

# STATUS OF THE UTILITY SYSTEM CONSTRUCTION FOR THE 3 GeV TPS STORAGE RING

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## Abstract

The construction of the utility system for the 3.0 GeV Taiwan Photon Source (TPS) was started in the end of 2009. The utility building for the TPS ring had been completed in the end of 2013. The building use license had been approved in Sep. 2013. The whole construction engineering has been completed. The acceptance test is scheduled on July 2014. Total budget of this construction is about four million dollars. This utility system presented in this paper includes the cooling water, air conditioning, electrical power, and compressed air systems.

## INTRODUCTION

Taiwan Light Source (TLS), the first third-generation synchrotron radiation facility in Asia, has been operated for two decades since it was opened for global users on April 1994. As TLS has gradually lost its advantage of competition due to its limitation of straight sections and available space for new IDs, NSRRC launched the TPS project in 2009 to achieve targets of low emittance, high brightness, stability and reliability. The utility system of the TPS had been designed [1]. The open bid of the TPS utility system construction was contracted out on December 2009. The whole construction engineering has been completed. The first phase test of the utility system had been conducted on the first quarter of 2014. The electrical power system, de-ionized water (DIW) system, air conditioning system, and the compressed air system have been delivered to accelerator machine subsystems for their tests.

On account of the site limitation and efficient operation manpower in the future, the TPS is constructed adjacent to the TLS. Part of TPS and TLS area is even overlapped. The existing Administration (AD) building is located on the core area of TPS ring, as shown in Figure 1.

The TPS civil construction includes three buildings, i.e., the storage ring building (T building), the Academic Activity Center (D building) and the waste water treatment building (C building). Utility Building III is constructed on the basement of the D building, where most main utility equipments are located. There is an Administration and Operation Center connected with the T building on the outer area facing the D building.

Main utility equipment of the TLS and cryogenic system was respectively installed in two existing utility buildings i.e., Utility Buildings I and II. Utility building III, especially for the TPS, is located near the existing two utility buildings.

There are two utility underground trenches from the Utility Building I and the Utility Building II respectively connecting to the TLS ring for the piping system and electrical power transmission. Likewise, there is an underground trench connecting the Utility Building III and the T building.

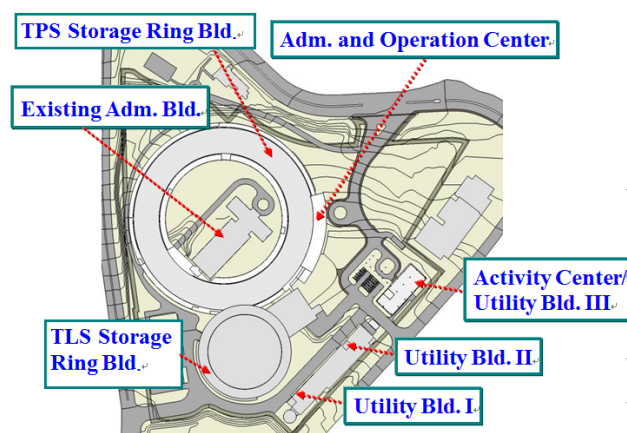


Figure 1: Layout of TPS, TLS and three Utility Buildings.

The T building may be generally divided into three areas, i.e., utility area (in the core area), the storage ring tunnel and the experimental hall. The utility area is further divided into two zones. Both widths of the inner zone and the outer zone are about 4~5m. Two zones are separated by a corridor with 2.3m in width. There are 24 control instrumentation areas (CIA) symmetrically distributed along the inner zone of the utility area. Each CIA serves for two sections of the storage ring.

## DE-IONIZED WATER SYSTEM

In both TLS and TPS, the water system includes DIW, chilled water, cooling tower water and hot water. All water subsystems are operated in close loops except cooling tower water. The DIW system may be further divided into four subsystems, i.e., Cu system for magnets and power supplies, Al system for vacuum chambers, RF system for the RF facility, and the booster system for booster devices and beam line optical instruments.

Traditional electrical heaters were applied to produce hot water in TLS. However, the coefficient of performance (COP) of the electrical heater is about 90%. For better COP and power saving purpose, we installed two heat pumps in the main machine room of the Utility building III. The COP of the heat pump is about 350%.

