TD Test Facility Operations: Our understanding of the covered scope

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The KA25 Test Facilities B&R will fund work associated with the operation and maintenance of Fermilab's accelerator test facilities and associated infrastructure and support systems. These activities support development and testing of superconducting RF and superconducting magnet technology.

We understand this B&R to covers operational expenses of maintaining and improving technical facilities that support multiple activities. The facilities are the technical infrastructure that enables design, fabrication, and testing of accelerator components. Facility operations does not cover the direct costs of fabrication and testing. The project or program pays for attaching instrumentation, connecting equipment to power supplies, installation of devices to be tested, executing the test (except for time spent by operators providing liquid helium for cooling), or analyzing the data.

In Technical Division we have a wide variety of such facilities that we find useful to account for separately. What follows is a list with a short description of each facility and the projects and programs that rely on the facility, along with a few example expenses. We think that each of the listed facilities meets the criteria for a test facility that should have an operations budget, but would be happy to discuss the choices.

Funding for these facilities has historically come from several sources. The Magnet Test Facility, including the helium liquefaction plant, was for over three decades funded by Accelerator Operations, since the Fermilab accelerator complex, especially the Tevatron, was the primary program supported. We did an imperfect job in reassigning tasks when agreement was reached to move funding to Test Facility Operations, so there is still clean-up to do there. The construction and operation of the SRF facilities, including VTS-1, VTS-2, and VTS-3, which share a liquid helium source with the cryogenic magnet testing, have been funded through Project 18, using a mix of GARD and operations money. Operations in several smaller facilities have historically been funded with Program Support guidance through the TD department responsible for the facility, but we think they are more appropriately included with Test Facility Operations.

Facility	Location	Description	Example expenses	Current Users
QC Lab	IB4	The Quality Control Lab is responsible for inspecting incoming components for conformity to the requirements. The capabilities include precision measurements of parts, vacuum leak testing, surveying for alignment, magnetic properties of materials, and the chemical composition of metals.	Equipment maintenance Equipment calibration New equipment Operator training Management effort (Effort for measuring components is charged to the project or program.)	Essentially every part that comes through TD for every project and program is measured here first. Both AD and PPD also make use of our services on occasion.
Superconducting Magnet Facility	IB3	The Superconducting Magnet Facility includes equipment for the construction and production tests of SC magnets. The capabilities currently include winding superconducting cable into long coils, reacting the coils in a large oven in an argon atmosphere, squeezing the coil in its collar, and assembling multiple coils into a magnet cold mass. Needs include the modernization of aging equipment (cabling, insulating and winding machines, curing and welding presses, reaction oven, etc.), installation and commissioning of new test equipment (cable quality control, coil size measurement, warm magnetic measurement, etc.), and continued support of safety and environment control operations.	Equipment maintenance Equipment upgrades New equipment Operator training (Forms, molds, and new specialized handling equipment are paid for by the projects, as is effort in building the magnets.)	High Field Magnet Program LARP LHC HiLumi Upgrade

Conventional Magnet Facility	IB2	The Conventional Magnet Facility supports construction of room temperature magnets, small superconducting magnets, and occasional other projects. The capabilities include a grit blast booth, rotating tables for winding coils, a large oven for vacuum impregnation, a large oven for coil curing, stacking tables for building laminated magnet cores, a magnet for magnetizing permanent magnets, instruments for in-process inspection of mechanical and electrical properties, an oven for debonding any vacuum impregnated component.	Equipment maintenance Equipment upgrades New equipment Operator training Production oversight (Forms, molds, and new specialized handling equipment are paid for by the projects, as is all effort in building the magnets.)	Essentially every magnet in the Fermilab accelerator complex is built, rebuilt, repaired, or at least inspected here. CLAS12 APS MBA Upgrade
Helium Refrigerator	IB1, IB1A	The IB1 Helium refrigerator is a subset of the operations in IB1 that support testing of SRF cavities and superconducting magnets. The refrigerator liquefies helium gas, which is stored in a buffer dewar. The helium that boils off as a test subject is cooled is captured and recirculated. The refrigerator system includes compressors, their motors, the heat exchange system, valves and piping, a liquid nitrogen system for precooling, and an elaborate controls system. The supply of deionized cooling water for the refrigerator, magnets, and power supplies is also covered here.	Equipment maintenance Equipment upgrades New equipment Helium Liquid nitrogen Refrigerator operators and supervision (The cost of installing piping to bring helium to a new test area is meant to be borne by the first user of the new area, but the subsequent maintenance is an operating expense.)	HFM LARP LCLS II PIP II SRF GARD

