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 will be completed in the end of 2012. The whole construction of the utility system is scheduled to be completed in the upper half of 2013. Total budget of this construction is about four million dollars. This utility system presented in this paper includes the electrical power, grounding, cooling water and air conditioning (A/C) systems.

INTRODUCTION

Taiwan Light Source (TLS), the first third-generation synchrotron radiation facility in Asia, has been operated for 19 years since the first beam stored in the storage ring. Although the reliability and stability of the TLS have been upgraded for years, TLS has gradually lost its advantage of competition due to its limitation of straight sections and available space for new IDs. To meet increasing demand for more state-of-the-art researches, the TPS project was proposed and designed to achieve targets of low emittance, high brightness, stability and reliability. Utility system is one of the most critical subsystems effecting on beam quality. The utility system of the TPS had been designed [1] and currently is under construction.

Considering the future efficient operation of both existing TLS and the TPS, the TPS is constructed adjacent to TLS on the same campus. Some areas of TPS and TLS are even overlapped. The existing Administration (AD) building is isolated in the core area of TPS ring. The first challenge of TPS construction is to keep the TLS and AD building in normal operation. Thus, a temporary piping system for the AD building from the Utility Building II had ever been built underground. The permanent piping system had also been recovered in Jan. 2012.

The TPS civil construction includes three buildings, i.e., the storage ring building (T building), the academic activity building (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. The civil construction of the D building has been mostly completed.

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

There are two utility 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 a trench connecting the Utility Building III and TPS. The schematic drawing of the TPS, TLS and three Utility Buildings is shown in Figure 1.

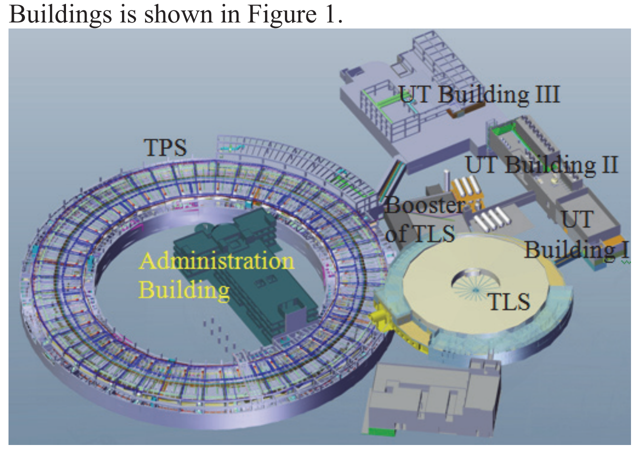

Figure 1: TPS, TLS and three Utility Buildings.

CONSTRUCTION STATUS

All the construction processes of utility system are under strict review procedure. All the shop drawings are implemented by 3 D drawings. Because some spaces where many pipes, cable trays and wind ducts pass through are compact, interferences happen often. Three D drawings can clearly show all interferences. Figure 2 illustrates one of the cases.

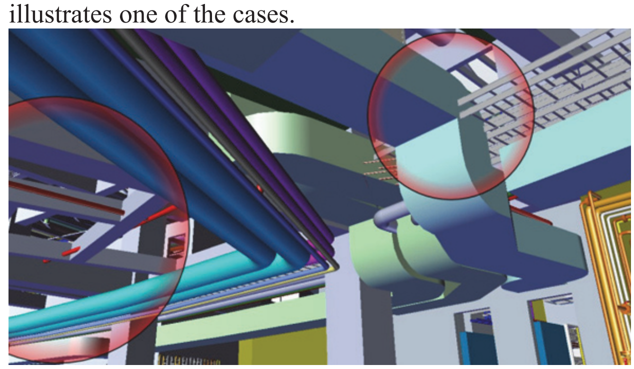

Figure 2: Interferences among pipes, cable trays and wind ducts.

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Figure 3 shows the status of the TPS civil construction. The picture is connected by 3 pictures. Thus there are two slight distortions on the connection areas. As shown in the figure, there is a bridge over the TPS ring from the AD Building to outside. The water and electrical power transmitted to the AD Building are through two sides of the bridge.

The D Building, where also the UT Building III located, has been constructed, as shown in the figure. Most utility equipment has been installed inside.

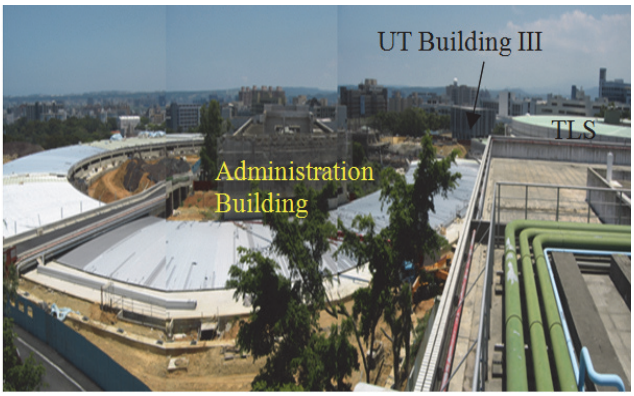

Figure 3: Status of the TPS ring construction.

The TPS storage ring building may be generally divided into three parts, 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 one sections of the storage ring. There are 13, 12 and 12 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. Two local de-ionized water (DIW) systems are located on both sides of CIA to supply DIW into the tunnel through trenches, as shown in Figure 4.

