

# Introduction of Emergency Water Supply Facilities in Taipei Metropolitan

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Sizable disaster could damage water supply facility and transmission and distribution pipeline and result in disruption of water supply in short period of time, and the interests of the public in maintaining life supporting water supply would be jeopardized. In order to be ready for such incidents, Taipei Water Department (TWD) built emergency water supply facilities gradually since 2004 and up to 2008, 30 sets of such facilities have been completed. It is estimated that these facilities are capable for supplying 280,000 cubic meter drinking water to 3.87 million people in TWD service area for 24 days. Subsequently, in coupling with the disaster preventing park plan of Taipei City Government, 3 new water storage tanks of pipe shape and 4 reinforced concrete storage tanks will be built in the following years. It is conceived that shut-off valve is to be installed to the connecting pipeline of storage tank which can be shut off automatically at occurrence of disaster and retain water in storage tank. Thus, people can take water from the storage facilities for life supporting purpose.

In this paper, the author will recount the target, content and present situation of TWD Emergency Water Supply Plan. We also present our life-supporting storage tank designs, emergency shutoff valves, flexible pipes , model test and the problems we encountered. Finally, the prospect will be discussed as well.

**Key Words:** Emergency Water Supply Plan, Emergency Water Storage Tank

## 1. INTRODUCTION

Taiwan is located on the earthquake belt of Pacific Rim and earthquake is a common thing. When a strong earthquake occurs, it could damage to water supply equipment and pipeline and interrupt normal water supply for a short period of time. It could cause growth of pathogens and initiate epidemics. In view of the above, in the city disaster prevention and protection facilities, the establishment of emergency water storage facilities is one of the most important things.

In 2004, Taipei City Government instructed Taipei Water Department (TWD) to review the places that are capable to store water and to plan for necessary facilities to ensure water supply services will be maintain despite of emergency situation. Following this instruction, TWD drew an Emergency Water Supply Plan to establish emergency water supply stations beside distribution basin, to draw water from water distribution mains, and to build emergency water storage tank in disaster preventing park of Taipei City.

## **2. EMERGENCY WATER SUPPLY PLAN**

### **2.1. Target of the Plan**

The target of this plan is to establish emergency water supply storage facilities, which enable TWD to maintain basic drinking water supply to the public at 3 liter per capita for 4 weeks, when a sizable disaster damages the water supply system.

### **2.2. Content of the Plan and Situation of Execution**

The emergency water supply drawing facilities to be established under this plan may be divided into 3 types. The first one is to establish emergency water supply drawing station beside the distribution tank. The second one is installing water drawing equipment which could draw clear water from the large-size pipes through the air relieve valves. The third type is establish underground pipes or reinforced concrete water tanks in the shelter parks. The following are the brief description of the 3 type emergency water supply facilities.

#### **2.2.1. Emergency Water Supply Drawing Station of Distribution Tank**

The water stored in the distribution tank can first be pumped to storage tank or supply tower above ground and then flow to the drawing ports through branch pipes. Citizens can receive water from the faucets of drawing port directly. Also, in order to increase the flexibility of water supply, the drawing port for water lorry will be installed to large distribution tank to facilitate the supply to neighboring area or for emergency use. Fig. 2-1 is the illustrative drawing of drawing water. So far, TWD has completed Emergency Water Drawing Station in 11 distribution tanks.

#### **2.2.2. Emergency Water Drawing Station of Distribution mains**

Tap-water pipelines are almost buried under ground. The transmission and distribution pipeline constructed in open-cut method are mostly 1.2 M deep under the ground. But in cases of passing through road intersections, passing river with siphon method, or in tunnel boring method, the depth will be far more than 1.2 M, and will be relative lower than those pipes constructed in

open-cut method. In outage incident, the relative lower section will be deposited with substantial volume of water and installing water drawing facility to these sections, it will be a source of emergency water supply. The illustrative Drawing is given as Fig. 2-2 (Installed with emergency water drawing equipment and pump(s) will be placed through the input hole of distribution mains for drawing water direct to the citizen or to water lorry to support neighboring area.) TWD has presently completed 19 Emergency Water Drawing Stations of distribution mains as well.

