

Revolutionary inspection technology for Pipe corrosion through Oil retaining wall



This paper includes the english translation based on
the published paper from JX Nippon Oil & Energy Corp.

ATLAS *ATLAS CO., LTD.*

ATLAS NEW NDT INSPECTION TECHNOLOGY

ATLAS Electrical Potential Difference (EPD) Method was developed to detect reduction of metal thickness owing to erosion and corrosion. It is a non-destructive test.

We can provide two type inspection methods: **“Continuous Monitoring”** and **“One Time measurement”**

One is that the continuous measurement can be done by extending the cable from the monitor area. (We call **“Continuous Monitoring”**)

This time we would like to introduce our developed **NEW INNOVATIVE INSPECTION TECHNOLOGY** by **“ One Time measurement”**.

This new technology developed by ATLAS can inspect the pipe corrosion through the oil retaining wall etc. and can provides higher accuracy and resolution than most measurement technologies available in the market.

It has a big advantage of:

- ◆ **Only ATLAS success in the world**
- ◆ **Short time of inspection**
- ◆ **Very High Cost Benefit**
- ◆ **Full Satisfaction of Inspection Service**
- ◆ **Proven technology by JX Nippon Oil & Energy**

Background Our Technology

1 min. Review

- We, ATLAS, have developed “**New innovative inspection technology on Pipe corrosion in OIL RETAINING WALL**”

Japan Patent No. P5734789

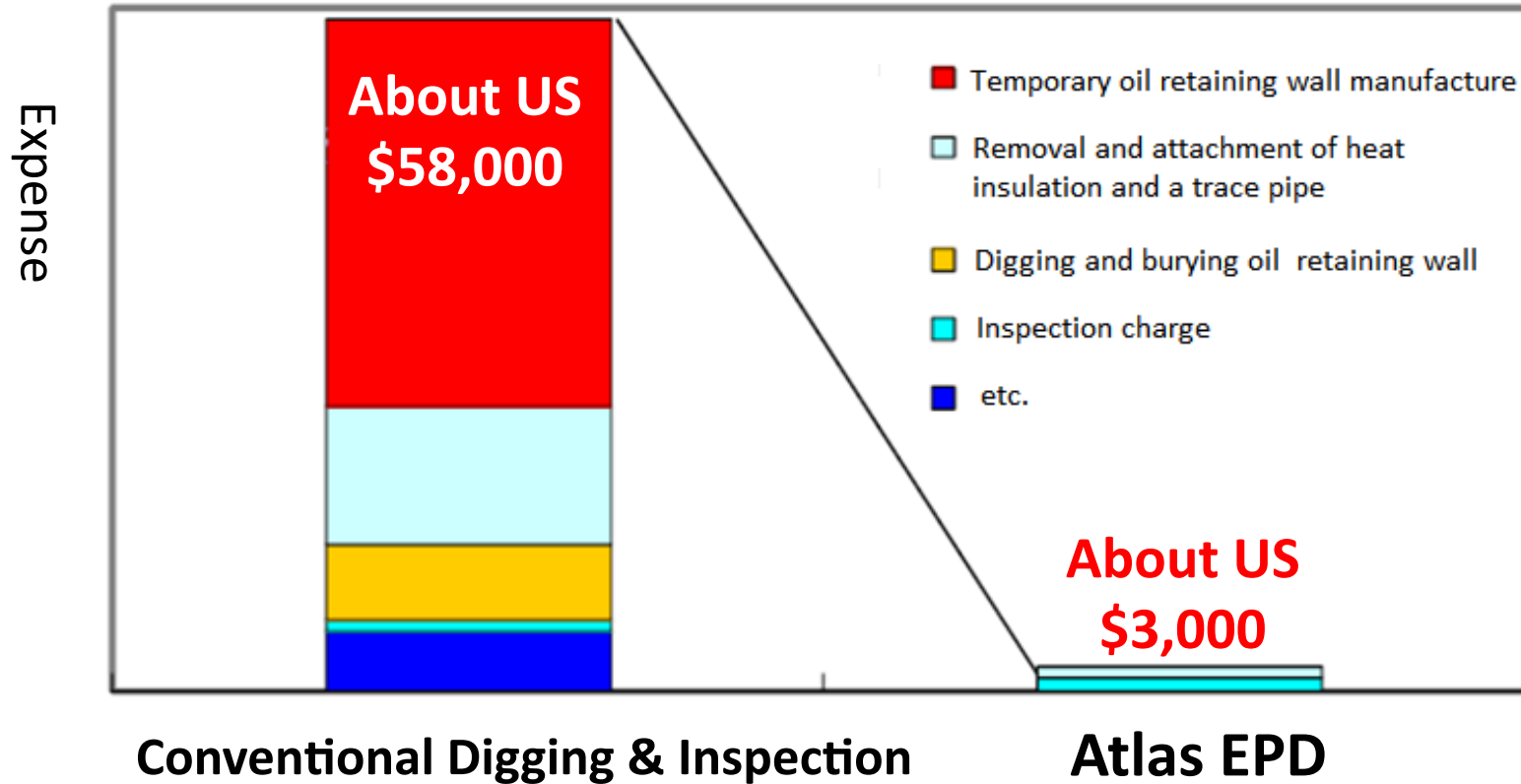
- We have been very successful in JPN Market.
It has been **proven by** JPN Energy Giant called “**JX Nippon Oil & Energy**”.

Over 3,000 pipes have been already applied so far.

Very significant cost down: Conventional 1/10 – 1/20

Inspection expense comparison per pipe in Japan

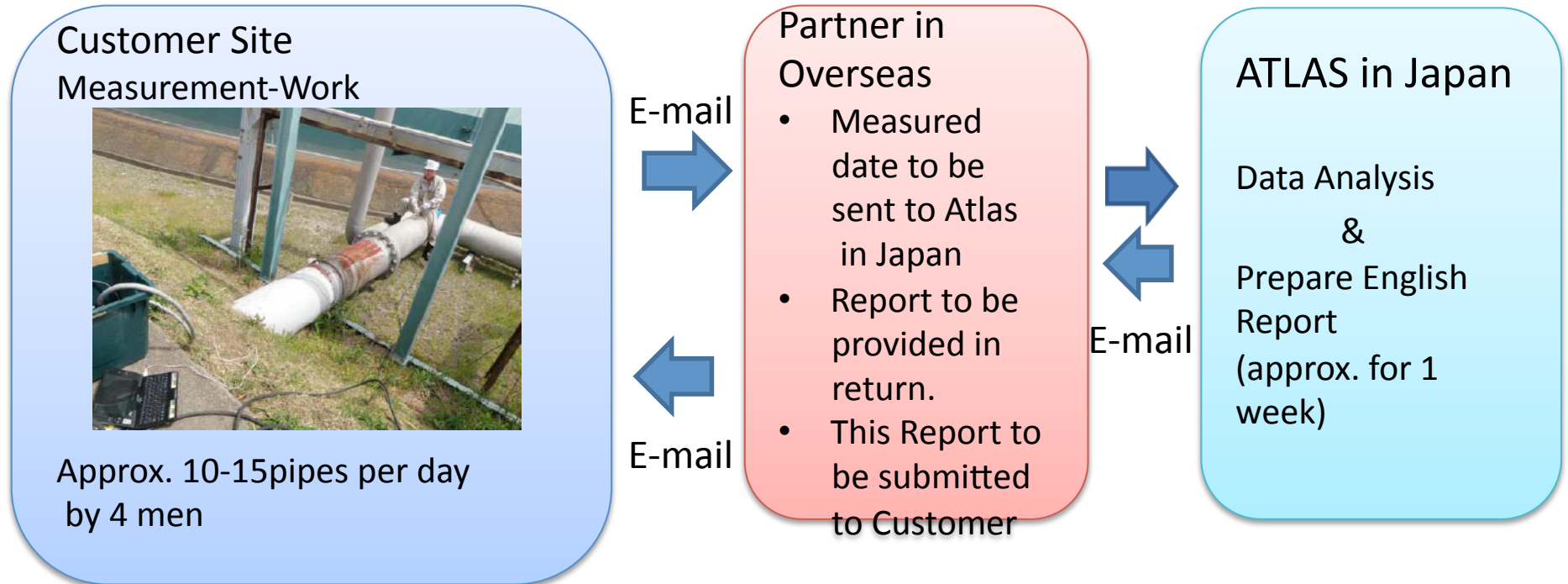
26B pipe (those with a trace pipe)



1/19 reduction of cost was possible !!

