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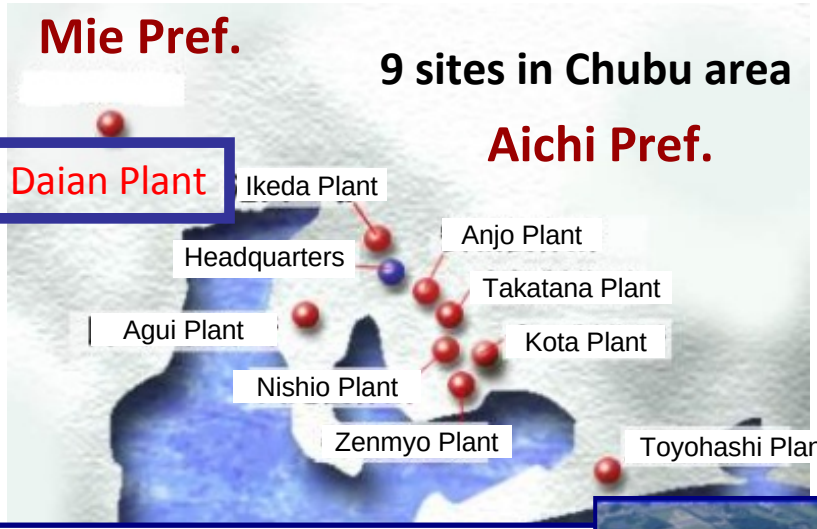
Theme: Activation of Energy-Saving Initiatives through Establishment of Energy-Effective Organization & Development of New Technologies

T. Ohta, Manufacturing Planning Office, Functional Products Manufacturing Dept., Denso Corporation

1. Corporate Profile

■ Domestic Sites



Daian Plant (Inabe City, Mie Pref.)

(Functional Products Manufacturing Dept., Ignition Manufacturing Dept., Driving Safety Manufacturing Dept., Ceramics Manufacturing Dept.)

Type-1 Designated Energy Management Factory

■ Major Products

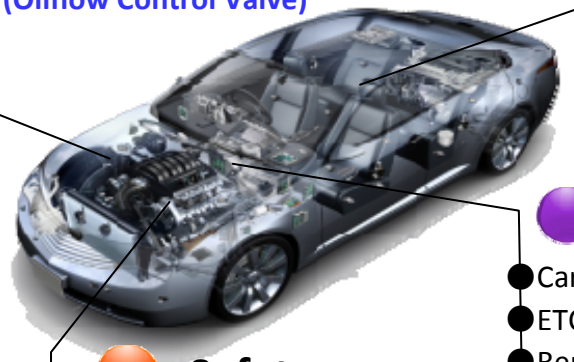
Environment

Functional Products Manufacturing Dept.

- ISCV (Idle Speed Control Valve)
- VCT (Variable Cam Timing)
- OCV (Oilflow Control Valve)

Comfort

- Car air-conditioning system
- Air cleaners, etc.



Convenience

- Car navigation system
- ETC on-board equipment
- Remote security system

Safety

- Sensing system for driving assist system
- ABS/ESC actuators & ECUs
- Airbag sensors and ECUs / Vehicle periphery monitoring system
- Combination meters ... etc.

We deliver satisfaction to our customers by offering attractive products.

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2. Denso's Environment Policy

Denso Eco Vision 2015

Eco-Management

Improvement & Expansion of Eco-Management

Eco-Products

Development & Designing Ensuring Both Eco-Friendliness & Advanced Performance

Eco-Factory

Eco-Friendly

Cross-company collaboration & improved provision of information concerning eco-activities

Constant Reduction of Impact on the Global Production Environment

CO_2 Reduction in Production & Logistics Activities

1. Production

- Epoch-making improvement in productivity (e.g. innovative production technologies)
- Building of a change-resistant, energy-saving structure and achievement of significant improvements in per-unit CO_2 emissions by promoting "Energy JIT"[*1] and other activities designed to halve the energy consumption in a long run.

[*1] JIT: Just In Time

Emission per sales[*2]: Reduction by 60% from the 1990 level
Emission: Reduction by 7% from the 1990 level[*3]

[*2] Physical production value (Actual production value adjusted for selling price, etc.)
[*3] Average for the 2008-2012 period.

2. Logistics

Worldwide energy-saving by ensuring efficient transportation and eco-driving.

We are engaged in continuous eco-activities to achieve numerical targets.

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3. Energy Management System

■ Environment Committee & Action Organization

Environment Committee

- CO2 Project (2008 -)
- REACH Project
- Product Environment Subcommittee
- Production Environment Subcommittee
- Social Environment Subcommittee
- Business Group & Region Environment Committee
- DENSO Group Environment Conference in Japan
- Overseas Regional Environment Committees

(Launched in 1992)

- Energy Group
  - Field-based Kaizen & implementation
  - Energy-Saving Tech. Group
  - Public Relations Group
- Powertrain Control Systems Business G.
  - Functional Products Mfg. Dept.
    - Gasoline Injector Mfg. Dept.
    - Diesel Injector Mfg. Dept.
    - Ignition Mfg. Dept.
    - Ceramics Mfg. Dept.
    - Electric Sys. Mfg. Dept. I
    - Electric Sys. Mfg. Dept. II
    - EHV Components Mfg. Dept.
  - Thermal Systems Business G.
  - Electronic Systems Business G.
  - Information & Safety Systems Business G.
  - Components Eng. Dept.
  - Prototype Mfg. Dept.
  - Machineries Dept.
  - Facilities Dept.

Energy-Saving Committee in the Functional Products Mfg. Dept.

Chief Implementation Officer: General Manager of the Dept.

Implementation Leader: Head of Manufacturing Planning Office [Me]

Secretariat

<Execution Organization>

Eng. Div. 1 | Eng. Div. 2 | Eng. Div. 3 | Eng. Div. 4 | Production Eng. Div. | Plant No. 1 | Plant No. 2 | Inspection Office | Production Management Office

Production Sec. 1-8

To monitor the progress made in implementing energy-saving plans and undertake follow-up activities

The Manufacturing Department is working as one team to implement initiatives and achieve the company's common goals.

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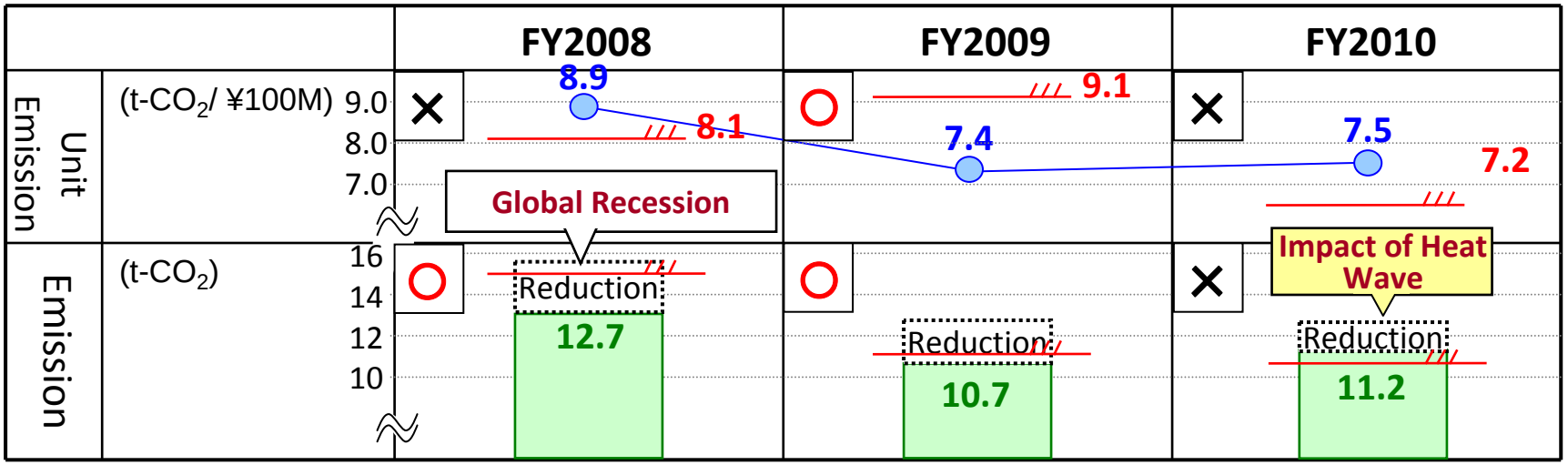
4. Performance in Past 3 Years and Goals for FY2011

