

Workshop on Radiation Exposure Control at the TEPCO  
Holdings' Fukushima Daiichi Nuclear Power Plant

# Report on improvement of work efficiency and reduction of exposure dose by improving the working environment and using mechanization

Maintenance work on south side of site

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# Presentation content

- Overview of work
- Dose control results
- Examples of measures to reduce exposure dose
- Summary

# Overview of work

# Overview of work: Location



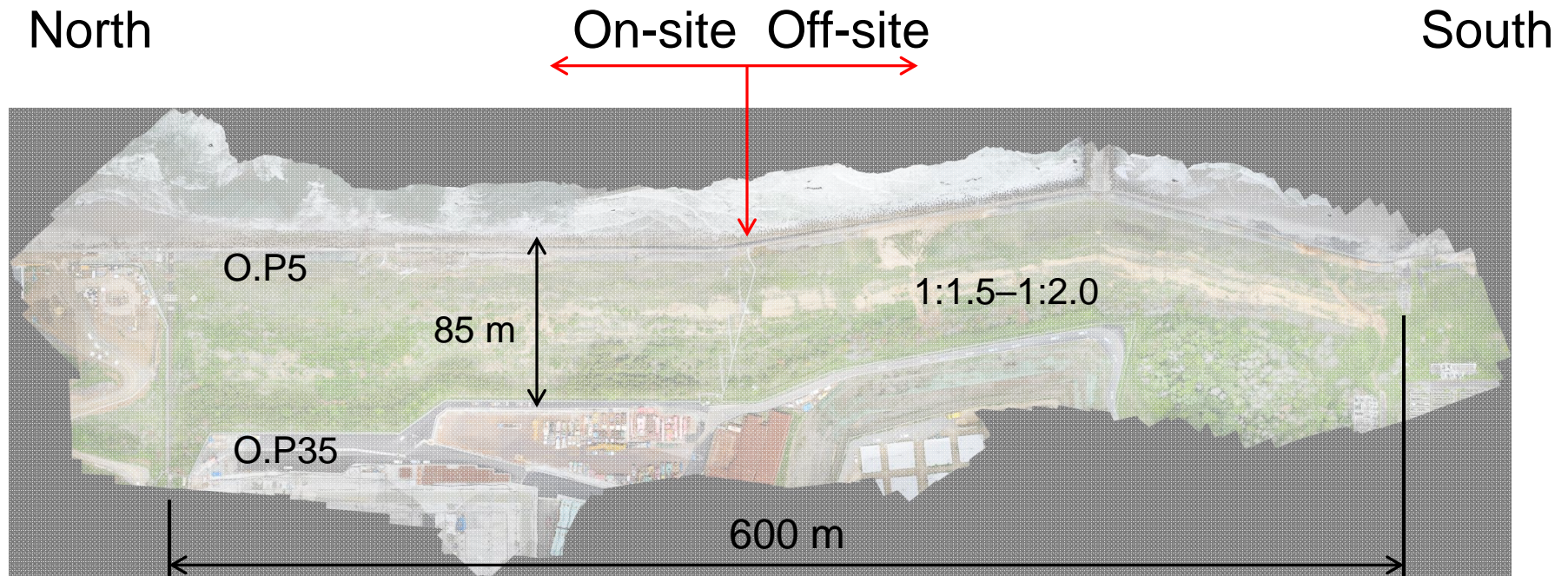
# Overview of work

- Work period
  - Review work: June 2015–September 2015
  - Slope restoration work: December 2015–August 2016
  - Sea wall and other restoration work: September 2016–October 2017
- Main content of work
  - Restoration work for collapsed slope
  - Restoration work for destroyed sea wall
    - Remove and clean up damaged equipment
    - Create access road for heavy equipment
    - Establish water drainage
    - Restore fence, etc.

\*Average of 5 Taisei employees and 25 workers engaged in work

# Overview of work:

## Overall view of work area



# Overview of work:

## Overall view of work area

North

Location of destroyed sea wall

Location of collapsed slope

Temporary  
equipment yard  
Rest station (1)

Rest station (2)  
On-site clean  
room

South

# Overview of work: Collapsed slope area



Work finished

# Overview of work: Mowing



※The picture is partly modified for security reasons.