Outline of Business

1. Expected Procedures



2. Equipment Required

- 1 x EPD measuring instrument
- 1 set of detachable sensors, cables, connector etc

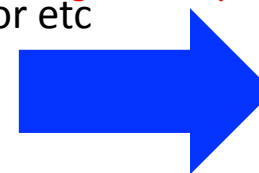
3. Field Technicians

- 1 Team consisting of 4 x Technicians

4. Time to require

- 7-10 days for 100pipes case

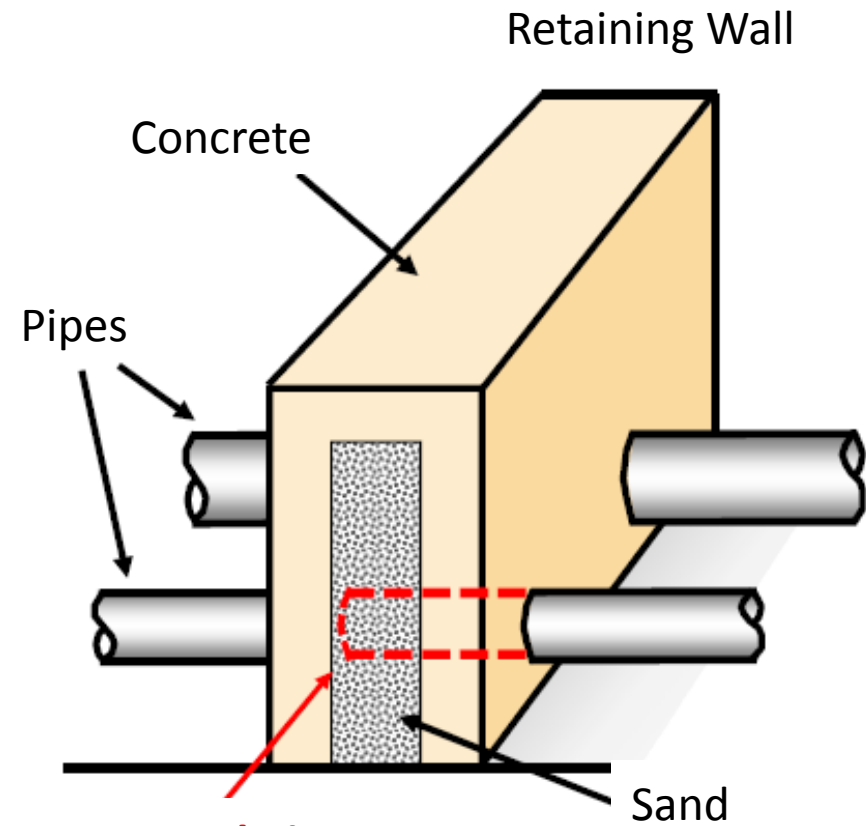
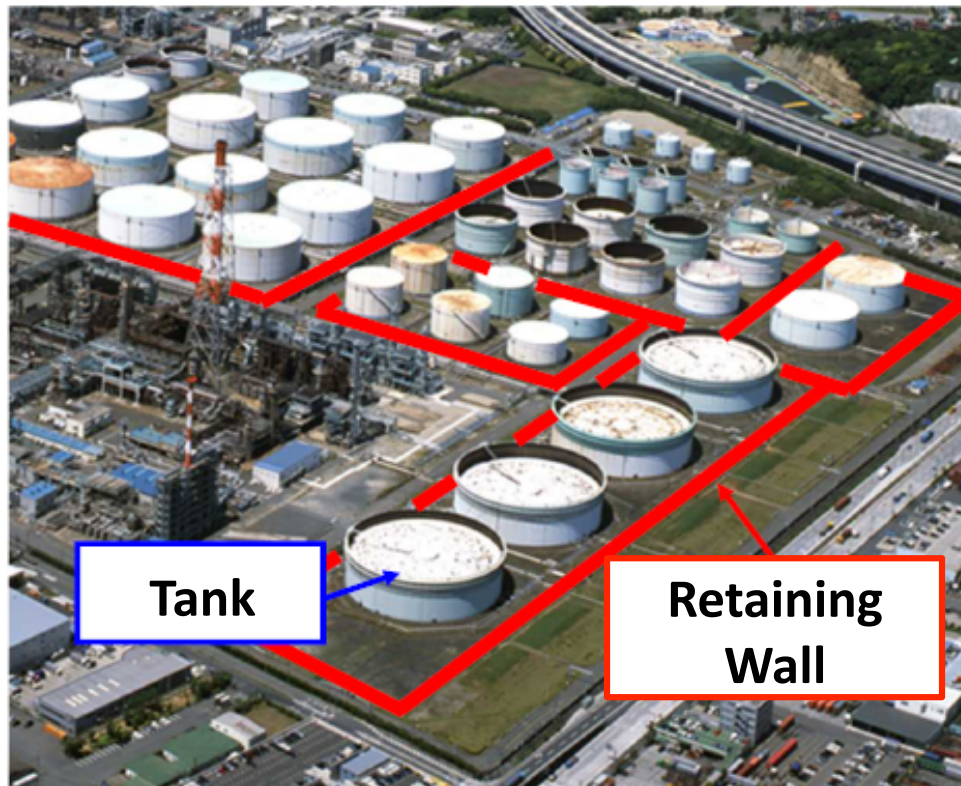
If efficiency is improved significantly



It is expected to complete inspection on site within 4-5 days !

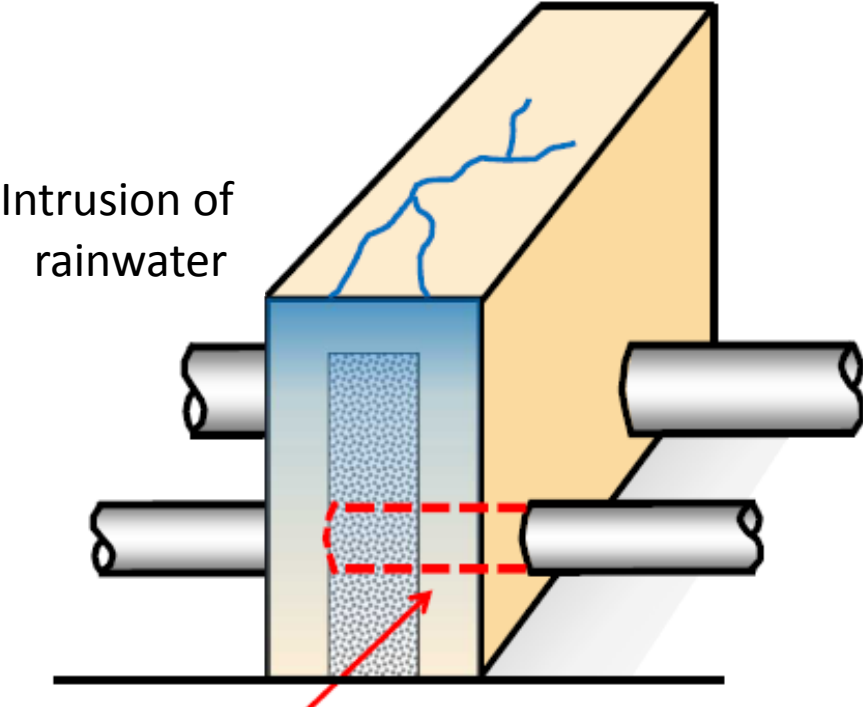
ATLAS technology Application field

Oil retaining wall Pipes (=Dike penetrating pipe)



**Penetrated Pipe
with anticorrosion tape**

Outside corrosion of oil retaining wall penetrated pipe



Penetrated Pipe (Damaged anticorrosion tape)

Photo: Corroded Pipe after dismantling retaining wall



Nominal Thickness 6.5mm
Max. Corrosion Depth: 4mm

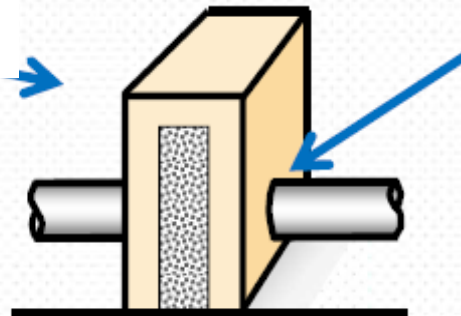
The conventional inspection

Preliminary inspection

The appearance visual check of an oil retaining wall is conducted, and the necessity of a secondary inspection is judged.

Oil retaining wall outer wall

It checks that there is no crack which serves as a permeation course of rain water.

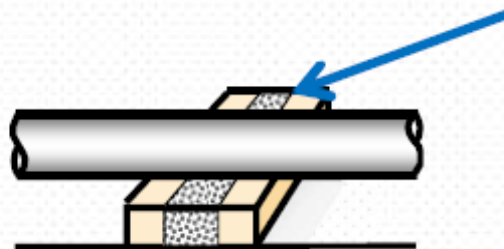


Pipe surface near the oil retaining wall

It checks that there is neither generating of rust nor degradation of a corrosion-proof tape.

Secondary inspection

An oil retaining wall is excavated, detailed inspection is conducted, and the necessity of repair is judged.

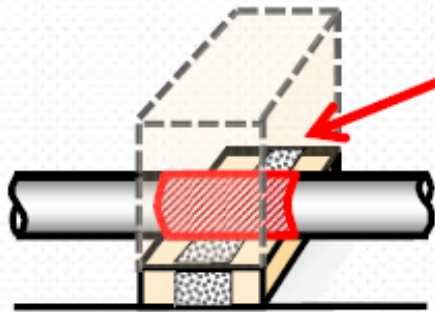


Penetrated Pipe

- The corrosion depth is checked.
- Residual thickness is checked.