■ Reduction in CO2 Emission

(1,000t-CO_2)		FY2008		FY2009		FY2010	
	Target	2.29	Evaluation	1.67	Evaluation	1.27	Evaluation
	Actual	2.42	○	1.74	○	1.37	○

■ Unit CO_2 Emission & CO_2 Emission



Unit CO_2 emission goals were not achieved due to external factors.

■ Goal Setting for FY2011

Company-Wide

<Baseline Goal>
Continuous reduction in unit CO_2 emission (40% or more lower than the 1990 level)

<Internal Stretch Goal>
Improvement of unit CO_2 emission by 3% on a Y-o-Y basis

Functional Products

Unit CO_2 emission: 7.31t-CO_2/¥100M or lower

⇓

Reduction in CO_2 emission: 710t-CO_2or more

150% of company mandate

⇒Stretch Goal: 1,065t-CO_2

We will continue our efforts toward achieving the unit emission target even if we face unexpected external factors similar to those in 2010.

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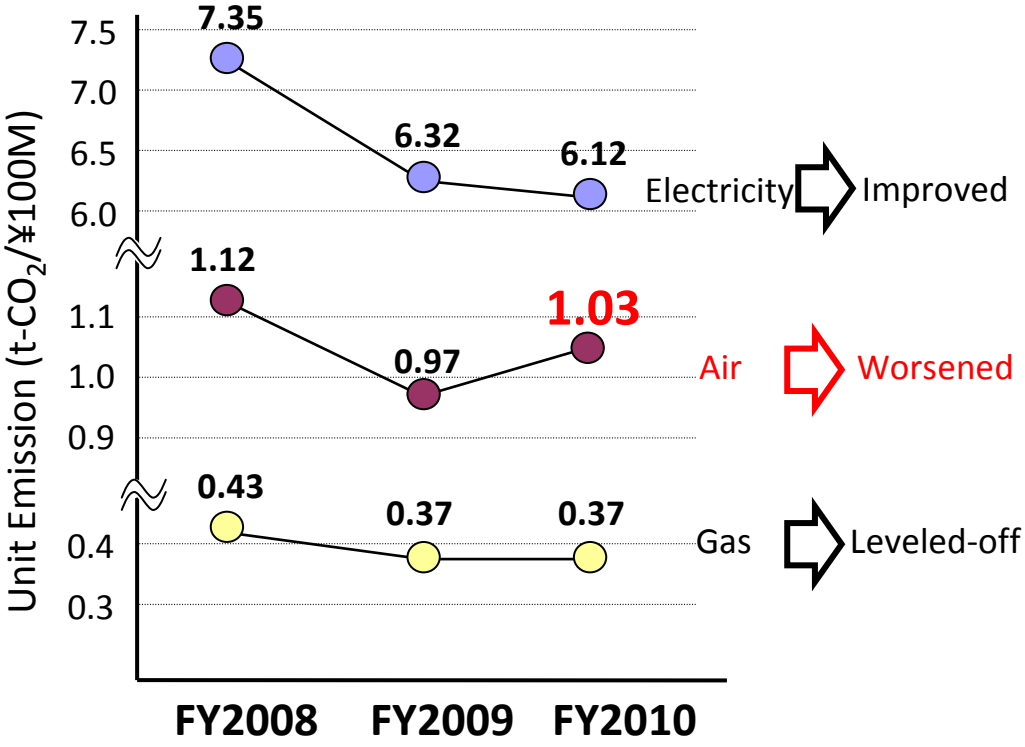
5. Current Energy Consumption by Manufacturing Dept.

■ Changes in unit CO_2 emission by energy

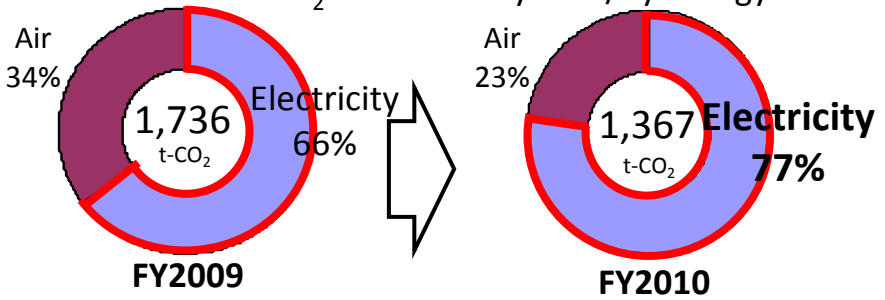


The unit air consumption has been worsening.

■ Factors of the Increase in Unit Air Consumption

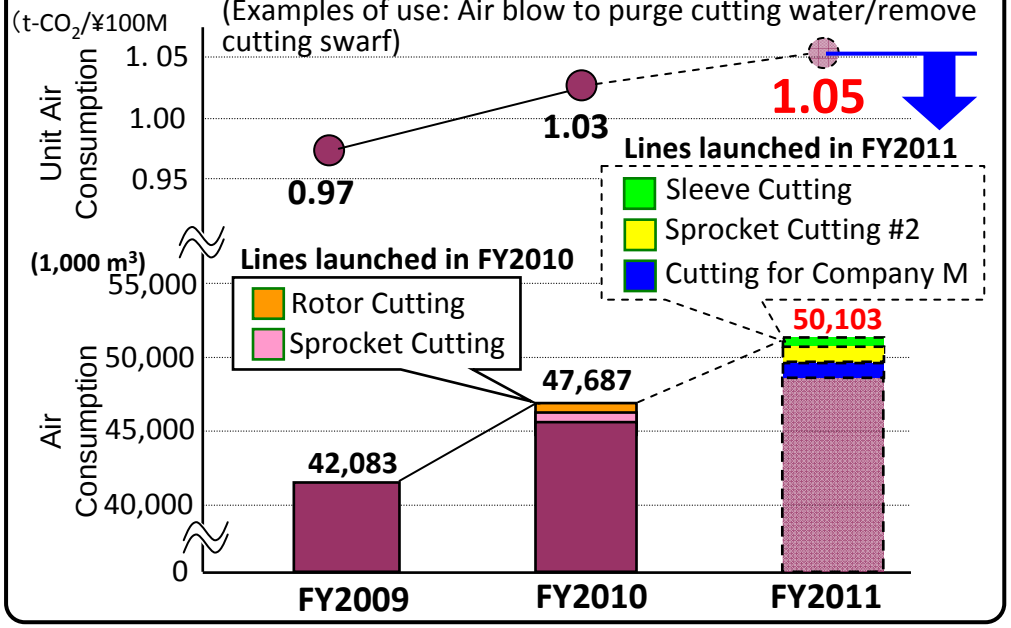
Factor 1. Our FY2010 Kaizen activities focused on the saving of electricity.

