

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

Youichirou Kuroha
Fukushima Daiichi Stagnant Water Work Site,
Tohoku Branch, Taisei Corporation

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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

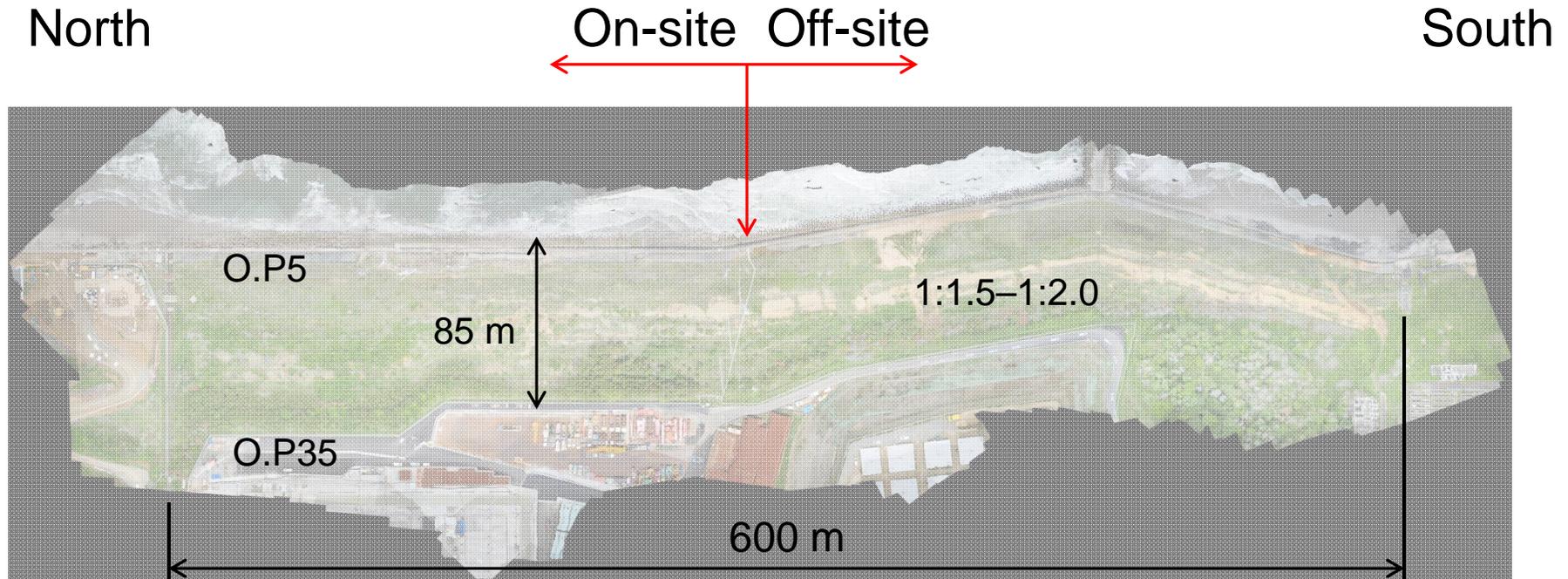


Overview of work

