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Maintenance, Repair and Operation (MRO) Of Shutdown Facilities

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Abstract:
What level of maintenance does one apply to a shutdown facility? Well it depends on who you ask. Operations staff sees facilities that have completed their useful life cycle as a cost drain while Decommissioning staff sees this as the start of a new life cycle. Based on the decommissioning plan for the particular facility the building could complete another full life cycle while under decommissioning whether it is in storage with surveillance mode or under active decommissioning. This paper will explore how you maintain a facility and systems for many years after its useful life until final decommissioning is completed.

When a building is declared redundant, who looks after it until the final decommissioning end state is achieved? At the AECL, Chalk River Labs site the safe shutdown and turnover process is one key element that initiates the decommissioning process. The real trick is orchestrating maintenance, repair and operation plans for a facility that has been poorly invested in during its last years of useful life cycle. To add to that usually shutdowns are prolonged for many years beyond the expected turnover period. During this presentation I will cover what AECL is doing to ensure that the facilities are maintained in a proper state until final decommissioning can be completed.

All facilities or systems travel through the same life cycle, design, construction, commissioning, operation, shutdown and demolition. As we all know, nuclear facilities add one more interesting twist to this life cycle called Decommissioning that lands between shutdown and demolition. As a facility nears the shutdown phase, operations staff loose interest in the facility and stop investing in upgrades, repairs and maintenance but continue to invest and focus on maximizing operations. Facility maintenance standards produced by the International Facility Maintenance Association (IFMA) based on a survey done every year state that 2.2% of the total operating costs for the site should be attributed to maintenance and repair of the facilities. At CRL the percentage of budget attributed to maintenance, repair and operation of a facility does not exceed 1.2% on average. The result of this under funding is typical of many other campus type facilities where the higher priority facilities will see MRO budget figures attributed to their facilities or systems in the 2% range to 3% for nuclear related facilities while non priority facilities or systems will have less than 1% allocated against them for MRO. Listed below in Figure 1 is a comparison of CRL Decommissioning Budgets over the past few years.

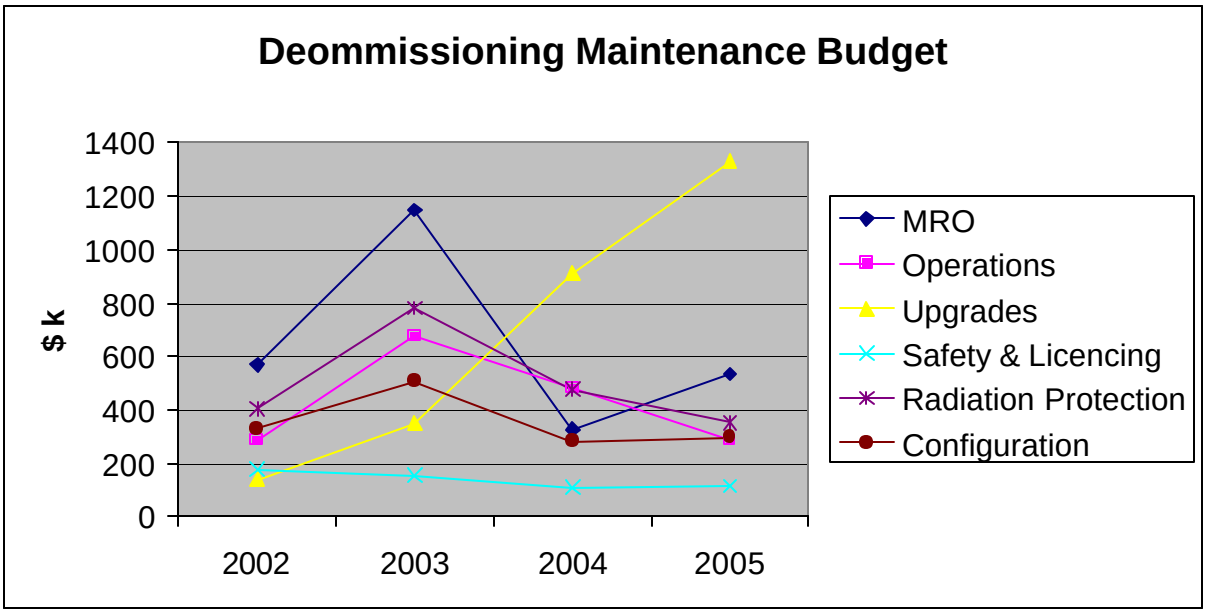

Figure 1

The variations in different types of budget are easily explained and should be referenced in the annual business plans. For example, the upgrades budget shows a reflection of a major roof replacement.

