OPERATION OF BOTH UTILITY SYSTEMS OF TPS AND TLS AT NSRRC

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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 2014. The final acceptance test and improvement had also been completed in the end of 2014. The TPS is in commission and TLS is still in operation. Within limited manpower and budget, it is challenge to operate both utility systems stable and reliable. We provide good quality of electrical power, cooling water and precision air temperature. Power saving is also an important issue. The utility system presented in this paper includes the electrical power, cooling water, air conditioning, compressed air, and firefighting systems.

INTRODUCTION

Utility system is the infrastructure of a facility. It is also one of critical subsystem of an accelerator. Therefore, a good utility system can provide not only stable and precision electrical power, cooling water and air temperature for the beam operation, but also a safety, comfortable and working environment for all personnel. Besides, power saving becomes another important issue for the environment. There are more requirements for the utility system than ever.

After 22-year operation of TLS, TPS has been constructed and in the phase of commissioning. Based on the operation experience of TLS utility system and utility system design of other advanced accelerators, the utility system of TPS had been designed and constructed [1].

Considering the efficiency of operating TLS and the TPS, the TPS is constructed adjacent to TLS on the NSRRC campus. Some areas of TPS and TLS are even overlapped. Figure 1 shows the bird view of TPS, TLS and three Utility Buildings. The existing Research building is enclosed by the TPS storage ring building.

There are three utility buildings providing utility system for TLS and TPS. Utility Building I was constructed with TLS storage ring building in 1992. Utility Building II was constructed for the Cryogenics and superconducting systems in 2002. Main utility equipment of the TLS is installed in Utility Buildings I and II. Utility building III, especially for the TPS, is designed near the existing two utility buildings, as shown in Fig. 1.

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.

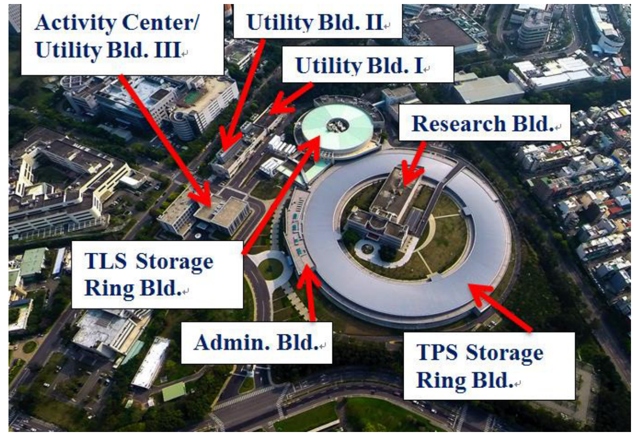

Figure 1: Bird view of TPS, TLS and three Utility Buildings.

MAN POWER OF UTILITY SYSTEM

When the TLS was constructed, there was an Engineering Division in charge of the civil and utility system construction and maintenance. Most members of the engineering division were engineers and technicians. As accelerator technique developed, the requirements of precision and stability of utility system were much higher than ever. The Engineering Division was reorganized under the Instrumentation Development Division as the Utility Group and recruited scientist members in 1996.

We had made many efforts on studying utility effects on beam quality and upgrading utility system since 1998. [2] Our monitoring and control system was first set up in 1999. The first SCADA (supervisory control and data acquisition) of electrical power system was built in 2003.

For the civil construction of TPS, there was a civil management group formed in 2006. As the civil construction was completed, the utility and civil management groups were merged as the utility and civil group in 2015. The man power of each subsystem is listed in Table 1.

Table 1: Man Power of Utility and Civil Group

Subsystem	Scientist	Engineer	Technician
Electrical Power		2	1
Water	1	1	1
Air Conditioning		2	1
Grounding/ EMI	1	1	
Civil		1	1
Others	1	1	
Total	3	8	4

ELECTRICAL POWER SYSTEM

The electrical power of TLS and TPS are individually provided from TPC (Taiwan Power Company). Both electrical power systems of TLS and TPS consist of two independent electrical power feeders. The voltage level and the contract power capacity of TLS are 11.4 kV and 5.5 MW, respectively, while that of TPS is 22.8 kV and 7.5 MW, respectively.

