

Successful Demolition of Historic Cape Canaveral Air Force Station Launch Facilities: Managing the Process to Maximize Recycle Value to Fund Demolition - 8481

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ABSTRACT

This paper will present the history of the Atlas 36 and Titan 40 Space Launch Complexes (SLC), the facility assessment process, demolition planning, recycle methodology, and actual facility demolition that resulted in a 40% reduction in baseline cost. These two SLC launched hundreds of payloads into space from Cape Canaveral Air Force Station (AFS), Florida. The Atlas-Centaur family of rockets could lift small- to medium-size satellites designed for communications, weather, or military use, placing them with near pinpoint accuracy into their intended orbits. The larger Titan family was relied upon for heavier lifting needs, including launching military satellites as well as interplanetary probes. But despite their efficiency and cost-effectiveness, the Titan rockets, as well as earlier generation Atlas models, were retired in 2005. Concerns about potential environmental health hazards from PCBs and lead-based paint chipping off the facilities also contributed to the Air Force's decision in 2005 to dismantle and demolish the Atlas and Titan missile-launching systems. Lockheed Martin secured the complex following the final launch, removed equipment and turned over the site to the Air Force for decommissioning and demolition (D&D). AMEC was retained by the Air Force to perform demolition planning and facility D&D in 2004. AMEC began with a review of historical information, interviews with past operations personnel, and 100% facility assessment of over 100 structures. There were numerous support buildings that due to their age contained asbestos containing material (ACM), PCB-impacted material, and universal material that had to be identified and removed prior to demolition. Environmental testing had revealed that the 36B mobile support tower (MST) exceeded the TSCA standard for polychlorinated biphenyls (PCB) paint (<50 ppm), as did the high bay sections of the Titan Vertical Integration Building (VIB). Thus, while most of the steel structures could be completely recycled, about one-third of 36B MST and the affected areas of the VIB were to be consigned to an on-site regulated waste landfill. In all, it is estimated that approximately 10,000,000 kg (11,000 tons) of PCB-coated steel will be landfilled and 23,000,000 kg (25,000 tons) will be recycled. The recycling of the steel and other materials made it possible to do additional demolition by using these funds. Therefore, finding ways to maximize the recycle value of materials became a key factor in the pre-demolition characterization and implementation strategy. This paper will present the following:

- Critical elements in demolition planning working at an active launch facility
- Characterization and strategy to maximize steel recycle
- Waste disposition strategy to maximize recycle/reuse & minimize disposal
- Recycle options available at DOD installations that allow for additional funds for demolition
- Innovation in demolition methodologies for large structures - explosive demolition and large-scale dismantlement
- H&S aspects of explosive demolition and large scale dismantlement

INTRODUCTION

Since the 1960's, Cape Canaveral Air Force Station (CCAFS) has supported the nation's space program with a number of different rocket programs. Two of the most effective and longest duration programs were the Atlas and Titan rockets, flying from Space Launch Complex (SLC) 36 and 40, respectively. These Atlas and Titan SLC launched hundreds of payloads into space from CCAFS. The Atlas-Centaur family of rockets could lift small- to medium-size satellites designed for communications, weather, or military use, placing them with near pinpoint accuracy into their intended orbits. The larger Titan family was relied upon for heavier lifting needs, including launching military satellites as well as interplanetary probes. Despite their efficiency and cost-effectiveness however, the Titan rockets, as well as earlier generation Atlas models, were retired in 2005, made obsolete by the high cost and toxicity of the specialty fuels they required, the post-9/11 downturn in the United States satellite launch market, and evolving new technology, such as the Delta rocket fleet.

After hosting 168 Titan launches, the final Titan launch from CCAFS took place on April 29, 2005. Atlas 36A saw 69 launches from 1962 through August 2004 and Atlas 36B had 76 flights from 1965 until February 2005. Meanwhile, salt air and sea spray had begun to take their toll on the launching pads, towers, and associated facilities once used to launch the rocket fleets into space. Concerns about potential environmental health hazards from PCBs and lead-based paint chipping off the facilities also contributed to the Air Force's decision in 2005 to dismantle and demolish the Atlas and Titan missile-launching systems soon after the programs ended. Experience with abandoned facilities at other, earlier complexes had shown that the coastal environment would quickly reduce an untended facility to a state hazardous in safety and environmental terms. Lockheed Martin secured the complex following the final launch, removed equipment and turned over the site to the Air Force for decommissioning and demolition (D&D).