Figure 2 below is an indication of the square footage assigned to CRL Decommissioning along with the removal of buildings. The cost per sq. ft. is associated to the hazard and complexity of the facility.

Building #	Description	Sq. Ft. 02/03	Removed during 02/03	Sq. Ft. as of March 03	Sq. Ft. as of March 04	Projected Sq. Ft. 04/05
100	NRX Reactor	51998		51998	51998	51998
100X	Reactor Effluent Experimental bldg.	194		194	194	194
101	NRX Fan Room	1042		1042	1042	1042
101X	NRX Fan Room	1768		1768	1768	1768
103	Delay Tank	230		230	230	230
104	Delay Tank	289		289	289	289
107	General Chemistry			36607	36607	36607
122	Reactor Exhaust Stack Base	0		0	0	0
125	Process Water Line Valve House				0	150
126	Monitoring and Water House	213		213	213	213
133	Rod Bay	555		555	555	555
144	NRX Gas Holder Building	369		369	369	369
145 PTR	PTR Reactor	1763		1763	1763	1763
157	Abandoned Section of Reactor Exhaust Stack Duct			0	See Note #1	See Note #1
201	Filter Storage and HVAC Shop			1277	0	0
204	NRX Fuel Rod Bays	15091		15091	15091	15091
210	Heavy Water Upgrading Plant				0	13692
212	D2O Storage Building				0	3824
215	Tritium Extraction Plant				14090	14090
220	Chemical Operations Lab	10887		10887	10887	10887
221	Fan house for B220	1443		1443	0	0
223	Plutonium Tower	1352		1352	1352	1352
228	Waste Water Evaporator	960		960	960	960
232	Active Material and Test Storage	240	240	0	0	0
409	Plant Engineering (north and east wings)	11119	11119	0	0	0
430	Radiation Training & Filter Testing	5356	5356	0	0	0
464	Plant Hospital				0	11887
535	NRU Oil and Paint Storage				0	0
	Total	**104869**	**16715**	**126038**	**137408**	**166961**

Table 1

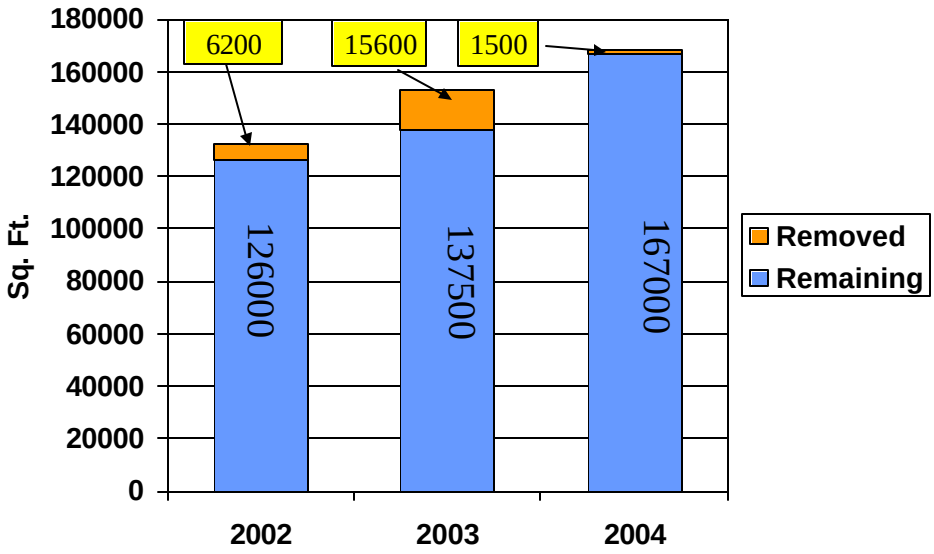

Figure 2

The above figure graph reflects the information given in Table 2. It shows how the sq. ft. for CRL Decommissioning has grown over the past 3 years along with what has been removed.