<Breakdown of CO_2 Reduction by Year/by Energy>



Factor 2. The cutting-process in-sourcing increased air usage.

(Examples of use: Air blow to purge cutting water/remove cutting swarf)



Reduce the rising air consumption and improve the unit air consumption.

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6. Review & Analysis of Air Reduction Initiatives

■ Verification of Implementation Using Kaizen Matrix

●: Implemented ○: To be implemented —: N/A

＜In the past: Improvemen

＜Kaizen needs are prioritized in order of air consumption/unit>

Large Air consumption Small

Process	Line Name	Mon Ave. (m³/r
Assy	Intake VCT #7	180,0
Assy	High-vacuum DS	157,6
Assy	Intake VCT #6	123,6
Cut	RII Housing*	106,2
Assy	Exhaust VCT #3	103,3
Cut	VCT housing*	93,1
Assy	APM III Tr #1	89,
Assy	Intake VCT #4	89,
Assy	OCV V #1	87,
Cut	NP2 Cutting	87,

Process	Line Name	Usage per Unit (m³/unit)	Mon. Ave. (m³/m)	Washing M/C		Air Purge			Air Blow		
				Shift to blowers	Pressure Reduction	Shift to C/Ps	Intermittent Control	Pressure Reduction	Intermittent Control	Pressure Reduction	Connection to standby
Cut	VCT Rotor #4	4.2	82,996	—	○	○	●	●	○	○	●
Assy	Intake VCT #1	3.2	45,958	—	—	—	—	—	●	●	●
Assy	ECT #2	2.5	54,212	—	—	—	—	—	●	●	●
Cut	NP2 Cutting	2.4	87,397	—	—	●	●	●	○	○	●
Cut	RII Housing*	2.2	106,258	○	—	●	●	●	○	●	●
Assy	AT liner #1	1.9	74,139	—	—	—	—	—	●	●	●
Cut	E-VCT Cutting	1.7	70,120	—	—	○	●	○	○	○	●
Cut	High-Vacuum DS Off										

Cutting lines rank high, indicating a lot of Kaizen works to do

⇒Assign a person in charge of each item to ensure 100% Kaizen.

	Prod. Tech	Secretariat/Prod.
Difficulty	Difficult	Easy
Investment	Large	Small
Kaizen Scale	Large	Small

Investigate actual state to exert utmost air reduction efforts in cutting lines.

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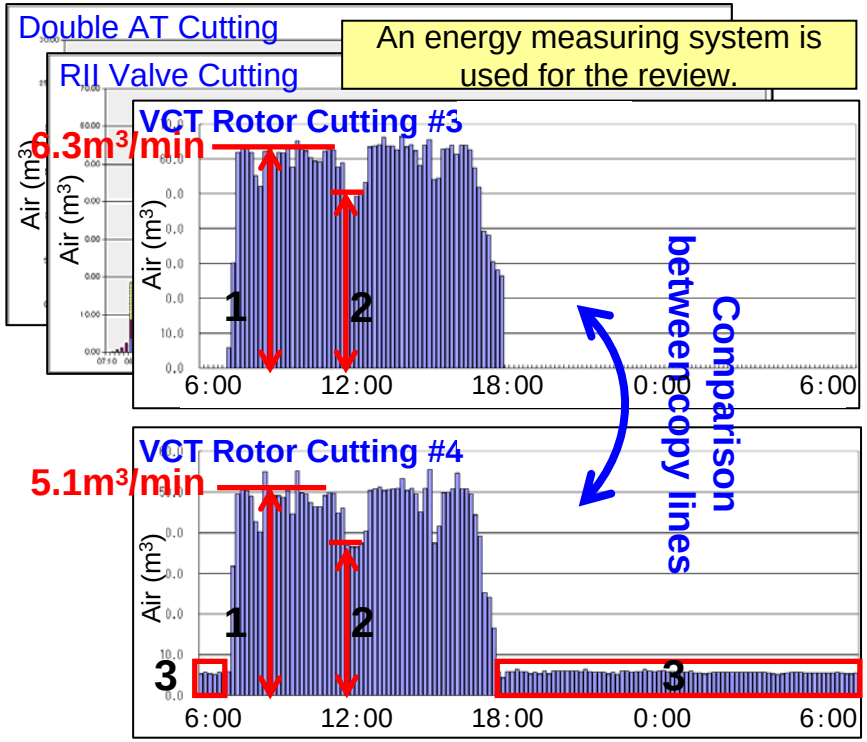
7. Investigation of Actual State to Exert Utmost Air Reduction Efforts

Procedure: Analyze cutting lines' air consumption to identify all Kaizen opportunities.

■ Review of Air Consumption by Major Cutting Lines



Results

1. **Different volume of consumption during operating hours**
   →Larger air consumption at copy lines
2. **Large air consumption during lunch time**
3. **Air consumption during non-operating hours.**
   →Air is consumed when no production is taking place.

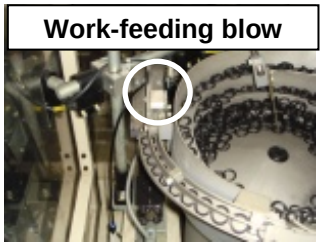
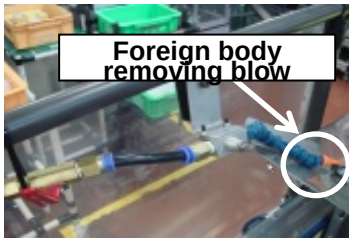
■ Findings from On-Site Investigation

<List of Inspection Results> Investigation by Secretariat in Dec. 2010

[Classified by Factor]

● Air reduction with no energy-saving consideration (for quality/productivity improvement)

■ Insufficient maintenance & control (administration issue)

1	2	3	Findings
●	●		Continuous air blowing for post- installation improvement  
●			Too long airgun discharge time
■	■	■	Excessive air pressure
■			No use of energy-saving air guns
		■	Incorrect calendar time switch on/off time
■	■	■	Air leakage

Many air-loss cases were identified.

Identify causes by gathering opinions directly from relevant departments.

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8. Investigation of Causes for Air Loss (Hearing Directly from Relevant Departments)

Review meeting with relevant departments

<True Causes>

1. Although the importance of energy-saving is well recognized, priority is placed on production activities.
2. Kaizen activities to ensure quality and productivity are hindering energy-saving efforts.

<Challenges>

3. Activate energy-saving initiatives by developing human resources who can play an active and leading role in Kaizen efforts. — Case 1
4. Develop a new and low-cost air blow technology that can achieve both improvement in quality/productivity and energy saving. — Case 2

Accelerate energy-saving initiatives through human resource and new technology development.

9-1. Case-1 Development of "Core" Human Resources

Challenge: Activate energy-saving initiatives by developing "core" human resources who can play an active and leading role in Kaizen efforts.

