MOX Overview

NA-APM-1.4

Federal Project Director

Scott Cannon

Oct 2, 2018

MFFF Transition to Pit Manufacturing

National Nuclear Security Administration

- People
  - Manual/Non-manual
  - Future need: Term/Transition/Maintain/New Mission
- Facilities – Permanent & Temporary
- Equipment and Materials
  - Plant Equipment-onsite/offsite
    - Technology Transfer Fee Agreement (TTFA) w/AREVA
  - Construction Equipment
  - Materials – Fabricated/Stock, onsite/offsite
- Pedigree-Documents and Records
  - Electronic or paper
  - Onsite or Offsite
- Subcontracts-Closure
  - Impact on People, Facilities, Equipment, Materials & Paper

National Nuclear Security Administration

People: MFFF August 2018

NNSA PMO 34

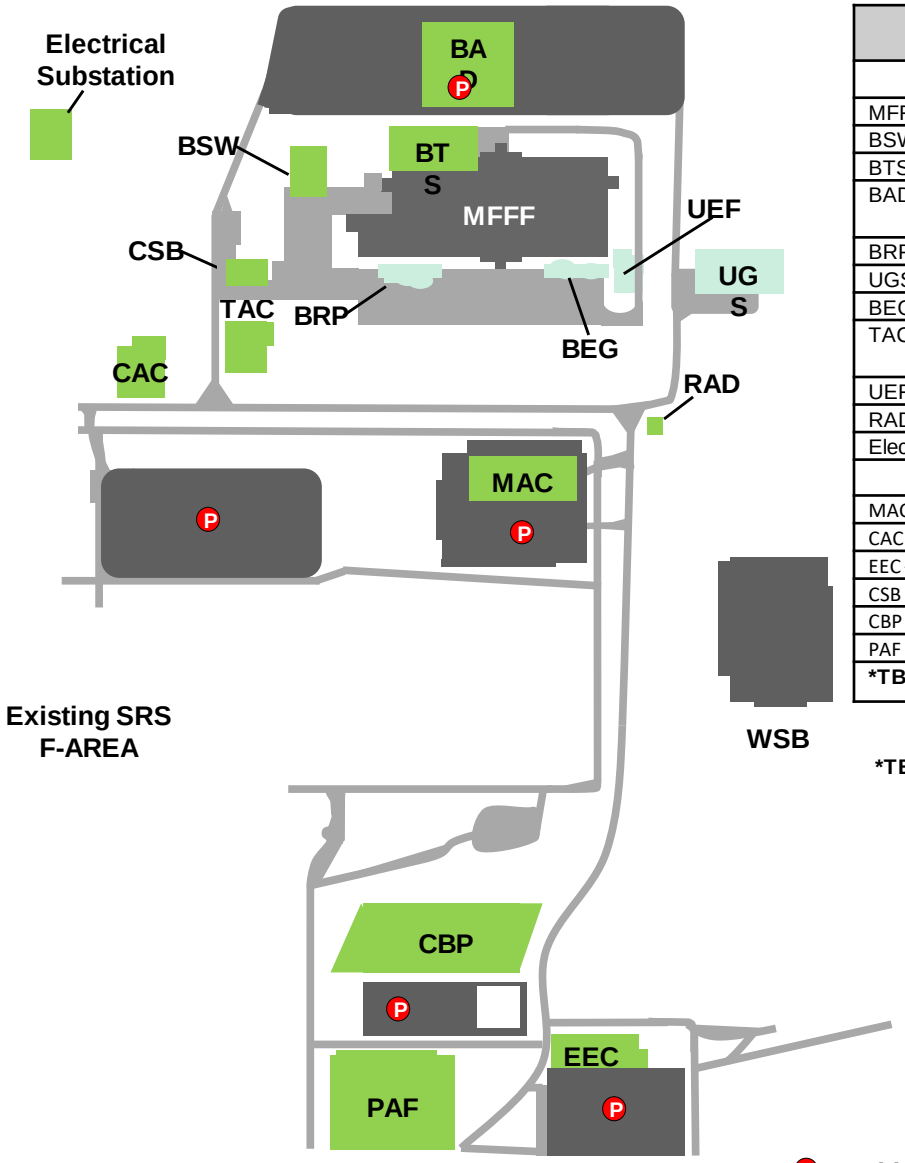
FPD	***1***
Project Engineers	***10***
Contract Officers	***3***
Business & Admin	***2***
Support Service Contr.	***16***
USACE Proj. Eng..	***2***
Total:	34

MOX Services 1823

Manual	
Laborers	60
Carpenters	50
Cement Finishers	12
Teamsters	8
Ironworkers	72
Operators	25
Painters	36
Millwrights	18
Boilermakers	12
Sheetmetal	127
Electricians	69
Insulators	12
Pipefitters	96
Total:	597

Non-Manual	
Project Support	
IT	32
Project Controls / Office OPS	76
Training	11
HR	3
Finance and Accounting	19
Document Control	10
Communications	3
Security	33
Legal	7
ES&H	19
Engineering	
Software / Software Design	22
Services / CGD	15
Electrical / I&C	60
Structural	22
Chemical / Mechanical	61
Plant Design /Seismic / Supports	88
Resident	21
Nuclear	14
Commissioning	110
Strategic Planning & Integration	26
Construction & Project Management	110
Work Planning and Control	84
Construction Engineering	185
Materials Management	42
Property	7
Procurement and Contracts	43
Compliance	3
Project Assurance / QA	100
Total Non-Manual:	**1226**

MFFF and Support Buildings



Facility	Construction		Status
	Start	Complete	
Permanent Buildings			
MFFF – MOX Fuel Fabrication Facility	Sep 2007	2016*	Construction
BSW – Secured Warehouse Building	Jan 2009	Dec 2009	Complete
BTS – Technical Support Building	2010	2012	Complete
BAD – Administration	June 2008	June 2009	Complete
BRP – Reagent Processing Building	2015	2015*	Planning
UGS – Gas Storage Area	2015	2015*	Planning
BEG – Emergency Diesel Storage	2015	2015*	Planning
TAC – Training Administration Complex	June 2007	Jan 2008	Complete
UEF – Emergency Diesel Storage	2015	2015*	Planning
RAD – Radiography Building	July 2008	July 2008	Complete
Electrical Substation	Feb 2009	2010	Complete
MOX Site Infrastructure			
MAC – MOX Administration Complex	Dec 2006	May 2007	Complete
CAC – Construction Administration Complex	May 2007	Aug 2007	Complete
EEC – Equipment Engineering Complex	Sep 2007	Nov 2007	Complete
CSB – Craft Support Building	Mar 2008	May 2008	Complete
CBP – Concrete Batch Plant	Apr 2007	July 2007	Complete
PAF – Process Unit Assembly Building	Apr 2008	Sep 2008	Complete
***TBD upon Project Re-Plan**			

*TBD upon Project Re-Plan

COMPLETE

CONSTRUCTION ONGOING

PLANNED

MFFF and Support Building Aerial

Permanent MFFF Buildings

Technical Support
75,000 sq. ft.

Secure Warehouse
20,000 sq. ft.

Training Facility
17,000 sq. ft.

Admin Building
56,100 sq. ft.

Permanent Facilities

Process Assembly Bldg (PAF)

110,000 ft^2
Assembly, Startup & Test
Office Space for 100

2- Warehouses

40,000 ft^2

Temporary Support Facilities

Craft Building
7,000 sq. ft.
(Temporary)

Construction Admin
54,000 sq. ft.
(Temporary)

Engineering Admin
39,000 sq. ft.