### 2.2.3. Pipe Form Storage Tank and Concrete Storage Tank

#### (1) Pipe-Form Storage Tank

This is large diameter pipeline buried under park, greens, school or road / sidewalk .The length is from few meters to more than 10 meters and in diameter of 1500 mm to 2400 mm. If the length is 10 meters, the capacity will be 18 – 45 cubic meter. The pipe-form storage tank is hermetical and connected with the distribution pipes, so that water can flow in and out of it at normal time. Emergency shut-off valve shall be installed to the connecting pipe, which can be used as manhole for maintenance. At occurrence of sizable earthquake, the shut-off valve will be closed automatically to keep the water inside the pipes. By using drawing equipment, the stored water can be drawn out as emergency water supply for the neighboring citizens. TWD plans to install 3 pipe-form emergency water storage tanks in Shelter Parks and they are under construction. Two are almost completed.

#### (2) Reinforced Concrete Emergency Storage Tank

The capacity of reinforced concrete emergency storage tank is large than Pipe-Form water storage tank and is generally more than 500 cubic meter. It is installed with connecting pipe to connect with the neighboring distribution pipe. It is an open-to –atmosphere facility and therefore, boosting facility is required for pumping deposited water from the tank into water supply system and to maintain the freshness of water deposited. Similarly, emergency shut-off valve is installed to the connecting pipe. In normal days, it is used as system distribution tank in supplying water to users. At occurrence of sizable earthquake, the emergency shut-off valve will be closed automatically and keep the water inside the storage tank. Water drawing equipment can be used to draw water out as emergency supply of water. TWD plans to build 4 reinforced concrete emergency storage tanks in 4 shelter parks.

## **3. PIPE-FORM EMERGENCY STORAGE TANK**

### 3.1. Principle of design and key points

#### 3.1.1. Principle of design

In open-cut method, place enclosed pipe-form storage tank under ground of park. The material of storage tank shall be ductile cast iron or steel and both shall meet quake resisting, water tight, pipe-tank water retention ability and fall-off resistance. Emergency shut off valve shall be

installed to the connection pipe between storage tank and existing distribution pipeline. At occurrence of earthquake, the emergency shut-off valve will be closed automatically and retain water inside the emergency storage tank, while the regular water flow will be maintained as usual in the pipeline network. Water drawing facility can be used to draw water out for emergency use of neighboring residents.

At normal days, the water stored in the tank is a part of the distribution pipeline and is maintained fresh all the time. At top of storage tank, two drawing port is fitted to be drawing port for emergency supply as well as firefighting hydrant. Remote monitoring system will be installed to transmit back the data of conditions of valves and storage tank to TWD monitoring center and Taipei City Fire Department. A store room shall be set up in park for storing diesel pump, manual pumping facility, emergency water supply equipment (water supply rack and hose), portable ventilator, and portable gas detector, for assembly and application within the shortest possible time.

### 3.1.2. Design Steps

In designing pipe-form emergency storage tank, the following are main items to be included in consideration :

- (1) Capacity of storage tank
- (2) Checking of Pipe-form storage tank section: thickness of pipe wall, internal and external pressure, stress and deformation rate
- (3) Checking of pipe axial direction: fall-off resistance
- (4) Checking of buoyancy and settling
- (5) Quake resistance: shall be meeting the requirements of “Building Quake Resistance Design Specification and Detail Interpretation” with regards to quake resistance requirements
- (6) Capacity of Air Release Valve
- (7) Support and soil improvement method for construction
- (8) Emergency Shut-Off Valve Set

### 3.1.3. Model Experiment

In order to ensure the safety of water quality inside the tank, keeping away pollution due to idled water, TWD made a 1/10 storage tank model (Fig. 3-1) to simulate the flowing of water to find out the velocity and water replacement status with change in time.

In this experiment, we used colorimetric method to observe idle of water. We store firstly pigment contained water in the model, then pure water is introduced into model to replace pigment contained water. The pigmented water in the storage tank model must be repelled before the replacing rate (inflow volume / storage tank capacity) exceeds 6.

After 6 tests of different velocity, the finding is –“when the velocity is fast, the replacing time is short; on the other hand, when the velocity is slow, the replacing time is longer. The results of

experiment are shown in Fig. 3-2.

### 3.2. Construction Steps and Precautions

#### 3.2.1. Construction Steps

Main construction items can be divided into the building of storage tank, connection pipe, control panel and power supply system. The inspection items of storage tank are:

- (1) Outer appearance and dimensions
- (2) Coating: Coating of water storage tank includes sand blasting and rust removing both inside and outside, 2 primer coats, 2 epoxy coats for inside, and 2 primer coats and anti-corrosion cladding for outside.
- (3) Non-Destructive Testing: Welding channels of storage tank must be X-Ray inspected.
- (4) Material test: Tolerable stress of material and radioactive-free inspection.
- (5) Water Quality Safety: Sampling at site and shall meet with the drinking water standard of TWD.
- (6) Pressure and Leak Test: Pressure test must be tested to 7.5 kg/cm<sup>2</sup> and last for 30 minutes and free of leak to be qualified. Leak test shall be tested to the pressure of 5kg / cm<sup>2</sup> for one hour and is qualified if the leak is less than the calculated value.

