ADVANCEMENT IN MAINTENANCE OPERATION FOR MANAGING VARIOUS TYPES OF FAILURE AND VASTLY AGING FACILITIES

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ABSTRACT

Chubu Electric Power Company Inc., one of the utilities in Japan, has been maintaining a large number of distribution facilities which were constructed in the 1970s, when the country was in the period of high-economic growth.
We are replacing these aged facilities with improved ones, to prevent faults. In order to improve maintenance operation, condition-based maintenance and time-based maintenance has been introduced.
In order to carry out more effective and efficient maintenance on increasing highly aged facilities, it is indispensable to maximize the life cycles of them and to average the replacement operation by upgrading the maintenance procedures.
To respond to these issues, we are improving the management of equipment data by introducing label with two-dimensional barcode, and strengthening the analytical capability of defect information by developing "Distribution Asset Management and Replacement Assist System" or "DAMRAS".

1. INTRODUCTION

In Japan, managing equipment failures and degradations due to aging has become one of the major concerns for DSOs. This is because a large number of distribution facilities has been constructed in the 1970s.
To respond to this issue, we have been replacing these aging facilities, including their similar type, with the improved ones. Additionally, this operation has been improved by introducing condition-based maintenance (CBM) and time-based maintenance (TBM), where CBM classifying deterioration based on standards during periodic patrol, and TBM evaluating lifespan of each facility followed by planned renovation. Example of the standards of deterioration is indicated on Figure 1.
With the limited amount of budget and human resources, it is important to maximize the life cycles of facilities and to average replacement operations for managing the aging facilities that are vastly increasing today.

2. ISSUES

In order to maximize the lifecycles of facilities and to average the yearly replacement constructions, it is necessary to analyze the occurred failure events in detail based on accurate equipment data.
Currently, there are two constraints in realizing the above operation.

2-(1) Accuracy of the managed equipment data is relatively low

We manage the equipment data of the distribution facilities by our proprietary system named "Distribution Operation Comprehensive Supporting System" or "DOS".
Currently, equipment data are collected by following procedures; constructors on the field write down information on each equipment to a certain document, which is sent back to the office for the operators to read them and input them to the "DOS" after the construction. This takes a lot of time and effort for the constructors and the operators, with the risk of inputting incorrect information to the system. As a result, accuracy of the managed equipment data is relatively low.

2-(2) Environment to analyze the defect event is undeveloped

Information of deterioration are collected through individual registration of the events to the "DOS" by the operators. This is more focused on dealing with the individual events corresponding to external authorities or customers.
However, because there are no specific standards or classified items in collecting information, registered information vary among the operators.
For this reason, there is a problem that the amount of information is insufficient and the accuracy of information is low for the usage of data analysis required for formulating efficient maintenance measures.

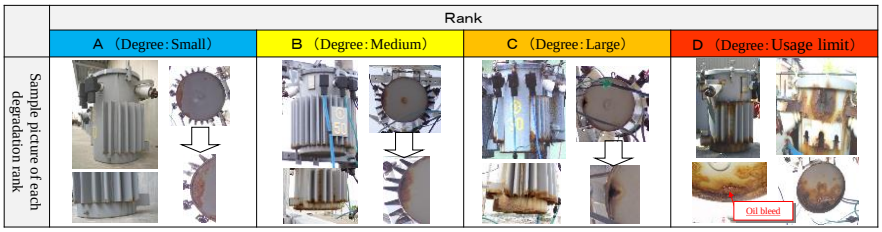

Figure 1: Example of the standard to evaluate degradation rank (pole-mounted transformer).

3. COUNTERMEASURE

In order to respond to the above issues, improvement in the accuracy of equipment data will be realized by introducing label with two-dimensional barcode, and by strengthening the analytical capability of defect information by developing "Distribution Asset Management and Replacement Assist System" or "DAMRAS".

3-(1) Introduction of label with two-dimensional barcode

To improve the accuracy and the efficiency of the equipment data management which is related to issue 2-(1), label with two-dimensional barcode (Fig. 2) is introduced. They are attached to each equipment with their information recorded on, sent back to the office after the construction and is read by a barcode reader for recording. As a result, data base can easily be maintained without any mistakes. They are applied to equipment that is particularly highly cost effective (quantity and unit price) in replacement.