# Overview of work: Constructing road for dump trucks

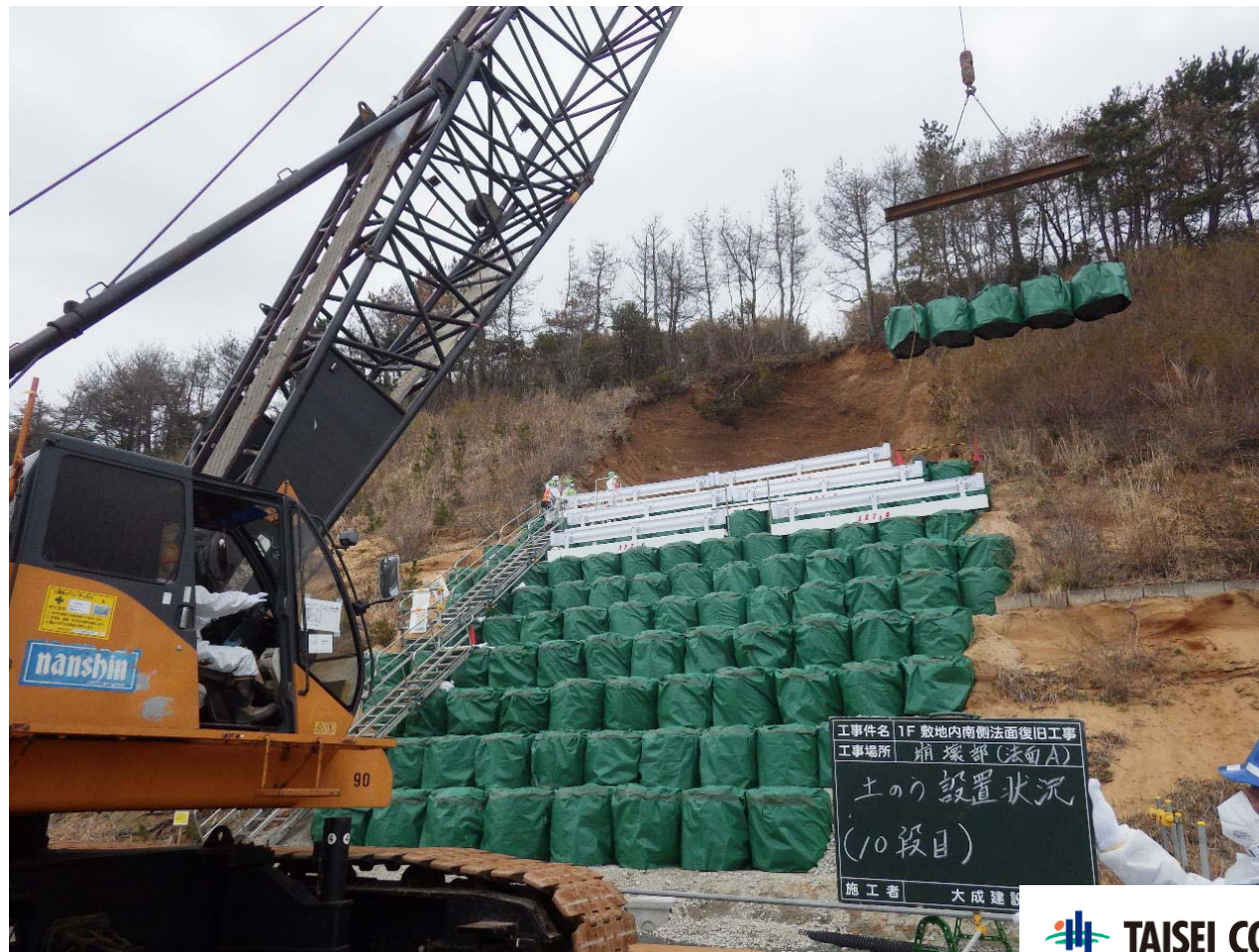


※The picture is partly modified for security reasons.

