

# **Downgrading the Los Alamos National Laboratory (LANL) Technical Area -18 (TA-18) from a Hazard Category 2 Nuclear Facility to a Radiological Facility**

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## **Abstract**

This paper discusses the experiences and lessons learned during the two year project to downgrade TA-18 from a Nuclear Facility to a Radiological Facility. TA-18 was, for over 50 years, home to the Los Alamos Critical Experiment Facility (LACEF). Since the 1950's the LACEF housed numerous Criticality Assembly Machines (CAMs) on which several thousand criticality experiments were performed. This mission was accomplished under a variety of safety basis regimes. The 2002 Basis for Interim Operations and related Technical Safety Requirement (TSRs) established the most recent documented Safety Basis. LACEF was required to store many metric tons of nuclear material to support the defense weapons program mission. Recent Department of Energy mandates required the relocation of the CAMs and the associated nuclear material at an accelerated pace. The relocation of the LACEF mission was driven by both economics and a revised Design Basis Threat (DBT) imperative. The accelerated removal of the critical experimentation mission to Nevada and the Nevada Test Site created many technical and business challenges which will be discussed in this paper.

The transition process revealed scheduling and business management issues, historical TSR issues, operational and cost issues. Additionally, the transition and house cleaning process for TA-18 also identified several legacy material problems. A team approach was required to devise and implement creative technical and business solutions to address these anomalies.

The facility, as a part of the downgrade process, was analyzed using a segmentation approach pursuant to DOE-STD-1027 Chg.1. Segmentation of nuclear material was used as an analytical technique to both allow for certain material to remain in storage while simultaneously establishing TA-18 as a Radiological Facility. TA-18 is now a Radiological Facility with a robust nuclear material inventory tracking program that accounts for the different types of radiological and nuclear material contained within the different facility segments.

This paper will discuss the two year venture to consolidate mission, relocate nuclear materials and experimental hardware and then to disposition and downgrade a 5 decade old experimentation facility at LANL.

## Executive Summary

Approximately twenty six months ago a team of about a dozen operations staff complimented by a rolling cadre of, at times, 30 additional subject matter experts, set out to close an operating nuclear facility at the Los Alamos National Laboratory (LANL). This was not just any nuclear facility closure but rather the cessation of operations at the DOE's only Critical Experiment Facility (CEF), the Technical Area 18 (TA-18) complex at LANL. More than two years, and \$25 million dollars later, the job of closing nuclear facility operations at TA-18 is complete. The DOE, Los Alamos Site Office (LASO) of the NNSA, on April 5, 2007, issued a letter approving the start of non-nuclear (radiological) facility operations at TA-18. The over fifty year legacy of experimentation and nuclear operations at TA-18 had come to a successful close.

Today, TA-18 is a non-nuclear, radiological facility, operating only to complete residual material clean-up in preparation for eventual wholesale facility decontamination and demolition. The story of the last two years of operations at TA-18 is one of great success and frustration. It's an inevitable saga of taking the DOE guidance and applying it to what is always a unique set of 'on the ground' situations and conditions.

Within this paper we will chronicle the most significant aspects of the TA-18 closure to date. Understanding that the eventual completion of the decommissioning, decontamination and demolition (DD&D) operation at the site is a story yet untold. To date the very interesting challenges of nuclear material removals and the downgrading of the site from a Hazard Category 2 nuclear facility to a radiological facility are the two major tasks that have occupied the TA-18 staff for the last two years. This then is the 'in progress review', post nuclear operations, and story of the TA-18 closure.

## 1. Introduction

### 1.1. DOE Mandate to Relocate the Critical Experiment Facility at TA-18

On April 9, 2004, the NNSA Deputy Administrator for Defense Programs issued a letter to the NNSA Site Office Managers at Livermore, Los Alamos, and Nevada, the Directors of Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory (LANL), and the Manager of Bechtel Nevada (BN) announcing specific direction regarding the Mission Relocation of Los Alamos Technical Area (TA) 18. This letter included a reiteration of the decision, made by NNSA on March 31, 2004, to begin moving Special Nuclear Material (SNM) from TA-18 to the Device Assembly Facility (DAF) at the Nevada Test Site (NTS). This effort is generally characterized as the LANL "Early Move" of SNM.