- 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

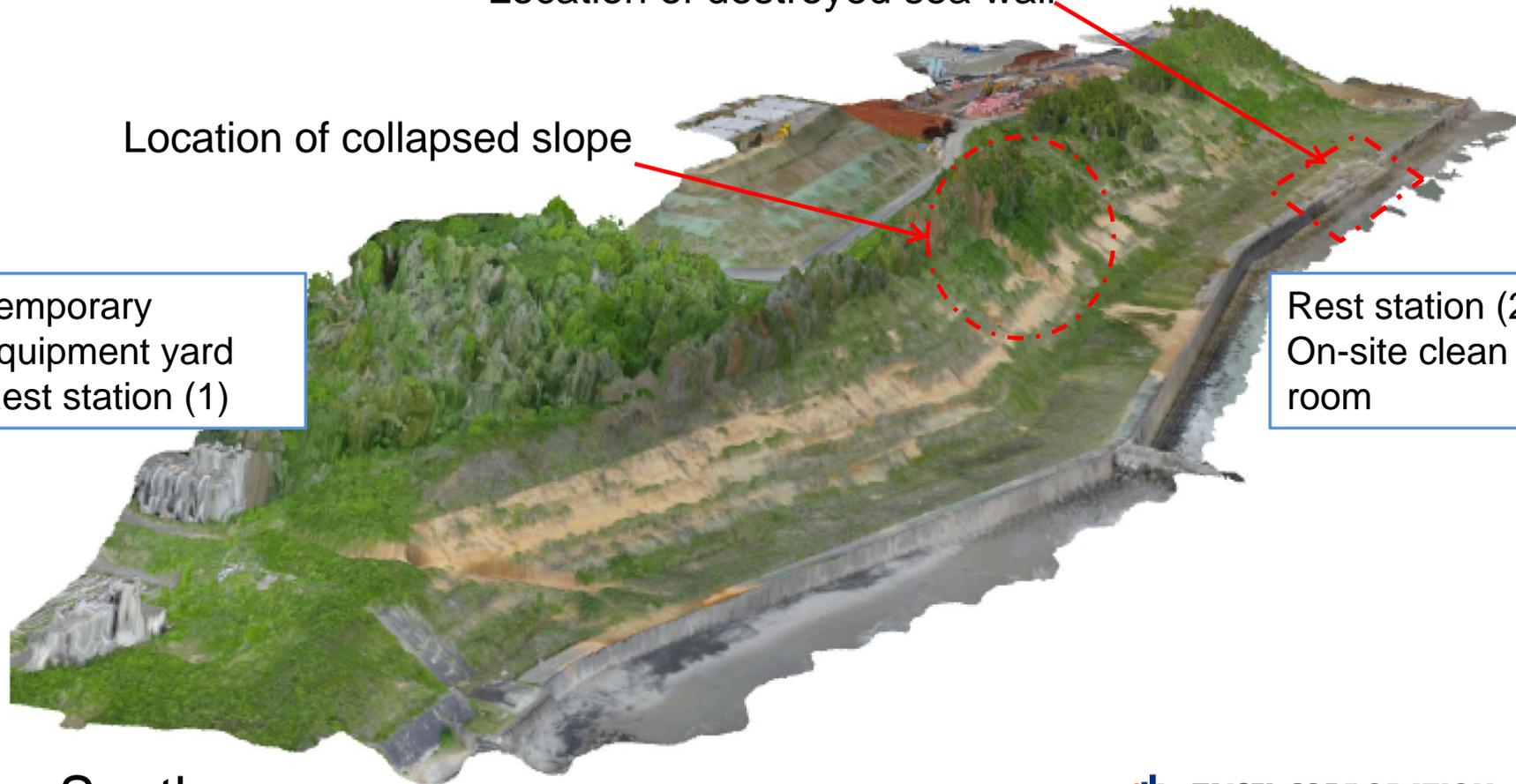
Location of destroyed sea wall

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