Glovebox & Testing
35,000 SF

Temporary Construction Support Facilities

Small Business
Piping Shop

Small Business
Carpenter Shop

Fueling Depot

Small Business
Electrical Shop

Welding Shop

Piping Shop

Temporary Construction Support Facilities cont:

Temporary HVAC Shop

Hazardous Liquid Storage

Equipment Support Machine Shop

Electrical Machine Shop

HVAC Machine Shop

Rebar Shop

MOX Fuel Fabrication Facility

National Nuclear Security Administration

Mixed Oxide Fuel Fabrication Facility

MFFF Process Building (BMF, ~350,000 ft^2 useable space, seismically qualified, steel reinforced concrete structure 73 feet tall above grade. There are three distinct areas:

1. **The BAP stands for aqueous polishing building. This area has all operations to purify plutonium through chemical processing. The input is plutonium oxide with impurities and the output is plutonium oxide. There are five main levels in the BAP totaling approximately 75,000 ft^2 of useable space.**

2. **The BMP stands for manufacturing process building. This area has all operations to manufacture nuclear fuel assemblies from inputs of plutonium oxide and depleted uranium oxide. There are 3 main levels in the BMP totaling approximately 225,000 ft^2 of useable space.**

3. **The BSR stands for shipping and receiving building. This area also has the personnel entrance and exit for the BMF, electrical equipment and control rooms. There are three levels in the BSR totaling approximately 50,000 ft^2 of useable space**

Structural and Seismic Design

- The slab on grade is 6.5 feet thick
- The roof is 4.5 feet thick
- The exterior wall varies from 3 to 4 feet thick
- The interior walls vary from 1 foot to 6 feet thick.
- The security ‘gabion’ wall is 2.5 feet thick and extend to the top of the second floor of the BMP (el. 46’ 10″)
- The building is made of ~130,000 cubic yards of concrete with rebar from #6 bar (0.75 inch diameter) to #11 bar (1.41 inch diameter).

Structural and Seismic Design

- **BMF Seismic input is between PC-3 and PC-4 for DOE facilities. BMF could be considered PC-3+.**
- **Higher estimates of eastern seaboard seismic activity were published by the U.S. geological survey around 2011. The NRC is satisfied that the BMF is designed to the revised higher estimates.**
- **MFFF seismic design input exceeds current SRS SDC-3 curves for structural frequencies. This means that the MFFF design contains conservatism relative to current DOE requirements.**
- **MFFF was constructed subject to NQA-1 qualify requirements.**

HVAC Design

- **The MFFF HVAC is essentially a once through system with three tier dynamic confinement. The supply air system (HSA) supplies air to the majority of the building. Multiple layers of HEPA filtration are included in the supply and exhaust systems.**
- **Leakage Air Flow Direction (explained on next slide)**

- **Other HVAC Systems:**
  - **Truck Bay ventilation.**
  - **Control Room ventilation**
  - **Safe haven ventilation**

HVAC Design

Zone	Description	HVAC Exhaust System	Notes
C1	Areas with an opening to the outside. Virtually zero contamination risk		
C2	Areas where contamination risk is very low such as corridors and process rooms that have multiple barriers.	MDE	
C3a	Airlocks to process rooms	HDE	HDE system is designed to operate before and after a design basis earthquake. EDG supplies power after the earthquake.
C3b	Process rooms with gloveboxes	HDE	
C4	Areas where radioactive material is present (inside gloveboxes).	VHD	VHD has uninterruptible power supply and is designed to operate before, during and after a design basis earthquake. EDG supplies power after the earthquake.

Non-Safety Electrical Design

- **The MFFF has two separate, independent 13.8 kV offsite sources of electrical power.**
- **These independent 13.8 kV feeds supply independent 4.16kv transformers which provide power to HVAC fans and several 480V transformers.**

- **The Electrical supply system is designed to prevent single-point vulnerabilities. Cross tie connections enable power to be supplied when one component fails.**

Safety Electrical System

- **Two, independent and redundant 1,800 kW emergency diesel generators**
- **Diesel fuel is stored in two separate, redundant tanks in an underground vault.**
- **Uninterruptible power supplies provide power to glovebox exhaust fans (VHD system) and other loads that must not lose power, even briefly, in the time it takes for the EDGs to provide power after a loss of off-site power.**

Fire Protection Design

- There are over 1,000 fire dampers in the BMF design to contain fires to small areas.
- Most fire barriers are 2-hr rated. There are 3-hr and 4-hr rated fire barriers.
- Fire suppression consists of three types used in different areas
  - Water: Generally used in Corridors, personnel areas
  - Halogenated Clean Agent: Generally used in Electrical and Control Rooms
  - Non-Halogenated Clean Agent: Generally used in Process Rooms
- Gloveboxes are designed with polycarbonate (lexan) windows, which adds to the combustible loading, but this material is very difficult to ignite and to sustain a flame.
- HEPA filters selected have been tested for soot loading impact on functionality.

Gloveboxes

- The BMF has 550+ rooms. 59 of these rooms are designed to have gloveboxes.
- The BMF has over 300 gloveboxes.
- The BMP is already designed to have supply of nitrogen sufficient to inert many gloveboxes. Argon is used for one glovebox where welding occurs.

	# GB Rooms	GB ventilation supply
BMP Level 1	20	Nitrogen, Argon and Dry Air
BMP Level 2	6	Nitrogen, Argon and Dry Air
BMP Level 3	15	Nitrogen and Dry Air
BAP Level 1	1	Dry Air
BAP Level 2	3	Dry Air
BAP Level 3	9	Dry Air
BAP Level 4	5	Dry Air
BAP Level 5	0	N/A

Glovebox Areas of Note

- **NTM Hallway (B-123): The NTM hallway (approx. 15 ft by 100 ft) consists of a long storage and transfer glovebox that has nine automated material transfer connections to seven other processing rooms. The seven process rooms are all 29 feet wide and vary in length from 26 ft to 50 ft. The room height is approximately 23 ft. The majority of these gloveboxes are inert.**

- **Cladding (B-264): The cladding room is a large glovebox room (approx. 55 ft x 135 ft). The room height is approximately 23 ft. All gloveboxes, except one, in this room are inert.**

- **LAB (3rd floor BMP): There is a large lab space on the third floor of the BMP, with almost 100 gloveboxes contained 15 rooms. There is a pneumatic transfer system to transfer samples to the Lab from four locations in the BMF (1st and 2nd floor BMP and 2nd floor BAP).**

Nuclear Material Storage Design

- **3013 Storage Capacity:**
  - **DCM – Main Storage, approximately 1,700 3013 cans can be stored.**
  - **DCE – interim storage, approximately 400 3013 cans can be stored.**

- **Other Storage Types: Four gloveboxes for pellet storage, NTM for powder storage, STK for rod storage and TAS for fuel assembly storage**

Network and Control System Design

- **The network system includes classified and unclassified systems.**
- **The MFFF control system includes normal and safety Programmable Logic Controllers (PLCs), Control and remote workstations, a Manufacturing Management and Information System (MMIS), a diagnostic aid system (DAS), sensors and actuators, Ethernet communication networks, fieldbus networks, a laboratory management information system (LIMS) and other components.**
- **The MFFF design includes 83 non-safety PLCs, 13 safety PLCs, and 68 supervisory control and data acquisition (SCADA) systems.**
- **The normal, non-safety control system has approximately 35,000 different inputs and outputs.**