# Overview of work: Restoring slope



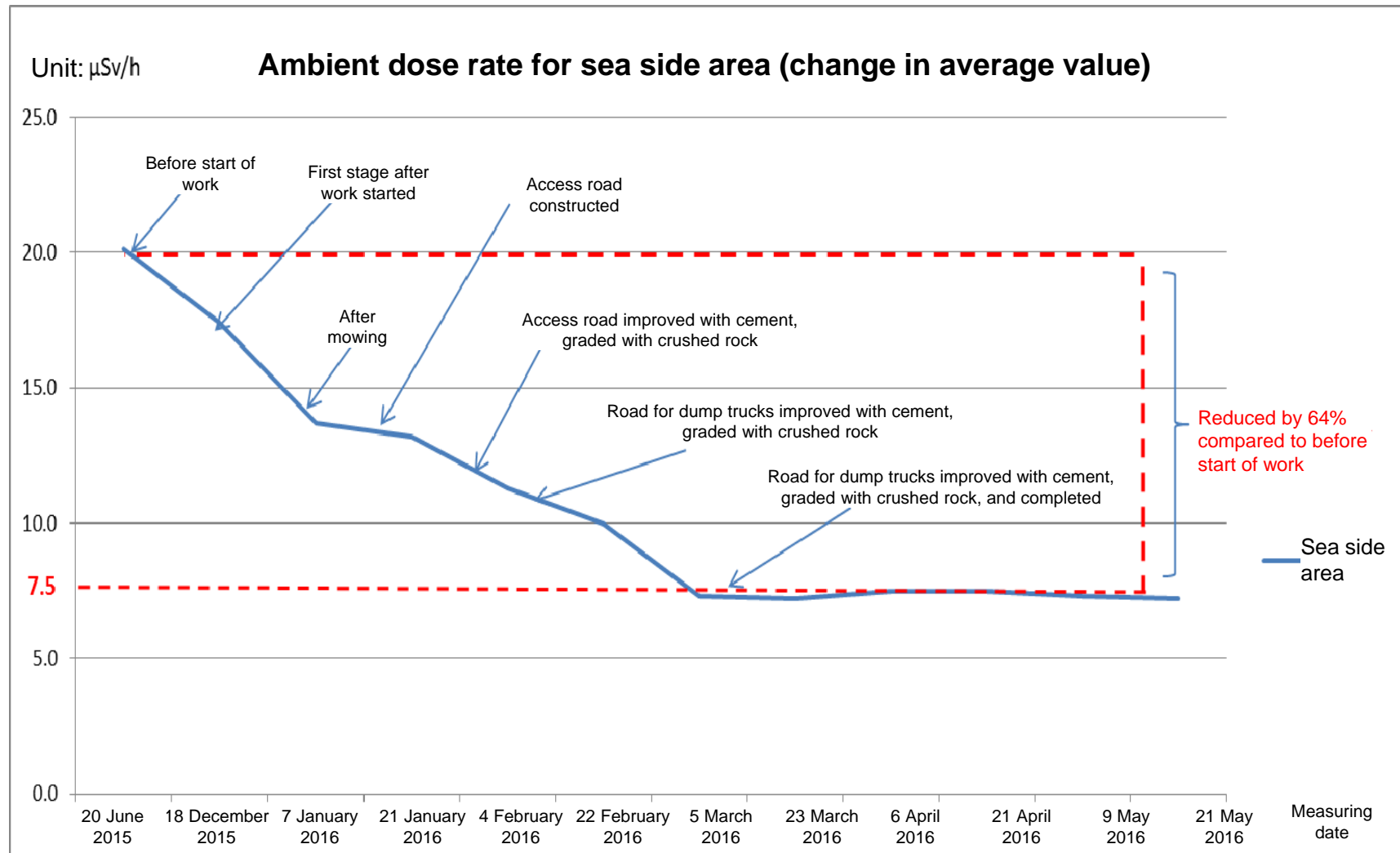
# Overview of work: Restoring slope



- (1) Ambient dose
- (2) Exposure dose comparison with other areas

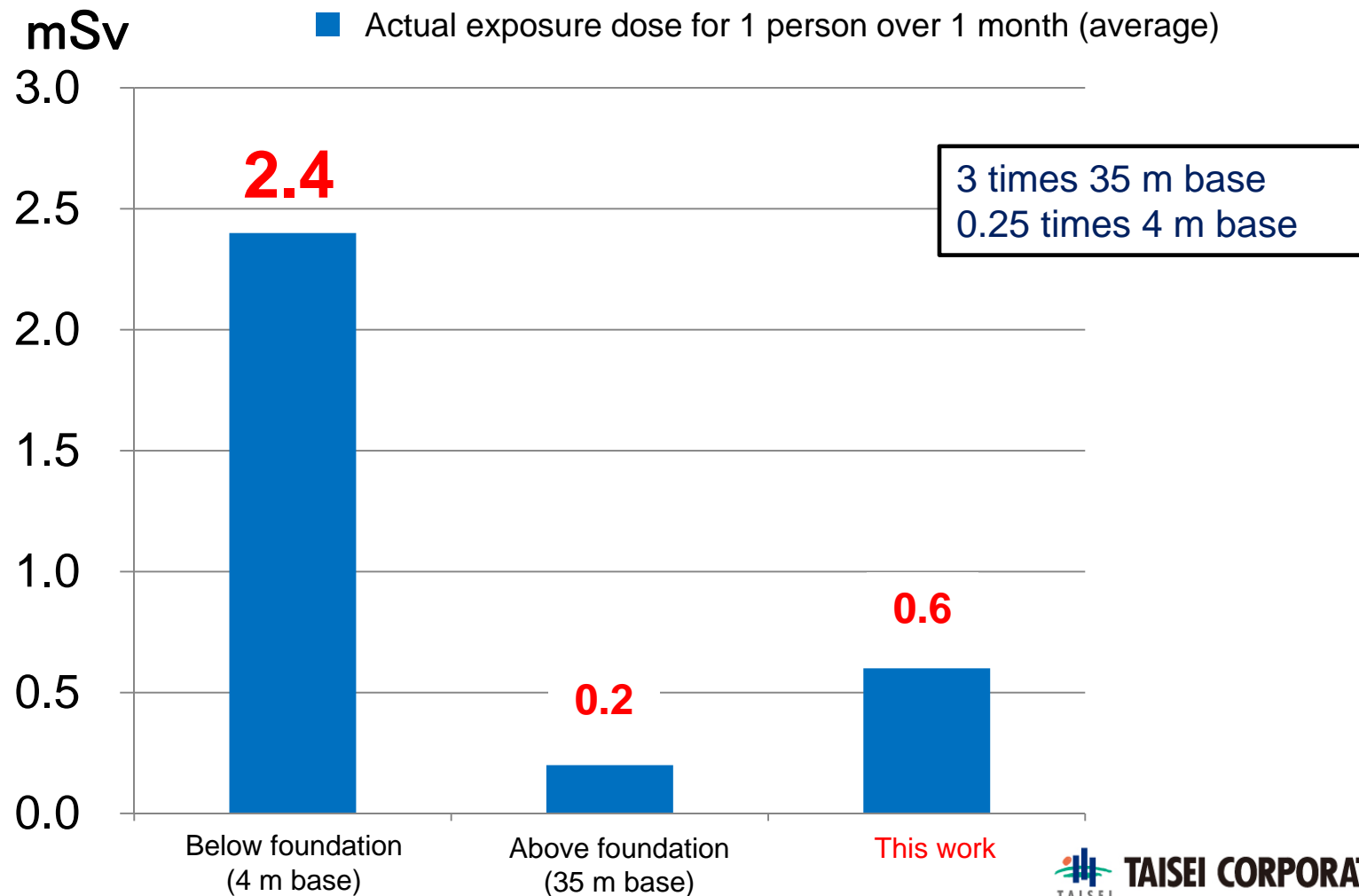