The major facilities at Atlas SLC 36A and B included: 64-m tall Mobile Service Towers (MST) that provided shelter to workers and the launch vehicles during launch preparations; 58-m tall umbilical towers (UT) containing approximately 92,000 kg (100 gross tons) of steel each, which provided access to upper stages of the launch vehicle and satellite payload for fueling, providing conditioned air, and telemetry connectivity prior to launch; and several other facilities, including a 9-m high x 9-m wide x 102-m long Launch Support Facility (LSF); and a concrete flame bucket designed to direct heat, flames, and shock wave away from the ascending rocket. There were numerous support buildings that due to their age contained asbestos containing material (ACM), PCB-impacted material, lead-based paint (LBP), and universal material that had to be identified and removed prior to demolition.

The Titan SLC 40 contains similar but larger launch structures than the Atlas; the MST at SLC 40 weighs approximately 6 million kilograms (over 13 million pounds). SLC 40 was also served by a number of vehicle assembly buildings, several of which were converted to follow-on use after the Titan program ended. One facility slated for D&D along with the complex was a 73-m. high x 91-m wide x 83-m deep Vertical Integration Building (VIB), once used to assemble up to four Titan core vehicles at a time, as well as a nearby railroad system that carried the erected Titan core vehicle to the other processing facilities for additional component installation.

Environmental testing had revealed that while the 36A MST did not exceed the TSCA standard for PCB paint (<50 ppm), about one third or 552,000 kg (600 tons) of the 36B MST exceeded the TSCA standard, as did the high bay sections of the Titan Vertical Integration Building (VIB). Thus, while the 36A MST could be completely recycled, about one-third of 36B MST and the affected areas of the VIB were to be consigned to an on-site regulated waste landfill. The other materials comprising the other large-scale structures could be recycled. The materials comprising the UTs, LSFs, and flame buckets for both pads, as well the numerous support structures, could be recycled. In all, it is estimated that approximately 6,900,000 kg (7,500 gross tons) of PCB-coated steel will be disposed of in landfills and 11,592,000 kg (12,600) will be recycled.

The challenge for the Cape Canaveral AFS D&D project was designing a demolition plan that addressed these contaminants during large-scale demolition such that the recyclable material could be segregated. The proceeds from the valuable recyclable material were to be used to fund the demolition of the other non-valuable or contaminated material. Large-scale demolition also required the planning of additional safety precautions and associated monitoring during implementation. The following sections will detail the D&D approaches used to address these items.

DEMOLITION PLANNING

Demolition planning involved gathering the necessary information to support removal, recycling, and disposal of buildings, structures, foundations, and site infrastructure associated with Atlas and Titan programs. The primary objectives achieved are listed below.

- Evaluated and identified removal options for specific structure types and facilities.
- Determined logistics for the removal, transportation and disposal of waste materials.
- Identified recoverable/recyclable materials, salvageable items, and salvage rights.
- Identified facility contaminants and abatement options to be addressed prior to and during facility demolition.
- Developed criteria, drawings, and schedule for implementation of facility removal/recycle/disposal activities.
- Presented cost-effective site restoration options to be completed after removal activities.

Due to the large number of facilities, they were sorted into smaller manageable groupings. Grouping the facilities together in manageable packages based on customer defined priorities allowed for the D&D to be implemented as funding was made available. The facilities were grouped together based on the following factors:

- Construction material (steel, concrete, reinforced concrete, wood, etc.)
- Facility type (tank, camera tower, launch tower, pump, office building, etc)
- Facility deactivation schedule
- Facility occupancy schedule
- Facility square footage
- Facility hazardous material inventory (asbestos, mercury, lead, PCBs, etc.)
- Facility proximity to other structures
- Structural stability
- Health and safety concerns

The D&D approach involved the evaluation of each facility scheduled for demolition to determine the best method to accomplish the goals set forth by the Air Force. AMEC reviewed all available information (engineering drawings and characterization data) for the structures, walked through the facilities, and consulted with available personnel familiar with past operations to determine the best approach. In addition, lessons learned during previous demolition efforts at Complexes 13, 19, and 41 were researched and considered in developing D&D approach. The determination of the appropriate demolition approach is a tiered approach and best illustrated graphically as shown in Fig. 1 below.