MOX Control System Architecture

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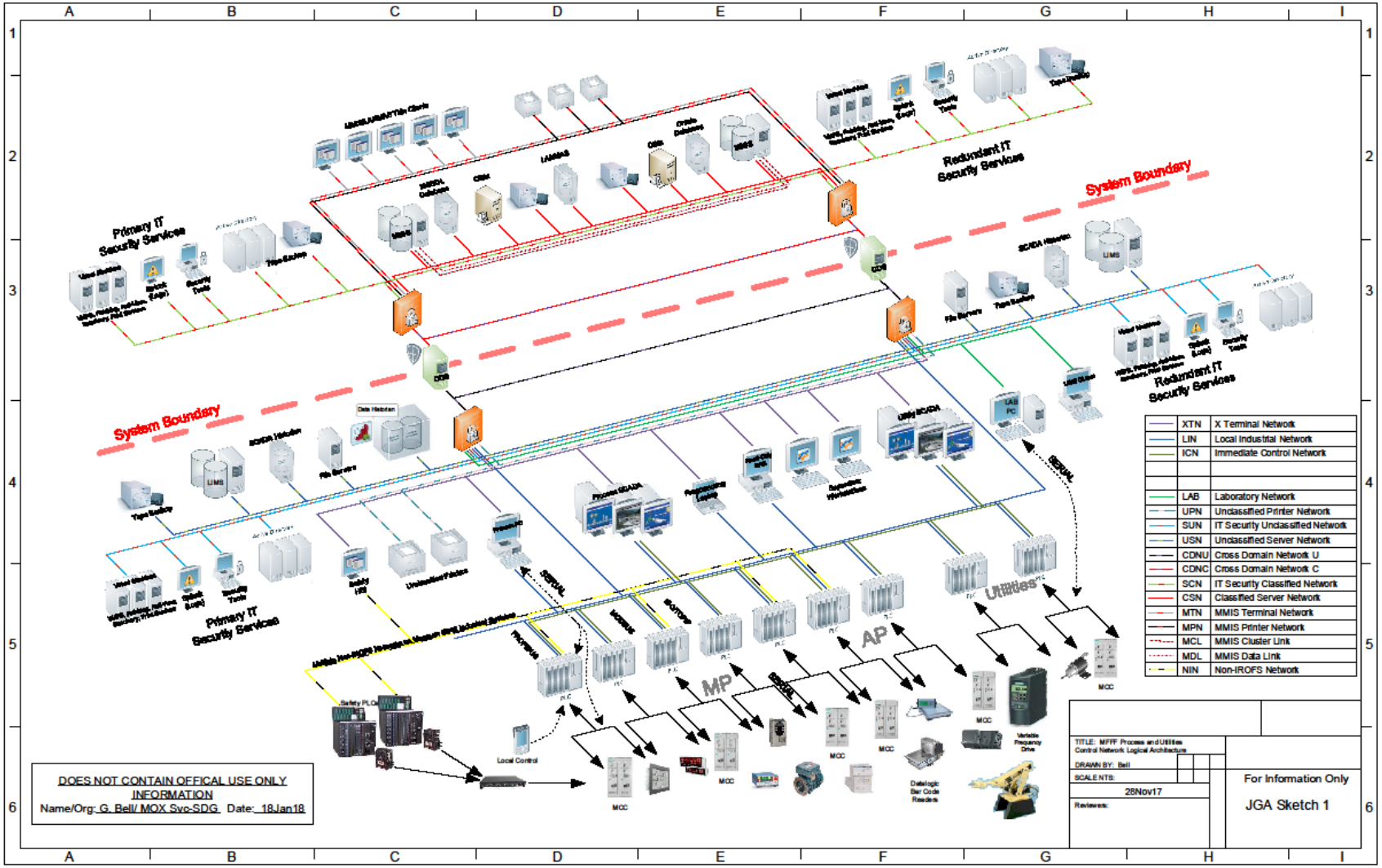


Radiological Waste Design

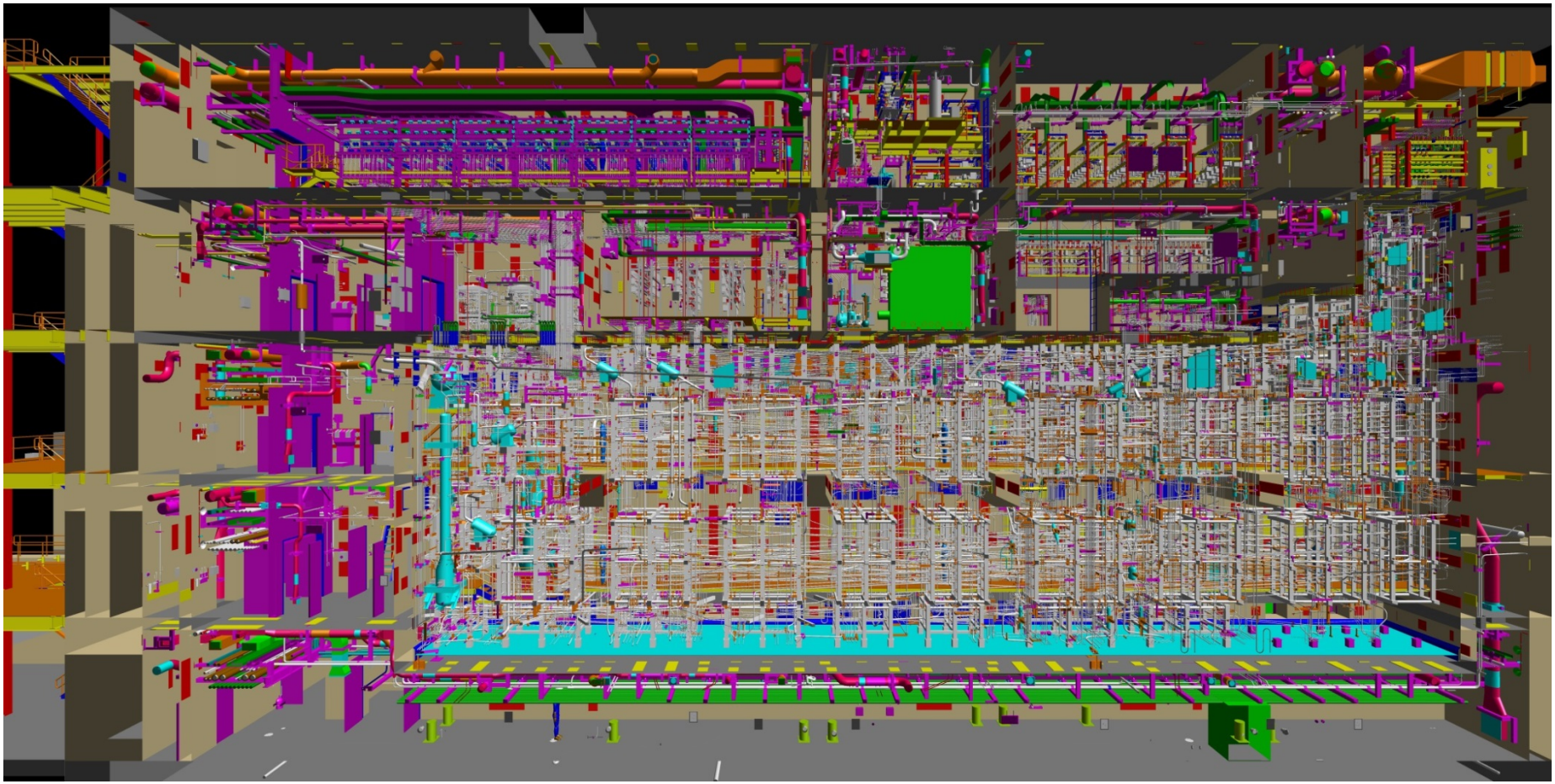
Solid Waste:

- Inside the BMP is a solid waste packaging, assessment, and storage area.
- It is designed:
  - to handle low-level waste and TRU waste,
  - to store up-to 712 drums, and
  - for a throughput of 2,556 55-gallon drums per year.
- Pallets of four drums are shipped out through the shipping bay

Liquid Waste:

- The BAP stores, and transfers liquid waste to the WSB.
- The types of waste transferred to the WSB in separate lines are:
  - Low Level Waste
  - Stripped Uranium
  - High Alpha (Americium primarily)

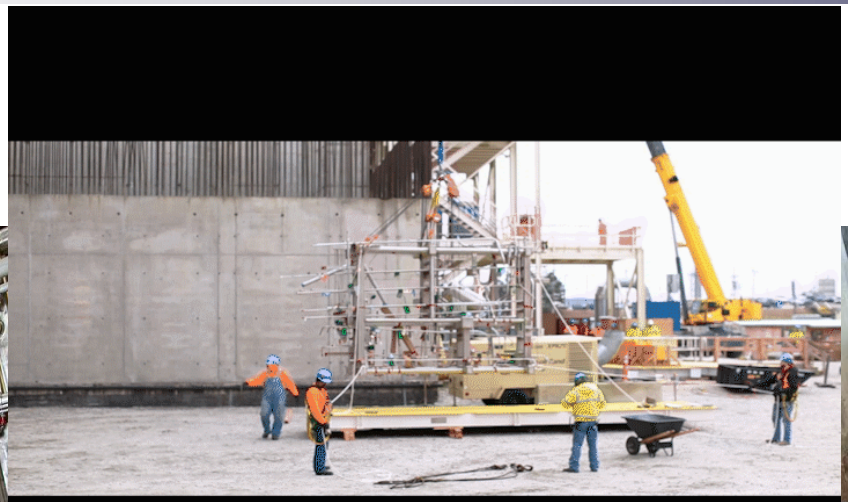
BAP Active Gallery

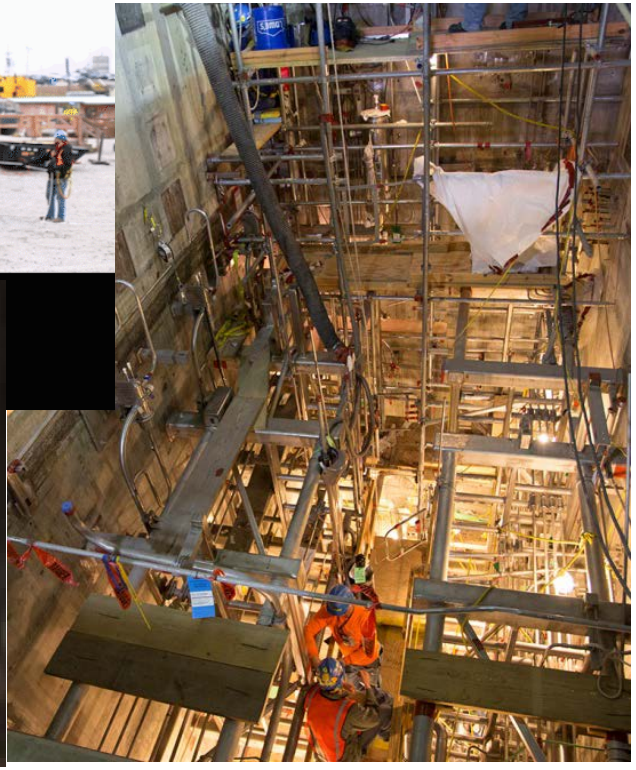


- **Dimensions:**
  140 ft long
  12 ft wide
  45 ft high

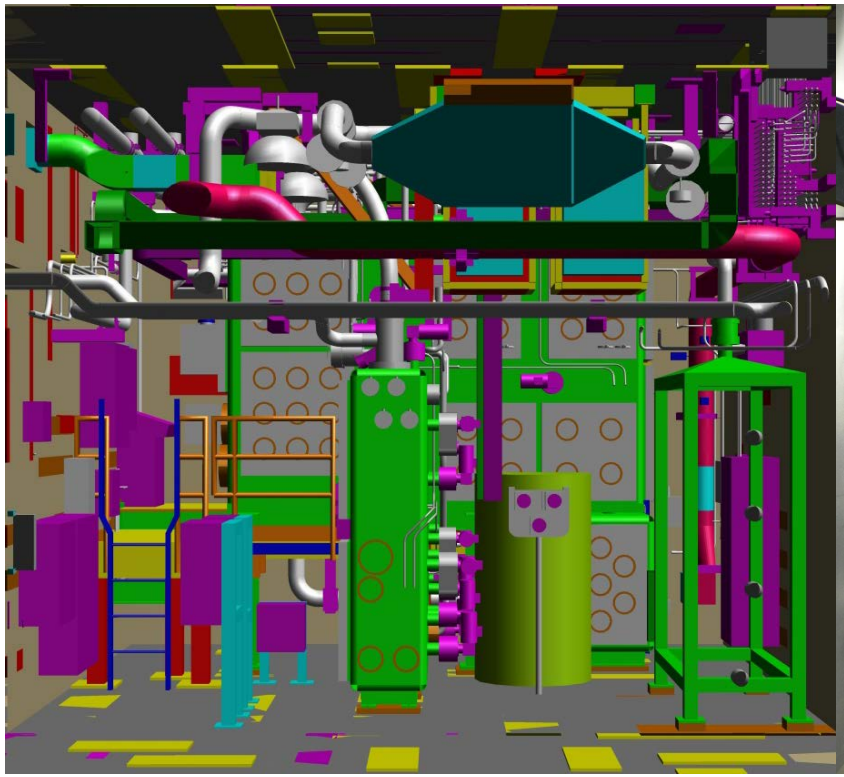
- **Process Piping:**
  15 miles
  10,000 welds

BAP Active Gallery : cont.