## **Dose control methods and results**

# Dose control results: Ambient dose



# Dose control results:

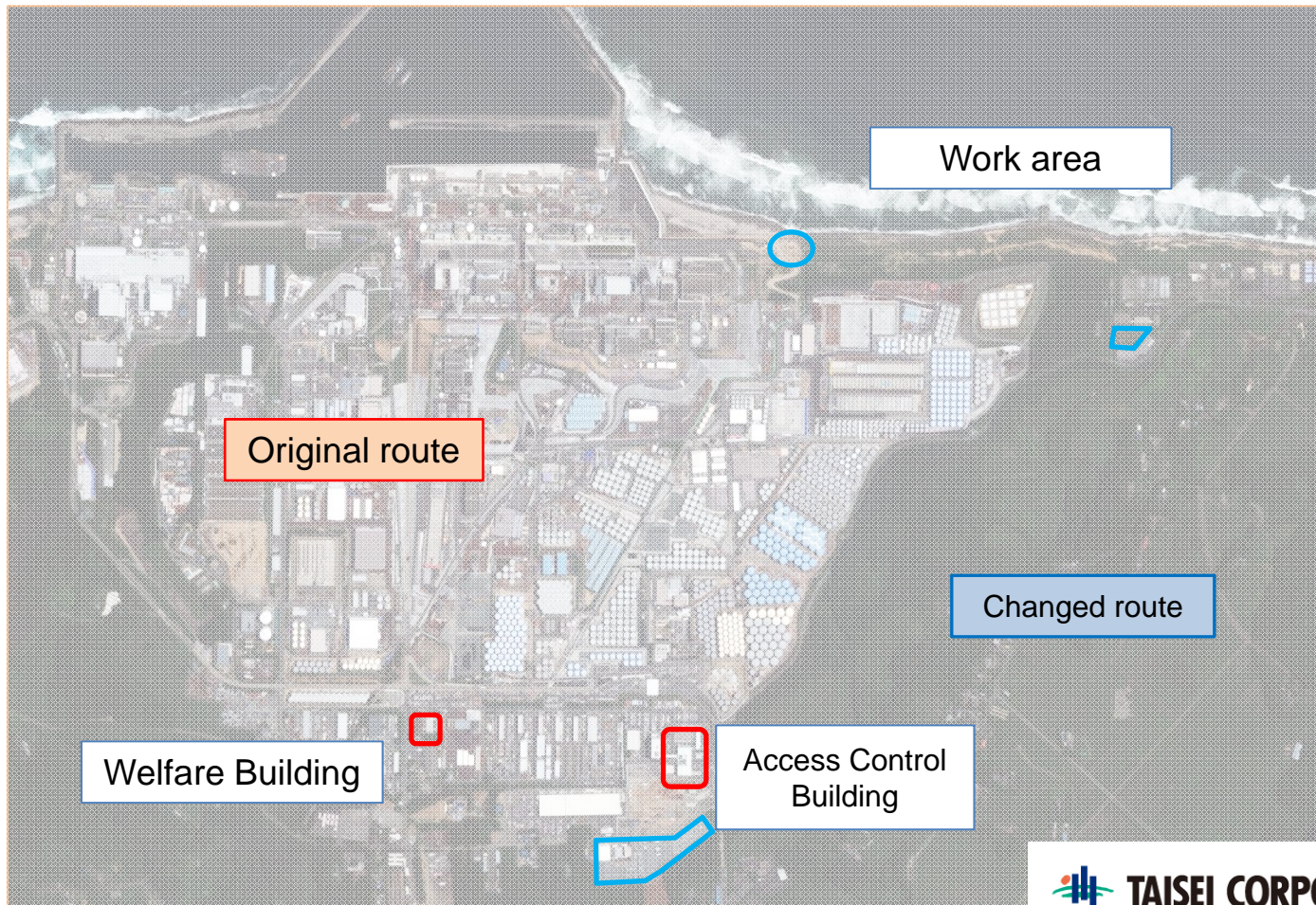
## Exposure dose comparison



- (1) Improvement of method of access to work location
- (2) Providing rest facilities near work location
- (3) Mechanization of mowing work
- (4) Topographic surveying of inclined ground using drones
- (5) Backhoe equipped with robot
- (6) Other examples