For decommissioning staff this can become the first obstacle in the process of taking over a facility. Facilities that have been neglected for a long period of time require more financial effort to put them into an acceptable storage with surveillance period. The facility has to be analyzed from a perspective of cost to determine early in the process whether or not prompt decommissioning is inevitable along with the cost justification for whatever decision is made. A weighting criteria has to be established to determine what budgets are attributed to what facilities. At AECL we spend time with the Operations staff in the development of their long-term plans or a Site Master Plan, which allows decommissioning to be proactive in developing a decommissioning strategies and the requirements to mesh with this plan. Decommissioning staff works with operations staff to develop long-term plan for decommissioning that integrates the operations plan with a decommissioning plan. On a semi-annual basis a prioritization meeting is held where Decommissioning and Operations staff prioritize what is being turned over to decommissioning, what needs to be decommissioned from an operations view and where resources will be allocated over the next two years. These plans lay the groundwork and become a key input into the decommissioning strategic plans.

A Safe Shutdown document that states both parties agreement on what is required to initiate the turnover of a facility to Decommissioning is then worked out between Operations and Decommissioning staff for the higher priority facilities. The safe shutdown plan itemizes the steps required to bring the facility to a safe state. These activities usually include the removal of all radioactive sources, fume hood cleanup,

removal of storage vault contents, misc. loose materials removed from the building which includes anything that isn't nailed down. The shutdown plan also includes the removal of all hazardous materials e.g. chemicals, PCB's and identifies industrial hazards that require repair or replacement before turnover to Decommissioning. The shutdown plan also includes items that won't be dealt with during the safe shutdown. These items may include activities such as the removal of asbestos, PCB's, radioactive materials, etc. Items of this sort are negotiated and agreed to in the plan. Other activities that should be considered prior to turnover are a review of the maintenance records for the facility. Items that require regulatory compliance are of a particular importance e.g. pressure safety valve compliance, pressure vessel inspections, removal of Freon's, halocarbons, etc. that can lead to a one time spike in operating costs.

Once the safe shutdown activities are completed a review of what has been accomplished against the plan is transposed into a Safe Shutdown Achieved document that states progress against the plan and any deficiencies against the plan including any new items that may have been discovered during the safe shutdown phase. When agreement between the parties is reached a transfer certificate is issued that is an agreement to transfer a facility, associated costs and any identified deficiencies from Operations to Decommissioning.

When the facility is under the care of decommissioning the real work commences for decommissioning. Sequential activities begin starting with a facility walk down to identify or become familiar with the facility and all identified deficiencies, operational equipment and systems and general awareness of the facility. It is important that the walk down involves the appropriate people to analyze the current condition of the facility including the previous operations and maintenance staff.

Other activities that will begin at this time include searching for records. Maintenance and operations records can be obtained from the previous tenants where applicable. Maintenance files, computerized maintenance management systems (CMMS), operations files, engineering records or even information written on the walls should be looked at to gain some knowledge of the condition of the facility. It has been our experience that maintenance staff tend to keep detailed maintenance information on walls or near the piece of equipment for easy reference, sometimes a digital camera will transpose this key information into your CMMS for everyone to access. A trained eye or experienced person can validate the integrity of records against the condition of the facility and determine how well a facility was maintained. Current design drawings are important for ongoing and future work to the buildings. At this time it usually becomes evident that previous attempts at record keeping have left you with little information that will assist you in the MRO of the facility and has certainly raised countless questions on the facilities use, design, etc. At CRL numerous records were destroyed in a fire in the 1950's. During this presentation I will discuss the bottom up approach on how to re-build the history of the facility, its tenants, their practices, etc. in the absence of information to facilitate decommissioning efforts in the future.

Why is historical information so important? From a pure radiological standpoint the history of the facility is an indicator of what should be looked for during characterization work. What is really important is the present condition or what can be detected in the field today at the facility despite what the history records say. When historical MRO is considered one is searching for a combination of industrial, radiological, structural and condition based evaluation that will tell you the story of the building. Imagine removing a wall as part of the decontamination effort and realizing that you have now put the entire staff at risk by removing a support wall or a gas found in a compressor is now a reportable environmental release. The challenge of not knowing the history of the building is why you have to treat it as highly contaminated or a structurally unsafe facility and work backwards to an appropriate start point. Until this is completed you are at risk, either to your employees/public or at risk of allocating sufficient/insufficient funds to MRO and Decommissioning.

Now you have a plan of attack, you think you know the history, deficiencies, and radiological, industrial make-up of the facility. You now have the start of the Storage with Surveillance plan (SWS). Another evaluation of the facility will develop a list of due diligence and safety issues along with the basis for a preventive maintenance plan and other maintenance, repair and operational activities that need to be conducted.