Subsequently, after a review of Security Category (CAT) I/II SNM Inventory at TA-18 and costs related to known and projected safeguards and security requirements, this direction was amended to require that TA-18 be entirely de-inventoried of CAT I/II SNM by the end of Fiscal Year (FY) 2005. As a result of efforts under the TA-18 Early Move Project, removal of CAT I/II SNM from TA-18 was completed on October 28, 2005.

The removal of NM alone would not necessarily reduce operating costs at TA-18. What was needed was the reduction in operating controls and the rigor that differentiates nuclear facility operations from those operations not governed by the strictures of 10 CFR 830, part B. The nuclear facility downgrade, had to be coupled with a reduction in operating staff, leaving behind only those staff sufficient to operate safely and compliantly using a non-nuclear, radiological facility control set. The counter-proposal developed by LANL, in collaboration with the Los Alamos Site Office of NNSA, proposed concatenating these two vital downgrade missions. We needed to both move SNM and reduce operating staff in order to realize real operational cost savings.

## 1.2. Brief Description of TA-18

TA-18 is located within the LANL boundaries. TA-18 is adjacent to Pajarito Road and at the confluence of Pajarito and Three-Mile Canyons. The main structures at TA-18 are the Critical Assembly and Storage Areas (CASAs) buildings: CASA 1, CASA 2, CASA 3; the Solution High-Energy Burst Assembly (SHEBA) building; Building 127; Building 227; and Building 30. In total there are approximately 40 structures at TA-18. The CASAs (formerly KIVAs) are the remote-controlled laboratories in which criticality experiments were performed. Building 30, the main office building, houses the control rooms for these laboratories. Building 30 is centrally located, and the CASAs and SHEBA are on the periphery of the site, arrayed like spokes of a wheel. This overall site layout was designed to ensure safety for critical experimentation using the distance principle for the safe, remote operation of the critical assemblies.

Technical Area (TA)-18 was originally established during World War II as an explosives test facility for the Manhattan Project. Shortly after World War II, TA-18 became the site of the Los Alamos National Laboratory (LANL) Critical Experiment Facility (CEF). Criticality experiments originally were performed by hand, but fatal accidents occurred in 1945 and 1946. Following these accidents, the Laboratory decided that criticality experiments were too dangerous to be done by hand and instead should be performed in a remote-controlled facility. Such facilities were built at TA-18 and eventually became known as CASAs (Critical Assembly Storage). The criticality and other experiments supported emergency response, safeguards and weapons program activities.

## 2. Early Move Risk Management

### 2.1. Critical Milestones

The TA-18 Early Move and Transition Project had strong, empirical opportunities for the project to fail. Consequently, a risk management process was developed that looked at and categorized the types and severity of risks the project might encounter. The project team conducted a risk assessment that included the identification and mitigation strategies for potential risks.

No fewer than 22 project risks were identified that could have had cost and schedule impacts. Also identified were associated mitigation strategies. The following risk items were particularly noteworthy;

Availability of Critical Staff: Critical staff members were required to perform several specialized tasks associated with material transfers and shipments. Schedules were

developed that assigned specific staff members to specific tasks, and periodic meetings were held with line management to ensure availability of key staff members.

NNSA Approvals: NNSA approvals were required for several critical external milestones. Most important of the numerous LASO interfaces included;

- Approval to transfer Off-site Source Recovery Project (OSRP) materials to TA-55
- Approval to operate the Safe Secure Transport (SST) Facility at TA-55 for storage of SNM coming from TA-18
- final declaration of TA-18 to be a Radiological facility
- Availability of the warehouse at NTS for receipt of TA-18 materials
- Availability of packages for shipment of materials to DAF

A strong communications effort coupled with teaming opportunities with LASO helped assure continuous and almost unprecedented success in getting timely approvals from NNSA. Regular meetings, walkdowns and other communication techniques were also used to maintain a constant, back and forth, flow of information and status with LASO. In this way LASO remained constantly informed of the project's approval needs and the approvals were kept on track.