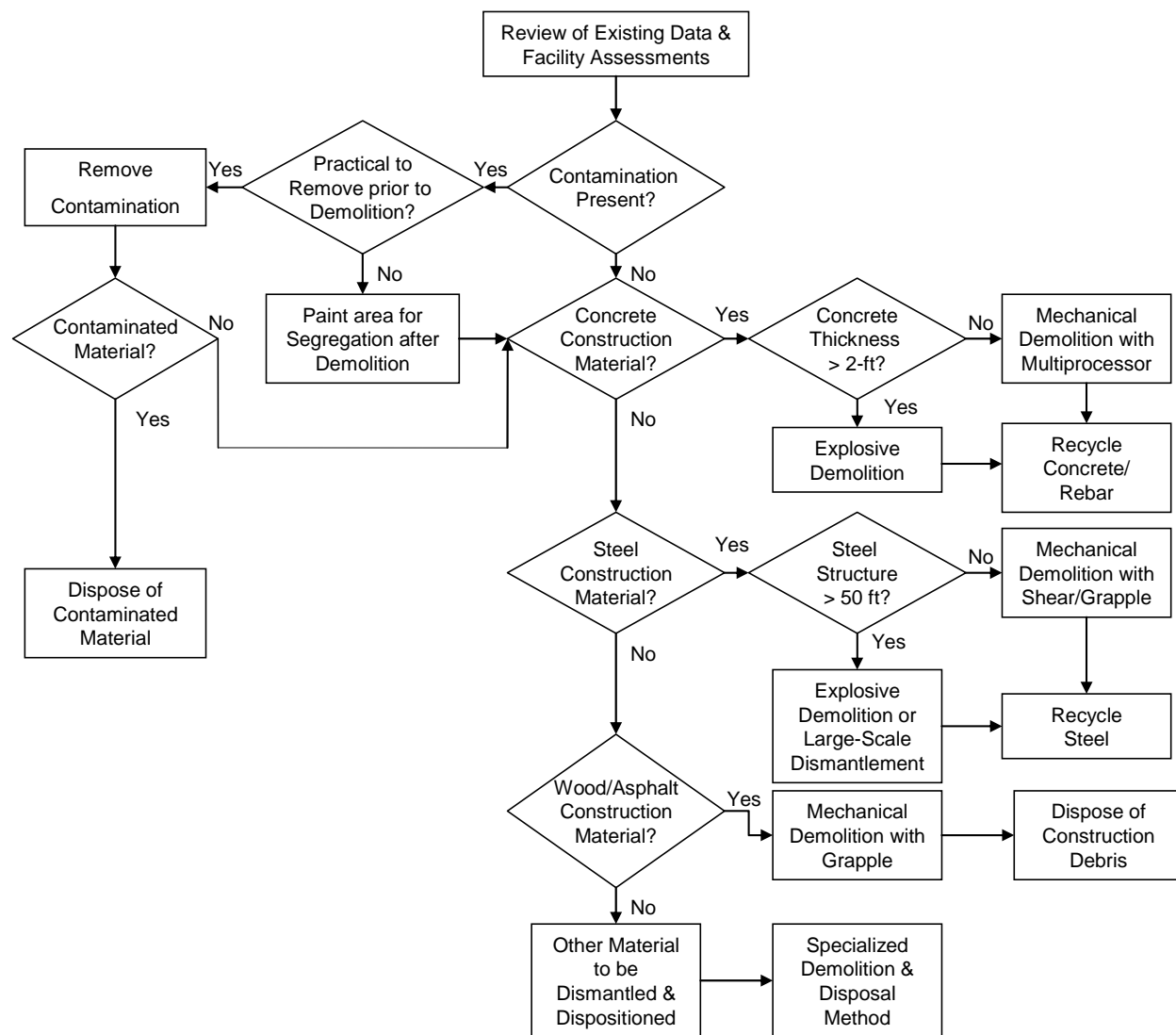


Fig. 1. Cape Canaveral AFS Demolition Decision Process

As indicated in this demolition decision process, many factors must be considered to determine the best demolition approach for a particular facility. In many instances a facility will require a combination of methods to achieve removal action objectives as discussed in the following sections.

