Universal Laboratory Equipment Maintenance, a 10-year Program Review

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Introduction

In 2010 the Penn State College of Medicine (COM) experienced a catastrophic eight-hour power outage that put millions of dollars of research materials and equipment in immediate risk. As a result of this incident, COM Administration sought to find solutions and processes to better protect these valuable research samples and equipment in the event of another campus-wide disaster. To this end, the Office of Research Quality Assurance working under the direction of the Associate Dean for Research and the Vice Dean for Research were tasked with administrating and implementing these solutions as they were developed in situ.

Methods

After completing a formal review of the power outage event, one of the initial vulnerable areas identified was that of the several hundred Ultra-Low-Temperature (ULT) freezers located throughout campus. These units were estimated to contain 150 million dollars in research material and must maintain -80C indefinitely to ensure product stability. Because of the high-value of the product within each ULT and their overall commonality throughout campus, initial actions were focused on completing a campus-wide check to ensure each freezer was serviced and in proper working order; regardless of an individual lab's ability to pay for the service to be completed.

This campus-wide ULT check ultimately took the form of an institutionally-funded routine freezer service and inspection program. The program was made available through direct funding from the Office of the Vice Dean for Research and is approved annually by the Office of the Controller. Having a centralized funding source allowed for contractual agreements with third-party vendors to be initiated at a bulk-discount rate providing annual Preventative Maintenance (PM) and calibration for each individual ULT at the COM for a competitive cost.

The ULT protection program also included the development of a Specific Laboratory Emergency Plan (SLEP) document. The SLEP is a posting to be physically attached to the door of each ULT and provides the contact information for each sample owner as well as specific steps needed to transport the materials to a predetermined backup ULT location. Also, written into University policy at the same time as the ULT protection program was the requirement for all new freezers to be equipped with a syphon-CO_2 back up system and a standardized encrypted WIFI-based temperature alarming device. These additional safeguards work in concert to provide liquid-delivered CO_2 within the freezer chamber (*keeping each ULT at -60C, even with no working compressors or outside power*) and alerting the sample owners of the unit's failure (*via call, text, email, page, fax*).

Through the successful implementation of the centrally-funded ULT protection program additional university-funded services were offered for free to the campus research community. This growing list of services lead to the development of a robust Asset Management Program (AMP) that encompasses all routine service agreements on each individual piece of essential laboratory equipment on campus. This includes PM and routine service, regardless of laboratory funding status, for all: ULTs, Micropipettes, BioSafety Cabinets, Chemical Fume Hoods, Scales, Balances, Glass Washers, DI Water Systems, RO Water Systems, Anesthesia Machines, Autoclaves, Ventilated Cage Racks, and many other specialty scientific devices.

The AMP has been developed to ensure all services offered are based on defined, manufacturer- or ISO-specific, protocols and procedures, with service expertise provided by companies specializing in the specific needs of the individual equipment pieces covered.

Results

Initial observations showed the Asset Management Plan:

- Reduced the repair and operating costs over the lifetime of over 5000 pieces of equipment due to annual routine servicing/maintenance (Fig2)
- Increased the operating efficiency of the equipment
- Provided a comprehensive up to date inventory of COM equipment (Fig3)
- Provided accurate experimental data and reproducibility
- Increased staff safety and technical knowledge of equipment
- Provided periodic financial reviews and institutional metrics on select lab equipment

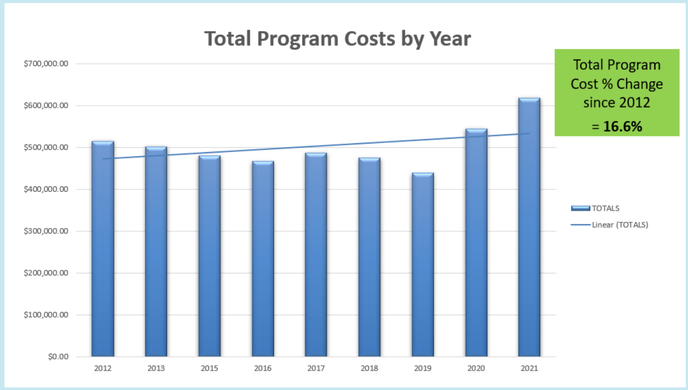

Fig1: Total costs of the Asset Management Program increased 16.6% over the past ten years of service.