## 2.2. Management Structure

It's important to note that the success of the Early Move Project and the downgrade of the facility to radiological status came as a result of a wholesale management change at the site that reached back to March, 2005. It was in that month that the Lab Director, Dr. Pete Nanos, instructed the Nuclear Material Technology (NMT) Division Leader to install a management team at TA-18 that would address the Early Move Project needs and the safe and compliant operation of the site to achieve the EM Project goals. Up until March 2005 the facility had been run, from its' inception, by the Nuclear Non-proliferation Division (or N Division) as landlord and chief experimental program owner at TA-18. This shift in management, coupled with the pressing needs of the EM Project, called for rapid response in numerous management areas. Chief among these were;

- Budget structure for the site
- Conduct of Operations infrastructure and improvements needed to operate efficiently and safely
- Operational lines of Authority and Responsibility and a mechanism for clear definition of these
- Project Schedule development tasks, scope definition and assignment of roles and responsibilities within the project schedule
- Mechanisms for incorporating LANS (the new Lab operating contractor), lab-wide changes to operating systems that either made sense for a non-enduring facility or had to be consciously rejected as too costly or time consuming to employ.

All these considerable strategic decisions had to be largely made real time given the accelerated pace of the material movement and infrastructure downgrade imperatives.

## 2.3. Existing Safety Basis

The existing safety basis was constructed for continued CEF operations. Approved activities included shipping and receiving of nuclear material. They also included removing nuclear

material from the Critical Assembly Machines. There was no discussion to completely de-inventory TA-18 or disassemble and relocate the CAMs.

Removing the nuclear material and the cessation of critical assembly operations lessened the operating risk at TA-18. For one of the CAMs, Godiva, removing the nuclear material required partial disassembly of the machine. This disassembly impacted a portion of the machine which had a credited Design Feature. The DF was related to and was only necessary during operation of the CAM.

The Technical Safety Requirements did include the following statement: "Conformance with DF is not required during FACILITY SHUTDOWN MODE or when the safety function of the DF is not applicable." NNSA/LASO effectively nullified that statement when a TSR violation was declared after the nuclear material was removed. Subsequently NNSA/LASO approved the continued disassembly of the CAMs. The In-Service Inspection for the other DFs continued. However, being able to step out of the DF when they were no longer required would have reduced the budgetary constraints. There were no other additional TSRs that were problematic from an operational view point.

### **3. New Safety Basis as a Radiological Facility**

Almost all of the previously approved activities at TA-18 were being discontinued as a product of the facility downgrade. The remaining radiological and nuclear materials were consolidated to a few buildings, rather than across the entire site. Enough nuclear material was transferred to other locations to allow TA-18 to be re-categorized as a radiological facility. Therefore, downsizing the existing BIO to reflect these changes was neither effective nor appropriate and a new safety basis was developed to reflect the reduced radiological/nuclear material inventory and limited set of approved activities.

The new safety basis consisted of five documents. These were the Facility Hazard Category Report (FHCR), Facility Safety Plan (FSP), Facility Disposition Report (FDR), Fire Hazard Analysis (FHA), and an overarching Criticality Safety Evaluation (CSE).

The FHCR established the foundation for the other documents to build on. It described the facility, activities, and established that TA-18 is a radiological facility with a low chemical hazard. LANL procedures required that the facility be categorized according to the ability to exceed the Emergency Response Planning Guide level 3 concentrations at various distances. Each of these safety basis documents are described below

#### **3.1. Facility Hazard Category Report**

The FHCR followed the format and content requirement of LANL LIR 300-00-05, *Facility Hazard Categorization*, and met the requirements of DOE-STD-1027-92, Chg.1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. Because NTS was not ready to receive some natural Uranium and depleted uranium metal pieces, DOE-STD-1027 allowance to segment a facility was exercised to establish four facility segments. This and other salient aspects of the categorization are discussed below.

### 3.1.1. Description

All of the CAMs were de-fueled and removed from TA-18. Additionally, no other programmatic work was to continue. The remaining activities were grouped into general facility operations; decontamination; and legacy material and equipment removal. General facility operations included activities to keep the facility safe, habitable, functional or compliant with applicable requirements. TA-18 did not process, chemically process, or machine plutonium. However, uranium and beryllium contamination remained. The Be was used in various experiments as a reflector/moderator. Removing legacy material and equipment include removing the Be, Pb, remaining radiological/nuclear material and experimental equipment. Included in the approved activities was the removal of security fences and equipment. However, demolition of facility structures was not specifically addressed though it would not be precluded once the appropriate plans were developed and approved.

