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THE MUTUAL BACKUP STRUCTURES OF TLS AND TPS UTILITY SYSTEM

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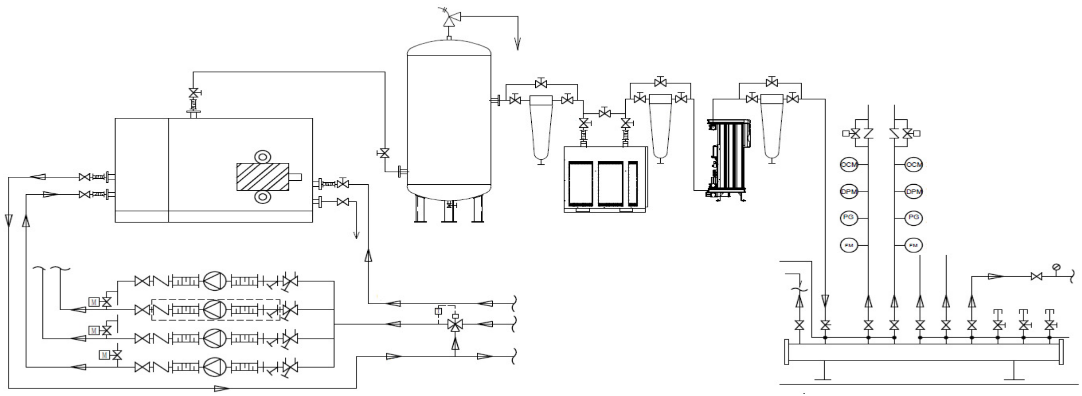

Figure 1: Typical compressed air system structure in TLS and TPS.

Abstract

Since December 31th 2014, the first synchrotron light from Taiwan Photon Source (TPS) was stored in the storage ring, the challenge to operate both Taiwan Light Source (TLS) and TPS smoothly and reliably became a significant issue for all members in NSRRC. On the one hand, the beam quality of former TLS must not been impaired due to the occupied resources by TPS, on the other hand, the most efforts were devoted to achieving steady operation of TPS. In order to operate both ring stably, some mutual backup structures were designed in the compressed air system and the chilled water system between TLS and TPS. The primary advantage of these mutual backup systems is minimizing the risk of beam-trip while any one of the utility system fails. Secondly, the mutual backup structures provide more flexible usage to accomplish energy conservation. From both risk-reduction and energy conservation points of view, the backup systems will do a great deal of good in the future.

INTRODUCTION

The utility team in NSRRC is in charge of providing steady compressed air, cooling water, including ordinary chilled water for air conditioner and chilled de-ionized water using in accelerator operation, and firm power. All of these resources affect the stability of beam operation indirectly. For example, all pneumatic equipments in front end area use compressed air as power source. Once the pressure vibration occurs, it may trigger the interlock safety process and let beam tripped; all the heat load of the equipments in accelerator is carried away by chilled de-ionized water. The pressure and flow of de-ionized water is used as a trigger signal to protect these sophisticated facilities. Not to mention the quality of electricity is a direct link to affect beam efficiency. In this period of transition while TLS and TPS operate at the same time, the operation of utility system must be more reliable than before. Two sets of utility facilities operate independently in TLS and TPS. They are designed with more capacity to cope with redundancy in critical systems, such as constant pressure de-ionized water pump system and all secondary pump systems. The compressed air systems in TLS and TPS are designed in similar architecture. Figure 1 shows the typical structure of compressed air system in NSRRC. The air is compressed by screw compressor and then stored in a buffer tank. Before delivery to end users, the air must be filtered by particle filters, condense dryer and absorption dryer in sequence. After these filtering and drying processes, only the particle diameter less than 0.01 micrometer could be found in the compressed air. The filter also reduces the oil content to less than0.01 mg/m^3. The stability of utility system and beam quality is interconnected indirectly.

THE MUTUAL BACKUP STRUCTURE OF CDA SYSTEM

Figure 2 shows the schematic of the mutual back up structure between TLS and TPS compressed dry air (CDA) system. It composed of two sets of check valves, pressure reducing valves and ball valves. The two ball valves are normally close unless any one of the compressed dry air system is under schedule maintenance. For the compressor of TLS compressed dry air system is oil-sealed, it will inevitably leave over residue oil and water in piping after long term operation. However, the

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compressed dry air system of TPS uses oil free compressor, which adopt water-sealed shaft to avoid oil vapour. Furthermore, new piping system is all constructed by stainless tubes, the quality of TPS compressed dry air is much higher than TLS. In order to avoid contamination from TLS, the compressed dry air from TLS must passes two filters to filtrate excess oil and water vapour and then transport to TPS compressed dry air system.

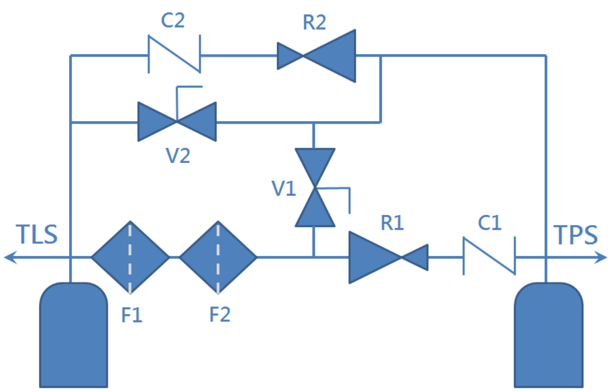

Figure 2: Mutual backup structure between TPS and TLS compressed air system.