## **Examples of measures to reduce exposure dose**

# Improvement of method of access to work location



# Improvement of method of access to work location

- Main items for discussion and review
  - Discussion of borrowing property for temporary equipment yard (Fukushima Prefecture)
  - Discussion of partial exclusive use of town roads (Police department/Okuma)
  - Stationing of dose control and access control personnel at on/off-site gates
  - Monitoring of contamination levels on borrowed land and roads
  - Stationing of security personnel to prevent access by unauthorized people
  - Setting up rest stations, equipment warehouses, and parking areas
  - Implementation of equipment borrowing, placement, and return

\*Blue items were handled by TEPCO

# Improvement of method of access to work location

	Original route			Changed route		
Entry time	Chuodai intersection			Chuodai intersection		
	Parking area	Car	5	Parking area	Car	5
	Access Control Building	Walking	5	Work area	Walking	5
	Welfare Building	Walking	15			
	Parking area (coastal area)	Car	7			
	Work area	Walking	10			
	Subtotal		42	Subtotal		10
Lunch time	Work area			Work area		
	Parking area (coastal area)	Walking	10	Parking area	Walking	5
	Welfare Building	Car	7	Work area	Walking	5
	Parking area (coastal area)	Car	7			
	Work area	Walking	10			
	Subtotal		34	Subtotal		10
Exit time	Work area			Work area		
	Parking area (coastal area)	Walking	10	Parking area	Walking	5
	Welfare Building	Car	7	Chuodai intersection	Car	5
	Access Control Building	Walking	15			
	Parking area	Walking	5			
	Chuodai intersection	Car	5			
	Subtotal		42	Subtotal		10
Total movement time (min)			118	Total movement time (min)		30

## Reduced movement time Reduced time spent at 1F

- Reduced exposure dose 17%
- Reduced fatigue
- Improved efficiency/reduced processes needed
- Increased costs for parking areas and rest stations
- Increased management costs such as equipment maintenance

# Providing rest facilities near work location



**Off-site:** Temporary equipment yard,  
off-site rest station  
**5 minute walk from work area**



**On-site:** Rest station, clean room  
**1 minute walk from work area**

※The picture is partly modified for security reasons.

# Providing rest facilities near work location (on-site)

Clean room



Delivers temperature-controlled clean air

※The picture is partly modified for security reasons.



# Providing rest facilities near work location



Break room



Body survey room

# Mechanization of mowing work



Before start



Completed

# Mechanization of mowing work



Mowing on flat land

Work area: 10,000 m<sup>2</sup>

- Manual mowing (30 days)  
240 worker-hours  
→ 12 person-mSv
- Mechanized weeding (20 days)  
+ manual (7 days)  
62 worker-hours → 2.5 person-mSv