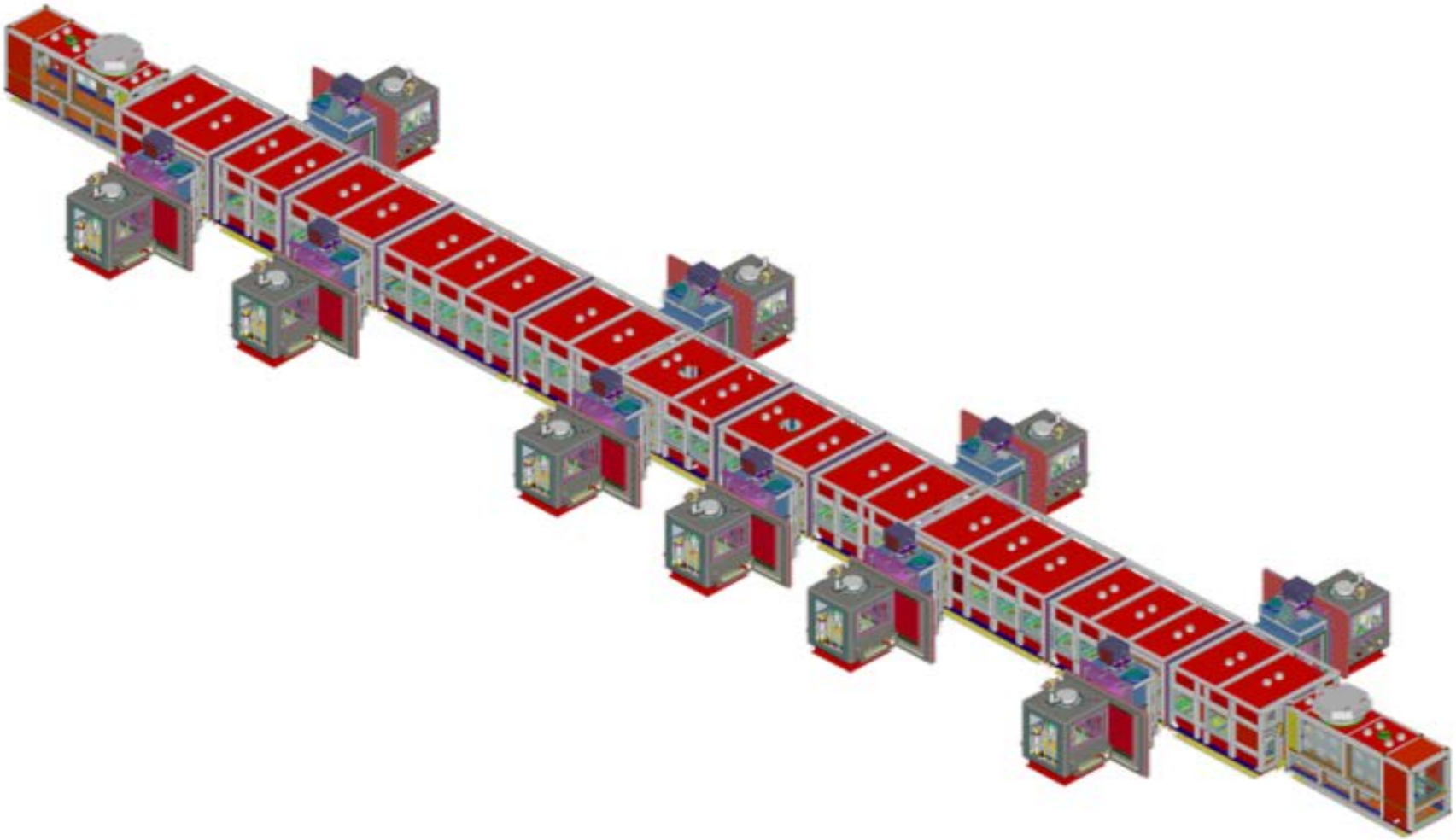




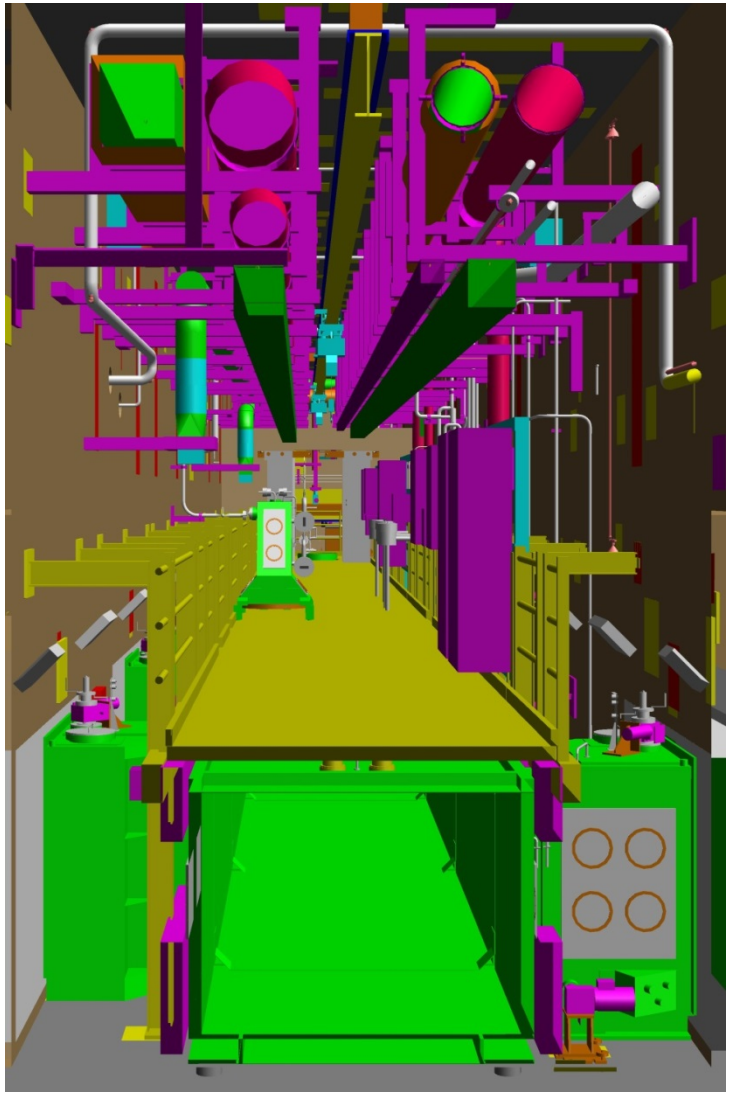
BAP Glovebox Room



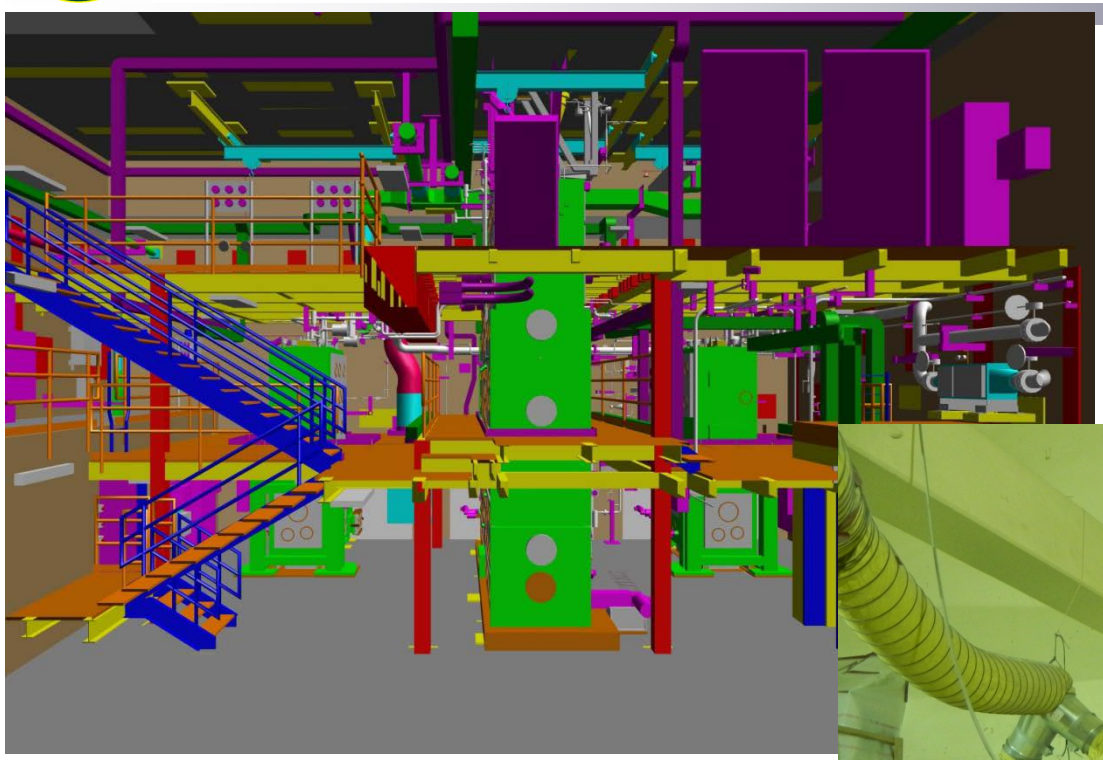
BMP; Powder Storage and Transfer Area

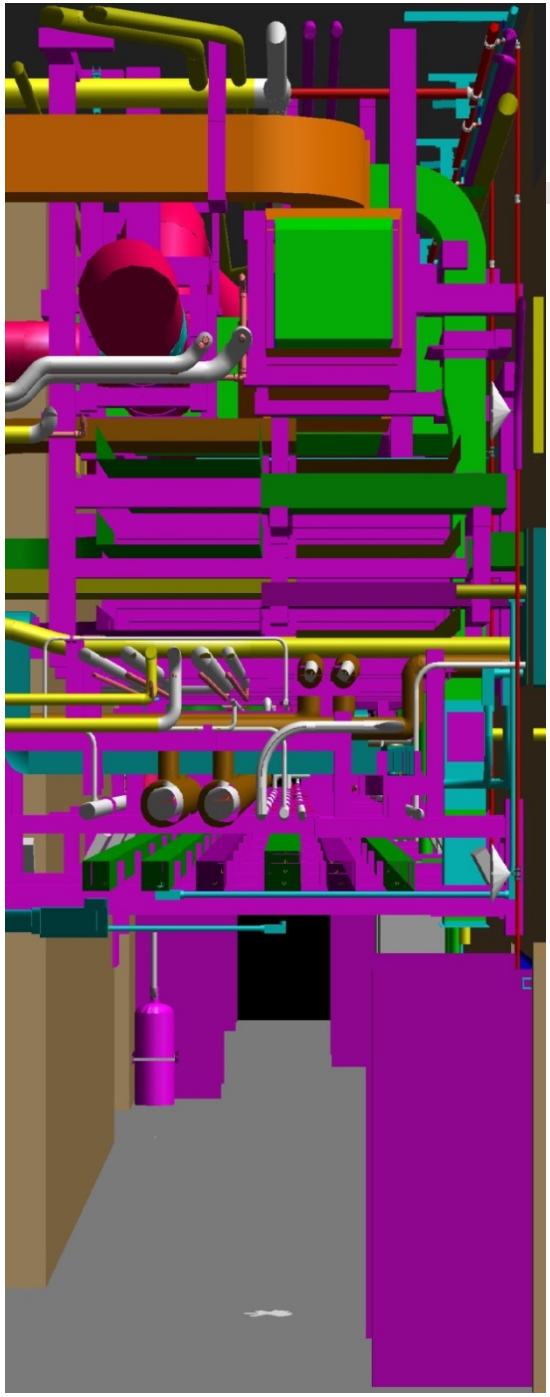


BMP Jar Storage and Handling Unit



BMP Powder Process GB Room





MOX Process (BMP) Corridor

Commodity Installation Status

Commodity	Total at Completion	Project to Date Quantities 30June2018	Project to Date % Complete 30June2018	Final Attributes Complete 30June2018	Final Attributes % Complete 30June2018
AG Pipe (LF)	80,375	59,048	73%	18,397	23%
Pen Plates (EA)	342	277	81%	0	0
AG Equipment (EA)	181	146	78%	0	0%
Balance Pipe (LF)	364,421	26,468	7%	10,556	3%
Duct (LBS)	1,234,751	529,256	43%	224,295	18%