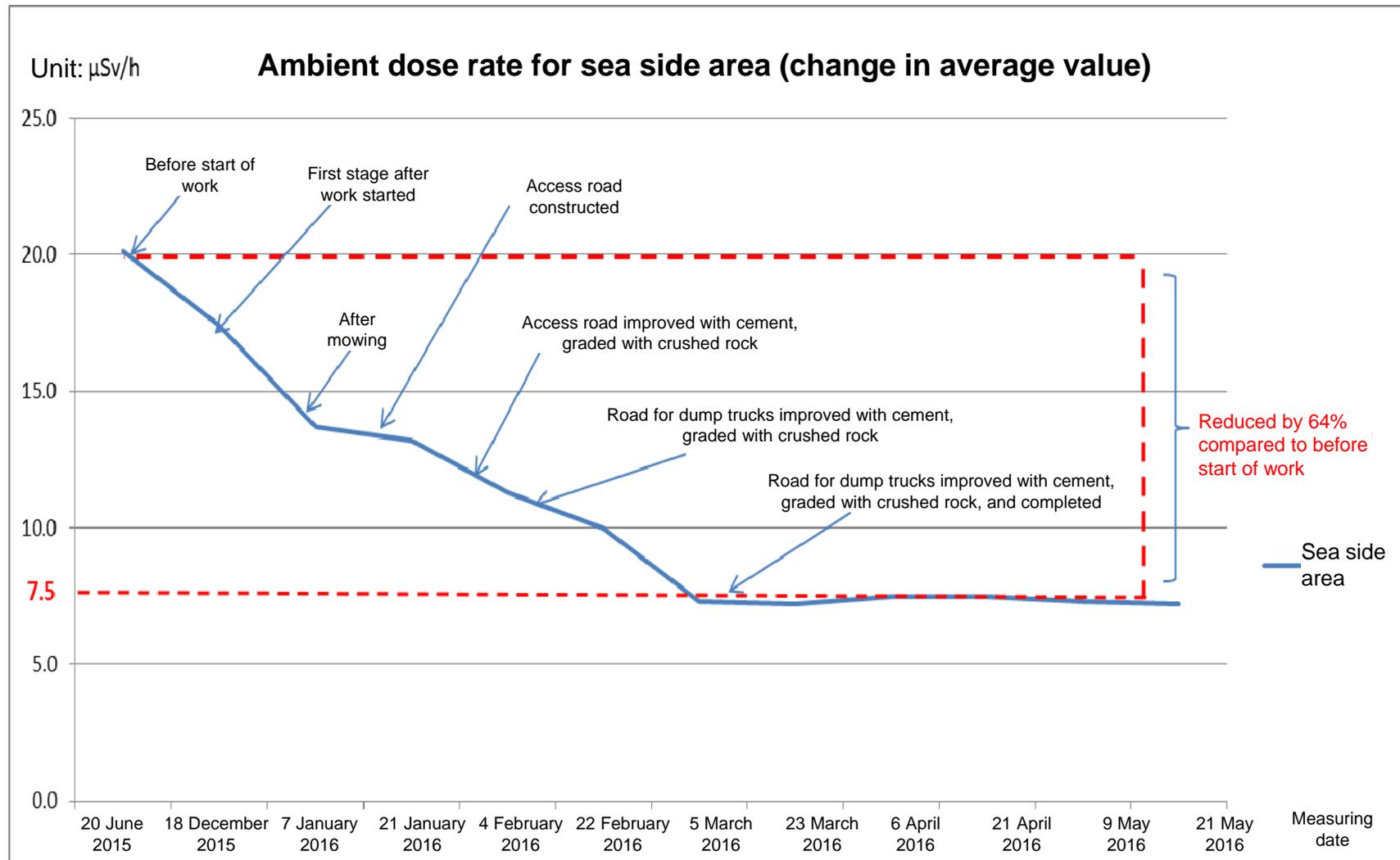
Overview of work: Restoring slope



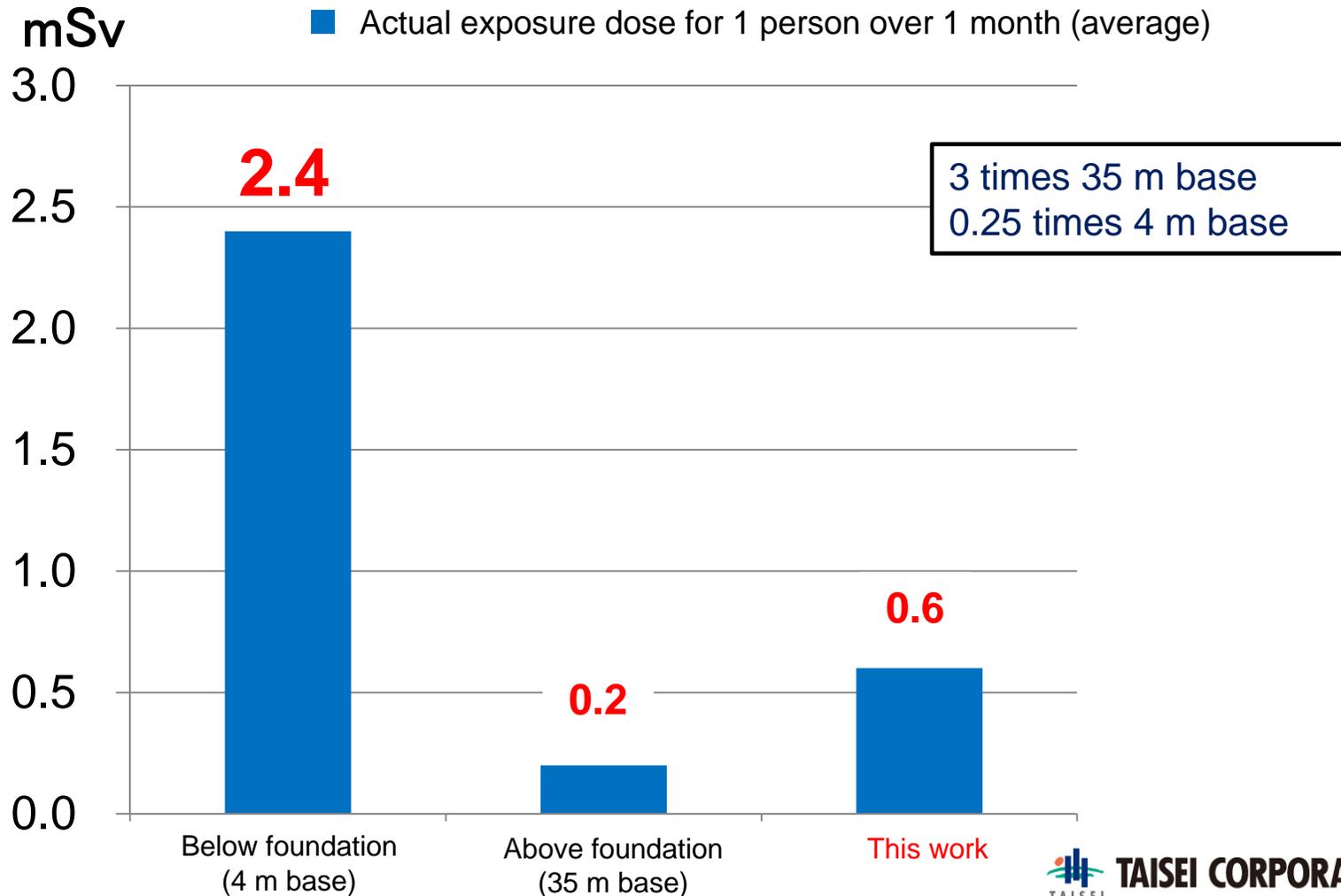
- (1) Ambient dose
- (2) Exposure dose comparison with other areas