Mowing on slope

# Topographic surveying of inclined ground using drones



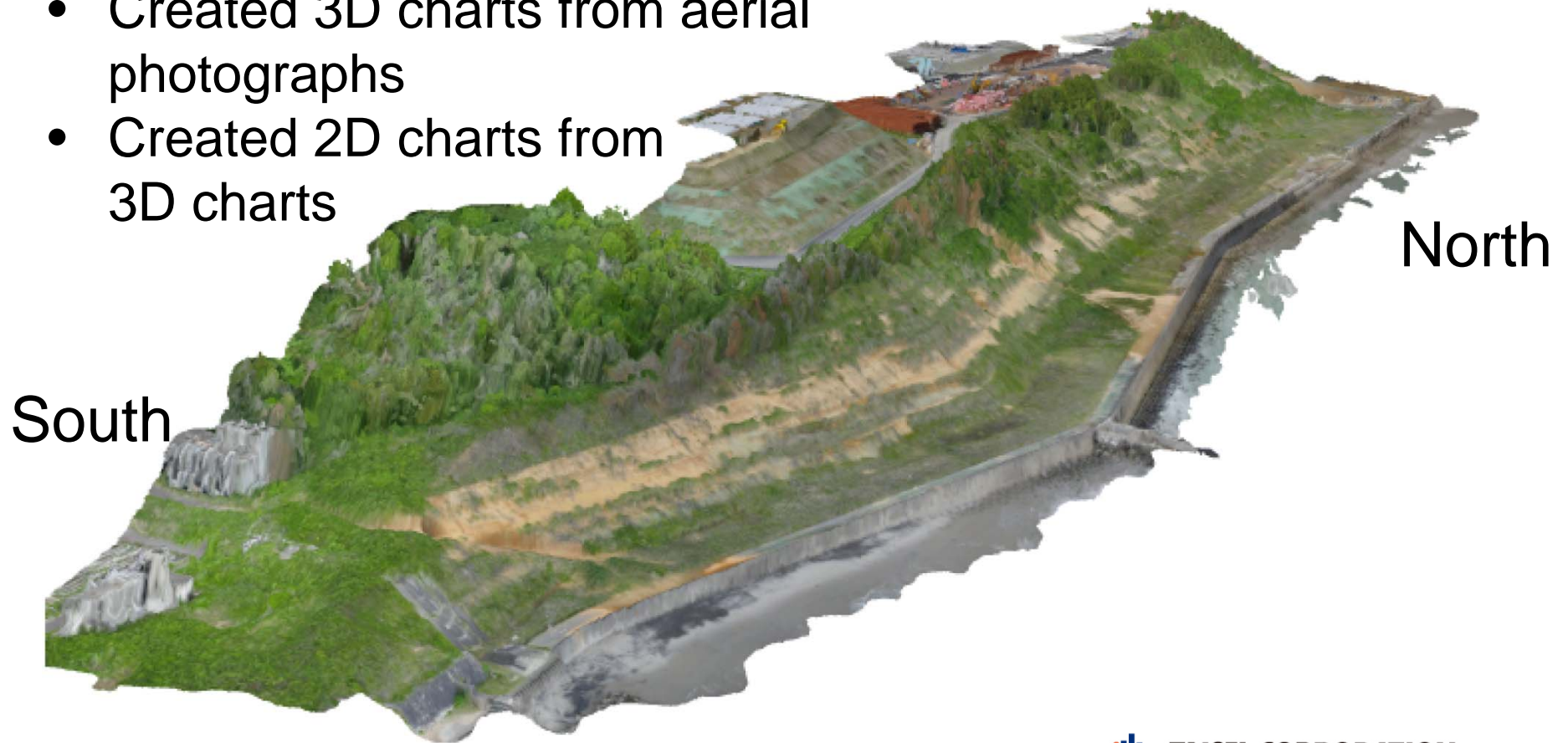
Drone main unit



Controller

# Topographic surveying of inclined ground using drones

- Created 3D charts from aerial photographs
- Created 2D charts from 3D charts



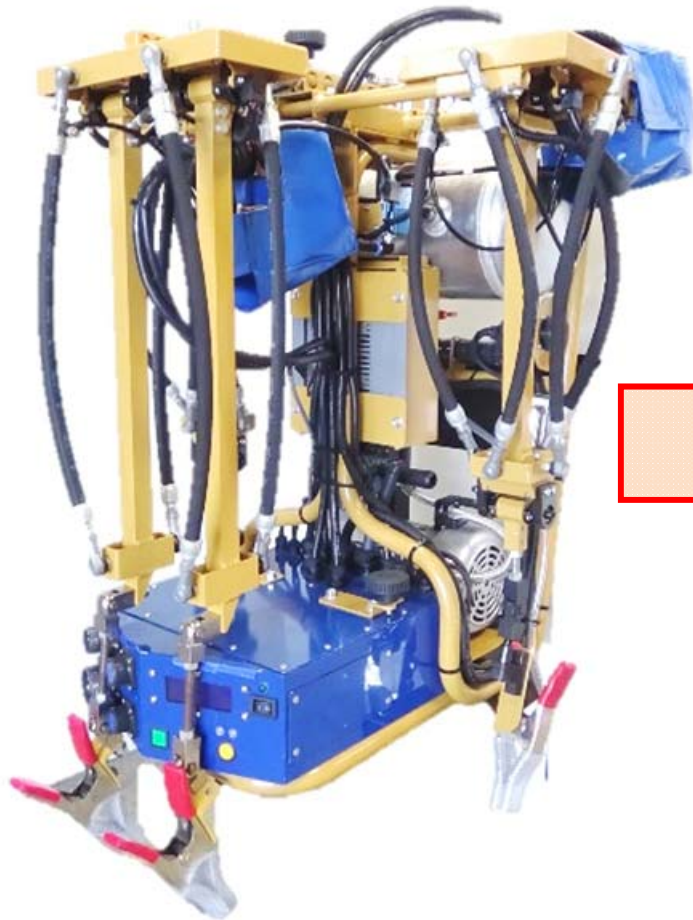
# Topographic surveying of inclined ground using drones



