4-1-1 Establishment of the Wastewater Technology Training Center

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ABSTRACT

The Bureau of Sewerage of Tokyo Metropolitan Government is currently facing a pressing issue of needing to nurture human resources who support its sewerage business, with the mass retirement of knowledge-abundant experienced staff. To address this issue, the Bureau opened the “Wastewater Technology Training Center” in September 2013 as a practical training facility to train people ensuring the transfer of related technologies, techniques and skills. By providing simulated exercise opportunities or hands-on practices of various arenas, “Wastewater Technology Training Center” promotes effective, efficient early-stage acquisition of knowledge and skills for the workers, and successful inheritance of technology and operational know-hows.

The center also welcomes people working for private enterprises in the industry to make good use of the facilities, in the hope of contributing to the human resources cultivation of the whole sewerage industry.

KEYWORDS: technical training center, staff training, technology transfer, training facility, practical experience

INTRODUCTION

Background

The sewerage business in Tokyo is facing various issues needed to be tackled with alacrity. Those issues include soaring numbers of worn-out facilities, the need of flood control and the expected contribution to the high-level disaster-resistant city development, etc. In order to address those issues, nurturing human resources who support the sewerage business and successfully passing on the technologies, techniques and skills are both critical.
Meanwhile, large numbers of staff in the Bureau of Sewerage of Tokyo Metropolitan Government have reached or are reaching their retiring timings, and hence there is less and less knowledge-abundant experienced staff that would play an important role in human resource nurturing. As a result, on-the-job training in the field, the very foundation of human resource development, is becoming increasingly challenging, and ever-more effective and efficient transfer of practical skills and know-hows long accumulated in the field is the pressing and critical issue. This issue is not just of the government administration, but of all players in the whole sewerage industry including private companies carrying out construction or maintenance. This is why the Bureau of Sewerage opened, in September 2013, the “Wastewater Technology Training Center” as a major initiative for solving those issues, a facility for practical training, development of human resources and inheritance of technologies and skills (See Figure 1).

The outline in facilities
The Wastewater Technology Training Center is Japan’s first large scale training facility specializing in wastewater technology. The center is located inside the Sunamachi WWTP in the Koto ward, with a site area covering approximately 13,800 m². The floor area of the training building is about 2,700 m². There are 20 types of training facilities inside of the building and 12 facilities are located outdoor. The training facility is constructed to resemble the actual site using the real material, structure and scale as much as possible, so that the conditions on-site can be reproduced in the training. In this training center, practical training in areas such as civil engineering, machinery, electrical engineering and water quality inspection wastewater can be conducted. By utilizing this facility, technology transfer can be conducted effectively by the self-experiencing process such as practical training and simulation in each domain.

METHODOLOGY

Construction of the training facilities
In 2008, a study committee for idea conception was established and its members from the authorities, the administrative party and academic experts discussed how the transfer of technologies and skills can be carried out. The team reached to a conclusion that construction of a training center where people can immerse themselves in simulated experiences replicating the actual situations they would encounter in the field would be a way to go. In constructing the training center, technological content and skills we need to pass on to the next generations were listed for each of the following fields; civil engineering, machinery, electricity and water quality inspection wastewater. The listed items were then internally examined further to narrowed down and being prioritized. After that, those essential technological content and skills were grouped into the following three categories; 1) “Safety management”: technologies and skills necessary to ensure the safety during construction or project executions. 2) “Risk management”: technologies and skills required in cultivating the ability to handle crises in emergency situations. 3) “Quality Assurance”: technologies and skills sought in nurturing leadership or the ability to make technical judgment on quality (See Table 1).

Then, the committee discussed how to realize the training facilities which transfer those technologies and skills in an effective and efficient manner. Details of training content and
methods were explored and considered what would be necessary for different career background members, clarifying what they individually need to acquire. Based on the discussion, the scale of the facilities or the materials the facilities should be made of was determined, and then conceptual drawings of each facility were drafted. Those conceptual drawings were used then in internal working groups to discuss further the details. The drawings were the seed plans for the facilities, and the ideas in them were reflected to the actual designs. The basic concept of those training facilities are to allow users to “See” “Touch” and “Experience” as much identical settings and conditions to the real fields as possible. To create such environments, equipment and facilities were made out of the same materials, with the same structure and scale, to the real ones.

The Pipeline In-Water Walking Model is illustrated in Table 2 and Figure 2 as an example, presenting the process it took, from its conceptual phase to actual design. The structure of the model at its inception actually had a square water tank, but further investigation revealed that with the linear model, generating the necessary water flow speed would be difficult both technically and economically. With that finding, the shape of the water tank was changed to oval and propellers were introduced to generate circumfluence of water.

