C.2. Laboratory Accelerators Operations Progress Report--*Tom J. Gray*

During the last year we have continued to expand the level of technical support in our mission of maintenance, upgrade, and operations of the accelerator facilities of the laboratory. Over the last few years there has been a shift in responsibilities for the technical support staff. As the level of complexity of the experimental research program has increased it has been necessary to add responsibilities for the technical staff in the areas related to the set up of target systems in collaboration with the researchers. These added responsibilities are related to the lack of sufficient research manpower to efficiently get the needed jobs done in a timely manner. The shift to direct support of the individual research programs within the laboratory has been facilitated through increased system reliability for the major systems in the laboratory.

The High Voltage Engineering Corporation (HVEC) model EN tandem Van De Graaff accelerator has logged 3116 hours of operation during the last year. Tank openings for maintenance were limited to two times through January of this year. The research groups were provided a variety of beams from H to I over a range of tandem terminal voltages ranging from 0.56 MV to 6.65 MV. The percentage of downtime was 8% of the time for beam on target through late December 1999.

We had ordered a replacement charging belt for the tandem accelerator in October 1997. After placing the order we became aware that the vendor was having problems supplying replacement charging belts due to the loss of a subcontractor who supplied the cotton carcasses for such belts. During the summer of 1999, we were approaching 5,000 hours of operation on the charging belt in the tandem. Our previous experience with charging belts had shown that belt failures occurred between 10,000 and 11,000 hours of operation. We became aware that the problems that the vendor was having in producing charging belts were acute and nowhere near solution. A number of HVEC accelerators worldwide were getting into serious problems due to belt aging and belt failures. We proposed to the Department of Energy an upgrade of our tandem accelerator to a pellet charging system (Pelletron) that was available from National Electrostatics Corporation (NEC). A model EN tandem accelerator at Sandia Laboratory and another at the University of Wisconsin had previously undergone a successful conversion to the NEC Pelletron charging system. Several HVEC model FN tandem accelerators had also been successfully converted over to Pelletron charging systems. The Department of Energy provided the funds to purchase the Pelletron conversion kit along with spare parts, onsite field engineering support by

NEC, and the additional SF_6 insulating gas required for Pelletron operation. The order for the conversion components was placed in October 1999, with delivery scheduled for April 2000. We planned to do the conversion in late August 2000.

On January 8, 2000, during an experiment, we experienced a catastrophic belt failure at 6963 hours on the charging belt. This failure was totally unexpected, given our long experience with previous charging belts. The charging belt in the EN tandem at Western Michigan University, another DOE-supported laboratory, had failed in September and we had shipped our last spare used belt to them in response to their call for help. Thus we were without a replacement belt. A worldwide search for a replacement was immediately initiated and a belt for an EN accelerator was located at the Weizmann Institute in Israel. That belt was loaned to us and we installed it in our accelerator after having to edge trim it because of prior damage resulting from a previous installation in their accelerator. We returned the tandem accelerator to service after six weeks of downtime for belt-related problems. As the Weizmann belt had a reduced width we were limited to lower maximum terminal voltages because of belt charge density considerations. Scheduled experiments were resumed and the research proceeded until the tandem was shut down on March 27, for the conversion to the Pelletron charging system, which was shipped from the vendor on March 20.

The technical staff removed all of the components associated with the belt charging system and modified some systems to remove conflicts with the Pelletron system. They also installed the major components of the Pelletron system prior to the arrival of the NEC field engineer on April 17. Mr. Larry Lamm from the accelerator laboratory at Notre Dame University (another DOE supported Laboratory) was invited to join us for training purposes during the conversion from belt to chain charging systems. He arrived on the 17^{th} and participated in the final phases of the work in progress. Notre Dame has a Pelletron system on order. When the NEC engineer arrived, the system was aligned and the pellet chains were installed. The charge induction electrodes were set into position and tested. The pressure vessel was closed, evacuated, and back filled to 80 psig of SF_6, and acceptance testing was done. The charging chains performed up to the specifications of providing 150μA of positive upcharge per chain. The field engineer from NEC left on the afternoon of April 19. The prior experience of NEC was a minimum onsite presence of 5 days before acceptance was achieved. We had completed the project to the acceptance test point in 2 days.