#### 3.2.2. Construction Cases

TWD has presently 2 pipe-form storage tanks under construction. Take Jing-hua Park project as an example ( Fig. 3-3 ) . The main specifications are described as the following:

- (1) Capacity: 100 M<sup>3</sup>
- (2) Internal water pressure: 7.5kg/cm<sup>2</sup>
- (3) Type of storage tank: Underground, total enclosed tank
- (4) Material of storage tank: Rolled Steel (SS400)
- (5) Circulating equipment: inflow and outflow pipes, emergency shut-off valve, air release valve
- (6) Power Supply system: normal civilian power system
- (7) Signal transmission: Installed to operate with valves
- (8) Water drawing manner: Diesel Self-Primed Pump and Manual Pumping Facilities
- (9) Others: Portable ventilator, portable gas detector, lighting and emergency power supply, store room and name plate (incl. brief illustration of the project and functional description).

#### 3.2.3. Precautions

- (1) Erection and lifting should be executed by heavy equipment, so the traffic conditions by the construction site must be fully aware.
- (2) The operation space must be investigated in advance to assure the length and burying depth of storage tank is proper.
- (3) Prior to construction, deep cutting must be conducted to find out the conditions of other possible pipelines barriers to assure with sufficient space.
- (4) When constructing above soft soil, firm and strong foundation must be made to avoid any soil

sinking.

- (5) Since the construction sites are mostly highly populated, retaining support must be made properly .Noise and the cracking of nearby buildings shall be watched too.

#### **4. PROSPECT**

The emergency water supply plan of TWD is planned basis the existing water supply system, and the emergency water supply stations are located based on distribution tanks and available distribution mains or in shelter parks, they could not be located evenly and the density will not be sufficient. In future, to fulfill the emergency water supply stations can be placed evenly , TWD shall be attended by finding more feasible places to build those stations, so that the system may be as more perfect as possible.

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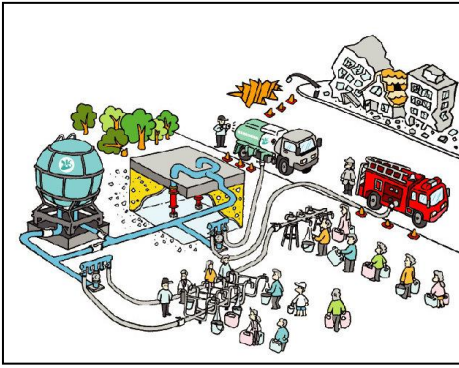


Fig. 2-1 Emergency Water Drawing from Distribution Pond

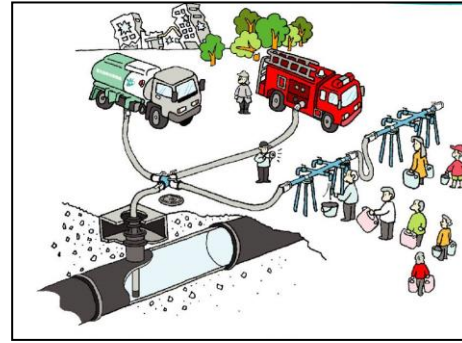


Fig. 2-2 Trunk Line Emergency Water Drawing Station



Fig. 3-1 Pipe-Form Emergency Storage Tank

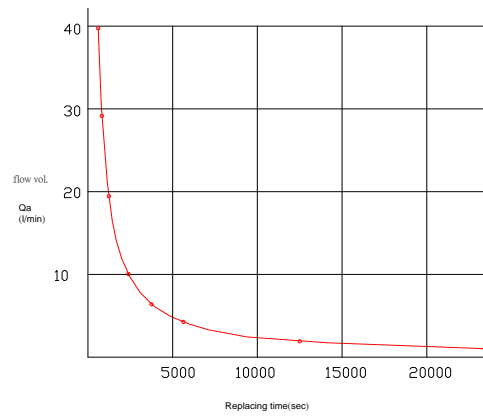


Fig. 3-2 Results of Experiment



Fig. 3-3 Site Construction



Fig. 3-3 Site Construction