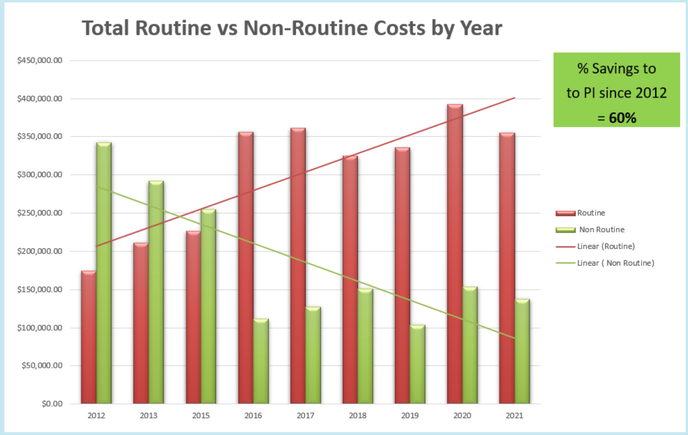

Fig2: The Asset Management Plan resulted in a 60% decrease in direct costs to investigators relating to non-routine equipment breakdown and repair. This, however, increased the overall routine maintenance costs covered by the institution (as shown in Fig1).

Discussion & Conclusions

Prior to the implementation of the Asset Management Plan, principle investigators within the Penn State College of Medicine had a variety of service agreements and providers for an assortment of their most commonly used equipment. The type and quality of service experienced by the lab was totally dependent on the amount of funding the lab received and by the availability of said funding to be used for equipment maintenance purposes. This fact, combined with continual decreases in federal funding to the sciences each year, had many investigators choosing to abstain from initiating any service agreements on the very equipment that their research and safety was so dependent on. This underlying risk became further apparent during the 2010 power outage and actions were immediately taken to ensure such a large vulnerability would not exist in the future. In response, the COM administration identified the vital need to assist all researchers by centrally-funding an equipment PM and certification/calibration program. This program grew to include all commonly used laboratory equipment and continues to be entirely funded by the administration under a central purchase order system.

Recent program expansions to the AMP have included the initiation of a Capital Replacement Program (CRP) covering the replacement of select equipment entering their end of operational life. A successful test of the expanded CRP program took place from 2018 through 2020 which focused on replacing the 30 oldest BioSafety Cabinets on campus with new 4-foot Class 2 Type A enclosures. The AMP provided funding for all costs associated with decontamination and removal of old BSC and installation/certification of the new units. Though BSC replacement expansion showed an upfront cost of $175k to the institution, it was well received by laboratories and provided incentives to researchers in the form of enhanced safety for product manipulation and cost savings on non-routine repairs of old equipment or the lab's potential purchase of a new BSC unit (Fig1).

Further miscellaneous expansions to the AMP have included the development of COM Laboratory Design Standards which mirror NIH internal policy for placement of laboratory equipment and overall spatial design. The standards at the COM also include the requirement for a facilities technician to assess the thermal-offload of all lab equipment and ensure adequate HVAC service is present to keep the lab and equipment at an optimum temperature – extending the service life of each device within the space.

Additionally through partnering the AMP with the COM Purchasing division, an all-encompassing laboratory equipment purchase list is formulated each fiscal year showcasing the best-available purchase prices from all University-approved vendors. This master list ensures the best prices are contractually locked-in for all investigators for the entirety of the fiscal year and that only the best equipment with the proper safety measures are available for COM laboratories to purchase.

Overall, Asset Management Program has driven non-routine repairs down 60% since it's inception in 2012 while only increasing total program costs by just 16.6%. The AMP has, and will continue, to provide many positives outcomes for all our 300+ IBC approved laboratories and the cutting-edge research they produce.

70 Anesthesia Machines/Vaporizers	**2631** Micropipettes
13 Autoclave, Large	**16** RO Operational Check
12 Autoclave, Small	**135** Ventilated Cage racks
358 Balances	**271** Ultra Low freezers
6 Bedding Dispensers/Rack washers/tunnel washers	**45** Beckman/Sorvall/Thermo – High end centrifuge operational check
299 Biosafety Cabinets	**36** PI chosen service agreement for PM/calibration of high end centrifuges
399 Centrifuges, Benchtop and microfuge	**2** Spectrophotometer Operational
36 Centrifuge, High Speed	**4** PI chosen service agreement for PM/Calibration of spectrophotometers
198 Chemical fume Hoods	**3** Scintillation Counter Operational
18 DI Carbon Exchanges	**3** PI chosen service agreement for PM/Calibration of scintillation counters
360 Incubators	

Fig3: The Asset Management Program allows for real-time tracking of thousands of individual pieces of laboratory equipment. Granular data such as equipment make, model, operational status, and physical location can also be extracted from the program's data.

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