Conventional demolition using mechanical means is best suited for smaller structures and infrastructure (roads, pads, railroads). Demolition is accomplished using a tracked excavator or front-end loader or other types of machines to raze a structure. The tracked excavator is equipped with a special attachment depending on the facilities construction material and method. Attachments commonly used for demolition include the following:

- Grapple or thumb/bucket attachment for small wood or concrete structures
- Multiprocessor or hoe ram for thick concrete structures
- Multiprocessor or shear for smaller steel structures
- Grapple or hoe ram for concrete and asphalt pavement and pads

After the structure has been brought to the ground and separated from its foundation, metal shears are typically used to cut steel beams to proper size for packaging/transportation. Grapples are commonly

used to remove rubble and other small debris that is to be loaded into containers for off-site disposition. A multiprocessor or hoe-ram attachment is used to break up concrete super and sub-structures.

In addition, the demolition method and size reduction of materials covered with PCB-containing paint using hot methods (e.g., torching) included appropriate measures to address industrial hygiene (IH) hazards. Demolition methods addressed PCB-containing paint in development of approach to minimize potential spread of paint chips during demolition. These special methods, large-scale dismantlement, and explosive demolition will be addressed in later sections. The following section will discuss the characterization strategy and resulting waste disposition options.

FACILITY CHARACTERIZATION

Facility characterization information was reviewed to evaluate the personal safety and health of the workers and includes asbestos and IH monitoring. Structures containing asbestos or other hazardous materials were evaluated to determine the waste disposition path forward and removal action approach. Process knowledge was used to characterize material such as lighting ballasts and thermostats (i.e., PCB and Mercury). Based on the review of existing data and facility assessments, the following facility characterization sampling activities were required:

- Paint to determine presence and concentration of PCBs and heavy metals
- Electrical wiring and components to determine presence and concentration of PCB and asbestos
- Pipe and tank insulation for asbestos
- Interior building materials for asbestos
- Exterior roofing and siding materials for asbestos
- Residual material in tanks and basins

A major concern uncovered during facility characterization at CCAFS was the prevalence of PCB's above TSCA limits in paint on steel structures that could otherwise be recycled. The metal coated with PCBs-containing paint then is defined as "PCB Bulk Product Waste" per 40 Code of Federal Regulations (CFR) part 761.3. PCB bulk product waste means waste derived from manufactured products containing PCBs in a non-liquid state, at any concentration where the concentration at the time of designation for disposal was 50 ppm PCBs. PCB bulk product waste does not include PCBs or PCB Items regulated for disposal under §761.60(a) through (c), §761.61, §761.63, or §761.64. PCB bulk product waste includes, but is not limited to:

"Non-liquid bulk wastes or debris from the demolition of buildings and other man-made structures manufactured, coated, or serviced with PCBs. PCB bulk product waste does not include debris from the demolition of buildings or other man-made structures that is contaminated by spills from regulated PCBs which have not been disposed of, decontaminated, or otherwise cleaned up in accordance with subpart D of 40 CFR 761."

AMEC completed sampling of Complex 36B MST and UT in October 2004. There were 68 samples collected from all areas and all paint types of the MST and UT. PCBs were not detected in 19 of the 68 samples. Total PCB concentrations ranged from 0.07 mg/kg to 17,500 mg/kg. In general, the higher concentrations of PCB's were on the interior surfaces of the MST and other steel structures, and were associated with specific paint schemes. It became apparent that over the years, as the outer parts of the structures were repeatedly blasted and painted for maintenance in the corrosive coastal atmosphere, non-PCB containing paints replaced the original contaminated paint.