#### 3.1.1.1. Radiological Material Inventory

As an operating nuclear facility TA-18 housed many metric tons of nuclear material and many sealed sources. This nuclear and radiological material was tracked according to Laboratory and DOE requirements. However, these systems have lower limit thresholds which do not require tracking in certain cases. For example, the lower limit for Pu is 0.5 gram. This quantity of material, or less, was typical of thin metal nuclear material foils placed in or near an assembly. Many of these foils remain in inventory, unaccounted for. The foils were composed of various nuclear materials.

DOE-STD-1027-92 does not make allowances for the security accountability of the radiological/nuclear material in inventory and at LANL. Security accounting is used as the primary tool to identify MAR or Material at Risk. . Therefore, all of the radiological/nuclear material needed to be included in the hazard categorization process and a system had to be developed to do that accounting. The system was named the RMIS (sect. 4.2). In order to ensure that all radiological/nuclear material was accounted for and not stored in an untoward safe or location, the LANL N-1 Safeguards Science and Technology Group used various detectors to survey TA-18. As expected a few minor sources were discovered in a couple of safes. The survey also roughly estimated the Be that had been activated during experimentation.

The NTS was not ready to receive the large metal pieces of natural and depleted uranium (nU and dU) that had already been packaged for over-the-road shipment. Therefore, a facility segmentation strategy was developed. The strategy was to place the uranium in transportainers such that each did not exceed the DOE-STD-1027 radiological facility criteria. As written in the FHCR, the transportainers were designated for one time use only. No additional radiological/nuclear material could be added to the transportainers and once the nuclear material was removed no other radiological/nuclear material could be stored in them. Three transportainers were placed in an area best characterized as gravel with sparse vegetation. The vegetation is minor amounts of grasses with no nearby trees or bushes, basically light fire fuel loading. The transportainers were also not located close to buildings.

#### 3.1.1.2. LANL Chemical Categorization

During many of the criticality experiments Be and Pb were used as reflectors/moderators and shielding. Part of the legacy material included many metric tons of both Be and Pb. These toxic

metals, along with minor amount of cadmium, were included in the hazard categorization process per LANL LIR 300-00-05, *Facility Hazard Categorization*. The Be and Pb in inventory were either large billets or bricks, which were mostly stored in warehouses. TA-18 did not process or machine either of these materials. Therefore, the metal pieces were relatively benign. However, the existing amount exceeded the pre-calculated quantities so as not to exceed the ERPG-3 criteria at 100 m. A document search revealed that a more appropriate ARF/RF should be used and more appropriate analysis performed to determine if the ERPG-3 values would be exceeded.

### 3.1.2. Analysis to Support Segmentation and Low Chemical Categorization

Because we exercised segmentation as allowed by DOE-STD-1027-92 and the quantities of Be and Pb exceeded the LANL pre-calculated values, additional analysis was performed to support the radiological, low chemical hazard categorization. For both cases the bounding accident scenario was a fire accident.

The transportainers were located in a sparsely vegetated area and protected by concrete jersey barriers to preclude vehicle accident fire initiators. They were also separated from each other by at least 40 ft. The additional analysis demonstrated that no single accident involved radiological/nuclear material in multiple segments. Because of their location only a grass land fire could impact all three transportainers. The postulated grass fire involved the heat release from a grass field approximately 100m x 50m. Using simple energy balance equations all of the heat released from this grass fire was imparted to a single transportainer. The heat addition caused the transportainer temperature to increase no more than 13 °C.

Ensuring that the ERPG-3 values could not be exceeded for the quantities of Be and Pb required postulating and analyzing two meaningful scenarios. The scenarios were a drop/spill and a fuel pool fire. Both scenarios were related to forklift operations during the disposition process. For a drop/spill and using the new ARF/RF, the quantity required to exceed the ERPG-3 was calculated and shown to exceed the capacity of the forklift and cranes, though the warehouses do not have cranes. Therefore, the drop/spill scenario was dismissed.