Process

Step1 Creation of Space for Joyful Experience

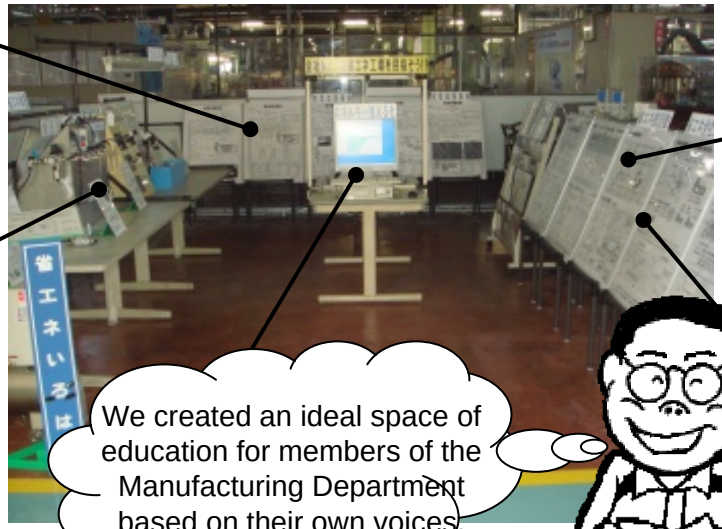
Step2 Active Human Resource Recruiting

Step3 Development of HR Specialized in Energy Saving

《Horizontal Implementation》

Exhibitions to present intra-department Kaizen efforts and promote their horizontal implementation

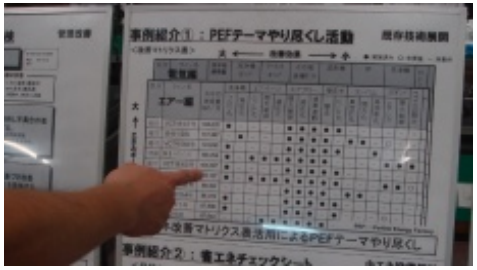
《Launch of "Energy-Saving Basic Learning Center" that provides hands-on experience》



We created an ideal space of education for members of the Manufacturing Department based on their own voices.

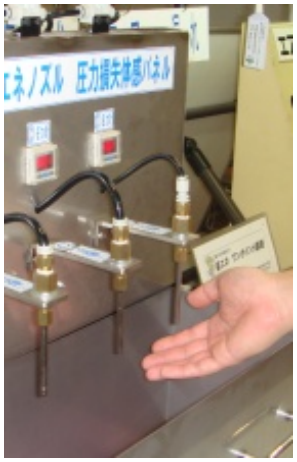
《Information Provision》

Ideas, tips, and insights to develop energy-saving technologies



《Hands-On Experience》

Visual and tactile experiences to physically feel energy-saving effects



《Energy Visualization》

Real-time view of energy consumption at individual production lines and facilities

《Showcase of Initiatives》

Exhibitions to present company-wide/intra-department energy-saving initiatives and their goals

The Center provides members of the Manufacturing Department with opportunities to learn about energy saving in a nearby place.

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9-2. Development of "Core" Human Resources

Process

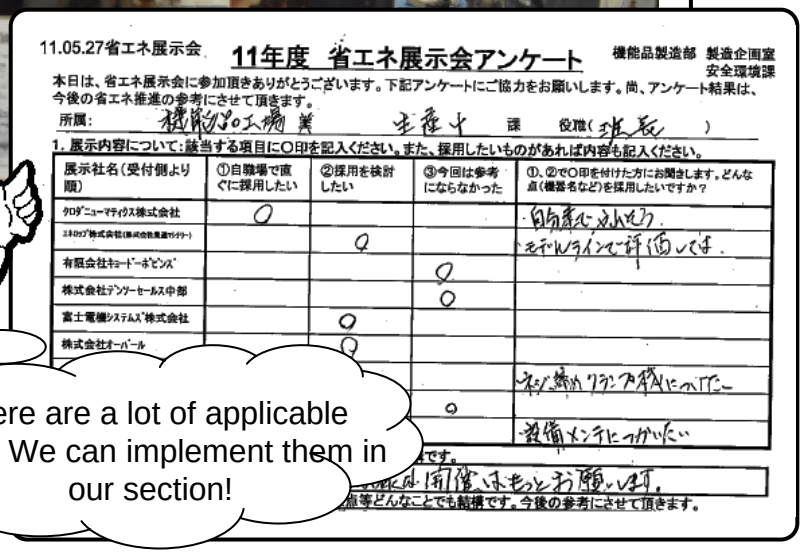
Step1 Creation of Space for Joyful Experience

Step2 Active Human Resource Recruiting

Step3 Development of HR Specialized in Energy Saving

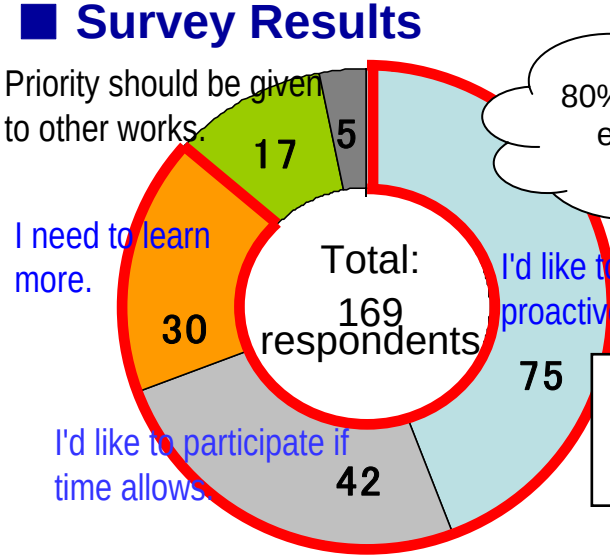
■ Energy-Saving Exhibition

・Sponsored by 8 outside manufacturers (May 27)



There are a lot of applicable items! We can implement them in our section!

■ Survey Results

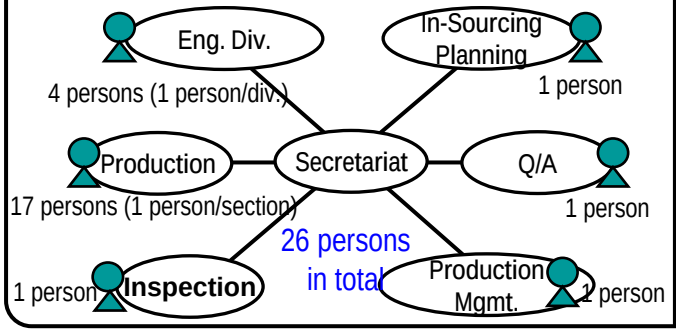


80% or more are interested in energy-saving initiatives.

Submitted a proposal to identify and organize human resources who will become a "core in the field."

Approval of the Energy-Saving Committee

Meeting of Energy-Saving Leaders (Organization & Activities)



1. **Regular Meeting (Monthly)**
2. **Workshop (Quarterly)**
→Introduction of latest technologies & joint study session with other departments

Energy-saving leaders are to play a central role in promoting energy-saving activities in their workplace.

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9-3. Development of "Core" Human Resources

Process

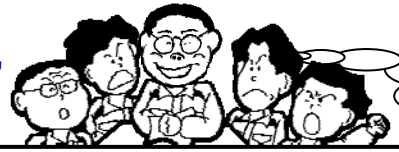
Step1 Creation of Space for Joyful Experience

Step2 Active Human Resource Recruiting

Step3 Development of HR Specialized in Energy Saving

〔My Idea〕Let people understand Kaizen procedures through practical experience of air leakage repair (HR development)

2nd Leaders' Meeting



Let's eliminate air leakage first!