DIW AND AIR CONDITIONING SYSTEMS

In both TLS and TPS, the water system includes DIW, chilled water, cooling tower water and hot water. All water subsystems except cooling tower water are operated in close loops. The DIW system may be further divided into four subsystems, i.e., Cu system for magnets and power devices, Al system for vacuum chambers, RF system for the RF facility, and booster system for booster devices and beam line optical instruments. The specifications of cooling water subsystems are listed in Table 1.

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.

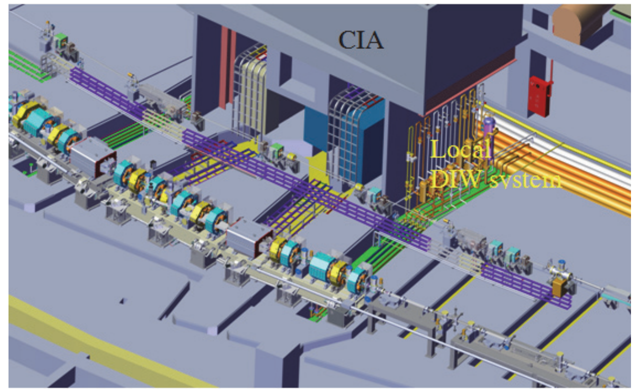

Figure 4: Layout of the TPS storage ring.

Table 1: Specifications of Water Subsystems of the TPS

	Temperature	Pressure	Capacity
Cu DIW	25 ± 0.1 °C	7.5 ± 0.1 kg	1600 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	1200 GPM
Booster DIW	25 ± 0.1 °C	7.5 ± 0.1 kg	700 GPM
Cooling Tower	32 ± 0.5 °C	3.0 ± 0.2 kg	9000 RT
Chilled Water	7.0 ± 0.2 °C	3.5 ± 0.2 kg	8400 RT
Hot Water	50 ± 0.3 °C	2.5 ± 0.2 kg	1600 kW

We design a stable and precision utility system; also consider the power saving issue. NSRRC formally used electrical heated water on the A/C system and de-ionized water to control temperature. For better coefficient of performance (COP), we will install two more heat pumps in the Utility Building III in the end of 2012. The heat pump absorbs waste heat from water to hot water. The COP of the heat pump is about 350%, which is almost 4 times that of the traditional electrical heater.

There will be eventually six chillers, each with 1400 RT installed in the main machine room. Four DIW systems, heaters, three air compressor, two heat pumps and pumps for DIW, cooling water and chilled water will be also installed in the main machine room. Figure 5 shows the 3D schematic draw the main machine room.

The Utility Building III is constructed on the basement of D building. The whole structure of the Utility Building III has been completed. Some main utility equipment has been installed. Considering there will be few cooling load imposing on the TPS before commissioning, only three chillers are installed in the first phase. These three chillers have been installed in the main machine room. The whole utility system in the Utility Building III is scheduled completed in the end of 2012.

A/C system is another critical system related to the thermal effect. The specifications of A/C system of utility area, the storage ring tunnel and the experimental hall are listed in Table 2.

Table 2: Specifications of the A/C System of TPS

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

In the first phase, all the AHUs for the ring tunnel and CIA will be installed. However, because no beam line will be constructed in the first phase, there will be only 12 AHUs installed for the experimental hall.

According to our latest schedule, the utility system construction of the D building as well as the trench between the Utility Building III and T building will be completed in the end of this year. The whole civil construction of the TPS is scheduled to be completed in 2013.

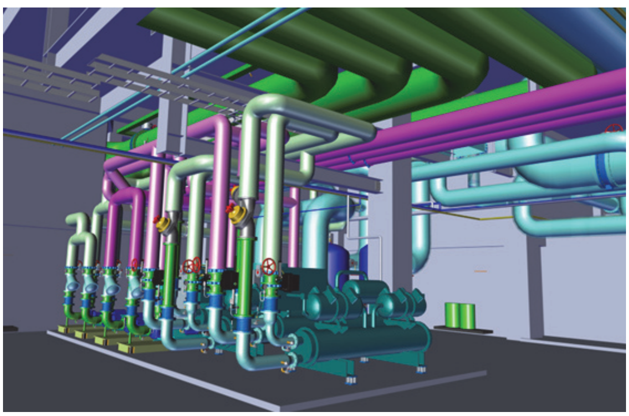

Figure 5: 3D schematic draw of the main machine room.

ELECTRICAL POWER AND GROUNDING SYSTEM

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. The total power capacity of the TPS is estimated about 12.5 MW. We will contract with Taiwan Power Company for 1MW power capacity in the first phase.

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

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, one generator, and high and low voltage power panels have been installed in the power substation in the Utility Building III.

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 will be completed on the first quarter of 2013. Figure 6 shows the installation of main electrical power equipment in one power substation.

Figure 6: Installation of main electrical power equipment in one power substation.

A low impedance grounding system of 0.2 Ω was designed. The grounding grid consists of 64 electrodes. Those electrodes are copper tubes with 30m in length. All electrodes are connected by bare copper wires. Three electrodes are specially buried under the ground of the RF area. The whole grounding grids are near accomplished. The final impedance of the ground system is estimated about 0.14 Ω.

CONCLUSION

The utility system layout of the TPS was designed and illustrated in 3D drawing. The construction of buildings D and T will be completed in the ends of 2012 and upper half of 2013, respectively.

ACKNOWLEDGEMENT

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REFERENCE

[1] J.C. Chang, et al., "Utility Design for the 3GeV TPS Electron Storage Ring" The 11th European Particle and Accelerator Conference (EPAC), Genoa, Italy, June 23-27, 2008

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