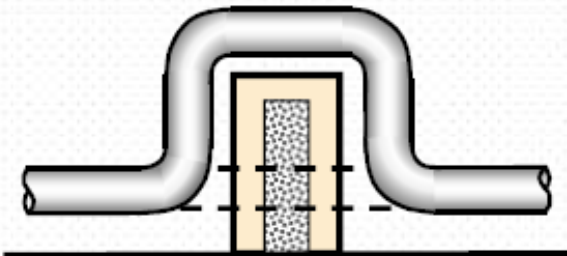
Conventional Solution

▪ Exchange of a thinning part



Exchange of a thinning part &
Re-construction of a corrosion-proof tape

▪ Jump over



A pipe is detoured in order to
avoid generating of outside
corrosion.

The weak point of the conventional inspection method

Preliminary inspection

The appearance visual check of an oil retaining wall

⇒ Since the inspection of the penetrating part cannot be carried out directly, conventional inspection accuracy is low.

Secondary inspection

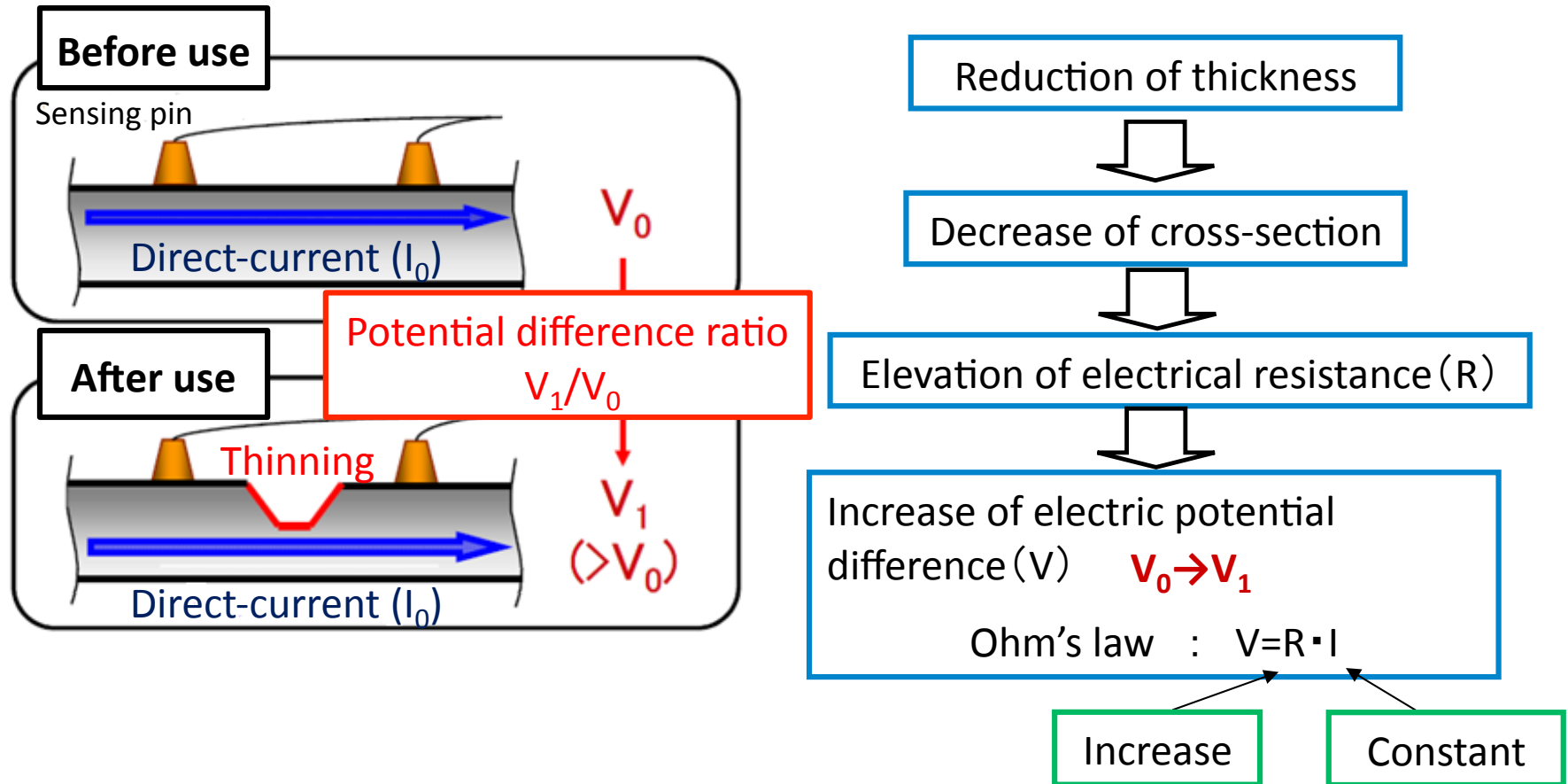
Detailed inspection by excavating an oil retaining wall

⇒ Large-scale appurtenant work, such as digging of an oil retaining wall and construction of a temporary oil retaining wall, is required.

⇒ **Inspection accuracy and cost were unsolved.**

The basic principle of ATLAS EPD

ATLAS EPD (Electric Potential Difference)



- Under supervising potential difference, generating of corrosion is detectable.
- The analytical curve prepared in advance can estimate the grade of corrosion.

About ATLAS EPD inspection technique

Fundamental principle

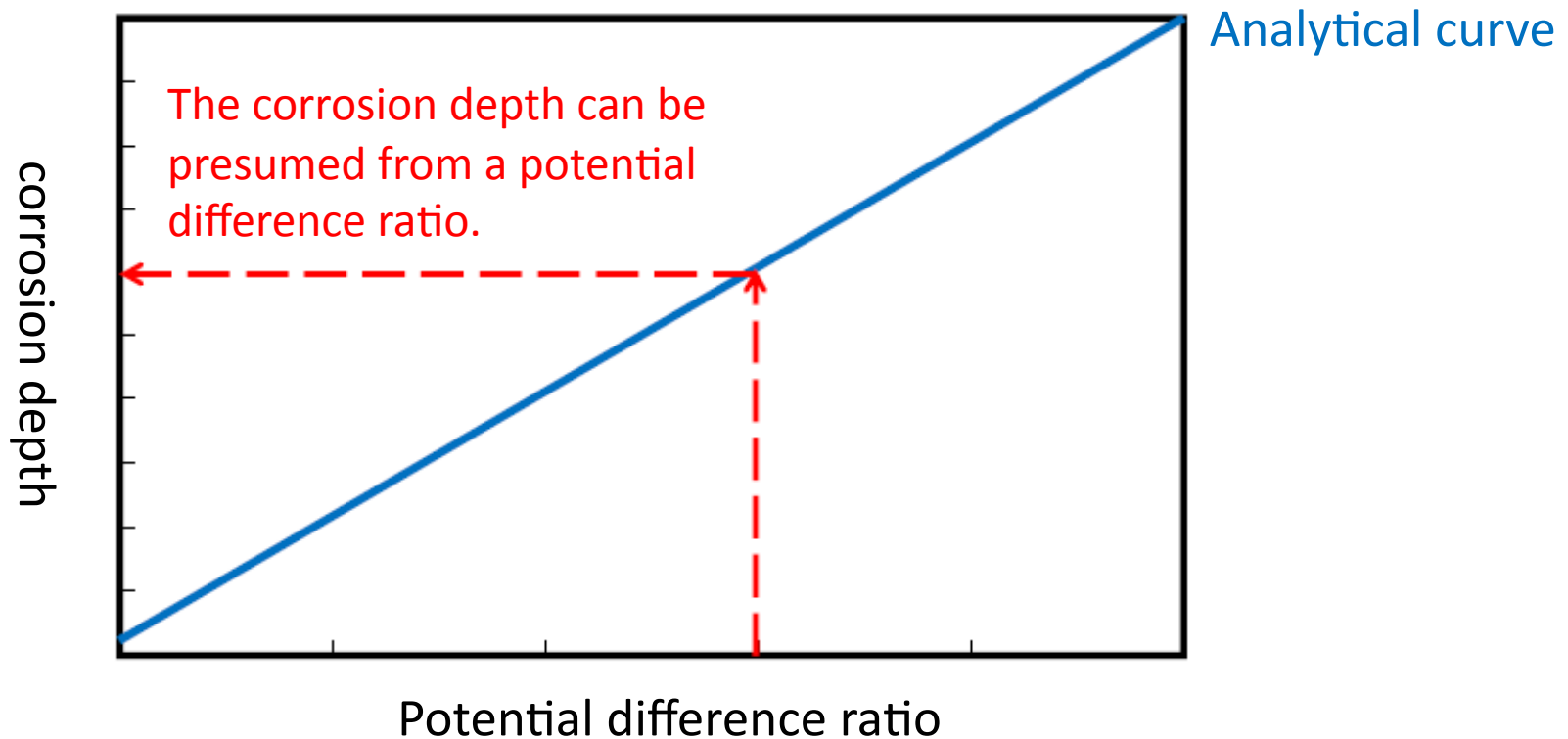
EPD fundamental principle is based on 'Ohm's law (Voltage 'V' = Current 'I' x Resistance value 'R')'.

Passing an electric current pulse through an electrically-conducting material to be measured, EPD measures an electric potential difference between both ends of the measuring position.