Fire Dampers (EA)	1,151	557	48%	250	22%
Glovebox Mech Ph 1 Complete (EA)	417	187	45%	187	45%
Cable Tray & WW (LF)	83,797	10,602	13%	7,130	9%
Conduit (LF)	834,293	38,188	5%	10,787	1%
Electrical Equipment	4518	104	2%	55	1%
Fire Protection Pipe (LF)	25,378	15,771	62%	0	0
Electrical Cable	6,867,153	75,107	1.1%	9,241	<1%
Electrical Terminations	364,965	284	<1%	0	0

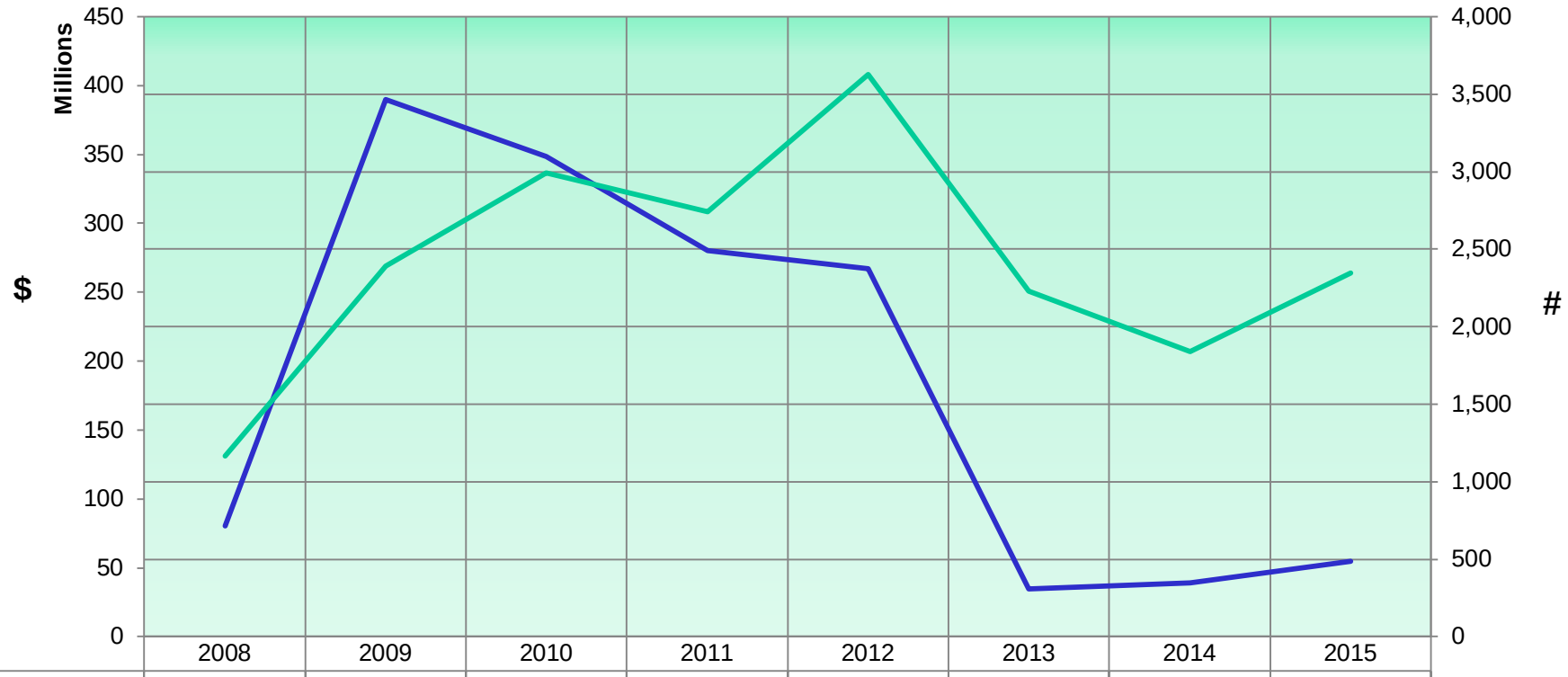
- Approximate Quantities of Materials/Equipment in Onsite & Offsite, Warehouses 40 Acres of Laydown Areas:
  - –407,284 pounds of HVAC duct
  - –6.21 million linear feet of electrical cable
  - –337,300 linear feet of pipe
  - 6,800 glove box assemblies
  - 2000 electrical cabinets/panels
  - 4,940 manual valves

