their synergetic effect (Fig. 17).

Type of Pumps	Electricity from Outlet [kW]	Inverter-controlled Electricity [kW]	Operation Hours/ Year [H]	Energy-saving effect in yen [thousand yen/year]
For Measurement Room	10. 8	5. 0	1, 920	196
For Test Room	10. 8	5. 0	8, 640	196

Electricity: 67 (MWh/year)
CO_2: 25 (t-CO_2/year)
Cost: 1,077 (thousand yen/year)

Successful Energy Conservation

・ Investment Recovery 1.9 year (Invested amount: 2.05 million yen for parts and construction costs, etc.)

・ Incidental Effect

Category	Before Improvement	After Improvement	Effect
Noise	93dB	76dB	▲17dB
Pump Oil Temperature	67℃	41℃	▲26℃
Frequency of Pump Oil Replacement	Once a year	Every third year	30 thousand yen

Fig. 17 Effect by Adopting Inverter-controlled Pumps

6. Verification of Effects

Monthly energy-conserving effects in each of the case studies are summarized in the following graphs (Fig. 18).

Total annual saving effect amounted to 109 tons of CO_2 (4.58 million yen/year), exceeding our target of 96 tons of CO_2 (Fig. 19).

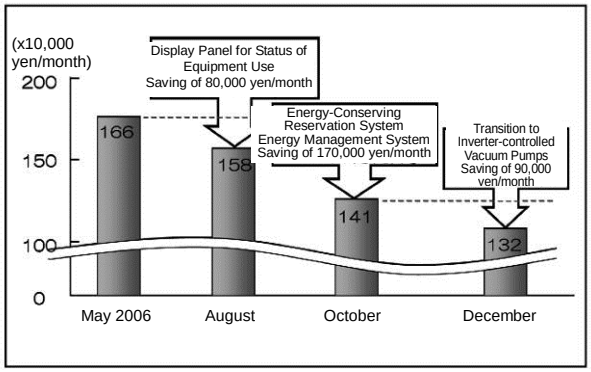


Fig. 18 Electricity Cost per Month

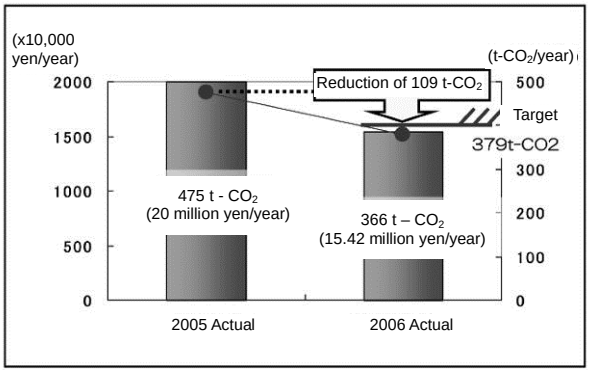


Fig. 19 Annual Energy-conserving Effect

As a result of the energy-conserving activities, employee awareness level has been significantly raised compared to before the “MOTTAINAI” activities launched, in the course of energy conservation cycles with improvements, awareness, and continued efforts moved forward (Fig. 20).

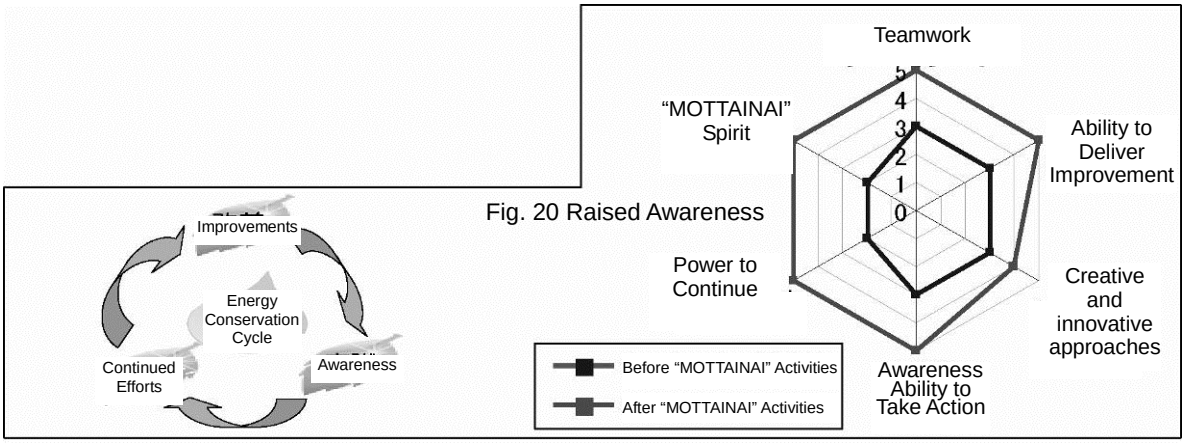


Fig. 20 Raised Awareness

7. Summary of the Activities

Functional Parts Energy Conservation Working Group is currently informing our achievement in the improvement activities to relevant departments (Fig. 21).

We are determined to continue further "MOTTAINAI" activities for achieving DENSO ECOVISION 2015 (Fig. 22).

I will continue sustainable improvement activities keeping the following things in mind.

- Everyone needs to contribute to prevention of global warming through energy conservation and ecological activities.
- We would like to leave the global environment to the next generation in possibly better conditions.

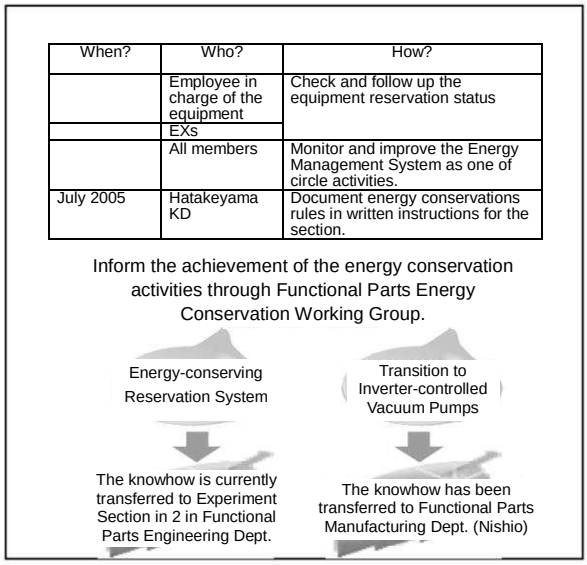


Fig. 21 Prevention of Setback and Expanding the Knowhow to Other Groups

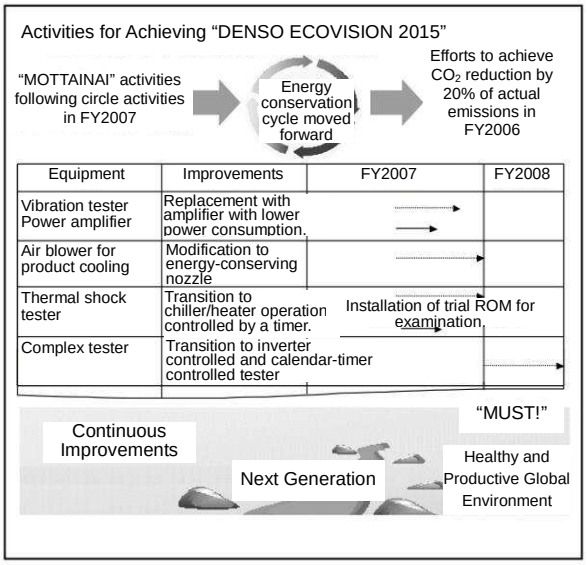


Fig. 22 Future Project Processes