If a flaw is present in the measuring position (any types of changes including cracking, surface erosion, suspension current, corrosion, pitting corrosion and inter-granular corrosion), the electric potential difference will show a different value from a standard value which should be gained when the measurement position is sound.

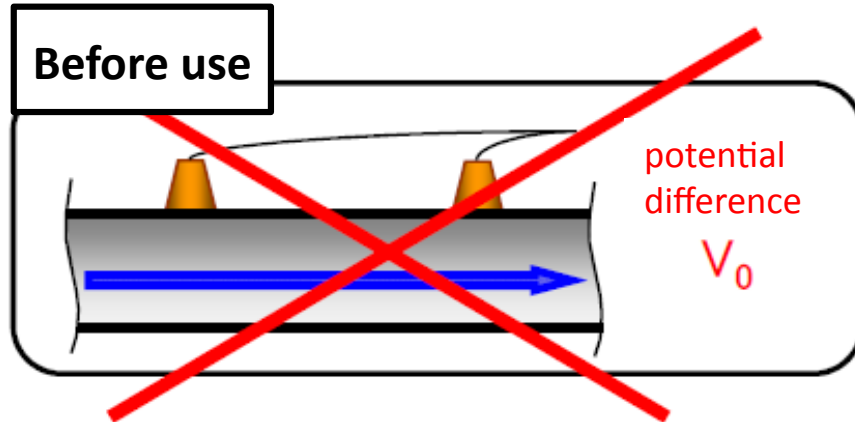
Therefore, the geometry of corrosion, thinning or crack length can be defined by comparing the measured electric potential differences with a standard value.

Analytical curve is the graph which shows the relation between a potential difference ratio and the corrosion depth. It plots the actually measured data and is created.



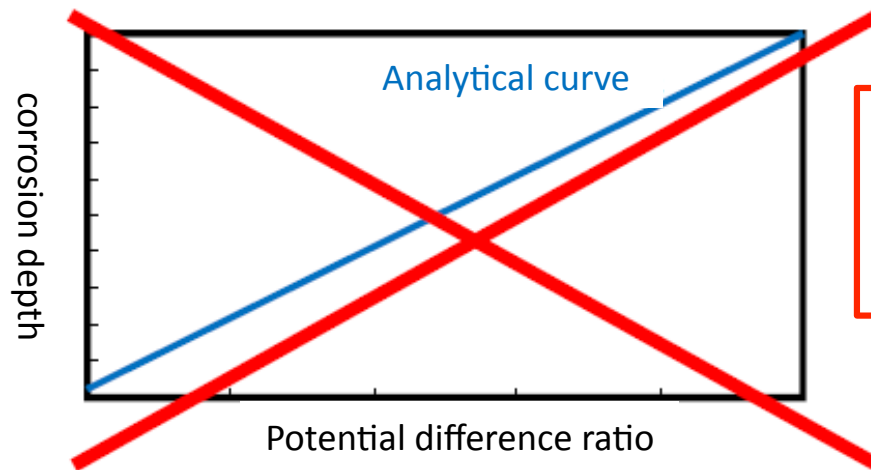
The faced problem when applying EPD

- The potential difference (Initial value V_0) before use cannot be measured.



A potential difference ratio (V_1/V_0) cannot be calculated.

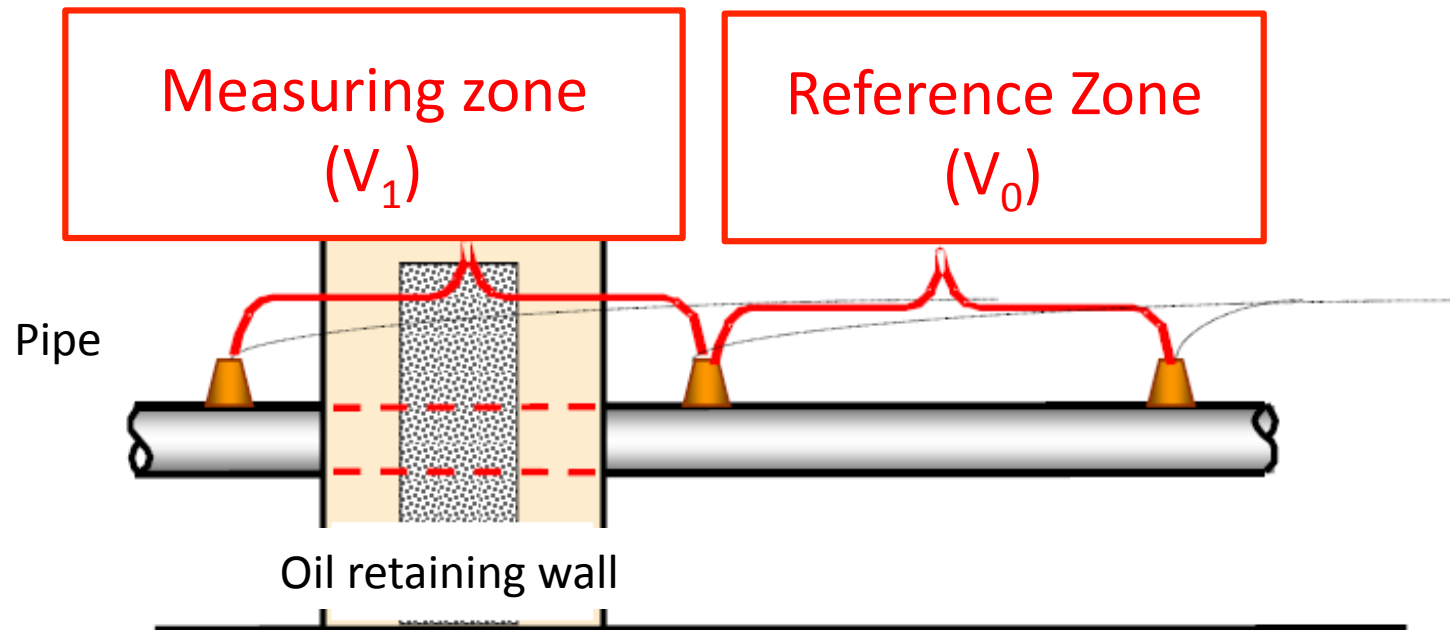
- There is no analytical curve of oil retaining wall penetrated pipe.



The corrosion depth cannot be presumed from a potential difference ratio.

Solution 1. : by preparing the reference section

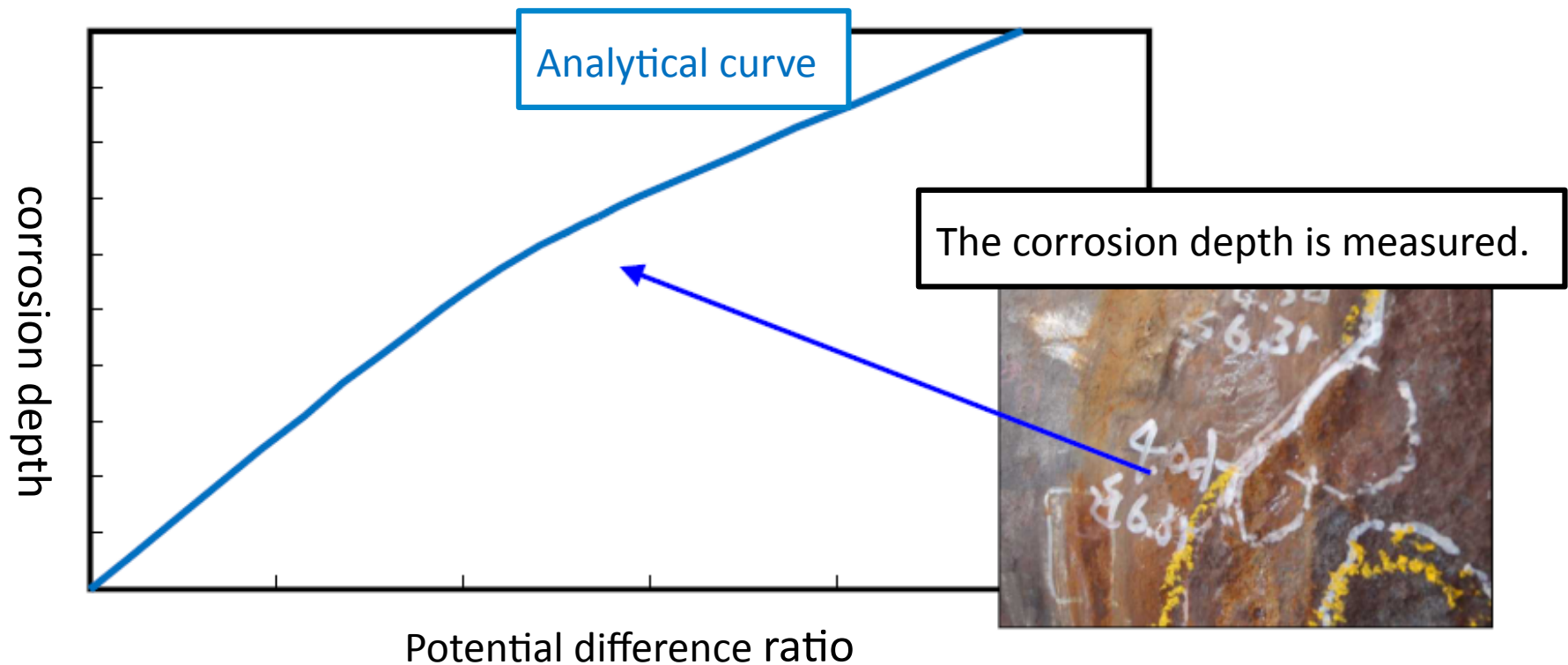
A potential difference ratio (V_1/V_0) is calculated by considering that the measurement potential difference of the reference section is an initial value (V_0).