~ 50% of the rooms in the 550+ room MFFF have no commodities installed

Contracts – Procurement and Materials Overview

- Overall procurement spend: $2.3B
- Four main categories of procurements
  - **Construction:**
    - **Installation: Concrete ~100%; Duct 34%; Pipe 15%; Electrical 1%**
    - **Commodity procurement: Concrete ~100%; Duct 90%; Pipe 68%; Electrical 83%**
  - Engineered Equipment: $71M/67 actions to go
  - **Process Equipment/Gloveboxes: $26M/30 actions to go**
  - Services/other: largely time-dependent, relatively low dollar value
- 40 Acres of Laydown Yards (23% Capacity Remaining)
- 315,000 square feet Indoor Storage (10% Capacity Remaining)

Dollar Value and number of Procurements/Awards



	2008	2009	2010	2011	2012	2013	2014	2015
$ of New Awards	$80,146,055	$390,030,20	$348,809,12	$280,501,62	$267,097,40	$34,675,526	$38,966,151	$54,618,701
# of New Awards	1,167	2,391	2,990	2,740	3,625	2,229	1,842	2,348

Pictures of Laydown Yards/Warehouse

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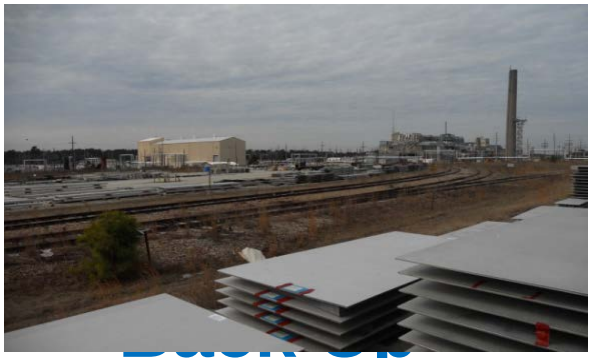


Barnwell Warehouse

Electronic & Paper Information Storage

National Nuclear Security Administration

MOX Services – Electronic Server Information

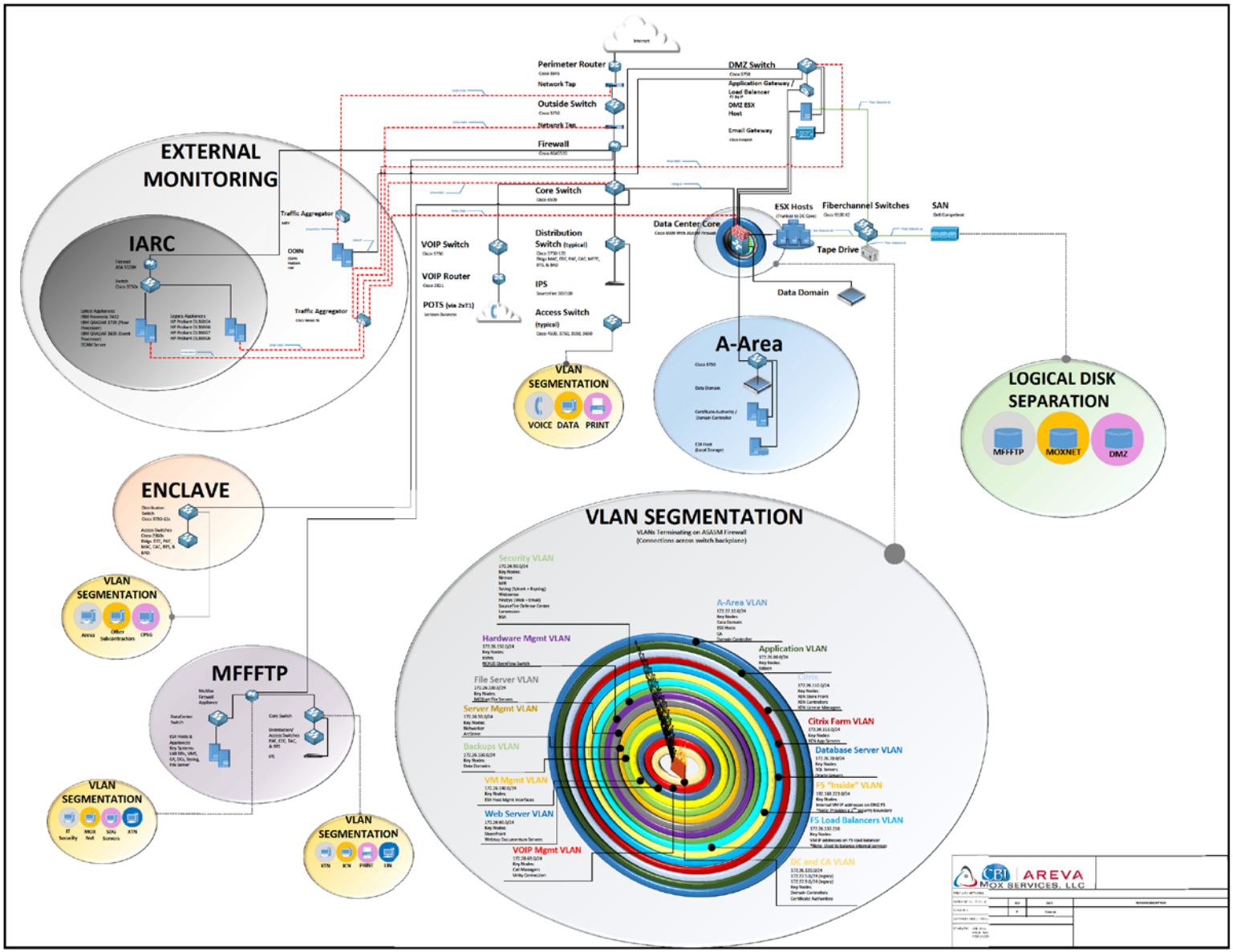
- Physical Servers (Hosts and Standalones): 32
- F-Area Cluster-VMWare Virtual Center (no data storage) – 16 Servers
  Total Data Storage – Storage Area Network (hard drives) = 196 TB
- A-Area Cluster (backup/disaster recovery) – 3 Servers
  Total BACKUP/DUPLICATE Data Storage – 210.1 TB
- Standalone – with limited data storage – 13 Servers
  Limited Data Storage (within Server) = 5 TB