Additionally, samples were collected from similar areas of concern on the 36A MST and UT in January 2005. There were 20 samples collected from all areas and all paint types of the MST and UT. PCBs were not detected in 11 of the 20 samples. Total PCB concentrations ranged from 0.08 mg/kg to 33 mg/kg. The lower PCB content was consistent with historical evidence of wider-spread surface restoration on the 36A MST and UT.

Samples for PCB-containing paint were collected from the VIB complex in 2005 and in 2007 prior to the commencement of demolition activities. There were samples collected from interior painted structural steel components from both the high and low bay areas since the building was built in multiple phases over the years. Total PCB concentrations ranged from non detectable to > 50 ppm. This extensive but focused sampling program resulted in a reduction of the volume of steel that had to be landfill disposed. Once the areas with > 50 ppm PCB-impacted steel were identified, the demolition plan could be completed to accommodate these findings. In addition, the data could be used to determine the proper protective equipment required by workers that would be cutting the contaminated steel. AMEC ran air dispersion models and followed this with actual field monitoring to confirm the conditions were acceptable during operations.

Other samples were collected from the smaller support structures associated with these two SLC with some results indicating > 50 ppm PCBs present in the paint. These isolated steel components were documented and removed/disposed during demolition activities with additional precautions for workers being incorporated into the demolition plans.

WASTE MANAGEMENT AND RECYCLE STRATEGY

A waste stream is defined as waste material that has been generated from a single process or from an activity that is similar in material, physical form, and hazardous constituents. The following are the waste streams encountered during demolition activities:

Sanitary Waste - Domestic waste that has been generated by the different facilities and is currently stored in the on-site septic tanks.

Asbestos Containing Material (ACM) - Any building materials containing more than one percent asbestos. ACM may be found in friable and/or non-friable form. Friable ACM includes any building material that can be pulverized, crumbled or reduced to powder by hand pressure when dry.

Construction and Demolition (C&D) Waste - C&D debris will comprise the majority of the waste generated during the demolition activities. These materials will include wood, concrete, metals, brick, and gypsum. C&D debris is a large and complex waste stream.

TSCA Waste - TSCA waste is that defined in 40 CFR 761 as discussed in the previous section. This included primarily the PCB-impacted steel and some used oils from past operations.

Hazardous Waste - Hazardous waste will include hazardous waste as defined by 40 CFR 261.3 and universal waste as defined in 40 CFR 260.10 and Part 273. All potentially hazardous materials encountered in the Atlas and Titan D&D activities were recyclable, and thus considered Universal Waste.

Universal Waste - Universal wastes include batteries, pesticides, thermostats, lamps and other similar materials.

All wastes were segregated by type (hazardous, asbestos, asphalt, concrete, C&D, recyclables, sanitary, etc). Wastes were labeled based upon specific Federal, State, and Base requirements. Wastes were segregated in a manner that minimized the volume of non-recyclable, hazardous and asbestos waste by

segregating general demolition debris from these wastes and consolidating the materials in waste containers. The primary methods of waste disposal were:

- Off-site Landfill (C&D)
- On-Site Cape Canaveral AFS Landfill (ACM & TSCA)
- Cape Canaveral Environmental Wing Staging Facility (Universal Waste)
- Off-site recycling/salvage location

Once a material was determined to have PCB concentrations < 50 ppm, it was able to be recycled for various purposes. The steel and other metal was transported to a licensed smelter for reuse. In Florida, the concrete was also able to be recycled and used for aggregate so it was sent to concrete crushers to be reduced to less than 3-in diameter. The reinforced concrete was crushed on site by grapple or equivalent just enough to remove the steel rebar so that both the steel and the concrete could be recycled. It became obvious early on in the demolition process that the additional effort to segregate, and prepare material for recycle produced additional funds that were utilized to fund demolition of other surplus or obsolete structures at Cape Canaveral AFS. Fig. 2 below illustrates the decision process used to maximize the recycle potential of demolition material.

The disposal of PCB-impacted steel in the Cape Canaveral AFS on-site landfill required that a modification to the existing disposal plan be request from the Florida Department of the Environment.