Electrical power system of both TLS and TPS are classified according to the power loads. Basically, most power feeders are classified as the technical load or the conventional load. Some subsystems of the TLS and TPS are equipped with specific power feeder, such as the RF system, power supply system, vacuum system and control system.

The Metering Out Fit (MOF) and the main power station of TLS is located in the Utility Building II. Two main feeders in the Utility Building II are distributed to Utility Building I, TLS Storage Ring Building, Research Building, and Instrumentation Building, respectively. The main page of the TLS SCADA is shown in Fig. 2.

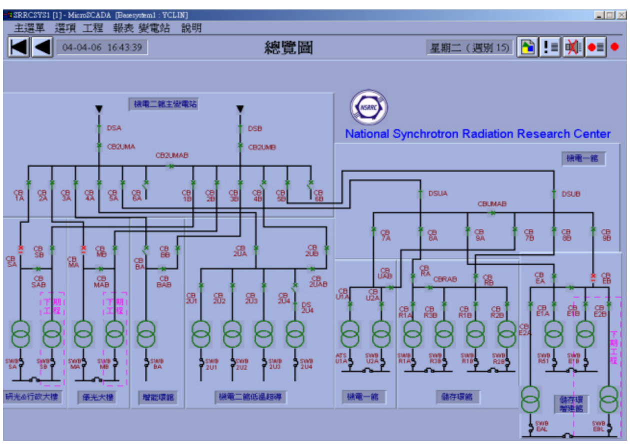

Figure 2: Main page of the TLS SCADA.

The MOF and the main power station of TPS is located in the Utility Building III. Likewise, two main feeders in the Utility Building III are distributed to Activity Center and TPS Storage Ring Building. Figure 3 shows the feeder A of the TPS SCADA.

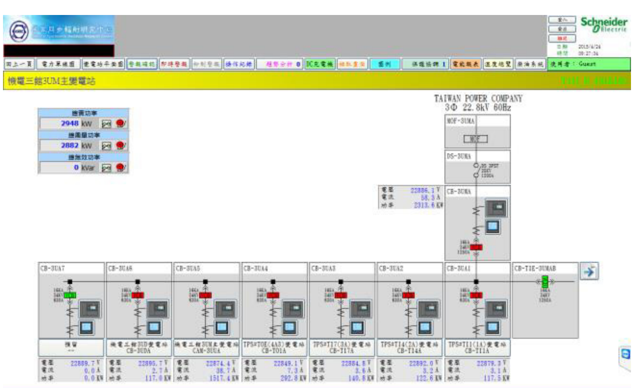

Figure 3: Feeder A of the TPS SCADA.

We plan to merge SCADA of TLS and TPS as one in the future. There are two power generators of 350 kW and 500 kW installed in Utility Building I and II, respectively. Two 1MW generators are installed in the Utility Building III.

WATER SYSTEM

Water system includes civil water, cooling water, heated water and DIW (De-ionized water). All water subsystems except cooling tower water are operated in close loops.

Chilled water and heated is used for temperature control of air conditioning and DIW. Table 2 lists specifications of water system of TLS and TPS. Basically, we control each water subsystem of TLS and TPS in the same temperature and pressure. The only difference between TLS and TPS is capacity.

For better chilled water operation, we connected supplied and return chilled water pipes, each with pipe of 10 inch in diameter, between Utility Buildings II and III in 2013. This scheme also can control power consumption between TLS and TPS. [3]

Table 2: Specifications of Water System of TLS and TPS

	Temperature	Pressure	Capacity (TLS/TPS)
Cooling	32 ± 0.5 °C	3.0 ± 0.2 kg	3000/9000 RT
Chilled	7.0 ± 0.2 °C	3.5 ± 0.2 kg	2400/8400 RT
Heated	50 ± 0.3 °C	2.5 ± 0.2 kg	600/1600 kW
Cu DIW	25 ± 0.1 °C	7.5 ± 0.1 kg	500/1600 GPM
Al DIW	25 ± 0.1 °C	7.5 ± 0.1 kg	100/380 GPM
RF DIW	25 ± 0.01 °C	7.5 ± 0.1 kg	160/1200 GPM
BL DIW	25 ± 0.1 °C	7.5 ± 0.1 kg	300/700 GPM

