COMMISSIONING OF THE NEW MAGNET POWER CONVERTERS ON THE SRS, AND OPERATIONAL EXPERIENCE.

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Abstract

The project reported at EPAC 94 to replace the SRS magnet power converters with line commutated thyristor equipment is now complete and the new units have been in operation for over a year and a half (at date of EPAC 96). Details of the commissioning are presented, and the improvements in the operational efficiency due to both the reduced time required for the energy ramp and the better reliability are detailed.

1 INTRODUCTION

It had been reported previously [1] that the magnet power converters of the SRS storage ring were to be replaced with thyristor equipment designed to the CERN LEP specifications. The project has now been completed, and this paper reports on the procurement of the equipment, its testing and commissioning and operational experience over 20 months.

2 PROCUREMENT

The converters were purchased in two stages. The 250kW unit used for the F-Sextupoles was exactly as CERN type B9[2,3]. The two 90kW units for the D-Quadrupoles and D-Sextupoles were based on CERN type B10, but modified to give lower voltage and higher current. These three converters were obtained from the supplier chosen for the LEP200 upgrade, and built immediately after the CERN production batch.

The two 750kW converters for the Dipoles and F-Quadrupoles were specified by Daresbury to the CERN design rules. After studying the tenders, it was decided to award the transformer and rectifier contracts to different companies, but those selected had also previously supplied similar equipment to CERN.

The control electronics were also built immediately after the CERN LEP200 production batch. Since some of the components were CERN “specials”, the electronic crates and modules were first set up at CERN before being delivered to Daresbury

3 TESTING BEFORE DELIVERY

The 90kW and 250kW converters were tested at the maker’s works using electronics loaned by CERN. Only sufficient modules were used to test the functionality of the power part.

The 750kW rectifiers could not be tested at full power before delivery to the Daresbury site. The two bridges in each unit were tested as separate six pulse rectifiers. A test at full output voltage with a small current was followed by a test at full output current with a small voltage. The latter condition was used to perform a heat run on one thyristor bridge.

The transformers for the 750kW units were of a new design, so type tests to BS171 were specified together with a special test to measure inrush current at 30 different phase angles. The short circuit test and the inrush current tests were performed at one testing station, and the lightning impulse tests at another. All of the type tests and all of the routine tests were passed successfully first time, showing that the transformers would operate comfortably within their specified ratings.

4 TESTING ON SITE

The electronics had been subject to burn-in tests and it was only necessary to calculate and fit the “select on test” components, and configure the data EPROM to set the correct parameters for the software. A special application for the Macintosh computer was written to make this latter operation easier than hand coding the data in assembler language.

The complete power converters were remarkably easy to commission. This is obviously due to the fact that the technology had been well developed and already proven, and more than 100 of them had already been built. The power converters were first tested into a dummy resistive load, and then into their respective magnet families.

5 PERFORMANCE IN THE SRS

After some cross calibration checks to compare the LEP and Daresbury current standards, tables for the SRS energy ramp were loaded and executed, to test the timing synchronisation. it took only a few attempts to ramp the SRS beam to full energy. Tests were then performed to progressively shorten the ramp time, and no difficulty was found in reducing the 14 minute time used with the old roller regulator type power converters to 70 seconds. An experiment to explore the limitation of ramping time achieved a full energy beam ramped in 22 seconds. The

hysteresis cycling before every refill was also much faster, taking only 30 seconds to complete instead of 4 minutes.

It was not possible to synchronise the ramp of the RF power as explained previously, but as expected, lack of accurate tracking has caused no operational problems.

6 OPERATIONAL EFFICIENCY AND RELIABILITY

The time scheduled to refill the SRS is 45 minutes. It previously required 60 minutes. When the vacuum conditions are good, the SRS operates with one refill per day, so the improvement has increased good beam availability to users by a minimum of 1%.

Because the new power converters are naturally air cooled, it was possible to decommission a closed circuit demineralised water cooling system required for the old units. This, together with the higher efficiency of the power converters yields a reduction in power consumption of about 30kW, resulting in a substantial saving on the running costs of the accelerator.

To date three problems have been encountered. The 16 bit DACs were found to drift in calibration initially requiring frequent use of the built in calibration trim facility. CERN advised us that they too had this problem and they were forced to grade the supplied DACs, using the most stable in the most critical circuits, and the inferior ones in less critical circuits. They had inadvertently supplied Daresbury with all inferior ones. Once identified, the problem was quickly remedied.

On three occasions thyristors have failed, always in the dipole power converter. One of these faults shorted the transformer and tripped the 11kV circuit breaker on overcurrent. It was discovered that the pressure on the thyristor clamps had decreased below specification, due to sustained running at high temperature and thermal cycling. When re-adjusted to the correct pressure, the problems ceased. All of these failures occurred during machine start-up after a shutdown.

One failure of a small switch-mode power supply in the electronics has occurred. A built in power backup system functioned correctly, and the stored beam was retained, although the machine control system lost contact with the power converter. At the next scheduled refill, it was replaced with no fault time incurred.

After the new power converters were commissioned in August 1994, no loss of scheduled user beam time on the SRS has been due to this equipment. In comparison, in the corresponding 18 months prior to the changeover, 45 hours of lost user beam time were attributable to the old roller regulator power converters.

7 CHANGE TO CERN ISOLDE CONTROL SYSTEM

While the new power converters were being built and installed, another development [4] was initiated to replace the SRS computer control system. After 6 months running with the control system previously described, the new control system was ready to take over the control room end of the operation. An application written for the ISOLDE system now provides the same facilities as were originally implemented with a Macintosh computer.

8 CONCLUSIONS

The operational efficiency of the SRS has been considerably enhanced by the new power converters. The improved electrical efficiency means that the capital cost of the equipment will be recovered from reduced electricity costs over the remaining operational life of the machine.

9 ACKNOWLEDGEMENTS

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10 REFERENCES

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