It has been our experience at AECL that systems left in a ready state during operations are only a time bomb for decommissioning. Everything from a roof leak that could spread contamination or short out an electrical panel, to electrical systems that are energized to a dead end, to pressurized systems, to a piece of equipment left operational, to a routine procedure or plan can end up in disaster. Non-operational equipment, the lack of operating procedures and evidence of poor maintenance can also be indicators of what to expect. Operational equipment left in a ready state can become difficult to isolate and shutdown if the experienced resources who operated or maintained the equipment have left or retired from the company. Large amounts of financial resources can be allocated to such activities when they could have been easily addressed early in the shutdown of the facility. All of these items can lead to the ruination of a proper SWS period and result in disaster. Just imagine the unmarked can sitting in an operating fume hood with measurable radioactive readings coming off it. The evaluation starts and can lead to a substantial waste of resources.

What can we do to avoid this potential problem? Through a structured approach to decommissioning and the SWS period with decommissioning maintenance, repair and operation and projects can be conducted without an undesirable event. This can be accomplished through proper shutdown documentation, work plans, maintenance plans, SWS plans, business plans, etc. Structural, mechanical and hazard assessments are a good source of information to gather this information from. What all these plans allow you to achieve is a documented and structured approach to MRO for many years to come. The consistency of structured plans enables you to monitor and measure ongoing operations and the effectiveness of good maintenance plan.

Maintaining a facility is similar to maintaining a car. If you plan on using it for a few years then trading it in only a little maintenance is required. If you choose to run it for many years then a more comprehensive maintenance plan is established and adhered to. Maintaining a facility is no different. Most companies don't build a facility to only use for a couple of years then abandon due to the high costs associated with it. Most facilities are built and operated long past their useful life cycle due to the high cost of replacement. Running a facility for this length of time requires a good maintenance plan from the start that involves a good preventive maintenance program, an upgrade or capital renewal plan, a routine maintenance plan and a general maintenance and housekeeping plan.

The debate over what a proper maintenance plan will consist of changes from facility to facility, site to site or even room to room. The stage is set once the facility is initially turned over for occupancy. Through the life cycle of the facility decisions are made that will impact decommissioning down the road. These decisions can range from who occupies the facility, what the occupants do in the facility, what adjoining facilities were used for, what the complex was used for to what materials were used.

For decommissioning staff one of the first activities that needs to be resolved is just how long will the facility be in a storage with surveillance state (SWS). Once this decision is made a maintenance plan must be established to see your way through this time frame. For example, NRX reactor will be in a SWS state for approximately twenty years. Obviously the maintenance plan for this building will include a full preventive maintenance plan, an operations plan and a capital renewal plan. For another building that can be completely shutdown without any impact on its internal workings then the maintenance plan may simply resort to an emergency type maintenance plan along with proper monitoring and surveillance.

CRL Decommissioning has recently re-evaluated its preventive maintenance plan as shown in Figure 3. In the following tables one can see the impact of moving from an operational stage to storage with surveillance stage. During the operations period most systems are running and require to be maintained appropriately. If the shutdown of the facility is performed properly maintaining equipment that is no longer operational isn't required. On the other hand, shutting down a facility can lead to increased preventive maintenance in non-traditional areas.

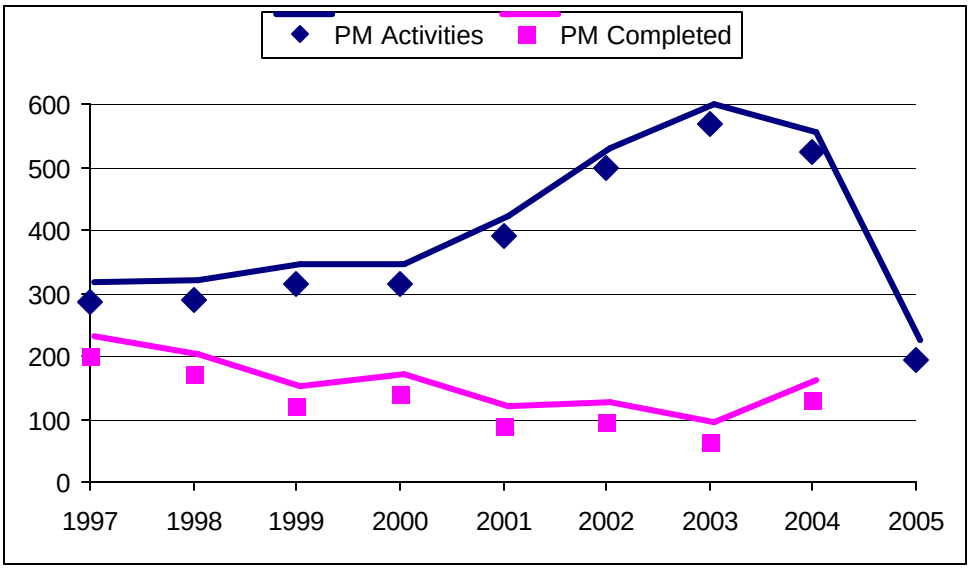

Figure 3

Preventive maintenance can be broken down into various categories. The following categories apply to most preventive maintenance programs.