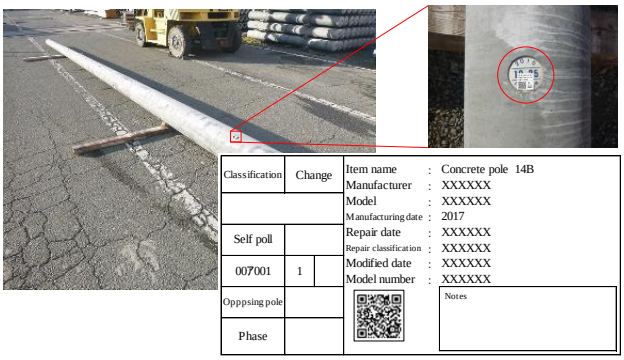

Figure 2: "Label with two-dimensional barcode attached on concrete pole."

3-(2) Development of "DAMRAS"

Related to issue 2- (2), system "DAMRAS" (Fig. 3) is developed and launched, which can collect and accumulate defect information without omission so that detailed and accurate data analysis can be performed on various failure events.

In the primary launch (March 2016), it became possible to accumulate accurate trouble information necessary for strengthening the analytical capability of troubled events.

In the secondary launch (February 2017), system support was provided for regular patrols for the purpose of efficient registration and of effective grasping and managing fault events.

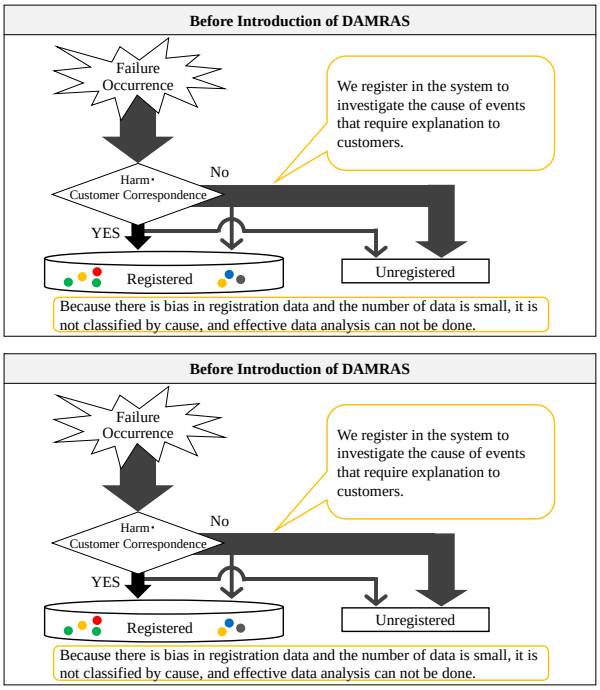

Figure 3: Conceptual diagram of "DAMRAS"

3-(2)-1 Primary launch of "DAMRAS"

In the primary launch of "DAMRAS," we limited the registration to serious problems that may cause serious harm, with the aim of suppressing a large increase in the registering work volume and to encourage smooth introduction of "DAMRAS".

Specifically, registered and accumulated categories for facility events are; equipment information, defect contents and their causes.

The main functions are as follows.

Work	Purpose	Functions
Replacement information management (Register information on replacement and degradation (Fig. 4))	Accumulation of information about; Removed facilities (manufacturing year / month, facility date / time, manufacturer etc.) Replaced facilities (defect content, degradation rank for each facility type)	Registration and retrieval of information on repair and disassembly Progress management of renovation (emergent, early, planned) Accumulation of completed replacement information
Management of troubled facilities (Registration of defective equipment (Fig. 5))	Accumulation of troubled facilities information	Registration and retrieval of information on defective facilities Accumulation of defective facility information according to each causes