Solution 2. : Creating the reliable analytical curve by actual verification test more than 100 locations.

ATLAS & JX had the verification test more than 100 locations in the actual fields. Then, we could create the correlation curve between a potential difference ratio and the actual corrosion depth.

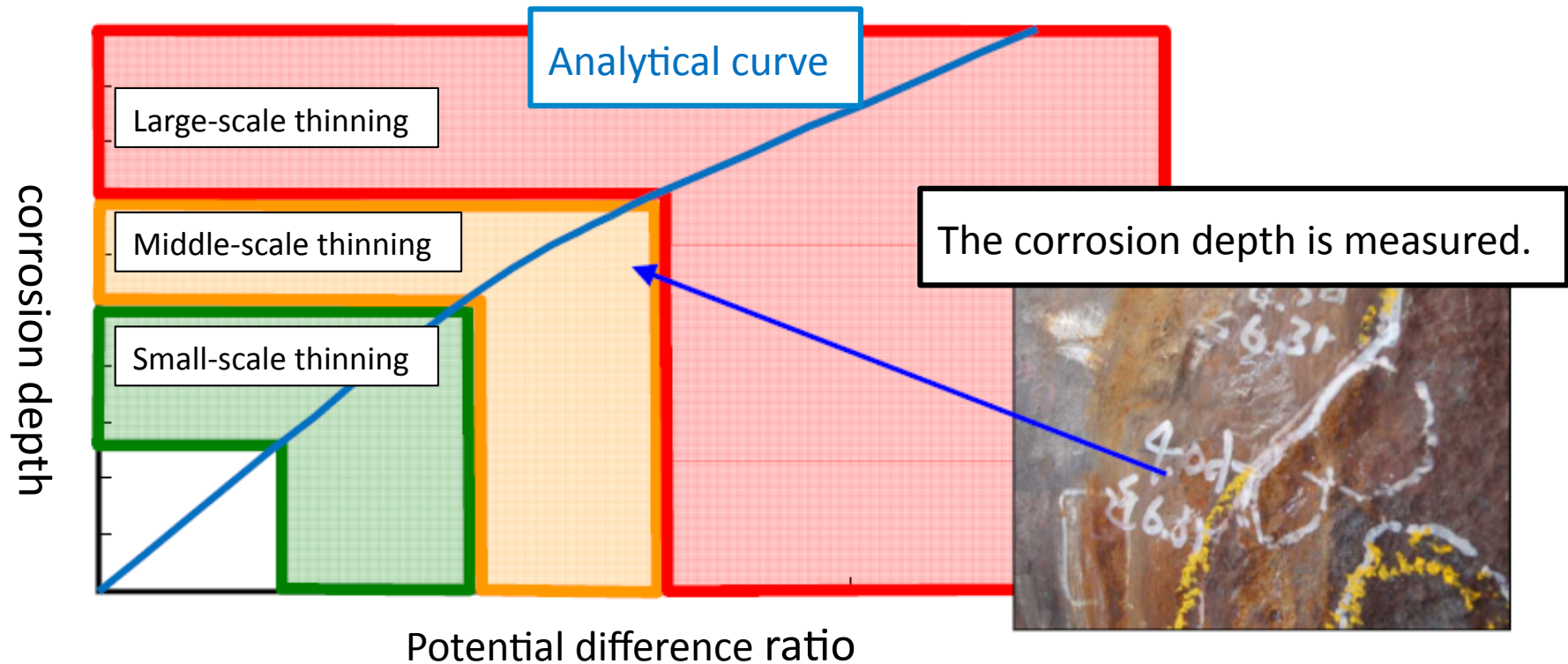
⇒ The grade of corrosion can be presumed from a potential difference ratio.



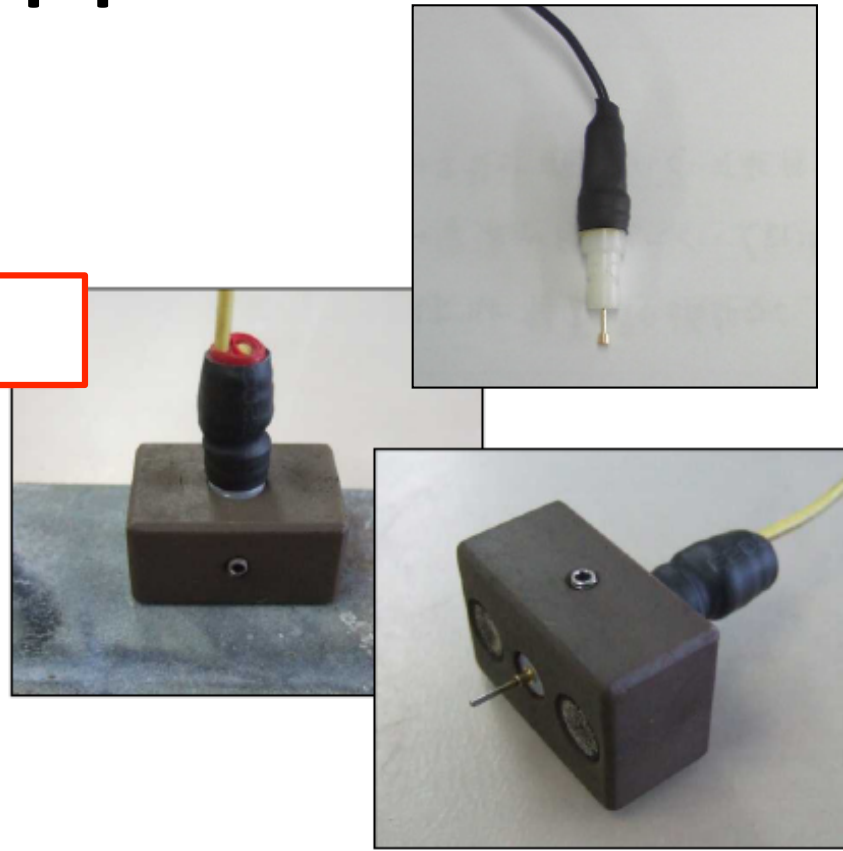
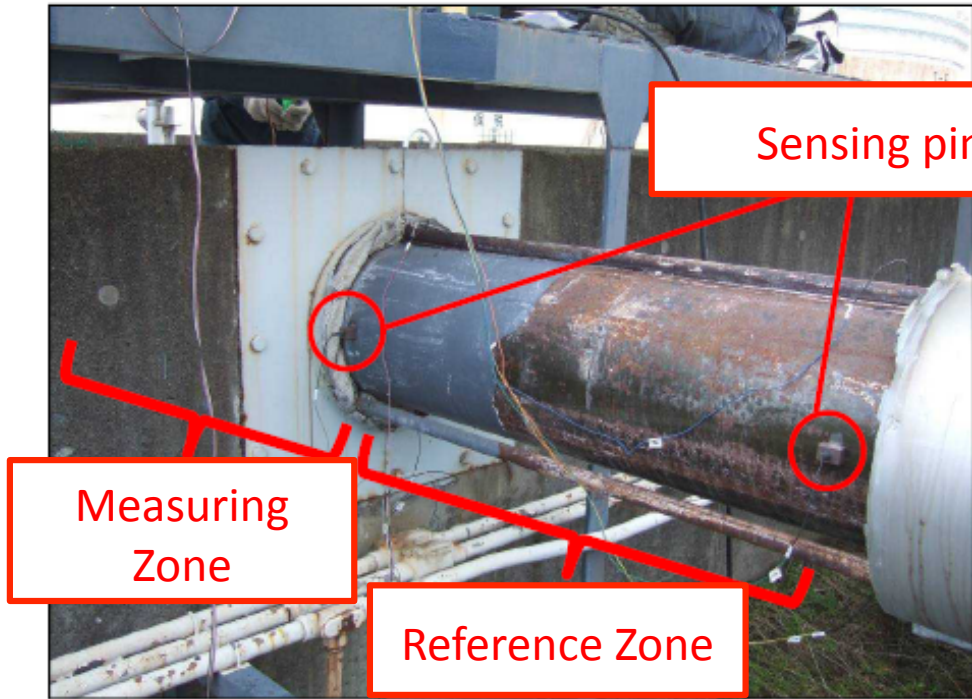
Solution 3.: Completion of practical usable Analytical curve

The measurement results were evaluated and divided into three grade (red, yellow, green area).

⇒ The grade of corrosion can be judged on a safe side.