Vertical Test Stands (VTS)	IB1	Vertical cavity test Stands provide testing capability for individual superconducting RF cavities. Three test stands (VTS-1, VTS-2, and VTS-3) allow the testing of single-cell or multiple-cell SRF cavities, bare or dressed, in a vertical configuration. Each stand is a deep cryostat installed in the floor that can accept liquid helium to cool the cavity under test. The system includes RF power supplies, controls, and instrumentation.	Equipment maintenance Equipment modifications to fulfill the needs of high priority projects and programs (Executing a test cycle, from preparing the cavity, through making and analyzing a measurement is at the expense of the program or project.)	LCLS II PIP II SRF R&D

Superconducting Magnet Stands	IB1 & CHL	The Superconducting Magnet Test Facility is the only facility in the US that can support testing of SC magnets at 1.9K. In this facility current and quench measurements are carried out, as well as detailed magnetic and performance measurements. Facility support includes power supplies and current leads, equipment and tooling for magnetic measurements and consumable costs (including He and LN2). Needs include extension of capability to test long (>4 m) magnets at higher currents and larger apertures. The Vertical Magnet Test Facility (VMTF) is a deep cryostat for testing magnet cold masses. A horizontal test stand can test large cryostated magnets. Another test stand can measure smaller, Tevatron-scale magnets. Another stand is configured to test HTS magnet leads. Another stand has a Tevatron dipole permanently mounted for calibration uses. The Solenoid Test Facility, located in CHL, can measure medium sized solenoid coils. The test stands are served by appropriate power supplies, controls, instrumentation, and magnet measurement systems.	Equipment maintenance Equipment upgrades New equipment (Executing a test cycle, from preparing the magnet, through making and analyzing a measurement is at the expense of the program or project.)	HFM LARP Mu2e LCLS II

Room Temperature Magnet Test Stands	IB1	The conventional test facility includes three test stands, additional portable equipment, and a calibration magnet. Various appropriate power supplies and controls, magnet measurement instruments, electronics, motion control, computers, and software are covered.	Equipment maintenance Equipment upgrades New equipment Historically, executing a test cycle, from preparing the cavity, through making and analyzing a measurement has been covered by Accelerator Operations, even for a Project. (Projects pay for any overtime necessary to meet a schedule.) (New measurement probes needed for a specific geometry are usually at the expense of the project, unless they are so clearly generally useful that they are absorbed as an operating expense.)	PIP Booster Main Injector Recycler NOvA Mu2e Muon g-2 Muon Campus AIP PXIE ASTA APS MBA Upgrade
T&I Management	IB1	The Test and Instrumentation (T&I) Department is responsible for the management of all the test facilities in IB1 and CHL except the CHL refrigerator. T&I also provides support for programs and projects, for which the other programs and projects pay.	All management effort in T&I, including administrative support M&S supporting the operation of the department	See above