Dose control methods and results

Dose control results: Ambient dose



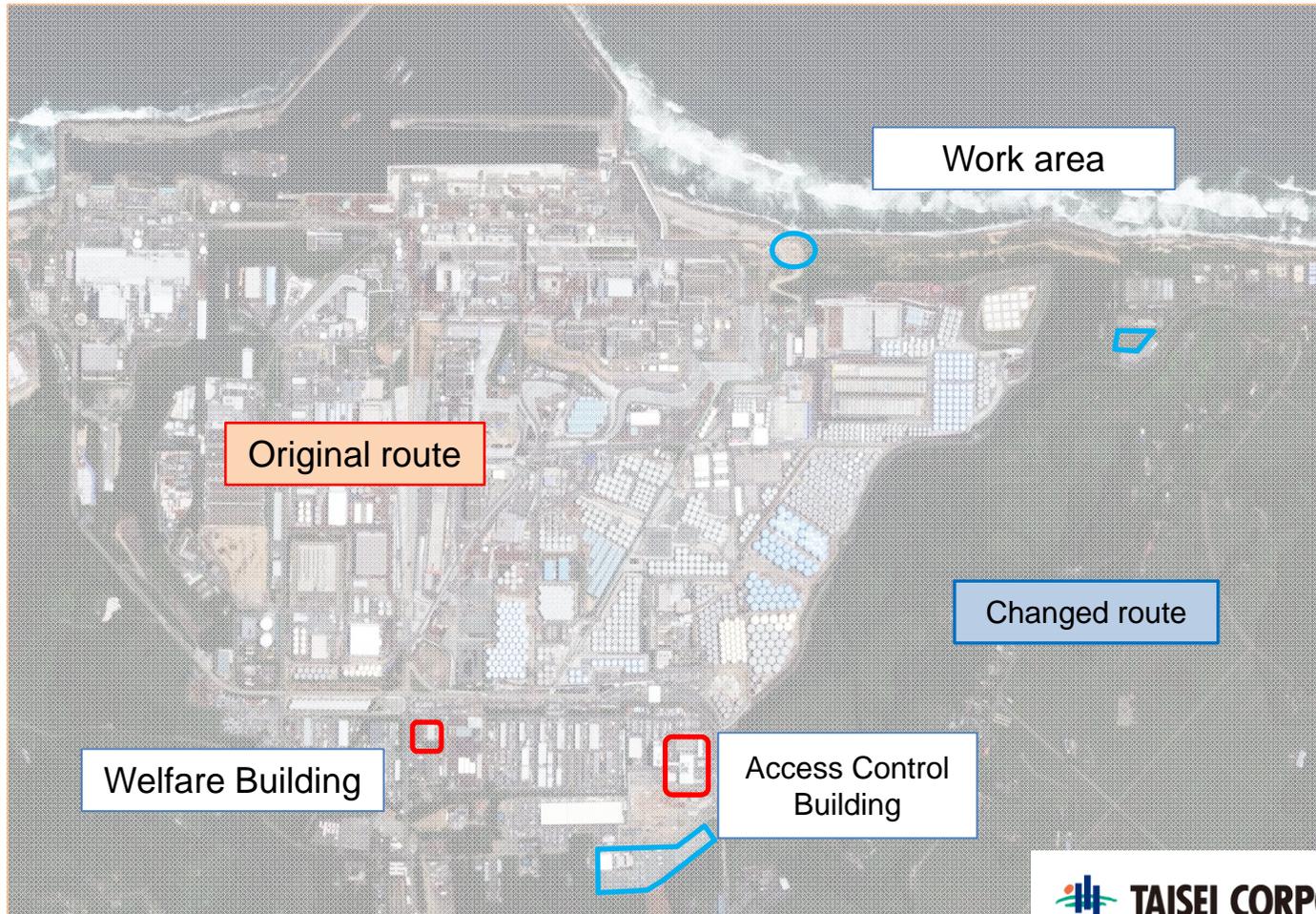
Dose control results: Exposure dose comparison