Application scenery to real pipe

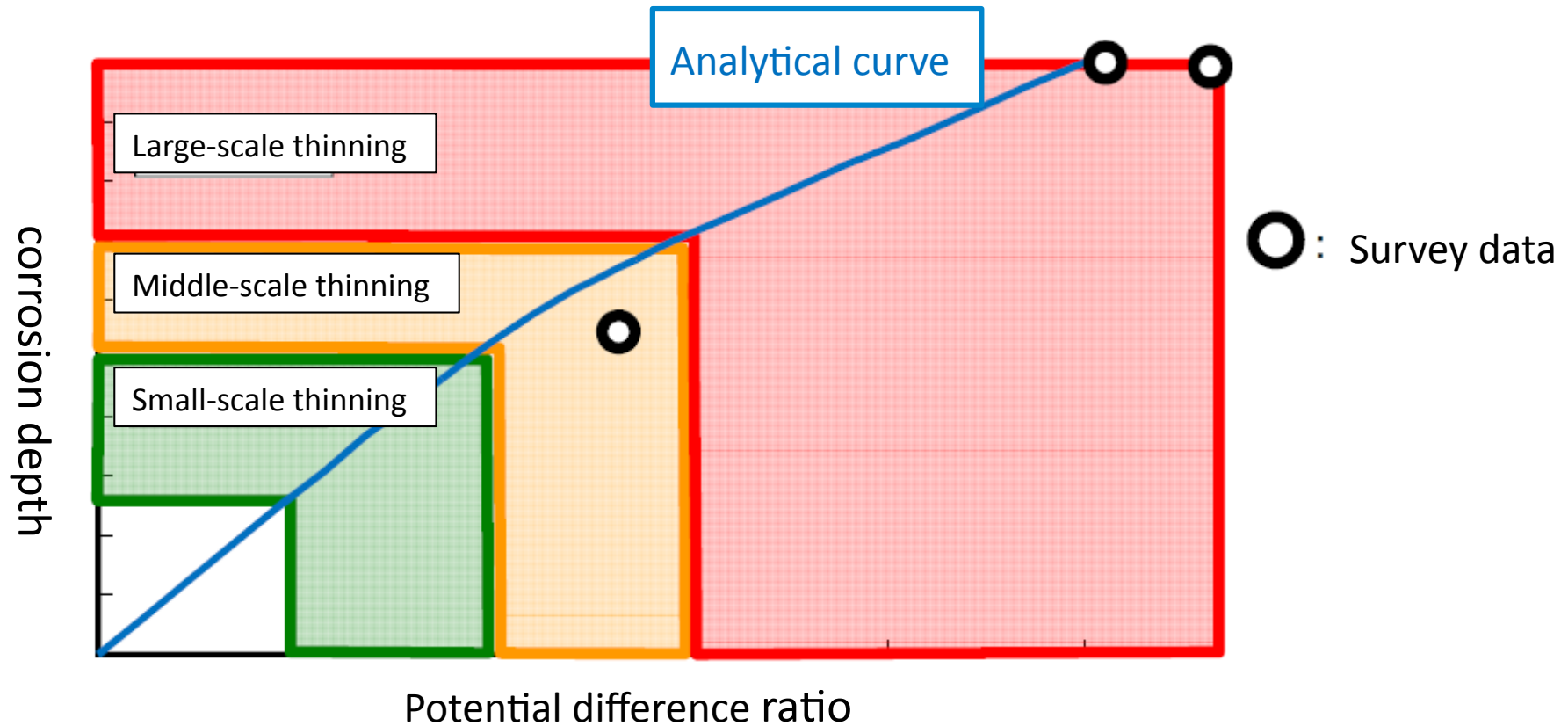


Sensing pin
(Detachable type)

Application scenery to real pipe



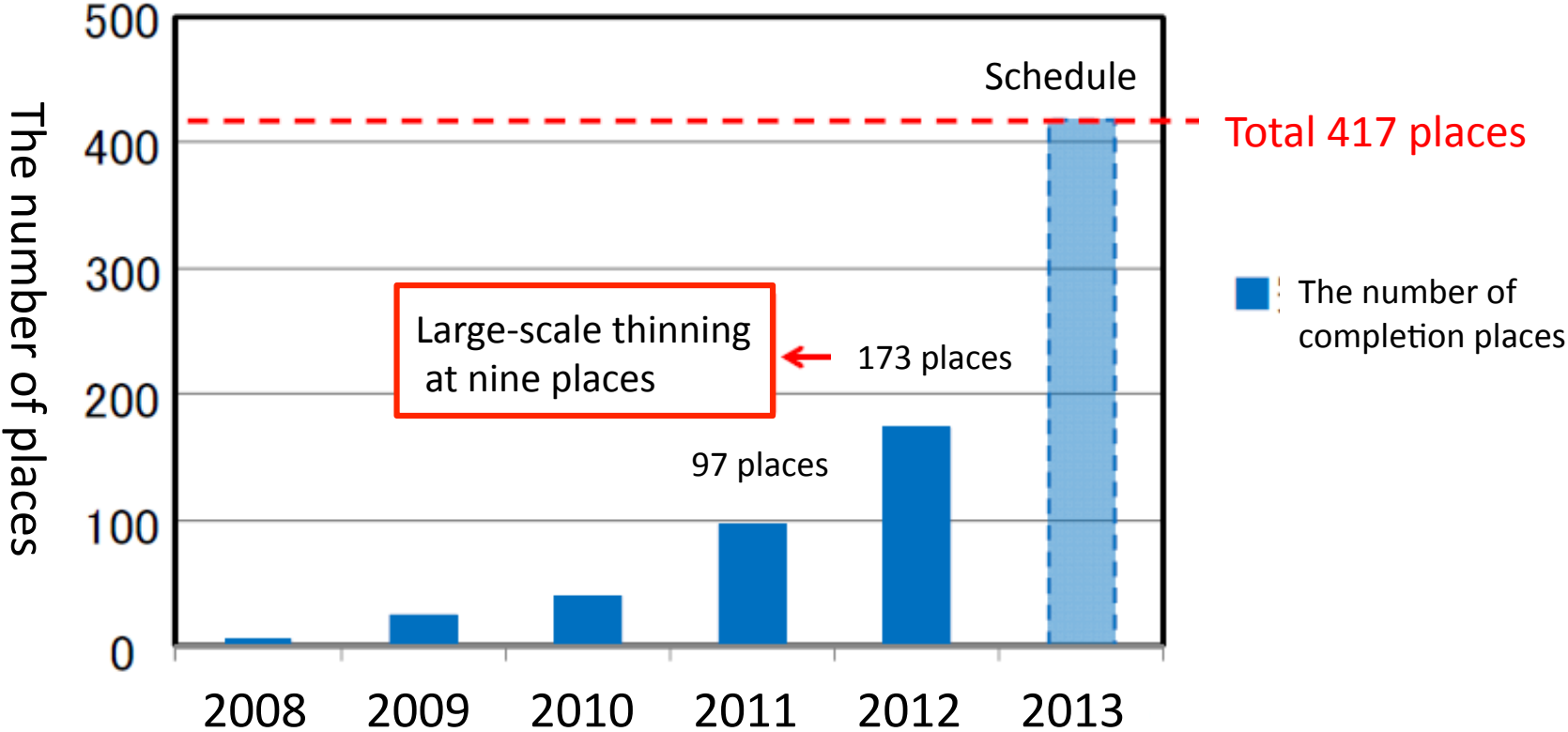
Accuracy verification



As compared with an appearance visual check, the judgment about corrosion is possible in high accuracy.

ATLAS EPD application situation in JX Negishi site

ATLAS EPD application track record of oil retaining wall penetrated pipe (JX Negishi oil refinery)



Over 3,000 pipes had been applied until the 2014 fiscal year in all JX sites.



The Future of Energy, Resources and Materials
JX Nippon Oil & Energy Corporation

6-3, Otemachi 2-chome, Chiyoda-ku
Tokyo 100-8162 JAPAN
www.noe.jx-group.co.jp



To: Atlas Co., Ltd.
C.E.O. Mr. Alita

Reference Letter

To whom it may concern,

We JX Nippon Oil & Energy Corp. hereby confirmed that we have utilized the Atlas's EPD(Electric Potential Difference) inspection method for inspecting the corrosion of the pipes through the oil retaining walls in our oil refinery sites.

Sincerely yours,

Date: Dec. 19, 2014

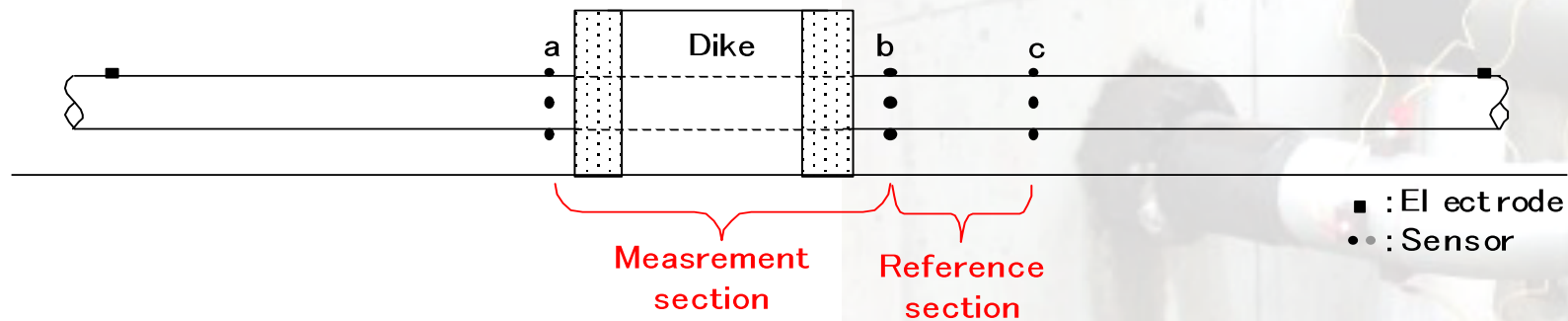
JX Nippon Oil & Energy Corp.