Table 1. Training facilities categorized into three groups

<table>
<thead>
<tr>
<th>Safety Management</th>
<th>Civil Engineering</th>
<th>Machinery &amp; Electricity</th>
<th>Water Quality Management &amp; Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• High-Altitude Workplace Model</td>
<td>• High-altitude Workplace Model</td>
<td>• Pump’s Pumping Capability Assessment Facility</td>
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<tr>
<td></td>
<td>• Open-Cut Construction Site Model</td>
<td>• Electricity Distribution Facility for Electricity Safety Inspection</td>
<td>• Sewerage Treatment Laboratory Equipment</td>
</tr>
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<td></td>
<td>• Road Construction Safety Facility Model</td>
<td></td>
<td>• Workplace Drainage Treatment Laboratory Equipment</td>
</tr>
<tr>
<td></td>
<td>• Pipeline In-water Walking Model</td>
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<td></td>
<td>• Manhole Model</td>
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<td></td>
<td>• Manhole Cover Open-Close Model</td>
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<tr>
<td>Risk Management</td>
<td>• Operation Simulating Equipment</td>
<td></td>
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<tr>
<td>Quality Control</td>
<td>• Superannuated Pipe + Line Pipe Model</td>
<td>• Sequence for Practical Training</td>
<td>• Pump’s Pumping Capability Assessment Facility</td>
</tr>
<tr>
<td></td>
<td>• Civil Engineering Work Machinery Model</td>
<td>• Protective Relay Test Equipment</td>
<td>• Sewerage Treatment Laboratory Equipment</td>
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<td></td>
<td>• Concrete Placement Site Model</td>
<td>• Water Level/Flow Rate Control Test Equipment</td>
<td>• Workplace Drainage Treatment Laboratory Equipment</td>
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<td></td>
<td>• In-pipeline Television Camera Investigation Model</td>
<td>• Pump Performance Test Equipment</td>
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<td></td>
<td>• Combined Sewerage Improvement Measure Model</td>
<td>• Pump Failure Corresponding Facility</td>
<td></td>
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<td></td>
<td>• Concrete Corrosion Protection Model</td>
<td>• Pump/Motor for Disassembly Checkup</td>
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<td>• Pressure Tube Model</td>
<td>• Tools for Inspection/Measurement</td>
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<td>• Black-water+ Rainwater Street Inlet Model</td>
<td>• Ductwork Repair Practical Training Instrument</td>
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<td></td>
<td>• Indoor Drainage Facility Model</td>
<td>• Welding/Fusing Instrument</td>
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<td></td>
<td>• Manhole Earthquake Disaster Countermeasure Model</td>
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<td></td>
<td>• Hydraulic Experiment Model</td>
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<td></td>
<td>• Multi-purpose Plaza</td>
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</tbody>
</table>
### Table 2. A sample listed item of transfer-required skills

<table>
<thead>
<tr>
<th>Category</th>
<th>Transfer-required techniques</th>
<th>Training Facility</th>
<th>Training Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Management</td>
<td>• How to safely walk in-water</td>
<td>Pipeline in-water walking</td>
<td>• Learn how to walk in-water inside pipeline</td>
</tr>
<tr>
<td></td>
<td>• Safety management practices when supervising construction/field task</td>
<td></td>
<td>• Firsthand experience of the pipeline variety, water flow and depth</td>
</tr>
</tbody>
</table>

**Figure 2. Pipeline in-water walking model illustration**
RESULT AND DISCUSSIONS

Examples of the practical training facilities
The followings are examples of the practical training facilities used to pass on skills and knowledge in the fields of “Safety Management”, “Risk Management” and “Quality Assurance”, respectively.

Pipeline in-water walking model (Safety Management)
This model lets users experience in-water walking just like how it would be inside sewerage pipe. The model is equipped with an oval-shape water tank where water depth (0.25 m-1.0 m) and flow rate (0 m/s-3.0 m/s) can be altered. The floor surface of the water tank has three different materials; concrete, vinyl chloride and stainless, to replicate that of sewerage pipes. This facility is created for users to experience and understand how to conduct in-pipe examination and realize how difficult and dangerous the in-water walking in sewerage pipe can be (See Figure 3).