1. Knowledge about air leakage (Launch of the Basic Learning Center)

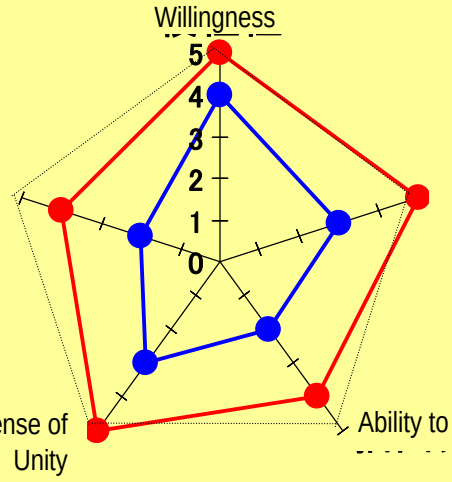
・Amou

・

・

Results of HR Development

[Evaluation by Leader Meeting Members]



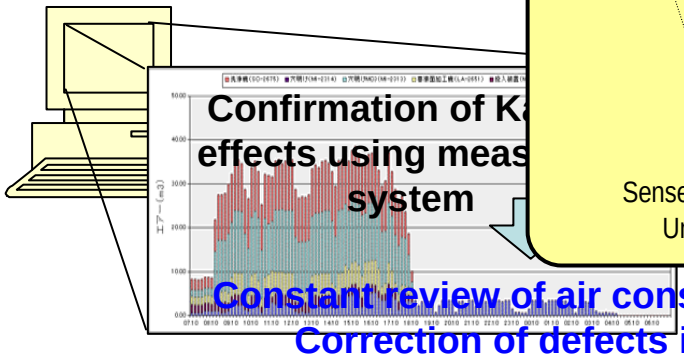
2. On-site leakage inspection

tion of all facilities using five senses & testing devices

	設備名称	機番No.	機器名称	機器型式	メーカ
1	ﾋﾟﾝｹﾞｰｼﾞﾁｪｯｸ	SMB-3457	継ぎ手	TU01	SMC
2	洗浄機	SC-2950	ﾚｷﾞｭﾚｰﾀ	AR20-01B	SMC
3	洗浄機	SC-2950	ﾚｷﾞｭﾚｰﾀ	AR20-01B	SMC
4	SP組付	AS-6250	ﾌﾞﾚｰﾄﾞﾎｰｽ		他
5	ｱｼﾞｬｽﾄ締付	SMB-3451	ﾌﾞﾚｰﾄﾞﾎｰｽ		他

ber of Leakage: 51 (1,860NL/min)

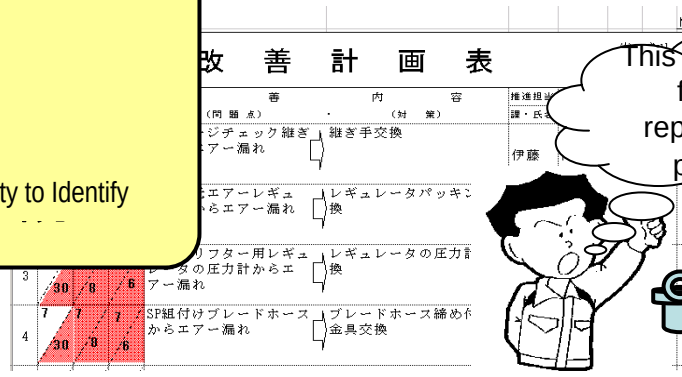
4. Confirmation of Practical Effect



Confirmation of K effects using meas system

Constant review of air consumption; Correction of defects if any

in the Kaizen Timetable/Schedule



This leak can be fixed by replacing the packing!

Implement Kaizen without fail

Repetitive implementation resulted in the rise in energy-saving awareness and activation of initiatives.

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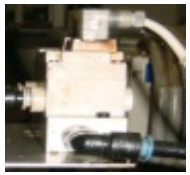
10-1. Case 2 Development of New Air Blowing Devices

– Company's First Pulsed-Air Blower

■ Investigation of Actual Air Blow Operation within Department

Blow Method	Image	Air Consumption per location (1,000 m³/year) Operation Time:8 hrs	Number of Locations (units)
Connected to Master Valve	Valve Open / Valve Shut; Dispensing; Left to blow; Shutoff	41	7 (Locations at which production is prioritized: 159)
Connected to the Standby Switch	Standby ON / Standby OFF	33	36
Intermittent Air Blowing	Start of Work / 0.5S / End of Work	12	116
Pulse (Electric)	Start of Work / End of Work; 0.1S / 0.1S; Intermittent and repetitive blows for maximum effect of impingement pressure	**4** Small air consumption; ideal for air-saving	**6** Not wide-spread

■ Reasons impeding the spread of (electric) pulse blow



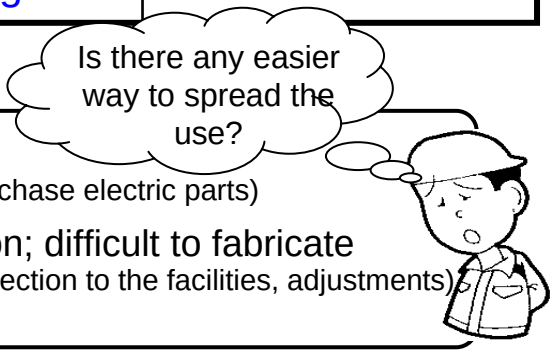
Electromagnetic Valve

+

Controlling Sequencer

1. High initial cost
(Cost to design electric hard/soft circuits; cost to purchase electric parts)

2. Long time required for control/installation; difficult to fabricate
(Wiring on the control board, work to establish connection to the facilities, adjustments)



Develop a low-cost, easy-to-attach pulse blow device.

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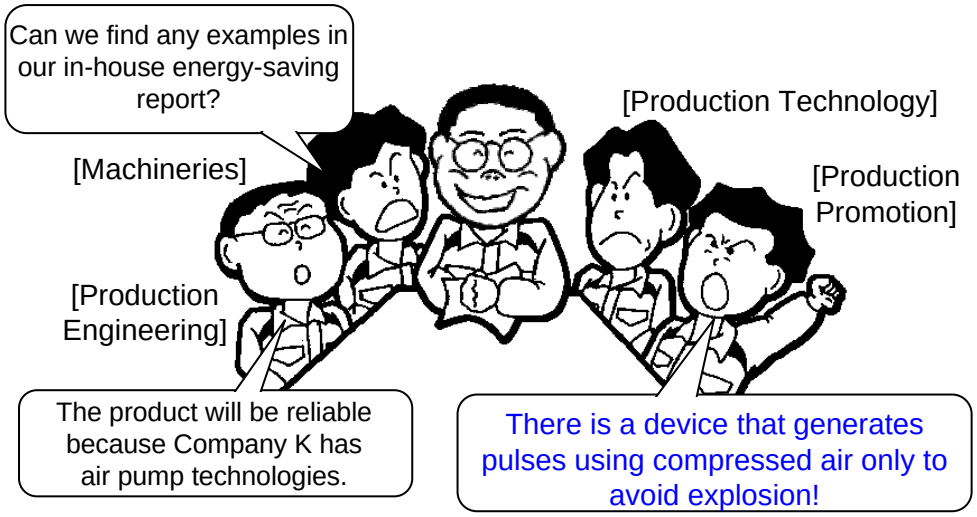
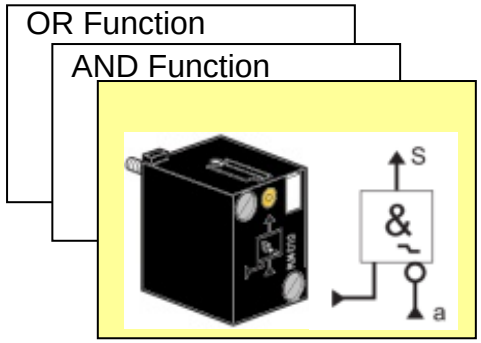
10-2. Development of Low-Cost & Easy-to-Attach Pulse Blow Device

■ Joint Review Meeting with Technology Departments



<Investigation on Company K's Air-Pulse Generator>

Air Sequence Device



＜Results＞

・There are approx. 40 types of air sequence valves.

・Threshold function is to switch on and off signals using air pressure differences.

This function will enable us to shift to the pulse blow system!