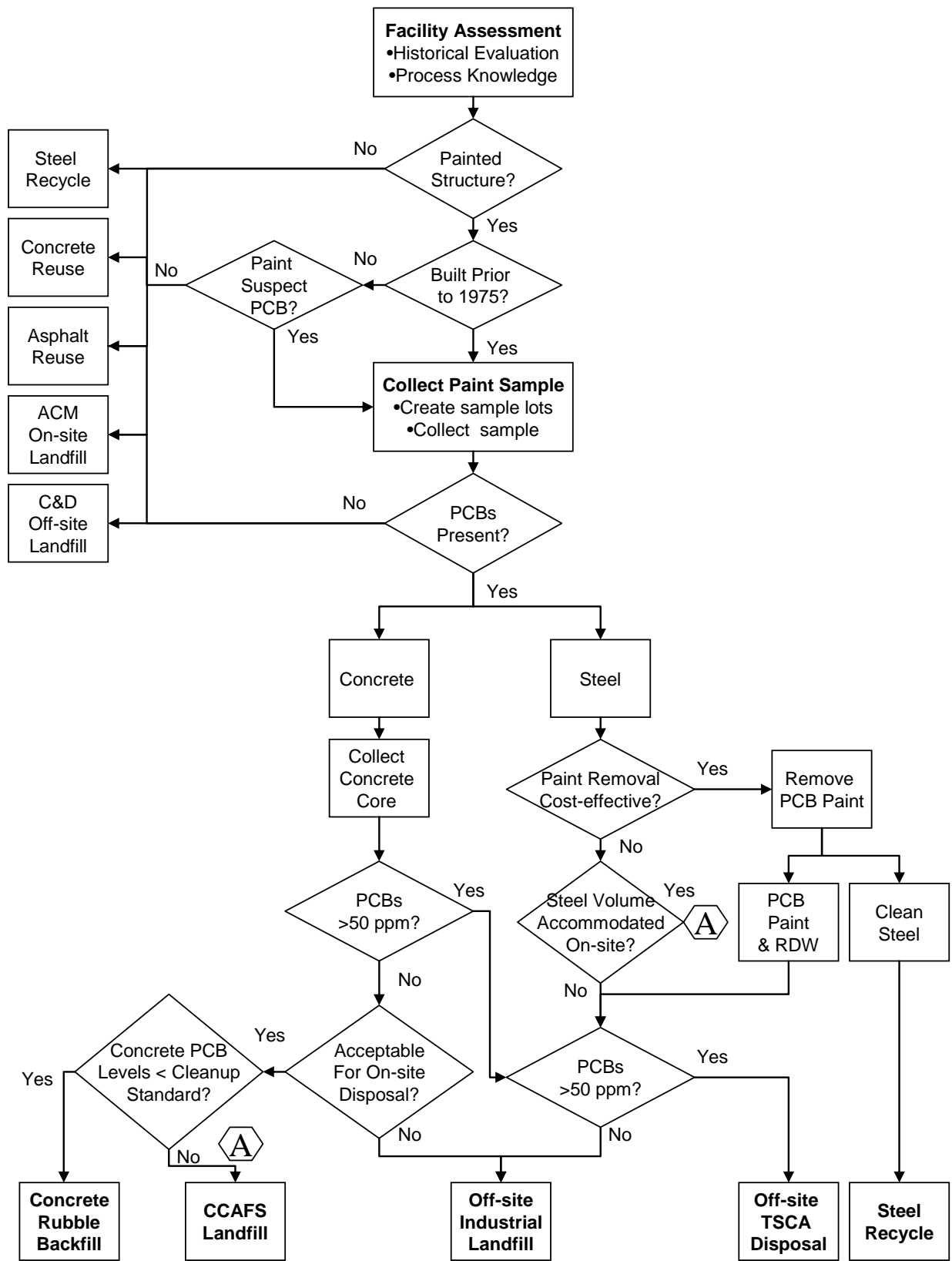


Fig. 2. Waste Disposition Decision Diagram Focused on PCB-impacted material.