The details of a sample training conducted at this facility are as follows:
1) The instructor first explains the trainees the background of why conducting this training and what to watch out during in-water walking.
2) The trainees walk through the water with its depth 30 cm and 50 cm, both along the current and against it. The water flow rate would be either 0.8 m/s, the slowest it can be for the sake of design, or 2.0 m/s. The trainees experience at first hand the different magnitudes of resistance force of water depending on the depth and speed of water.
3) After coming out of the water tank, the trainees will observe the extremely fast water flow of 3.0m/s, the fastest flow the water tank can created with its design. By this, the trainees will recognize the risks of tasks conducted inside the pipelines and how safety management measures are necessary.

The trainees answered in the post-training survey that they could really experience how a slight change in water depth could make the walking much harder. 80% of the trainees answered they came to understand clearly the difficulty of in-water walking.
**Operation simulating equipment (Risk Management)**

The whole facility is created as an exact replica of actual equipment, with the same operator station arrangements and accessory items of the peripheral equipment. The monitor screens layout and symbol displays are all matching the real central monitoring equipment settings so to let the trainees experience the you-are-there feeling. With this equipment, the trainees go through operating drills in assumed emergency situations such as storm rainfall, blackout of the plant, breakdown of the critical equipment etc., things you cannot conduct training for with the actual unit. Through this training, the trainees are expected to acquire the ability to make prompt judgments and conduct accurate operation (See Figure 4).

The details of a sample training conducted at this facility are as follows:

1) The trainees are grouped into two teams and the instructor intentionally causes an emergency situation on the system simulating a storm rainfall, blackout or pump breakdown, etc.
2) The trainees are assigned different roles such as leader, observer and operator. Those members are to communicate with each other operating various apparatus like pumps in attempt to prevent flooding.
3) After the exercise, the team reviews the recorded sequence of their operation from the top, and adequacy of the taken operation procedures is validated. The other team joins the discussion too so that learned operational know-hows can be shared.
4) At the end, the instructor gives feedback on the points emergency response was not adequate or the account on why flooding was caused if it did in the simulation.

The trainees answered in the post-training survey that by experiencing the rare situation of operating the equipment in storm rainfall, they could realize how one delayed judgment could cause substantial impact. Also, 80% of the trainees answered they understood clearly how to operate a pump in a storm rainfall situation or how to handle breakdown of a pump.

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![Figure 4. Operation simulating equipment](image-url)
Manhole Earthquake Disaster Countermeasure Model (Quality Control)
A Cross-section cut model showing the connecting part between an actual manhole and a sewerage pipe is displayed. The manhole earthquake disaster countermeasure equipment moves the coupling part connected to an aseismic sewerage duct in all four directions with a motor so that the flexibility of the coupling part can be observed. The liquefaction equipment creates vibration and the elevation of the excess pore pressure of the soil layer can be confirmed on the computer screen. With the lysis valve driving device, the water pressure around the manhole can be elevated and the operation status of the lysis valve be confirmed. The understanding of the structure and function of the aseismic technology adopted to the connecting part coupled with practical training at this facility allows people to understand the mechanism of the surfacing phenomenon of manhole and how it can be prevented (See Figure 5 and 6).

The details of a sample training conducted at this facility are as follows:
1) The instructor gives a lecture on the fundamental of the aseismic technology, the structure and the construction method of the Manhole Earthquake Countermeasure Equipment in front of the display.
2) The trainees are to observe the mechanism of the liquefaction caused by oscillating the water tank simulating soil layer.
3) The lysis valve driving device creates a situation where the lysis valve comes off because of the elevation of water pressure, and the excess pore pressure vanishing in an instant will be observed. This demonstrates the inhibitory effect on manhole surfacing phenomenon.

The trainees answered in the post-training survey that by seeing the actual settings, they could understand clearly the differences between various aseismic technologies. Almost all of the trainees answered they could completely or mostly understand the structures of aseismic technologies or how they function as a system.

Figure 5. Cut-model; Manhole earthquake disaster countermeasure Equipment
Introduction in other training facilities

Manhole model (Safety Management)
This facility includes a system manhole, conventional precast concrete manhole and pipes with lateral. Trainees can understand names and structures of manholes, pipes and attached equipment and learn methods for entering a manhole safely, using safety systems (gas detector and fall preventing device) and performing visual inspection of pipes (See Figure 7 and 8).