Survey area: 50,000 m<sup>2</sup>  
No. of survey lines: 40 survey lines  
Height differential: 35 m  
Length: 700 m  
Slope gradient: 1 : 1.7

- Manual surveying (30 days)  
Mowing, safety rope anchor installation and removal, and surveying  
270 worker-hours → **13.5 person-mSv**
- Aerial surveying by drone (5 days)  
Control point surveying, aerial surveying, and safety monitoring  
24 worker-hours → **0.5 person-mSv**

# Backhoe equipped with robot



Robot main unit



Installed in cab

# Backhoe equipped with robot

- Enables remote operation without modifying existing heavy equipment
- **Easier** and **cheaper** to use than previous unmanned units (does not require a PC)
- Can be operated after only 2 hours of training



Remote operation

Operation is exactly the same as a backhoe



Controller main unit

# Backhoe equipped with robot



# Other examples

- Switched from 10 t dump trucks to 25.4 t trailer-type dump trucks for hauling 10,000 m<sup>3</sup> of regenerated crushed stone from Hirono Thermal Power Station
  - **Halved number of dump trucks (= no. of drivers) and halved exposure**
  - **Shortened work schedule by improving efficiency**
- Monthly heavy equipment inspections by nationally certified mechanics
  - **Enabled high-quality inspection in a shorter time with fewer people**
  - **Shortened work schedule by completely eliminating heavy equipment trouble**
- Restoration of upper section of sea wall with precast components (planned)
  - **Will reduce on-site work to 1/3, shorten work schedule**

# Exposure dose reduction results

Workers: 5 company employees, 25 workers (average), for total of 30

Period: 9 months

	Route changes	Mowing	Surveying	Crushed rock hauling
	Shortened movement time Shortened time spent in 1F area	Mechanized work in high-exposure dose area	Used aerial photography surveying to eliminate work in high-exposure dose area	Used larger trucks to reduce number of trucks needed
Exposure dose in original plan [person-mSv]	182	12.0	13.5	2.6
Exposure dose after change [person-mSv]	152	2.5	0.5	1.3
Exposure dose reduction [person-mSv]	30	9.5	13.0	1.3
Percentage reduction in exposure [%]	17%	79%	96%	50%

# Summary

# Measures that were effective in this work

- Changing route, and securing rest stations, parking space, and materials yard near work location
  - Worker fatigue levels are clearly lower than for other work
  - Succeeded in reducing time spent at 1F despite keeping same number of work hours
  - Environmental improvements raised efficiency in all work phases and types of work, and had a positive effect on exposure dose reduction, safety and the work schedule
- Mechanizing or eliminating work in high-dose areas
  - Manual mowing, surveying work on high-dose slopes
  - Identification of high-dose work areas at the planning stage

# Acknowledgments

The following people and groups were helpful in examining issues such as dose control methods, movement/resting of workers, and gate control.

- Tomioka Labor Standards Inspection Office
- No. 3 Civil Engineering Group
- Radiation Administration Group
- Radiation Safety Group
- Protection Management Group
- Work Environment Improvement Group