V1 and V2 are normally closed ball valves and only are opened while any one of TLS and TPS compressed dry air system is in maintenance. When TLS compressed air system is in maintenance, the ball valve V2 will be opened and TPS compressed air system will be in charge of compressed air supply in whole ring area. Likewise, when TPS compressed air system is shutdown on schedule, the ball valve V1 will be opened, letting compressed dry air processed by two filters, F1 and F2, supports whole compressed air system. Only one of V1 and V2 will be opened during schedule maintenance. The two maintenance valves should be closed in normal operation, and two systems support mutually with a set of insulation piping between them.

As mentioned before, the compressed air coming from TLS system contains more moisture and oil, it must be filtrated by filters F1 and F2 before transporting to TPS system. The F1 and F2 are different size meshes. The F1 filter will remove particles bigger than 1 μm in diameter and reduce oil content to 0.5 mg/m^3. After the coarse filter F1, the fine filter F2 will remove particles larger than 0.01 μm in diameter and reduce oil content to 0.01 mg/m^3 further. The pressure reducing valve R1 reduces the inlet pressure slightly so as to keep alarm system works. For example, if the pressure in TLS compressed air system is about 5.8 kg/cm^2, the pressure will become 5.5 kg/cm^2 after passing through the pressure reducing valve R1, and the compressed air will be stopped in front of the check valve C1 due to the difference between two operation pressure in TLS and TPS. The TLS compressed air system can therefore operate in normal operation state without affecting the TPS system. In the mean while, the TPS compressed air system pressure, ranging about 6.2 kg/cm^2, will decrease to 5.5 kg/cm^2 after passing through pressure reducing valve R2, and the air flow stopped before the check valve C2. Also, the TPS compressed air system will not influence the TLS system during normal operation. In this case, the low level alert of TLS compressed air pressure is set as 5.6 kg/cm^2, and 5.8 kg/cm^2 in TPS. When the TLS compressed air system fails, the TPS compressed air system will take duty and maintain the TLS pressure at 5.5 kg/cm2, which will trigger the alert and the Archive Server will send message to relative staff. On the other hand, if the TPS compressed air fails, the TLS compressed air system will maintain TPS compressed air pressure at 5.5 kg/cm2 and the Server sends alert messages, too. The mutual backup system ensures the least operating pressure once any one of the compressed air system fails, and avoids undetected faults happening.

THE MUTUAL BACKUP STRUCTURE OF CHILLED WATER SYSTEM

The chilled water system consists of cooling towers, chillers and pumps basically. There are two sets of separate chilled water system in TLS and TPS originally. In order to achieve energy savings, the two individual chilled water systems are combined together through a set of connecting piping shown as the red portion in Fig. 3. The orientation of these two pumps flow can be changed between TPS and TLS system. By changing the open/shut states of these four valves in the connection piping, TLS and TPS chilled water system support each other when any one of them fails.

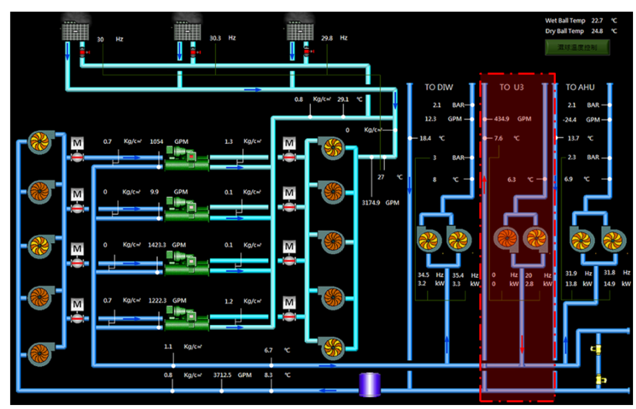

Figure 3: System diagram of TLS chilled water system.

The piping of mutual backup structure is shown as Fig. 4. The chilled water flows from TLS(U2) to TPS(U3) when the ball valves V1 and V3 are opened, V2 and V4 are closed. On the contrary, when V1 and V3 are closed, V2 and V4 are opened, it changes chilled water flow direction from TPS to TLS. There is a set of distribution pumps, P1 and P2, run alternatively with a 14-day period. This structure was built for more flexibility in chillers operation originally. There are several different cooling capacities chillers operating in TLS and TPS. By using the logic controllers, the chillers run in a more economic mode since the most heat load is carried away by larger

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capacity chillers [1]. The smaller chillers deal with the rest variation heat load. Our former test showed an obvious amount of energy saving in this operation mode [2].

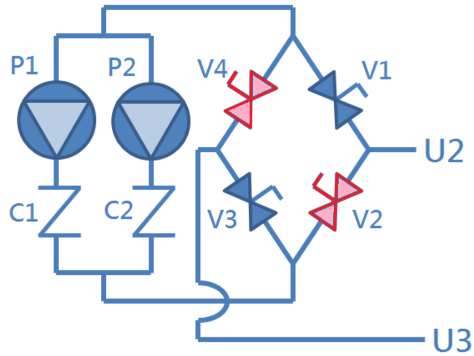

Figure 4: The piping of mutual backup structure between TLS and TPS.

One set of chiller system in TLS operates automatically. When the chilled water temperature rises over the setting point, the controller will activate the set of chiller and ensure the chiller turned on with all control valves and pumps operate in advance.

CONCLUSION

In this article, we describe the mutual backup structure of TLS and TPS utility system. For the importance of steady compressed air and chilled water in ring area, these two parts of backup system was built up in early stage. The rest site will be planned in sequence in the future. The compressed dry air and chilled water in TLS and TPS supply constantly and back up to each other. The Archive Server sends alert message once any of the system fails and prevent the happening of the un-noticeable errors.

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