Figure 6. Lysis valve driving device; Liquefaction equipment

Figure 7. Manhole model (The whole view)
High-altitude workplace model (Safety Management)
In this facility, a prefabricated scaffolding, a handrail pre-setting scaffolding and pipe scaffolding are assembled around a stage (3.7m high) as examples of scaffolding for high-place work. In the center of the stage, a hatch is installed for a training of ascent/descent in a reactor of sewerage treatment process.
Trainees can try to study features and material names of each scaffolding and learn how to use a fall prevention device. Using the hatch in the center of the stage, trainees can learn how to confirm safety, its procedures and usage of equipment for entering underground space for work (See Figure 9).

Open-cut construction site model (Safety Management)
This facility has an open-cut construction site model including earth retaining (steel sheet pile, lightweight sheet pile, horizontal sheet pile and supporting materials), sewer pipes (PVC pipe
and RC pipe), covering plate and suspended guard. As trainees can see and touch the model of opencut construction site, they can learn names and usage of materials for earth retaining, piping method of sewer pipes and suspended guard method to understand the proper construction process and the points of construction supervising (See Figure 10).

Electricity distribution facility for electricity safety inspection (Safety Management)

In this equipment, trainees can operate and inspect electric equipment and conduct some tests by switch board for high/low voltage which is actually installed in sewerage treatment plant. Also trainees can learn how to use safety equipment. Through the simulation of electricity security checks with same equipment in an actual facility, trainees can study appropriate operation procedures and prevention methods of unsafe actions to improve an ability of plant management and can also learn a security management skill by the operation check for machine troubles and electrical measurement using a protective relay installed in front of the distribution board (See Figure 11).
Concrete placement site model (Quality Control)
This facility has a pipe gallery model providing proper and improper construction examples of an arrangement of reinforcing bars and a concrete placement with explanation panel. As trainees compare the proper and improper construction examples, they can understand causes and prevention measures for improper construction and learn the proper concrete placement method and the points of construction supervising (See Figure 12).

![Figure 12. Concrete placement site model](image)

In-pipeline television camera investigation model (Quality Control)
In this facility, 3 types of old sewer pipes (reinforced concrete pipe, clay pipe and unplasticized polyvinyl chloride pipe) are relocated and set for a training. TV cameras are run in the different types of the pipes to monitor cracks, crevices or mortar pieces, oil balls and tree roots in each pipe. Trainees can see the difference between the image through the monitors and actual condition to enhance skills to examine the sewer pipe internal inspection (See Figure 13).

![Figure 13. In-pipeline television camera investigation model](image)
Sequence for practical training (Quality Control)
In this facility, based on multi-line connection diagrams, trainees can assemble circuits used for basic circuits of sequence control such as on/off, delay timer, self hold and star delta starter with lumps, relays and power lines and see how they works. Trainees can study an electrical operation process and a control mechanism and learn an operation control skill of actual equipment by understanding sequence control which is basic components of operation and control of plant equipment (See Figure 14).

![Figure 14. Sequence for practical training](image)

Pump performance test equipment (Quality Control)
This facility consists of pumps and water supply/drainage pipes to confirm the relations between flow rate and head characteristic. For designing, construction, operation and maintenance of pump facilities appropriately, trainees can learn how to see pump performance curves and study pump characteristics for pump head, pump input power and efficiency by preparing the characteristic curve by means of pump performance tests (See Figure 15).

![Figure 15. Pump performance test equipment](image)
Water level and flow rate control test equipment (Quality Control)
In this equipment, to operate a pump facility properly and response fluctuation of water level and water flow promptly, trainees can learn a control skill which is a basic skill of pump facility operation using water level and flow rate control test equipment. Trainees study adjustment technique to know methods of loop testing, zero adjustment and instrument calibration, and can also learn the control skill of sewerage treatment facility to study structures and mechanisms of equipment including industrial instruments, functional composition and data processing (See Figure 16).

Sewerage treatment laboratory equipment (Quality Control)
This facility can be provided for sewerage treatment experiments using activated sludge. The facility consists of sewage storage tank, reactor tank (combined with sedimentation tank) and treated water tank. The facility can be operated automatically, as time of reaction and sedimentation time will be set. Trainees can study sewerage treatment technique to understand differences among treatment water qualities and points of the treatment (See Figure 17).
CONCLUSION

**Human resource development of the whole sewerage industry**

Besides our staff, the center is available for use for other municipal or private organizations. Since its opening, over 3,000 visitors from all around Japan and overseas, for example Thailand, New Zealand and Brazil, have come to see the facility and receive training. Should anyone wish to go through training at the center, we can provide a team of instructors along with the use of those various facilities. All prices are set reasonable. We, the Bureau of Sewerage of Tokyo Metropolitan Government, will continue to utilize the center to keep contributing to the human resource development of the whole sewerage industry.