Confidential

Sales office name XXXXXX

Created date 2017/1/5

Detailed information on renovation and deterioration facility

Number of equipment for repair and deterioration	20170000001
Pole number	007001
Classification of patrol or inspection	Periodical patrol
Date of discovery or occurrence	2017/1/4
Register	XXXXXX
Target facility (Major classification)	Concrete pole
Meter number	
Target facility (System)	Main pole ー concrete pole ー 0 ー 14B
Target facility (Medium classification)	Pole ー concrete pole
Target facility (Small classification)	
Defective content	Crack
Defective content (complement)	
Separation	
Urgency	Early renovation
Temporary refurbishment	
Degradation rank	
aerial vehicle Propriety	
Remarks	

Simplified drawing Date of shooting(registration)

Picture 1 Date of shooting(registration) 2017/1/4

Picture 2 Date of shooting(registration) 2017/1/4

Picture 3 Date of shooting(registration) 2017/1/4

Picture 4 Date of shooting(registration) 2017/1/4

Picture 5 Date of shooting(registration) 2017/1/4

Figure 4: Registered information on replacement or deteriorated facility

3-(2)-2 Secondary launch of "DAMRAS"

In the secondary launch, system support was provided for periodic patrol work that checks all facilities once every five years, aimed to improve the efficiency of periodical patrol work.

As a result, limited registration at the time of primary launch has been cancelled, and all of the defect information is registered after the secondary launch.

Specific contents of secondary launch of "DAMRAS" are the following two points.

1) Automatic formulation of patrol plan and automatic summarization of their progress

There are annual and monthly plan for the periodic patrol work, which is a paper document form conventionally. Regarding monthly progress management, the result of each patrol execution was calculated manually as well. Also, for the management of the facilities which requires early replacement, manual-based ledger was implemented (Fig. 6).

In the secondary launch, system support was provided for automatic planning of annual plan, monthly plan, and automatic summation of monthly progress of them. Ledger to manage early replacement can also be created automatically, making it possible to grasp the details of the status of each facility that require early renovation (Fig. 7).

Pay attention to the handling of personal information

Investigation result sheet of defective facility （Occurrence event）

Workplace

Created date 2017/01/04

Troubled facility number	20170000001						
Urgency or importance	Cause classification unreasonable						
Basic information(date/place)							
Discovery date	2017/01/04	Discovery time	XX:XX	Weather	snow	Place of occurrence	XXXX XXXX
Pole number	007001	Supply rank	D1	Lightning countermeasure	Ⅱ	Salt damage countermeasure	General
Snow damage countermeasure	General	Wildlife countermeasure	1	Strong wind region	General	Specific area	earthquake C
Supply trouble / Operation relay information							
Types of blackout		Contents of supply trouble	Nothing	substation / Power plant			
Operation relay		Vo		Reclosing information		Reclosing result	
Article information							
Major classification	Low voltage drop wire						
Medium classification	Drop wire						
Small classification	DV						
Type1				Type2			
Manufacturer	XXXX	Model	XXXX	Serial number	XXXX		
Manufacturing date	XXXX	Repair date		Facility date	XXXX		
Customer correspondence information							
Whether or not to respond to customers	Nothing			Compensation for damages			
Business type				Service entrance pole number			
Remarks							
Presence of property damaged							
Damage content / other	Nothing						
Occurrence event information							
Occurrence situation	XX:XX Voltage drop information of smart meter terminal was entered in the workplace. XX:XX Arrival on site XX:XX The worker discovered that the drop wire was disconnected by fallen tree. XX:XX The worker exchanged the drop wire. Contract information Electric light contract 50 A Cause Wear due to tree contact						
Contents to the facility							
correspondence to facility							
Presence of facility	Nothing			Storage location			
Contact name	XXXX			Contact phone number	XXX-XXXX-XXXX		
E-mail	XXXX@chuden.co.jp						