Further testing of the upgraded accelerator shows the expected improvement in the terminal voltage ripple, going from 3 kV to 0.6 kV. With the inclined field acceleration tubes installed in our machine, the reduction in terminal voltage ripple translates directly into improved spatial resolution for the particle beams. We also benefit by getting better beam energy resolution and timing resolution for our time-bunched modes of operation. The tandem accelerator was placed back online for use by the users on May 1. Training of research personnel in the operation of the new charging system was done prior to their use of the facility.

During the last year we had other system failures that required attention. The diode ion source suffered a catastrophic vacuum failure while at high voltage. As a result, the high voltage acceleration column had to be rebuilt by the vendor. Upon receiving the rebuilt acceleration column we reinstalled it and aligned it. The source was returned to operation in late April 2000. We also had a failure in one of two redundant water chiller systems. A compressor failure occurred. We replaced the compressors in both water chillers and made modifications to facilitate future compressor replacements and returned the systems to service.

During the last year we found that the three harmonic beam prebuncher which is used for providing high time resolution bunched particle beams had deteriorated due to what we at first believed was related to the deterioration of the 200W rf power amplifier that is used to drive the buncher. Experiments using H ions required that we run the buncher at maximum field levels. We discovered that the buncher would not provide the required field levels because of distortions coming from the power amplifier which had been in service for 11 years. We purchased a new 500 W rf power amplifier and upon installing it found that we had severe problems with harmonic distortion due to low Q values in the three tank circuits for the 12, 24, and 36 MHz resonator circuits of the buncher. We transported the buncher to Argonne National Laboratory where we worked with the ATLAS engineer who designed and built the room temperature beam time bunchers for ATLAS. Design changes were suggested and training in tuning the buncher was received. Upon return the buncher was modified and reinstalled. In an experiment recently ran a time resolution of 800 ps for a 4 MeV proton beam was measured.

In the summer of 1999, extensive testing of the high beta resonators in the LCM3 cryostat of the LINAC was performed. It was determined that two of the four high beta resonators in that cryostat had maximum operational field levels of less than 1 MV/m. With our present variable reactance control (VCX) units on the super conducting resonators, the resonators have run at field levels of 2 MV/m to 2.7 MV/m. Further testing of the low field resonators showed that they exhibited the characteristics of resonators which had cracked welds in the connections of the service ports on the resonator body. This is a known problem with the earlier design of the split ring Nb resonators produced by Argonne. We are planning to demount the two bad resonators and have them repaired as soon as funds are available.

The LHe refrigerator continues to operate with great reliability. We provide 4.2 K cooling for the LINAC and LHe for CRYEBIS operation. We recently changed the low temperature expansion engine after over 13,000 of continuous operation. The purchase, using ARIMS funding, of a spare expansion engine for the refrigerator has been most beneficial in terms of minimizing refrigerator downtime and improving ease of maintenance.

In the last year, three additional beam lines were installed on the LINAC because of growth of the experimental program in the laboratory. Design, assembly, alignment, and vacuum testing were done by the technical staff in collaboration with the research users. One of the largest single areas of responsibilities for technical support on a continuing basis is the care and maintenance of the large number of high vacuum systems used throughout the laboratory. We service and rebuild all of the turbomolecular high vacuum pumps within the laboratory. Last year we rebuilt 10 turbo pumps. We have an inventory of over 80 turbo pumps, all of which are in service on a continuous basis. New experimental apparatus coming online require additional turbo pumps and all of the associated vacuum gear that are part of a pumping system. Currently, staff is spending .25 man-weeks/week on average, working on tasks associated with vacuum systems. The staff also provides all high vacuum stainless steel welding services as needed for the fabrication of systems built in-house by the local shops and research groups.