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which is almost 4 times that of the electrical heater. The heat pump absorbs heat from returned chilled water to hot water. The specifications of water subsystems are listed in Table 1.

The capacities of cooling tower, chilled water and hot water listed in Table 1 are equipment capacities, which are larger than the actual consumption. These three subsystems provide water for the DIW system as well as the air conditioning system.

Table 1: Specifications of Water Subsystems of the TPS

	Temperature	Pressure	Capacity
Cu DIW	25 ± 0.1 °C	7.5 ± 0.1 kg	1659 GPM
Al DIW	25 ± 0.1 °C	7.5 ± 0.1 kg	380 GPM
RF DIW	25 ± 0.01 °C	7.5 ± 0.1 kg	1284 GPM
Booster DIW	25 ± 0.1 °C	7.5 ± 0.1 kg	1238 GPM
Cooling Tower	32 ± 0.5 °C	2.5 ± 0.1 kg	12000 RT
Chilled Water	7.0 ± 0.2 °C	2.5 ± 0.1 kg	8400 RT
Hot Water	50 ± 0.3 °C	2.5 ± 0.1 kg	1600 kW

The main machine room is located in Utility Building III. In the first phase, only three chillers are installed. There will be eventually total six chillers, each with 1400 RT, installed in the main machine room. Heaters, three air compressor, two heat pumps and pumps for DIW, cooling water and chilled water have also been installed in the main machine room. There is a corner area for four DIW systems. Figure 2 shows the 3D schematic draw the main machine room.

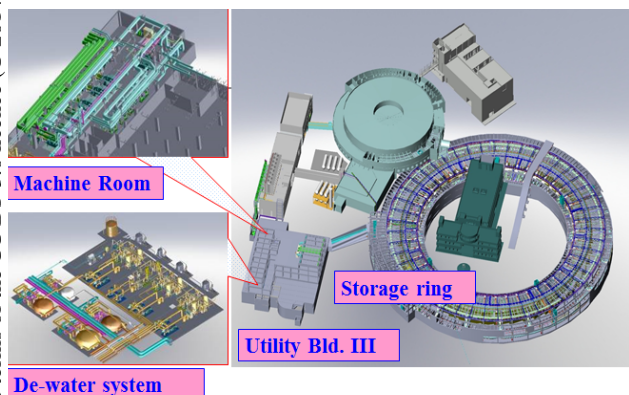


Figure 2: 3D schematic draw of the main machine room.

Water treatment is another important issue in the cooling water system. The recycle system, RO system and deoxygenating system are main schemes to control DIW quality.

The water resistance will be kept larger than 10 MΩ. The pH value and the concentrations of oxygen will be controlled within 7±0.5 and 10ppb, respectively. For better temperature control effect (within ±0.1 °C), we install a buffer tank on each DIW subsystem. Figure 3 shows the process of DIW treatment.

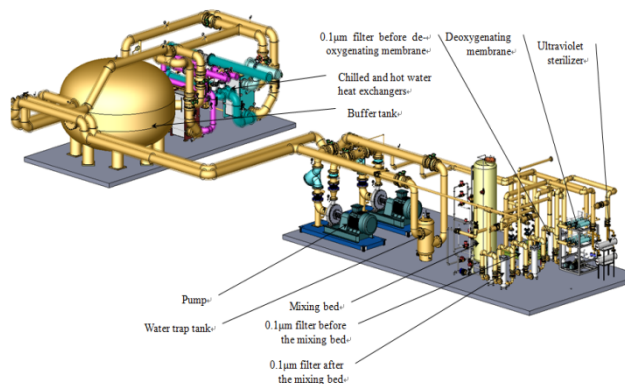


Figure 3: Process of DIW treatment.

In the T building, there are 48 DIW manifolds located on both sides of 24 CIAs. The main pipes of chilled water, hot water, and DIW are distributed on the 2m trench under the 2.3m corridor, as shown in the Figure 4. DIW is transmitted from the local manifold to the ring through trench. Figure 5 is a picture of one set of DIW manifolds.



Figure 4: 3D schematic draw of a local DIW system.



Figure 5: One set of DIW manifolds.