Explanatory drawing

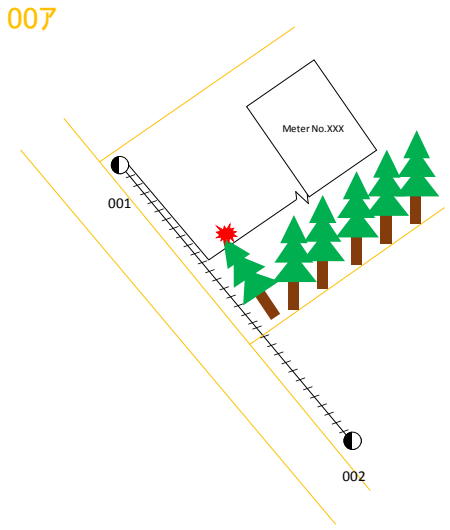

Figure 5: Register information on defective facilities

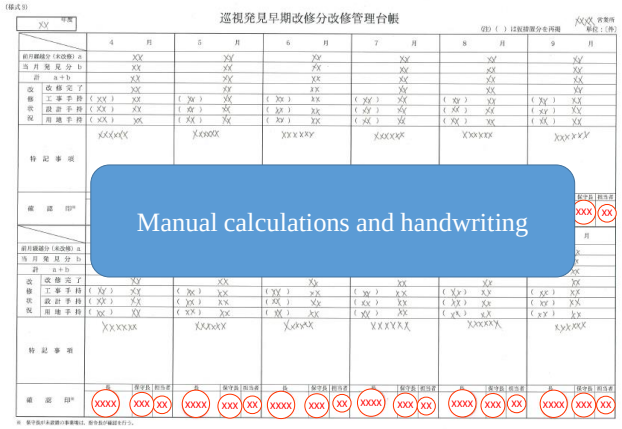

Figure 6: Early renovation management ledger (current)

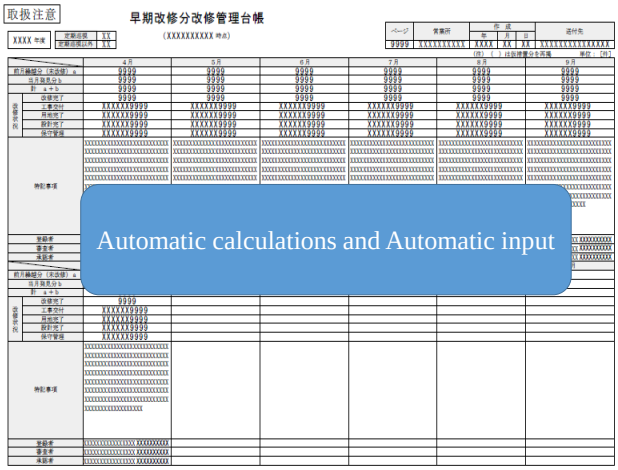

Figure 7: Early renovation management ledger (after secondary launch)

2) Registration of repair information on field using mobile terminal

Conventionally, when carrying out periodical patrol, field workers carried the necessary documents to the field and recorded the results on the paper form. For this reason, many hand-carried items such as patrol notebooks, utility pole layout maps, digital cameras, etc. were necessary on the field. Additionally, it took a lot of time in desk processing such as preparation of reports after returning to the office.

After the secondary launch, mobile terminals have been implemented (Fig. 8), streamlining periodic patrol works by reducing the number of items to be carried out on the field. In addition, we have made it possible to register the patrolled results and the required replacement information on the field (Fig. 9), which improves the efficiency of desk processing operations after returning to the office.