For fire releases a new ARF/RF was also used. The fire scenario was developed using equations from the *SFPE Handbook of Fire Protection Engineering*. The equations calculated a pool depth, pool area, burn duration, and heat flux. These were used to show that not all of the Be or Pb would be involved in the accident. The fire analysis showed that the Be would not reach ignition temperatures and that only a small portion of the lead would melt. Thus, the ERPG-3 values could not be exceeded by the bounding postulated accidents and TA-18 could be categorized as a low chemical hazard facility.

### 3.2. Fire Hazard Analysis (FHA)

Also part of the new Safety Basis is the recently revised TA-18 FHA. The FHA was revised to reflect the new mission at TA-18 (i.e. temporary storage of radiological/nuclear material). The FHA included a review of the fire assessment performed for the FHCR and concurred that the analysis was appropriate and reached the correct conclusion. The FHA also assessed the various

aspects of the property loss management and life safety code compliance issues. Recommendations made in the FHA were tracked with the LANL issues tracking database.

### 3.3. Facility Safety Plan (FSP)

Because TA-18 is a radiological, low chemical hazard facility, the hazards at TA-18 do not pose a significant threat beyond the localized area. Also, neither a Documented Safety Analysis nor Facility Safety Analysis was required. Subsequent TSRs were also not required. Therefore, the LANL Safety Management Programs (SMPs) became the sole directive to maintain the facility in compliant operations given the risks associated with limited operations.

The graded approach was used in developing the FSP. The graded approach relied on referencing the FHCR with regard to the description of the facility and activities. Description of the SMPs was limited to the salient information needed to protect the safety basis and to protect the worker. The FSP also defined the organizational structure and helped establish the operating roles and responsibilities in the Facility Tenant Agreement.

### 3.4. Facility Disposition Report

One of the most productive tools used by the management team at TA-18, to support the facility downgrade, was the development of a document entitled the 'Facility Disposition Report' (the FDR). The FDR found its genesis in the need to catalog and describe the priorities for correcting LANS 'due diligence' findings. Since TA-18 was being downsized coincidentally with the arrival of the LANS management team, at LANL, the FDR was a place to acknowledge the existence of numerous facility industrial safety and code compliance issues. Management made the decision to largely not correct these long standing issues in deference to the pending DD&D status of the Technical Area. The FDR originally was developed to capture these issues. Eventually however, as required by DOE-STD-1027, the FDR became the compendium of all issues and the inventory status of all items at TA-18. The FDR became the 'one stop shop' for all the SNM removal and material disposition descriptions at the site. The FDR also made the dual job of identifying items for removal, and DOE's need to completely understand the status of items at the site, a far easier task. Regularly when LASO had a question about a particular issue, the staff could be heard to respond (always professional and never trite) 'That's in the FDR'. The FDR chapters thus each became a description of a particular issue or item and the FDR as a whole grew up to become the 'user's manual' for TA-18.

### 3.5. Criticality Safety Evaluation

DOE-STD-1027 Hazard Category 3 threshold quantity for  $^{235}\text{U}$  is  $1.9 \times 10^6$  g; however, if the facility has more than 700 g  $^{235}\text{U}$ , a Criticality Safety Evaluation (CSE) must demonstrate that a criticality accident is incredible. Because the nuclear material at TA-18 exceeded the 700 g  $^{235}\text{U}$  limit, a CSE was written, demonstrating that a criticality accident was incredible. There are no programmatic activities to process or use the nuclear material in experiments. Most of the nuclear material is already packaged in drums and strong tight boxes ready for transport. The CSE and subsequent Criticality Safety Limit Approval established nominal controls to protect the criticality incredibility assertion. The controls basically require that the material remain in packaged configuration, containers can be moved one at a time, and any new packaging or repacking requires approval by the Criticality Safety Group.

#### 4. Implementation of the New Safety Basis

Due to past experience and the simplicity of the new Safety Basis, the new Safety Basis was implemented with a “turn-key” approach. That is, there was no phased implementation of the safety basis. All of the implementing procedures were prepared and no outstanding issues required resolution prior to starting the Management Self Assessment (MSA).

Two documents that actively protect the safety basis required additional work and received supplemental scrutiny. The Activity Approval Process (AAP) and the Radiological Material Inventory System, the two SMPs that were vital to preserving the facility categorization, received close scrutiny and improvements during the MSA.