EXPLOSIVE DEMOLITION

Explosive demolition refers to bringing down tall structures such as the MST or other tall steel structures by selective use of explosive devices. Explosive demolition is accomplished by a specialty contractor experienced in this type of work. The explosive demolition contractor uses drawings of the building structure to determine which beams and columns should be weakened by cutting and then sheared by explosive means such that the structure will collapse in a desired direction/location. The advantage of this type of demolition is that the inherent safety issue of workers doing demolition at great heights above the ground is eliminated. This type of demolition is also proven to be much more efficient from a time standpoint than demolition at height since most of the work can then be done at ground level. Once the structure is brought down, the completion of demolition and scrap removal is accomplished using shears and grapples.

For the Atlas SLC 36A MST and 36B MST explosive demolitions, 3 Explosive Safe Plans (ESP's) for each of the two structures was required. One ESP for the explosive storage trailer, one ESP for explosive installation and set-up at the towers, and one ESP for MST demolition. These plans outline the 762-m explosive clear zone for both MST's that was required. Occupied facilities within these clear zones were evacuated and roads leading into the area were cordoned off prior to the installation of electric initiators for the demolition. Road blocks were established at all roads at the perimeter of this zone. The majority of the other facilities in this zone are abandoned and no longer used with the ESPs identifying these clearly on drawings. All exposed sites are an accepted risk for loss since the loss of these facilities would not compromise the wing's mission.

Explosives demolition of tall, rigid structures involves a selection of a "direction of fall" based on improvements to remain. The choice as to direction for these structures was based on their configuration; more specifically, the height to width ratios on both the longitudinal and transverse axes of the structures. The specialty explosive demolition contractor proposed explosives operations were intended to create rotational moment about a reaction line across the rear longitudinal axis of the structure. There is a greater slenderness ratio in this tower by rotating the structure about that reaction line, reducing the amount of preparatory work in preparing this structure and reducing the quantity of explosives necessary to fell the structure. Both of these reductions are in the interest of safety. Lastly, by rotating the structure about the reaction line along the rear longitudinal face, the resultant structure lying at grade were easier and safer to reach for AMEC's material-handling crews.

Based on the above considerations, it was decided to fell each MST towards the south, onto the concrete apron between the MSTs. The MST was prepared for felling by cutting at specified locations to accommodate the desired direction of fall and allow for the majority of the superstructure to be on the ground after implosion. Due to heavy metals and PCB content, paint was abated from locations where torch cutting was required. Precision torch modification of selected structural elements to facilitate subsequent placement of linear shaped cutting charges was performed in areas previously abated of PCB-contaminated paint.

Once all was determined to be ready for explosive demolition, AMEC worked with Cape Canaveral AFS launch personnel and safety personnel to schedule the activity around other launch operations with adequate safety coverage to prevent intruders into the area where explosives were stored or placed on the structures. The launch was scheduled for a weekend and because of the historic nature of this launch facility, special guest and press were invited to view the explosive demolition from a remote location. Fig. 3 illustrates the sequence of demolition of the Atlas 36 MSTs.



Fig. 3. Atlas 36 MST Sequence of Explosive Demolition.

LARGE-SCALE DISMANTLEMENT OF THE VIB

Initially it was intended that the VIB would be explosively demolished; however, during final planning stages it was determined that due to other adjacent active facilities explosive demolition would not be the most expeditious process due to the extensive review/approval process. Therefore, AMEC proposed and implemented an alternative method, large-scale dismantlement of this structure. The key to dismantlement was involving a structural engineer early on to determine the best method to safely dismantle the structure to minimize the disturbance of the adjacent active facilities. In addition, since there were PCB-impacted steel components, an industrial hygienist was involved to ensure adequate measures were integrated into the process for worker safety during steel cutting operations.

It was determined that first the lower bays that could be demolished with conventional equipment would be removed. Then the high bay area roof and siding was removed. The siding was removed by workers in mastclimbers that were erected and fixed to the sides of the structure. Then the built-up roofing was removed. As this material was being removed it was either lowered to the ground in the case of the siding or dropped within cleared safe zones within the structure. At the end of the day, crews would work to remove this material and transport off-site for disposal. Once the structure was fully exposed, the large scale dismantlement of the steel components began.