■ Proposal to the Manufacturer

We want to develop a pulse blow device by combining with existing mechanical valves.

Mechanical valve

Combine

Threshold

Evaluate the feasibility and costs!

[Supervisor]

《Prior Comparison with Conventional Method》

Item		Current (Electric)	Developed (Air)
Kaizen Difficulty Level		Difficult	Easy
Initial Cost	Design Cost	¥20,000	Not required
	Parts Cost	¥70,000	¥40,000
	Construction Time	16H (¥100,000)	4H (¥20,000)
Running Cost		¥100/year (Electricity)	¥800/year (Cost of controlling air)
Total Cost		¥190,000	¥61,000
Payback Period		2.1 years	0.7 year

The development was launched as the air-based system was determined to be superior in all aspects.

The challenge is how to achieve smooth pulse operation and sufficient dispensing volume!

Fabricate an air pulse blowing device and carry out a test.

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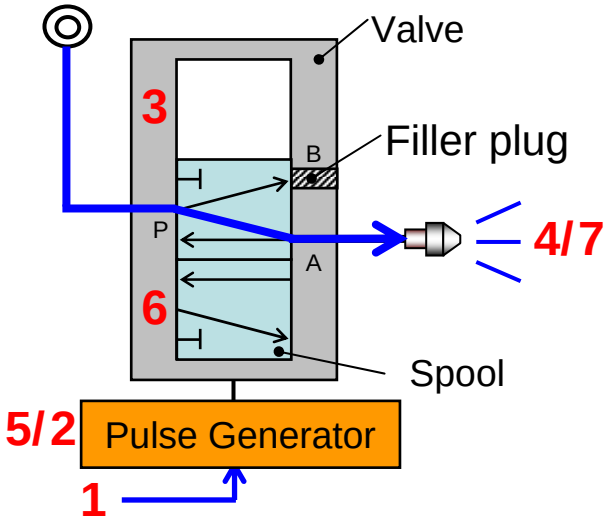
10-3. Pulse Operation Test

■ Operation Check Using a Test Device

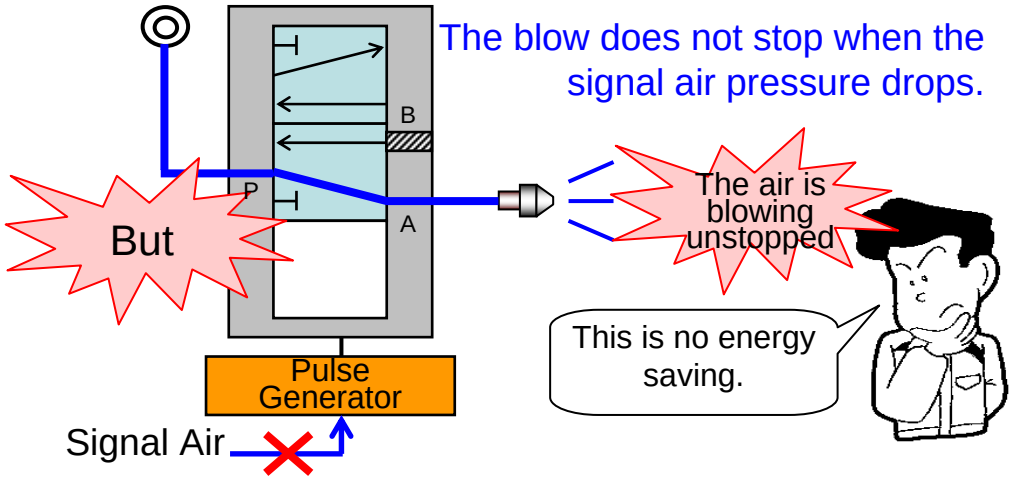
<Operation Flow>

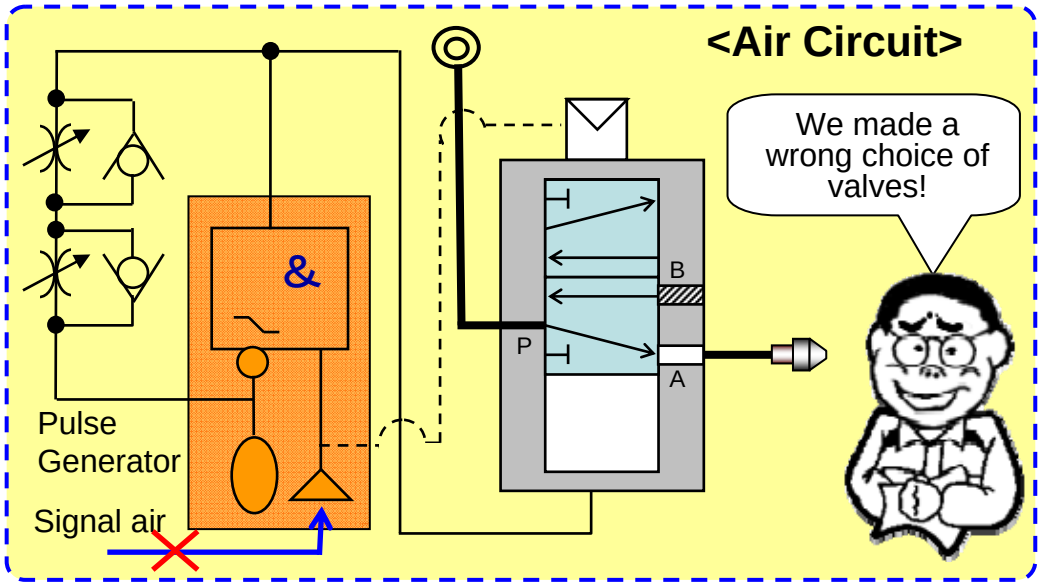


1. Signal air pressure is transmitted.	5. The pressure within the generator drops.
2. The pressure within the generator rises.	6. The spool moves.
3. The spool moves.	7. The blow stops.
4. The blow starts.	*The device repeats the process from step 1 through step 7 until the signal air stops.

＜Result＞

Well worked (repetitive & smooth operation)





We need to develop a function that stops the spool at one side.

The devise must be improved so that it can be controlled only with the valve and the air circuit.

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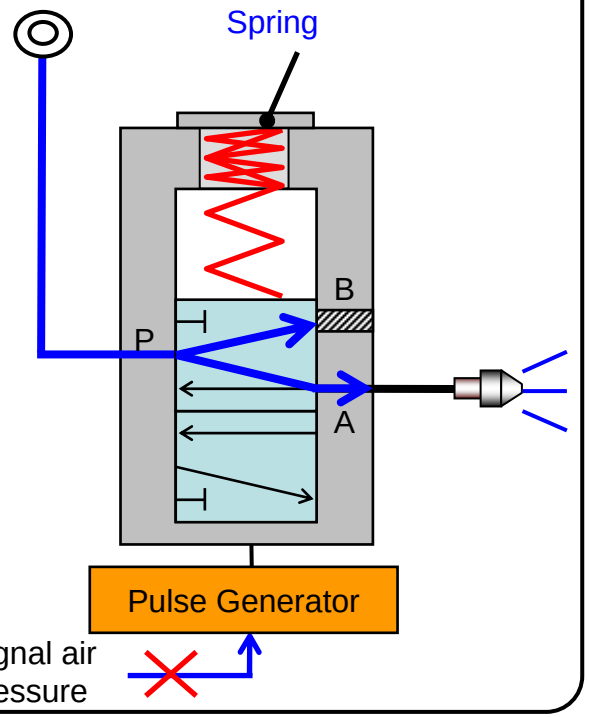
10-4. Improvement of Device & Operation Test