- (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 m²

- 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



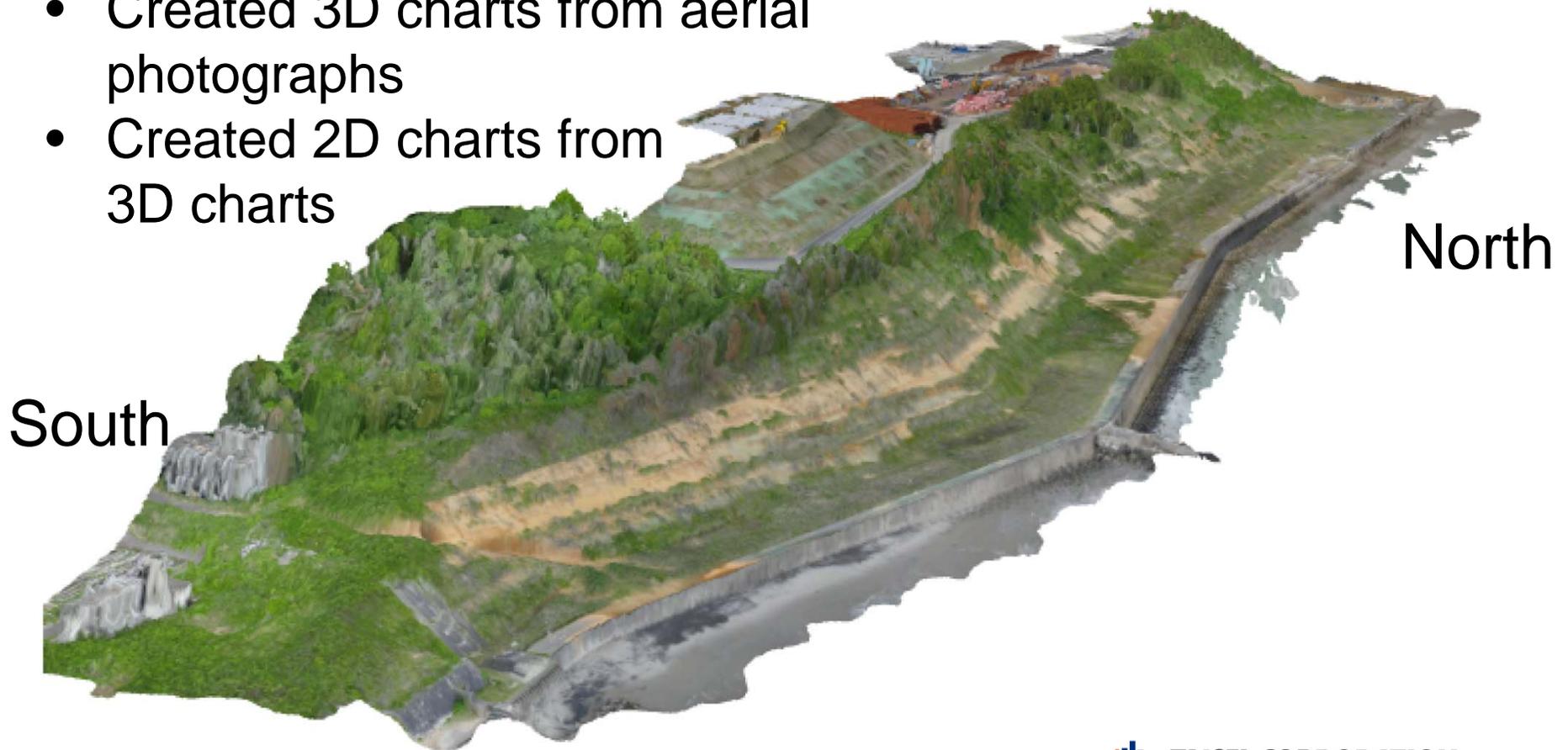
Drone main unit



Controller

Topographic surveying of inclined ground using drones

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



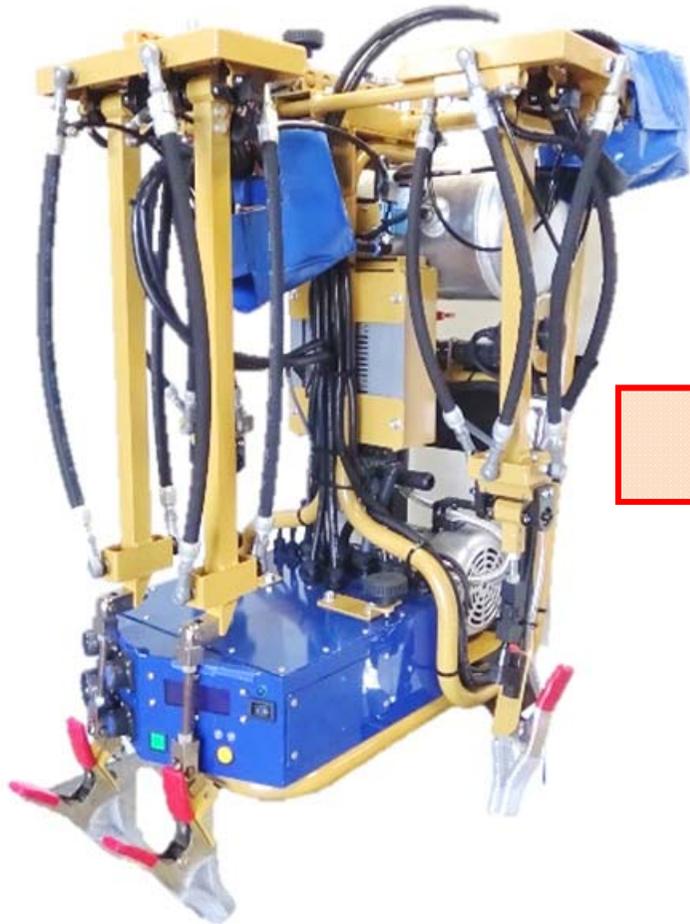
Topographic surveying of inclined ground using drones



Survey area: 50,000 m²
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 m³ 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
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- Radiation Administration Group
- Radiation Safety Group
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- Work Environment Improvement Group