## AIR CONDITIONING SYSTEM

The T building may be generally divided into three parts, i.e., utility area (in the core area), the storage ring tunnel and the experimental hall. There are 13, 12 and 24 AHUs serve for the CIA, the storage tunnel and the experimental hall, respectively. There are more 12 outer air AHUs providing outside fresh air for the whole TPS

ring. In the first phase, there only 12 AHUs installed for the experimental hall.

The specifications of air conditioning system of utility area, the storage ring tunnel and the experimental hall are listed in Table 2.

Table 2: Specifications of the Air Conditioning System

Area	Total flow rate(m <sup>3</sup> /s)	Total cooling capacity(kW)	AHU No.
Exp. hall	135	1811	24
Ring tunnel	56	760	12
CIA	79	1062	13

## ELECTRICAL POWER SYSTEM

There are four and eight AC electrical power substations distributed on the experimental hall and the outer zone of the utility area, respectively. All the power substations have been completed. The SCADA (supervisory control and data acquisition) system has also been online available. Figure 6 shows the distribution of 12 power substations in the T building.

- 4 power substations in outer area
- 8 power substations in core area

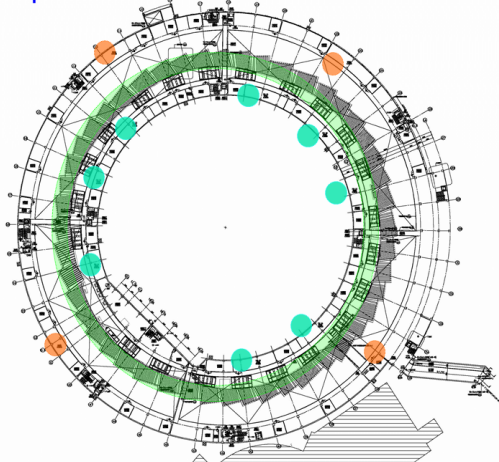


Figure 6: Distribution of 12 power substations in the T building.

The power load in the TPS storage ring can be basically divided into the magnet power supply system, the RF system, the HVAC and cooling water system, and other device. According to power demand of each subsystem, the total TPS power demand of the storage ring is estimated about 9,789 kW, as listed in Table 3.

Table 3: Total Power Demand for the TPS Storage Ring

	power demand (kW)
magnet power-supply system	3,540
RF system	3,196
other precision devices	2,553
Public-utility facilities	500
total	9,789

The total power capacity of the TPS is estimated about 12.5 MW. We contracted with Taiwan Power Company

for 1MW power capacity last year. [2] Currently, the contract capacity is 3 MW.

Electrical power system of TPS will be classified according to the power loads. Basically, most power feeders are classified as the technical load and the conventional load. Some subsystems of the storage ring will be equipped with specific power feeder, such as the RF system, power supply system, vacuum system and processing load. Main electrical power equipment, including transformers, two generators, and high and low voltage power panels have been installed in the power substation in the Utility Building III. The capacity of both generators is 1MW.

## COMPRESSED AIR SYSTEM

The compressed air system has also been built up. In the first phase, there are two water-cooling typed compressors installed in the Utility building III. The space of one more extension set is reserved.

Each compressor is equipped with one buffer tank of 1,500 L and fine filters of 0.01micrometer. The capacity is 13 m<sup>3</sup>/min. The air pressure is 6 kg/cm<sup>2</sup>. The dew point is -40 °C. Both compressors are variable-frequency drive for efficient operation. One set is equipped with emergency power.

## CONCLUSION

The construction of buildings D and T have been completed in Dec. 2012 and April 2013, respectively. The utility system of the TPS has been also constructed according to 3D drawing. In the first phase, we installed three 1400 RT chillers and two 13 m<sup>3</sup>/min air compressors. For power saving purpose, we installed two heat pumps with 350% COP. The acceptance test will be held on July 2014.

The total equipment electrical power capacity is 12.5 MW. The contract capacity is 3 MW currently. To fit the power requirements of the booster and LINAC test, the contract power will be increase to 4 MW this summer.

## ACKNOWLEDGEMENT

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## REFERENCE

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- [2] J.C. Chang, et al., "Status of the Utility System Construction for the 3 GeV TPS Storage Ring", 2013 The 4th International Particle Accelerator Conference (IPAC'13), Shanghai, China, May 12-17, 2013.