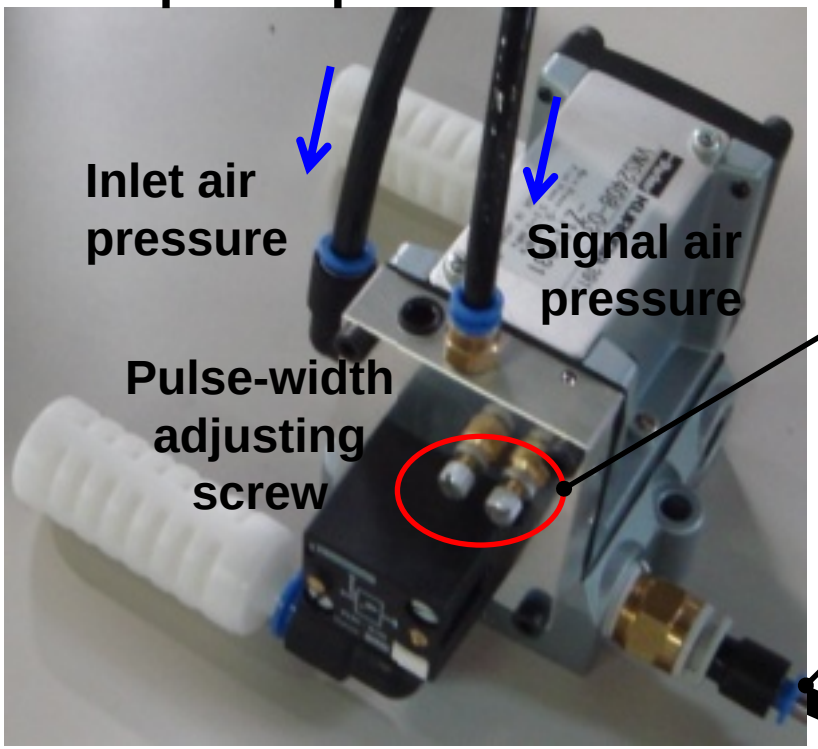
■ Apply the principle of unilateral electromagnetic solenoid valves.

<Pulse Generator Improvement Plan>

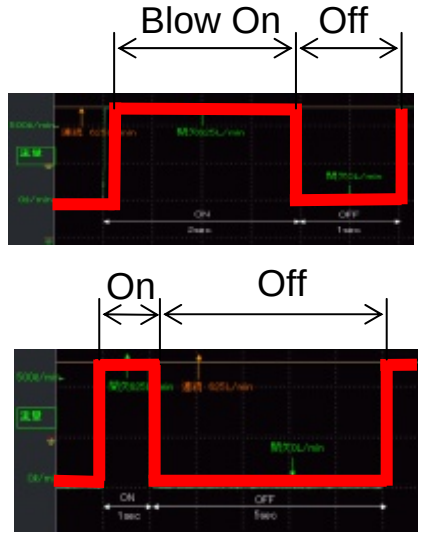
A spring is installed in the valve so that the spool always returns to the blow-off side.



Completed pulsed-air blower



1. The pulse width can be changed arbitrarily. (0.1 sec. – 15 sec.)



2. Dispensing Volume Adjustable up to 1,500NL/min.

Pulse blow

Let's examine the energy-saving effect using a real device.

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10-5. Examination of Energy-Saving Effects Using Actual Device

■ Evaluation Test

<Selection of Process for Installation>

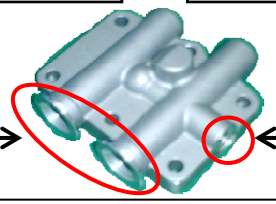
1. Time allowance to perform the test
2. Significant air consumption

Hydraulic pressure cutting line (Before the completion inspection)

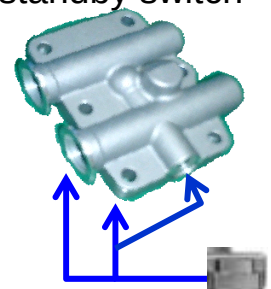
《Aim of Blow》
Improved productivity in the visual inspection process

Removal of cutting water & swarf from the end section

Removal of cutting water & swarf from the Φ20 hole

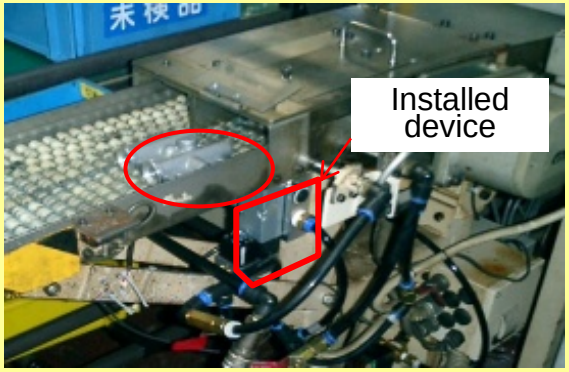


<Before Improvement>
Connected to the standby switch



Once the switch is turned on, the air continues to blow.

<After Improvement>
Pulsed Air Blow



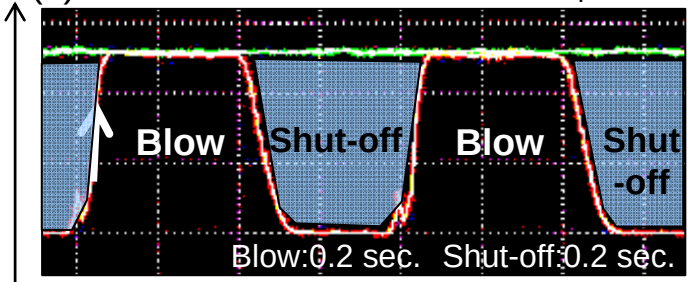
The blow work requires minimum air.

■ Confirmation of Effects

1. Pulse status ... Measurement of flow waveform

Flow (L)

*Measured with an airpower meter.



Time (t)

The pulse wave was shaped as intended.

2. Quality Check

	Before	After
Level of Cleanliness (Spec: Max. particle size 0.5mm)	0.2	0.3
Inspector's Visibility (Workability)	Good	Good

The result was also satisfactory in terms of quality.

3. Reduction in CO_2 Emission

1.2t-CO_2/year (Oil Equivalent: 1.12Kl/year)

(Effect of installation in the Dept.: **90.2t-CO_2/year** [Oil Equivalent: 84Kl/year])

We successfully developed a low-cost, easy-to-attach pulse blow device.

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11. Spreadability & Continuity of Improvements

■ Versatility and Spreadability

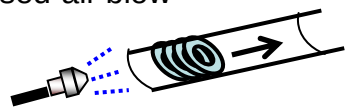
1. Development of Core HR (Energy Saving Leaders)

- Energy saving leaders' efforts activated the Department's energy-saving initiatives and fostered an energy-saving culture.
- The secretariat's expansion measures and the organized activities by the energy saving leaders (bottom-up activities) brought about synergy effects and achieved a significant reduction in CO_2.

2. Pulsed-Air Blow

<Versatility: Examples of Use of Pulse Blowers>

・Work feeding using pulsed-air blow



- Air blow to remove cutting swarf/foreign bodies
- Air blow to remove electricity
- Spraying of semidry cutting water

Applicable to most air blow work points.