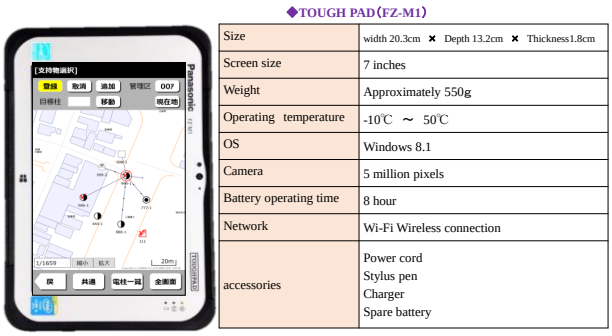

Figure 8: Specification of mobile terminal

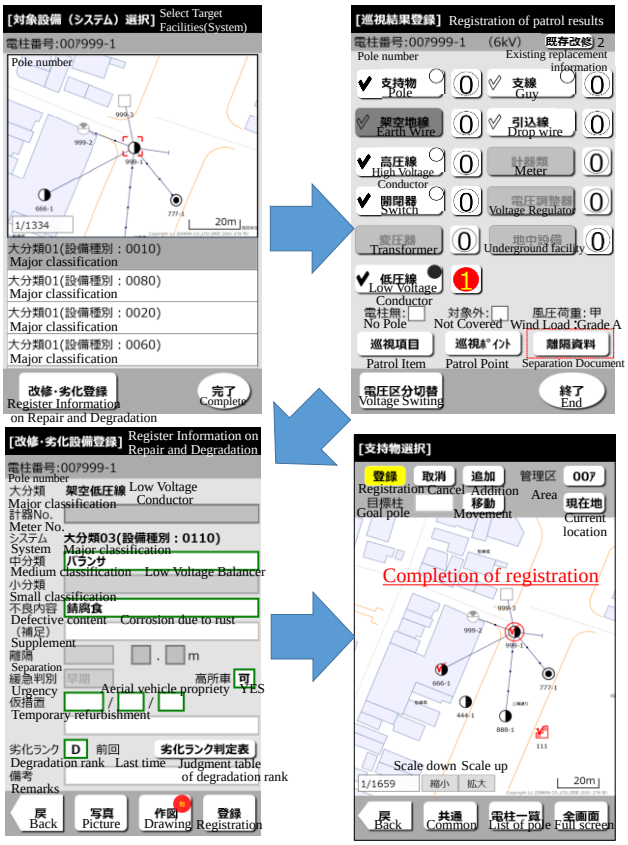

Figure 9: Registration screen of patrol results and repair information by mobile terminal

4. FUTURE PLANS

In the future, risk assessment will be performed on the failure events of each facility based on the accurate facility data and detailed defect information accumulated in "DAMRAS". By doing so, we will prioritize defects and improve the precision of replacement cycle of equipment, maximizing the life cycle of distribution equipment and flattening construction volumes.

Currently, as a risk assessment method, we are also preparing a risk assessment index (Fig. 10) to compare and evaluate the risk of each failure event for each facility, based on the troubled information accumulated by "DAMRAS".

In addition, since registration of defect information grasped through other than periodic patrol is still carried out manually, system support for them is also necessary to be considered.

			Number of occurrences (In the nearest 5 years)		Risk rank					
			Equipment origin	Contact with other things or Natural phenomenon						
Possibility of occurrence	5	Frequently	20 or more	200 or more	C	B	B	A1	A2	A3
	4	Sometimes	6 or more and less than 20	60 or more and less than 200	C	C	B	B	A1	A2
	3	Occasionally	1 or more and less than 6	10 or more and less than 60	C	C	C	B	B	A1
	2	Rarely	0.4 or more and less than 1	5 or more and less than 10	C	C	C	C	B	B
	1	Hardly ever	0.2 or more and less than 0.4	2 or more and less than 5	C	C	C	C	C	B
	0	never	0	Less than 2	–	C	C	C	C	C
				Electric shock	None	Worker	–	–	Low voltage	High or Extra-high voltage
				Blackout	None	Work barriers	Low voltage	High voltage	Extra-high voltage	–
				Falling	None	Cover, Less than 6g	6g or more less than 100g	100g or more less than 1kg, oil	1kg or more less than 10kg	10kg or more
				fire	None	–	–	Facility burnout	Spreading fire	–
				Measurement	None	Low voltage (Except smart meter)	Low voltage	High or Extra-high voltage	–	–
					None	–	Minor	Medium	Serious	Fatal
					0	I	II	III	IV	V
					Severity of harm					

Figure 10: Risk assessment index.

5. CONCLUSION

In order to maximize the lifecycles of facilities and to average the yearly replacement constructions, we have created an environment that enables us to acquire information that contributes to strategic facility maintenance.

Label with two-dimensional barcode have been introduced in order to improve the management of equipment data, which can provide the operator with accurate facility data in cases of defective events.

A new system named "DAMRAS" that can collect and accumulate defective events without omission have also been developed, which can strengthen the analytical capability of such events and lead to formulating efficient maintenance measures.

These systems are designed so that the field workers can carry out advanced maintenance operation precisely with less effort than ever.

In the future, we will make full use of these systems accumulating defect information, while continuously expanding the scope of system support. This will be aimed to establish data analysis method of accumulated troubled information, and to carry out efficient facility maintenance for aging facilities.