SC Strand and Cable Lab	IB3A	The Superconducting Strand and Cable Lab measures the performance of SC strands and cables for both R&D efforts and for quality control of production runs. A cabling machine can make cables from strands. The lab technicians prepare samples of strands and cables for testing. The lab has ovens for heat treatment of samples, including one high pressure oven. Cryostats with equipment to apply high magnetic fields and pressures allow performance testing under strenuous conditions. The necessary power supplies, controls, instrumentation, and data acquisition systems are available. Needs include the modernization and safe operation of cryogenics and vacuum equipment, power supplies and DAQ.	Equipment maintenance Calibration Equipment upgrades New equipment (Preparing samples and making measurements is at the expense of the program or project. New equipment needed for a specific program are usually at the expense of the program, unless they are so clearly generally useful that they are absorbed as an operating expense.)	Superconductor R&D High Field Magnet LARP Mu2e Muon g-2
Advanced Analytical Tools Suite	ICB & IB3	A suite of advanced analytical tools for surface imaging and physical property measurements include scanning electron microscope with EBSD and EDS attachments, laser confocal scanning microscope, optical microscopes, PPMS system, and sample preparation equipment. Two Instron® machines measure stress-strain curves, tensile strength, and the like.	Equipment maintenance & calibration (Preparing samples and making measurements is at the expense of the program or project.)	SRF R&D Superconductor R&D High Field Magnet LARP Mu2e Muon G-2 Accelerator Operations Detector Operations
MDTL	Village	Materials Development and Testing Lab includes chemical hoods, inventory of chemicals, mechanical polishing and cutting equipment for a full sequence of chemical treatments (etching, polishing) and mechanical preparation of parts and samples.	Equipment maintenance & calibration Handling of chemical supplies	Superconductor R&D High Field Magnet LARP Mu2e Muon G-2 SRF R&D Accelerator Operations Detector Operations

Optical inspection lab	ICB	Includes single and multicell cavity optical inspection systems, RRR measurement and Eddy current scanning setups.	Equipment maintenance & calibration Equipment modifications to fulfill the needs of high priority projects and programs	LCLS II PIP II ILC SRF R&D
ANL SRF Cavity Processing	Argonne	Superconducting cavity surface processing facility (SCSPF) located at Argonne National Laboratory and jointly operated by FNAL and ANL. This facility supports production processing of cavities intended for vertical, horizontal testing, and for cryomodules. The ANL SRF Cavity Processing Facility is jointly run by Fermilab and Argonne in support of research and production at both Labs. The lab provides buffered chemical polishing, electropolishing, and high pressure rinsing for SRF cavities.	Equipment maintenance Equipment modifications to fulfill the needs of high priority projects and programs (Processing cavities is at the expense of the program or project.)	LCLS II PIP II ILC SRF R&D
HTS/STC	MDB	Horizontal cavity test systems provide testing capability for fully-dressed SRF cavities, including high-power RF couplers. The SRF cavity Horizontal Test Stand (HTS) and Spoke Test Cryostat (STC) are located in Meson Detector Building. HTS is a cryostat in which dressed SRF cavities are tested for production QC or for R&D.	Equipment maintenance Equipment modifications to fulfill the needs of high priority projects and programs (Testing cavities is at the expense of the program or project.)	LCLS II PIP II ILC SRF R&D
CPL	IB4	Cavity processing laboratory includes vacuum ovens for heat treatments and doping, clean room with high pressure water rinsing stand, electropolishing setup for 1-cells, and mechanical polishing (tumbling) machine for SRF cavities. Most of LCLS-II cavity recipe development is happening here. RF lab for field flatness measurements and tuning is also part of the facility.	Equipment maintenance Handling of chemical supplies Equipment modifications to fulfill the needs of high priority projects and programs (Processing cavities is at the expense of the program or project.)	LCLS II SRF R&D PIP II

CAF/MP9	ICB and MP9	Cavity preparation and cryomodule assembly facility includes the facilities in which superconducting RF cavities are received in a polished and rinsed state and prepared, assembled into cavity strings, and assembled with other hardware into cryomodules. The Cavity Assembly Facility (CAF) is divided between MP9 and ICB. At MP9, bare cavities are dressed with their helium vessels and assembled into a string. At ICB, cavity assemblies are joined with magnets and other components, instruments, and installed in cryostats to complete a cryomodule.	Equipment maintenance Equipment modifications to fulfill the needs of high priority projects and programs (Assembling cryomodules is at the expense of the program or project.)	LCLS II PIP II SRF R&D
Engineering Computing	Virtual	TD's engineering computing facility provides powerful computer servers and software tools for complex modeling problems for a variety of SRF cavities and other radio frequency or microwave devices.	Equipment upgrades and replacement Software licenses and maintenance	LCLS II PIP II SRF R&D ILC PIP SPT CMB