As to heated water, we typically apply electrical heater to heat water. However, the coefficient of performance (COP) of the traditional electrical heater is only about 90%. It means per kW-hr can produce about heat of 774 kcal. For power saving, we installed one heat pump in Utility Building II in 2008, two heat pumps in Utility Building III in 2012, and another one in the Instrumentation Building in 2013, respectively. The COP of the heat pump is about 350%, which is almost 4 times that of the electrical heater.

The DIW 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 BL system for beam line optical instruments and booster devices.

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

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DIW resistance of TLS and TPS is kept larger than 10 MΩ. The pH value, and the concentrations of oxygen is controlled within 7±0.5 and 10ppb, respectively. For better temperature control, we installed a buffer tank on the TPS DIW system. Figure 4 shows the process of TPS DIW treatment.

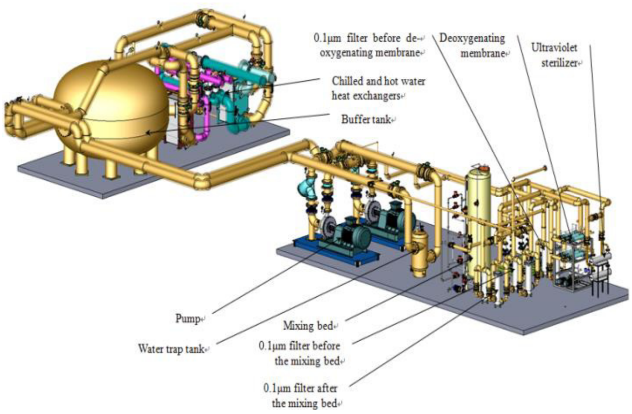

Figure 4: Process of TPS DIW treatment.

AIR CONDITIONING SYSTEM

Air conditioning system is another critical system related to the thermal effect. The layout of air conditioning systems of TLS and TPS Storage Ring Building are similar. The wind ducts are installed on the truss so that the air is supplied from ceiling.

The TLS Storage Ring Building includes the experimental hall, ring tunnel and core area, where power and control panels of accelerator subsystems are located. There are 2, 2 and 1 AHUs (air handling unit) serve for the experimental hall, ring tunnel and core area.

Likewise, the TPS Storage Ring Building may be generally divided as three parts, i.e., utility area (in the core area), the storage ring tunnel and the experimental hall. There are 24 control instrumentation areas (CIA) symmetrically distributed along the inner zone of the utility area, where power and control panels of accelerator subsystems are located. There are 13, 12 and 24 AHUs serve for the CIA, the storage tunnel and the experimental hall, respectively. Other specifications of air conditioning system of TLS and TPS are listed in Table 3.

Table 3: Specifications of the AHU of TLS and TPS

	Location	Flow rate (m^3/s)	Cooling capacity(kW)
TLS	Exp. hall	28	375
	Tunnel	12	160
	Core Area	9	120
TPS	Exp. hall	135	1811
	Tunnel	56	760
	CIA	79	1062

For more accurately and efficiently control the ambient air temperature around insertion device (ID), we ever isolated the ID area and provided the independent air conditioning system, known as the mini environment control. [4]

We also applied CFD (Computational Fluid Dynamics) on the air conditioning system TLS improvement [5] and TPS design. [6]

ARCHIVE SYSTEM

We had also developed a utility archive system to on line monitor thousands of utility parameters. Although each of the utility subsystem, such as the electrical power system, the water system, the air conditioning system is equipped with its own monitoring and control systems, the utility archive system still successfully integrates all those subsystems. The utility archive system is integrated software written by the LabView language. This archive system consists of a remote viewer level, a data service level, a data processing level, a control level and a device level. The remote viewer level is opened for all in house and outside users. The archive viewer in the remote viewer level is software of viewing for the whole archive system.

ACKNOWLEDGEMENT

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