Routines – routine preventive maintenance applies to activities that are conducted with no real formal program in place e.g. checking building heat. This type of preventive maintenance will protect the facility or equipment from events that could go unnoticed for some time. Routine preventive maintenance is generally conducted using a checklist for verification and auditing purposes.

Preventive Maintenance – a good preventive maintenance program is generally a formal list of activities with a pre-defined schedule, labor estimate and job steps. A good PM program will protect the assets, facilities or equipment from pre-mature failure and generally extend the life of them. This sort of program can be reviewed on a regular basis by reviewing completed activities to confirm the effectiveness of the program. Completed preventive maintenance activities should be reviewed with a history of breakdowns or emergency maintenance on a piece of equipment, building or system. The PM program should be modified through close monitoring to protect the assets and achieve the desired outcomes. Generally a formal PM program can be run on a card system (cards are populated with the PM activity, frequency, job steps, estimated hours, etc.) or in a computerized asset management system where the activities can be planned, scheduled and tracked in an electronic system. PM can be applied to facilities (doors, roofs, etc.), equipment (pumps, fans, electrical, etc) or systems in general (HVAC).

Predictive Maintenance – Predictive Maintenance (PdM) is a subset of a preventive maintenance program. PdM is a more involved type of preventive maintenance with activities including items such as; oil analysis, vibration analysis, and infrared, digital mapping, etc. PdM is usually completed on critical pieces of equipment or safety related equipment such as main cooling water pumps, main exhaust fans, electrical components, etc. PdM is performed to identify problems before they happen which leads to avoided maintenance costs verses breakdown costs.

Reliability Centered Maintenance (RCM) – RCM is a program that incorporates all of the above. The entire program in focused on maintaining equipment so that it is operating in a reliable state at all times. The RCM technology is no different than any other good PM program but it takes it one step further into a full analysis phase of the results and tends to be a little more high-tech.

Emergency Maintenance – emergency maintenance involves assets that have broken down and require repair immediately i.e. water main break or electrical outage.

Corrective Maintenance – corrective maintenance incorporates activities required to repair or correct a problem but isn't deemed an emergency i.e. sewer leak or roof leak.

Planned Maintenance – planned maintenance includes activities that don't require immediate attention or require some more formal review or further assessment before work can commence. These types of activities usually include material orders,

equipment rental, procurement or scheduled manpower. Planned maintenance activities are usually planned and scheduled within the CMMS.

A deficiency and due diligence list was developed by CRL Decommissioning as a way of tracking un-funded activities. The list is prioritized and forms the basis for future budgeting.

Imagine doing all of this and not having the resources required to perform the work. While developing maintenance plans, securing budget and getting approvals to proceed is important, you have to make sure you secure the proper resources to complete the plan. A good resource plan is critical will detail the type of resources required, the estimated time frames and periods that the resources are required. At CRL we only keep a few key resources in the core group as a base crew and staff up or down according to the work planned. Radiation Protection, trades groups and other support groups are on loan to decommissioning through a formal agreement. These semi-formal agreements between departments are called Inter Company Work Request Authorization (ICWRA) or a Service Level Agreement (SLA).

Configuration control is crucial to maintaining a facility for its SWS period. Operations and maintenance people can't be guessing what is operating/shutdown or speculating on what was done in the past. Configuration control involves the documentation of as found or as built conditions and focuses on what is operational as first priority over the total configuration of the plant.

Housekeeping is also extremely important. A clean, uncluttered facility will emphasize the real maintenance issues at an early stage. It also shows that the facility has not been neglected or abandoned and someone is still taking proper care of it.

In summary this presentation will present details on the CRL Decommissioning Facilities group and how they have established a due diligence list of identified deficiencies, developed a configuration control program, revamped a deficient maintenance program and secured the resources required to properly execute the decommissioning plan while satisfying the regulators and internal review boards.