The sequence for the large-scale dismantlement is as follows:

- Using a crane basket attached to a hydraulic crane with an anti-two block device, a burner and assistant witnessed a daily load test on the basket prior to utilizing the basket to reach the structural steel section to be rigged, torch cut, and pulled over.
- A wire rope, doubled by looping and clipping the ends, will be raised to an interior center column on the section to be pulled over. The wire rope is attached to the column flange with a screw pin shackle. The other end of the double wire rope will be attached to an excavator using a large screw pin shackle. All these items (wire rope, shackle, excavator, etc.) were sized in accordance with the structural calculation to have sufficient capacity with a factor of safety > 5 to ensure no single point failure during operation.

- The steel beam is then torch cut in sequence and depth at critical points to facilitate pulling the section of the structure over.
- The burner and assistant in the man-basket are removed from the area after designated cuts are completed.
- The drop zone is verified to be clear and the excavator then pulls the section to the ground using the wire rope. The section is pulled free of the structure for size reduction for disposition (disposal or recycle depending on presence of PCBs)

It should be noted that the crew doing the torch cutting was on supplied air with air monitoring occurring in the work area. This was to verify the anticipated conditions predicted from PCB air modeling and to protect the workers. Fig. 4 presents photographs of the dismantlement process.

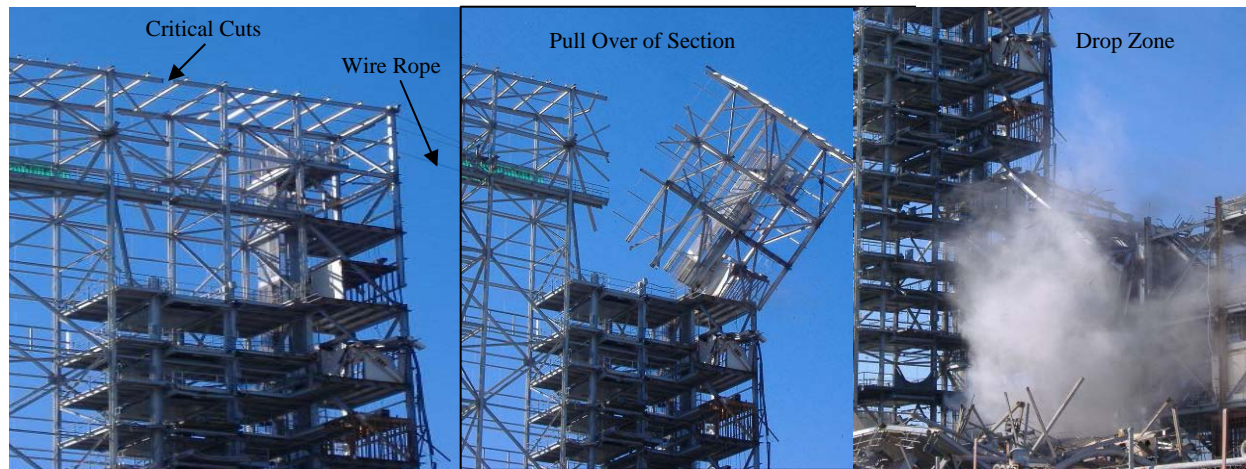


Fig. 4. VIB Large-Scale Dismantlement Sequence.

CONCLUSIONS

The Cape Canaveral AFS Demolition Program has been a great success due to the integration of multiple operations and contractors working together to determine the most cost-effective demolition methods. It is estimated that by extensive pre-planning and working with CCAFS representatives, as well as maximizing the recycle credits of various material, primarily steel, that the government will be able to complete what was baselined to be a \$30M demolition program for < \$20M. Other factors included a competitive subcontractor environment where they were encouraged with incentives to maximize recycle/reuse of material and creative demolition solutions. Also, by overlapping multiple demolition tasks at multiple facilities allowed for a reduction in field oversight. In summary, AMEC would like to acknowledge their tier one subcontractors that have worked together to make this program a success and they are: Core Engineering and Construction, Inc.; Controlled Demolition, Inc.; ECOR Federal Services, Inc.; Florida Environmental and Compliance Corp; and Marcor.