##### 4.1. Activity Approval Process (AAP)

The AAP outlines the process to obtain authorization for new or modified non-facility work activities and space requests. It ensures that the following receive appropriate review:

Waste Generation/Disposition Requirements;	Hazards;
Security Requirements;	Hazard Controls;
Radiation Protection Requirements;	Space Utilization Requests;
Facility Impact;	Industrial Safety;
Safety Basis Impact.	

This is done by applying a set of review forms and establishing a facility safety committee to review the proposed activity once submitted. This procedure refers to the LANL readiness review process for the startup of significant activities. Explicit approval is required to bring any additional radioactive material into TA-18. This approval invokes the Radiological Material Inventory System (RMIS) that ensures the radiological facility threshold criteria are not exceeded.

##### 4.2. Radiological Material Inventory System

As previously mentioned, TA-18 once housed many metric tons of NM. This NM was in a variety of material types as defined in DOE M 4704-6, *Nuclear Material Control and Accountability*. Though the majority of the NM was already shipped, several hundred smaller items still remained at TA-18. These items included accountable items, as well as sub-accountable foils that were used in criticality experiments. Each Material Type (MT) would normally consist of several isotopes. We used the standard equation to convert each isotope to an equivalent  $^{239}\text{Pu}$ .

The development of unique conversion factors is done routinely throughout the complex, since DOE-STD-1027 does not describe the use of a  $^{239}\text{Pu}$  equivalent factor. One of our reviewers required us to demonstrate that the method was conservative. For uranium MT's it was demonstrated to be conservative by a factor of 3.4 and for Pu MT's to be conservative by a factor of 1.1. But under no circumstances were the conversion factors demonstrated to be non-conservative.

The degree of conservatism is influenced by the clearance class and the particular dose conversion factors used. Only Y clearance class dose conversion factors were used and the dose

conversion factors were from the Federal Guidance Report (FGR) #11. The half-lives were also from the FGR #11 unless it was found to differ from the two other sources.

The entire inventory of radiological/nuclear material for TA-18 was inventoried and accounted for on an Excel Workbook. This included accountable and sub-accountable sources and nuclear material items. The existing LANL procedures that managed and tracked accountable radiological/nuclear material are still in effect at TA-18. This creates a two tier system, one for security and one for safety.

Under the RMIS, outgoing shipments did not require management approval but did require an independent verification of the material shipped. All incoming shipments had to be approved by the Operations Manager (OM). If the sum of the fractions was less than 0.8 the OM could approve the incoming shipment; If the proposed resulting sum of the fractions was greater than 0.8 but less than 1.0 than the shipment required approval by both the OM and the Associate Director.

## 5. Conclusion

In this paper we have presented some of the experiences and lessons learned during the two year project to downgrade TA-18 from a Nuclear Facility to a Radiological Facility while simultaneously accomplishing the Early Move Project. The accelerated removal of the critical experimentation mission to Nevada and the Nevada Test Site created many technical and business challenges which we discussed briefly in this paper. The business challenges included the continued availability of critical staff members, coordinating and getting NNSA approval of activities external to TA-18, and installing a management team to lead the Early Move Project. Along with the new LANL operating contractor LANS, came the re-assignment of roles and responsibilities and establishing funding mechanisms.

The previous safety basis was not designed to de-inventory the site or disassemble the CAMs. At certain points in the process challenges emerged, all of which were eventually overcome. Creating the new safety basis as a radiological facility also presented its' own challenges. Chief among those challenges was accounting for all of the radiological/nuclear material at TA-18. In analysis space we also, rather uniquely, had to justify radiological facility segmentation as a means to an end to downgrade the facility. During that process the bounding assessment of the potential for Pb and Be to exceed the ERPG-3 values at 100 m was addressed.

One of the greatest managerial successes in this process was the continual open communications with all of the involved parties. This especially included numerous meetings and walk downs with the NNSA/LASO. The hierarchal regulator/operator structure was maintained yet there was sufficient ease of communication that issues were openly addressed and resolved. One of the key products of this open dialogue was an FHCR reviewed and approved by DOE without comment. The rad. facility start-up MSA took a mere 1.5 weeks to accomplish start to finish.

Mr. Tom D'Agostino has labeled the success of the Early Move Project 'a model for project success and the collaborative process between regulator and operating contractor'. We will harness the TA-18 Early Move successes and apply those lessons to many more collaborative projects in the future.