<Spreadability: Listing in the manufacturer's catalog>

Developed device

型式	L8000-AFT	ASC500-1W-01	ASO500-1W-01	VMS2408-03-Z11-031	ASV5000-AA-04
切り替え方式		ノーマルクローズ	ノーマルオープン		
外観形状（概略寸法：L×D×Hmm）					
サイズ	64×62×59mm	65×35×50mm		130×82×68mm	140×60×105mm
駆動方式	オールエア駆動方式	電気駆動		オールエア駆動方式	オールエア駆動方式
配管サイズ	M5	Rc1/8		Rc3/8	Rc1/2
駆動電源	不要	DC24V		不要	不要
使用圧力範囲	0.3-0.8MPa	0.2-0.7MPa	0.2-0.5MPa	0.3-0.8MPa	0.3-0.8MPa
流量	220ℓ/min(0.3MPa)	500ℓ/min（0.5MPa）		2000ℓ/min(0.8MPa)	5000ℓ/min（0.5MPa）
想定寿命*	約3000万回	1億回		約2000万回	約3000万回
標準価格（円）	33,000	33,000	33,000	46,500	42,000

Currently expanding the application to offshore sites

■ Continuity of Improvements

1. Plan to Spread the Use of Pulsed-Air Blow to Existing Lines

Blow Method	Number of Locations Installed		
	FY2011 (0 50 100 150)	FY2012 (0 50 100 150)	FY2013 (0 50 100 150)
Connection to Master Valve	7→0		
Connection to Standby Switch	36→20	20→0	
Intermittent	116	116→65	65→0
Pulsed-Air Blow	29	**94**	**159**

2. Installation into Newly Launched Lines

Line Name	Lines Lau
Integrated sleeve	Apr.
Sprocket cutting	May
Cutting line for Company M	
Assembly line for Company M	

1. Verification of Energy-Saving Efforts Implemented

Category	Item	Applicability
1. Selection of Energy	Circle the energy being used: Electricity / Air / LNG / Steam / Water	
2. Saving of air consumption in the plant	1. Electrification of air-driven devices	Yes / No
	2. Switching to energy-saving nozzles	Yes / No
	3. Use of air blowers in the air blow work	Yes / No
	4. Elimination or electrification of air pressure booster valves	Yes / No
	5. Electrification of vacuum generators	Yes / No
	6. Electrification of air hydro-boosters	Yes / No
	7. Electrification of air pumps	Yes / No
	8. Anti-air-leakage measures	Yes / No
	9. Installation of Pulsed-Air Blowers	Yes / No
		Yes / No

Examine whether the energy saving is considered from the planning stage.

Now we have built a foundation for the establishment of energy-saving (low-energy) facilities (our goal).

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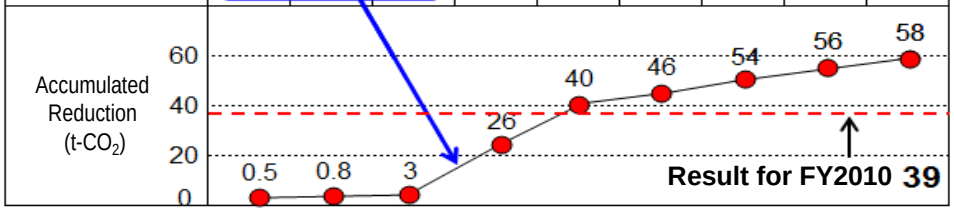
12. Summary of Energy-Saving Effects

■ Effects of Core Human Resource Development

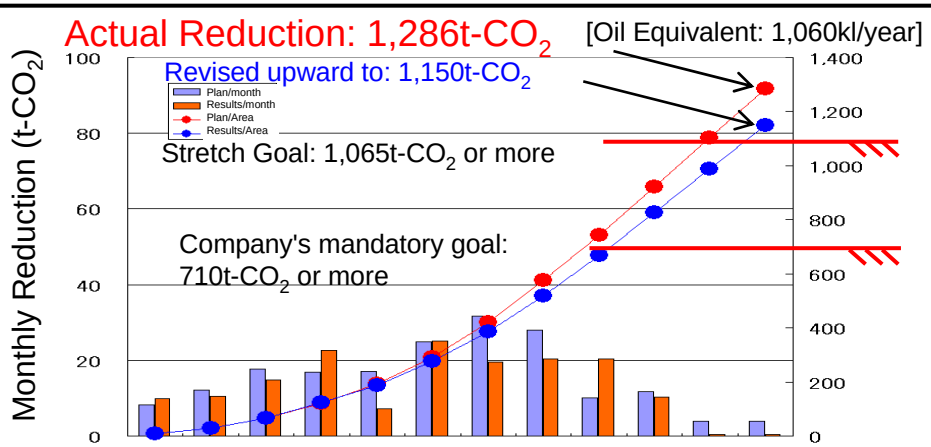
<Reduction Effects Achieved through Improved Management

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Installation of booth	★								
Exhibition		★							
Leaders' Meeting			★		→		→		→



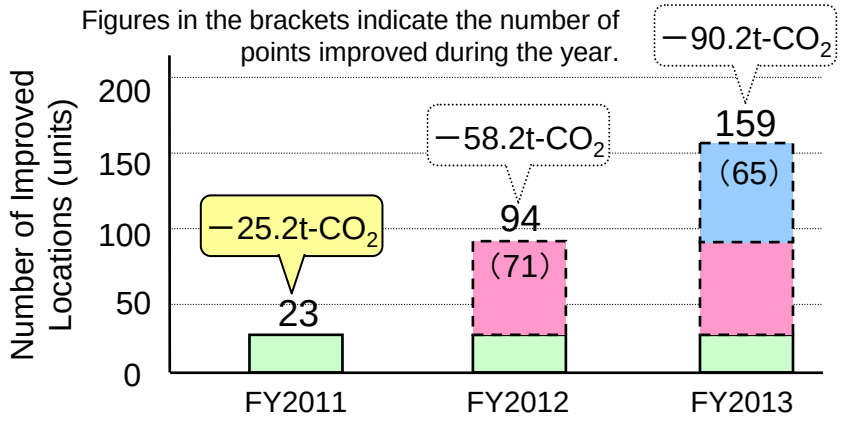
Reduced 58t-CO_2 (1.5 times the previous year)

■ CO_2 Reduction within the Department



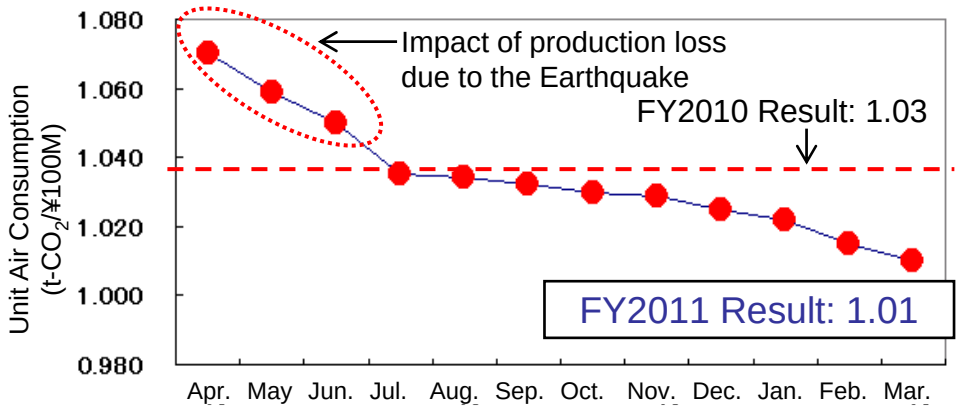
The department's stretch goal was also achieved!

■ Effects of the Introduction of Pulsed-Air Blow Function



The function was introduced to 23 locations and reduced 25t-CO_2 during FY2011. [Oil Equivalent: 23.3kl/year]

■ Actual Unit Air Consumption



The unit consumption improved through the air-saving efforts centered on the introduction of pulsed-air blow system.

For further effects, we will implement electricity reduction efforts by leveraging the momentum created through the current energy-saving initiatives.

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