Yasunori Mukoujima

Manager

Maintenance Technology Group

Application ① : Corrosion of the dike-penetrating pipe



- Corrosion is checked based on the following potential difference change rate.

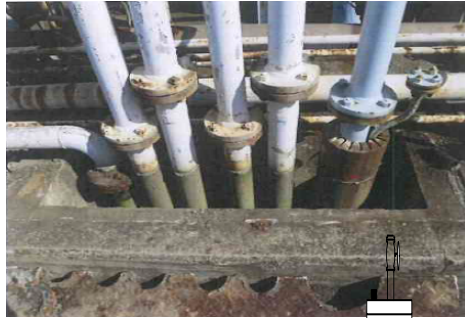
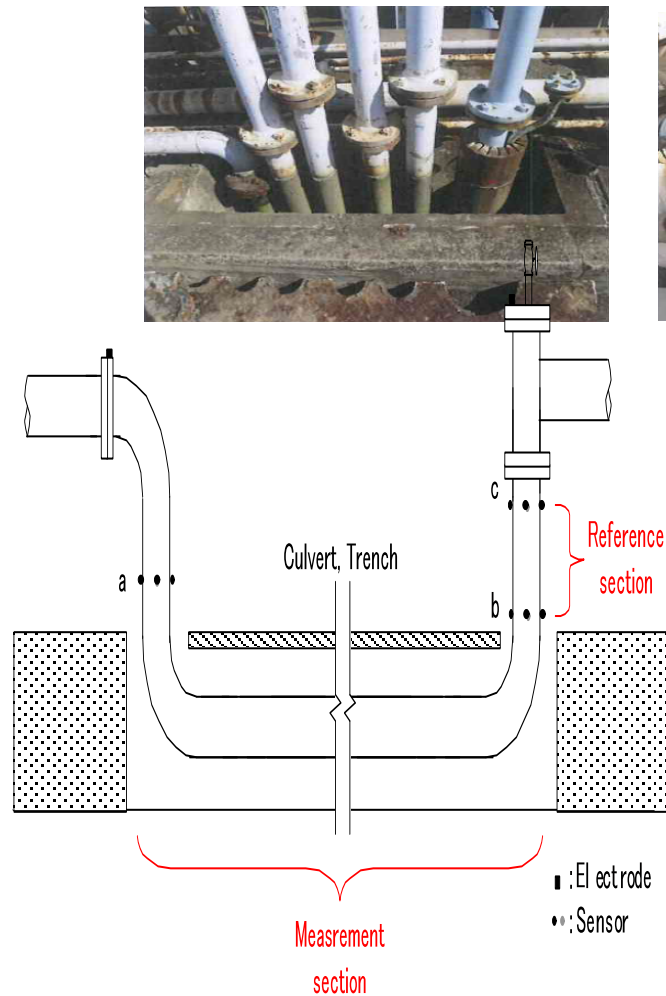
Potential difference change rate (%)

$$= \left(\frac{\text{Potential difference of measurement section}}{\text{Potential difference of reference section}} - 1 \right) \times 100$$

- If corrosion wastage has not occurred in the dike, potential difference change rate is 0%. However if corrosion wastage has occurred, it will be the positive value.
- When corrosion is large-scale, potential difference change rate becomes big.

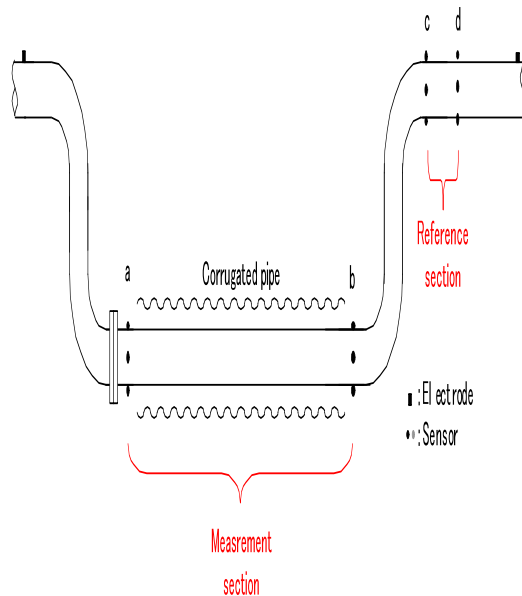
Application ② : Corrosion of a pipe in Culvert or Trench

ATLAS inspection is also possible for **the pipe in culvert or trench** by a similar method.



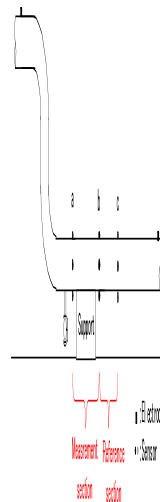
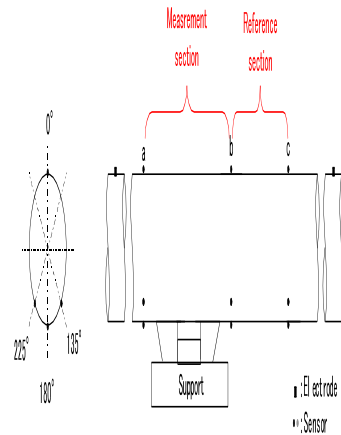
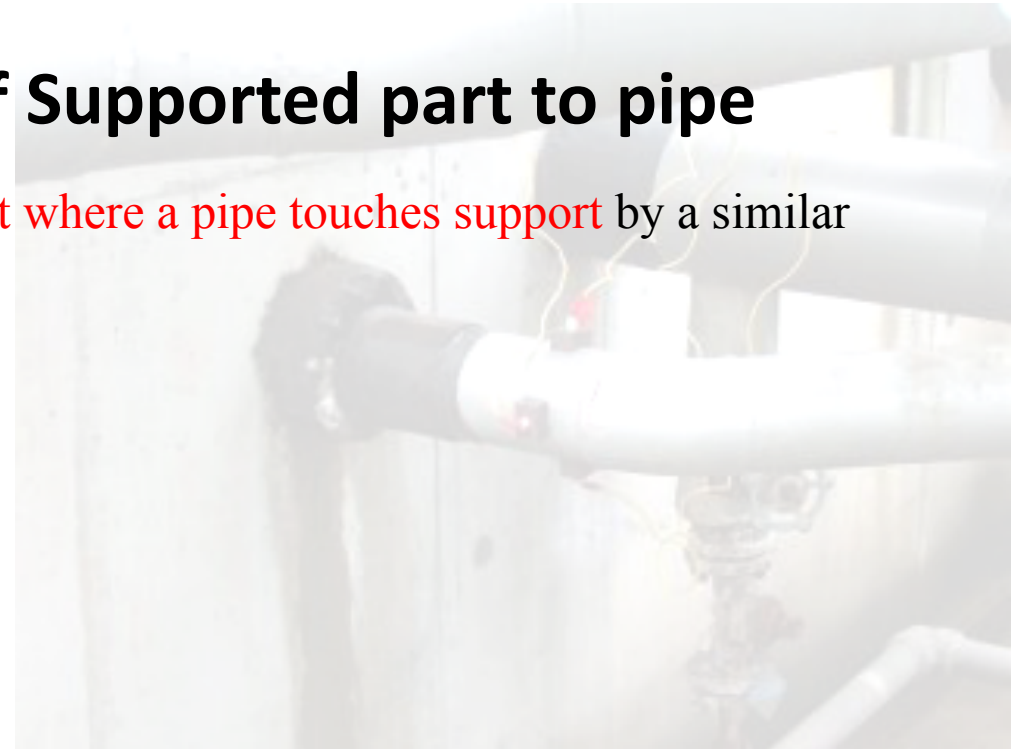
Application ③ : Corrosion of a pipe in the Corrugated Pipe

ATLAS inspection is also possible for **the pipe in the corrugated pipe** by a similar method.



Application ④ : Corrosion of Supported part to pipe

ATLAS inspection is also possible for **the part where a pipe touches support** by a similar method.



The conclusion

◎The new inspection method of ATLAS has been established.

The grade of corrosion could be evaluated and judged by one measurement, without performing needed long-term monitoring conventionally.

◎Inspection accuracy improved markedly.

ATLAS technology can evaluate corrosion which was not found in a visual check.

As the existing preliminary check technique, ATLAS technology has the highest accuracy.

◎It puts in practical use as a preliminary inspection.

In JX group, there are already 3,000 or more inspection track records. ATLAS technology is as follows a sufficiently practical inspection method.

- Inspection speed: About 15-20 pipes/day
- Expense: About US\$2,000-US\$3,000/pipe

Main Client in Japan

➤ Oil and chemical

JX Nippon Oil & Energy Corporation

Idemitsu Kosan Co., Ltd.

Mitsubishi Chemical Co., Ltd.

Mitsui Chemical Co., Ltd.

INPEX Corp.(Teikoku Oil)

➤ Steel and Crane

Nippon Steel Co., Ltd.

Toyota steel center Co., Ltd.

➤ Electric power

Tokyo Electric Power Company

Tohoku Electric Power Co., Inc.

Chugoku Electric Power Co., Inc.

Shikoku Electric Power Co., Inc.

Japan Atomic Energy Agency (old JAERI)

➤ Road and bridge

Hanshin Expressway Co., Ltd.

Ministry of Land , Infrastructure and Transport

➤ Research laboratories and universities

Osaka University

Tohoku University

➤ others ...

(Appendix) About preliminary inspection

Although the following inspections are known as a non-destructive test of oil retaining wall penetrated pipe, these methods have low accuracy as compared with ATLAS technology.

▪ Guided Wave

The guided wave which is a kind of an ultrasonic wave is made to spread in the longitudinal direction of pipe.

⇒ ▪ An ultrasonic wave declines greatly by the corrosion-proof tape or a weld zone.

▪ The grade of pipe thinning cannot be judged although the existence of pipe thinning can be checked.

▪ Rack Scan (Rack Through)

Probes are installed on the both ends of a penetration part, an ultrasonic wave is transmitted and received, and thinning is detected.

⇒ But it can inspect a short distance only and it is difficult to apply for an oil retaining wall penetrated pipes.

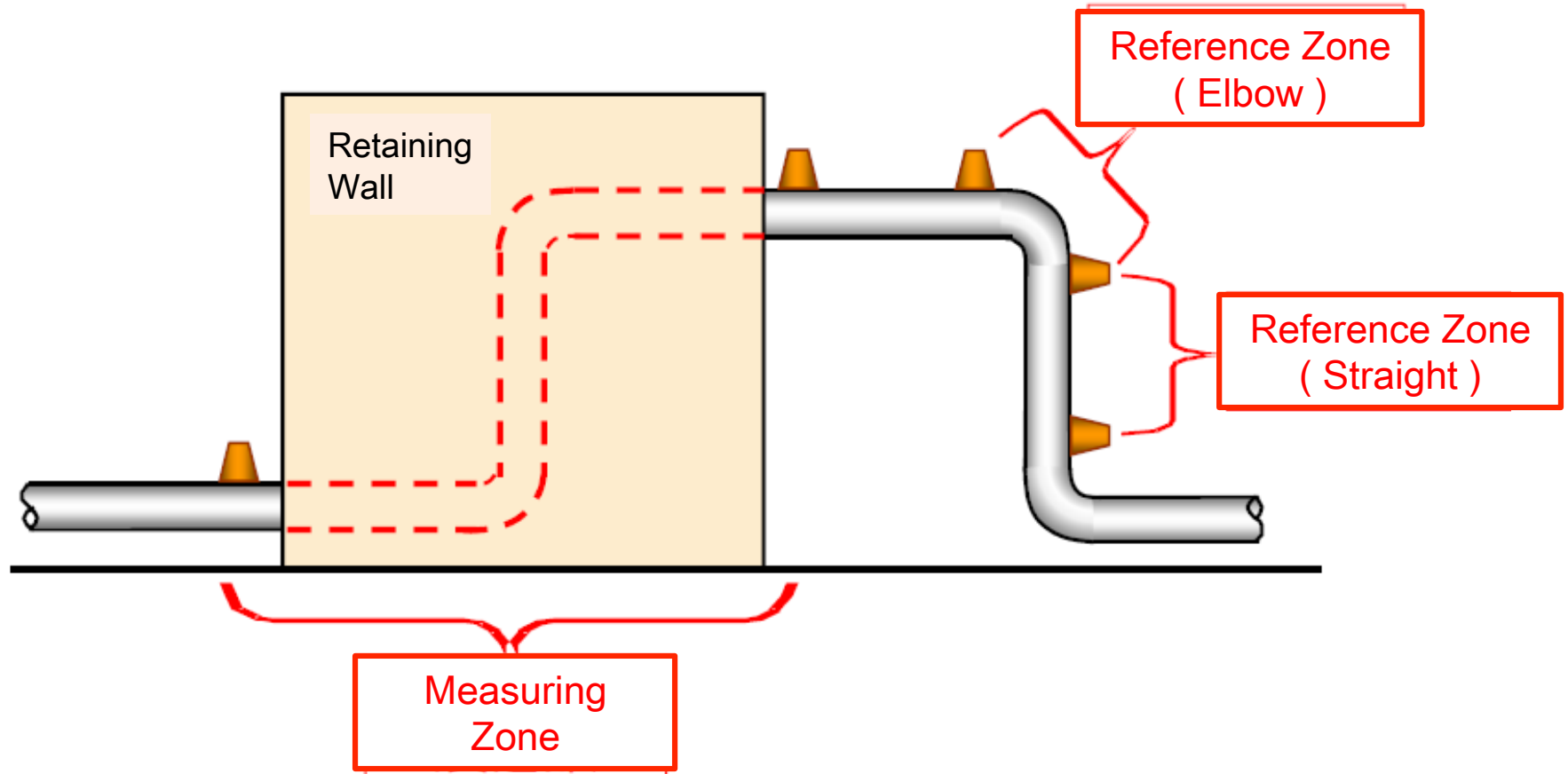
Pipe corrosion inspection for oil retaining wall (Dike-penetrating Pipe)

When conducting thickness measurement by UT (Ultrasonic Testing) or RT (Radiographic Testing), not only does it require taking down a tank dike, but also it costs a lot of money to build a temporary dike in the meantime. In recent years, it has been tried to inspect a dike-penetrating pipe without demolishing its dike, for example, by means of a guided wave detection technique. Still, there were many places where accurate examination was unavailable by the technique because guided waves are likely to be affected by external conditions on pipes such as corrosion proof tapes. In contrast, EPD testing ensures an inspection unaffected by external conditions on pipes or internal fluid nor requiring the demolition of a dike.

In EPD testing for penetrating pipes of a dike, sensing pins are spaced in the measurement section evenly and parallel to the direction of the impressed electric currents. Furthermore, sensing pins for comparison will be placed at a regular interval on somewhere healthy outside the dike.

Comparing electrical potential differences between sensing pins in the measurement section and those in the reference section, it is possible to understand if corrosion is present or not and its severity, if any.

(Appendix) Case of elbow pipe in retaining wall



(Appendix) About Safety

The main body of the EPD Method measuring instrument applies to EEx zone 2. The following items were examined with each electric power company, Mitsubishi Chemical, and JX Nippon Oil & Energy Corporation for use with the plant.

1. About the leakage of electricity
2. About generation of heat
3. Possibility of spark (spark discharge)
4. Comparison with minimum ignition energy of hydrogen
5. Comparison with minimum ignition energy of ethylene oxide
6. About the electric shock
7. Influence on measuring instruments in surrounding



It has been confirmed that there is no problem for use in the site.

(Appendix) Standard

The Japanese Society for Non-Destructive Inspection standard "**NDIS 3426 General rules of the method of measuring thickness and the crack size by the potential difference method**" was enacted by the cooperation of Tokyo Electric Power Company, JX Nippon Oil & Energy Corporation, Mitsui Chemicals, Inc., Osaka University, and Hanshin Expressway Co., Ltd.

In the field of the electric power, it is recognized as alternative technique of UT, and as an inspection technique for filling both thinning measurement and screening measurement in The Japan Society of Mechanical Engineers issue: "**Pipe thinning management of thermal power generation equipment standard**".

ATLAS Corporate Profile

About Us

- In 2002, Atlas has acquired an exclusive license of FSM (=basic principle), CorrOcean's new technology developed in Norway as national policy.
- We have developed and refined Japanese market-friendly systems based on the technology in our own way and realized to apply the method to power plants and bridges. Since 2008, we have developed our original EPD (Electric Potential Difference) instruments and methods for oil refinery, chemical and steel industries.
- Using a highly developed world-class technology for corrosion inspection, we have achieved satisfactory performances in the area of maintenance and security management for oil refinery, chemical, steel, highways and railway bridges.
- We will pursue further to become 'Atlas', a company who can make contributions to the safety and security of equipment industries and infrastructures.

Company profile

Head office	ATLAS CO., LTD 〒260—0013 3-18-3 Chuo, Chuo-ku, Chiba-shi, Chiba Pref., Japan Tel: +81-43-202-7740 Fax: +81-202-7742 E-mail: info@atlas-ndt.co.jp
Established	June 2000
Capital	13 million Yen
President	Keisuke Alita
Business	Exclusive agency of Norway's CorrOcean in Japan Nondestructive testing services Nondestructive testing consultancy Development, production and sales of nondestructive testing equipments
Bank	Chiba bank, Chuo Branch
Associated company	AXIS Limited Company (Trading)
Major customers	Oil, chemical, major electric power and bridge works companies, governmental research institutes and others