Total Data Storage (SAN and Standalone) = 201 TB

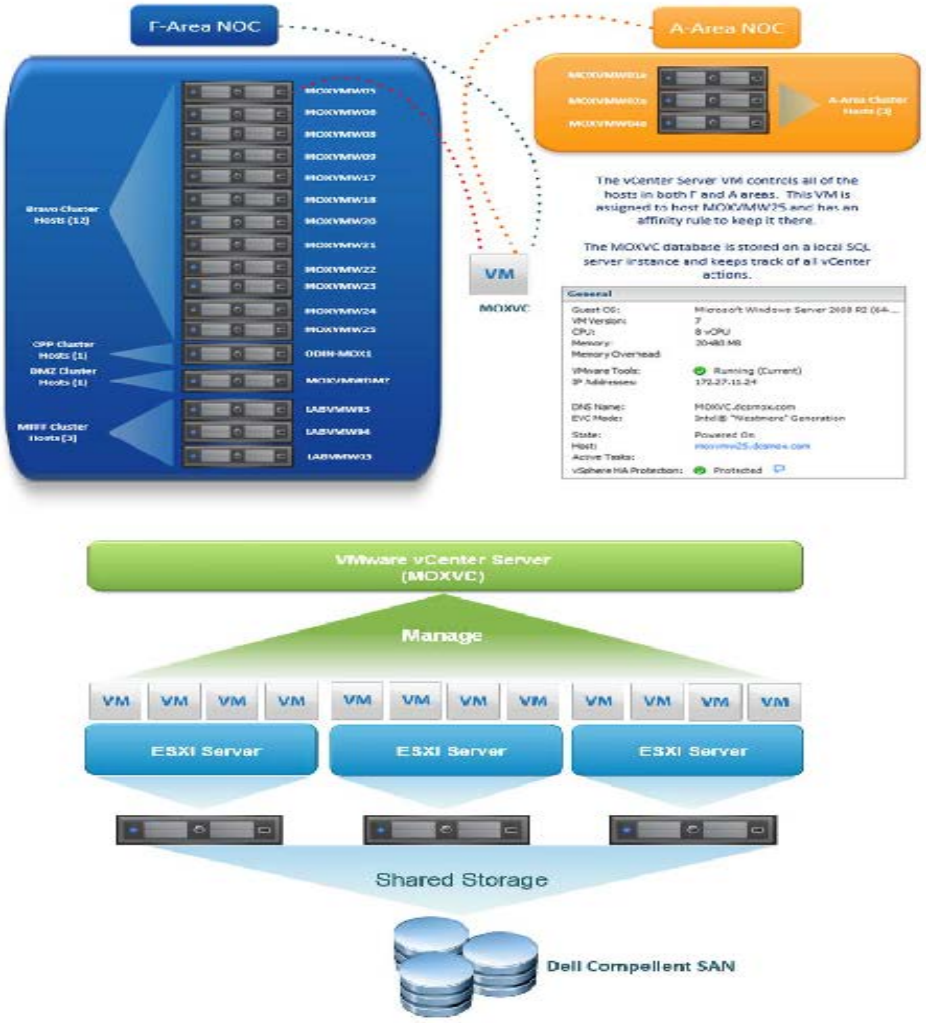
MOX Services – Paper Records/Information

- Unknown-MOX Services now inventorying office spaces

MOX Network Structure

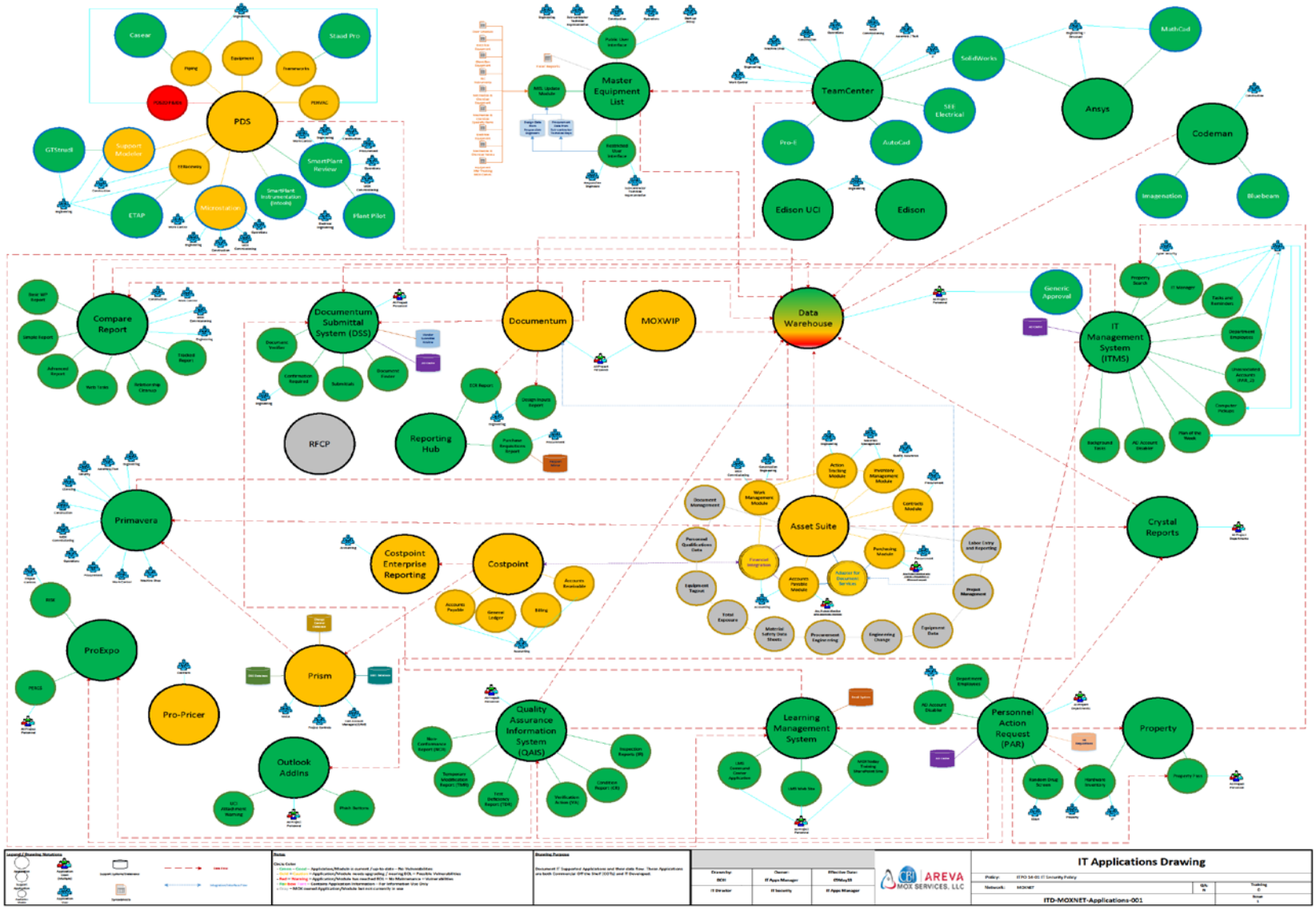


MOX Virtual Machine (VM) Ware Diagram



Project: MOX Services Information Systems

National Nuclear Security Administration



Plutonium Metal and the BMF

- The current license basis with the NRC does not include handling plutonium metal, but…
- A conceptual design has been developed for the BMF to process plutonium metal into plutonium oxide.
- This is referred to as Direct Metal Oxidation (DMO).
- This conceptual design was done when another project (Pit Disassembly and Conversion Facility - PDCF) was cancelled.
- This is mentioned because considerations for handling plutonium metal have already been considered at the level necessary for that conceptual design.
- The hazards considered for plutonium metal are documented in several evaluations
  - DCS01-AAS-DS-ANS-H-38609 DMO Preliminary Hazards Analysis
  - DCS01-DMO-DS-ANS-R-24999 DMO Fire Safety Evaluation
  - DCS01-AAS-DS-ANS-H-38540 DMO Process Hazards Analysis

NRC Regulatory Summary

- **Nuclear Regulatory Commission**
  - **Issued Construction Authorization in 2005**
  - **Regulates nuclear safety for the MFFF through resident inspector and regional inspection teams**
  - **Issued Safety Evaluation Report in 2010 with no issues**
  - **Will issue License to possess and process nuclear material**
  - **Completed Atomic Safety & Licensing Board Hearings 3/9/2012**
- **MFFF was designed to NRC seismic requirements**
- **DOE equivalent would be PC-3+**
- **Design Earthquake for MFFF is based on a 0.20g maximum horizontal and vertical ground acceleration (Reg Guide 1.60)**

NRC License and Safety Analysis

- **MFFF is a NRC licensed facility (10 CFR 70)**
- **NRC Docket No. 070-03098**
- **Integrated Safety Analysis (ISA) approved by NRC**
- **DOE Documented Safety Analysis (DSA) not prepared**
- **ISA process is similar to the DSA process**
  - **Identify internal and external hazards for events**
  - **Analyze their likelihood and consequences**
  - **Define Systems, Structures and Components (SSCs) that are items relied on for safety (IROFS)**
- **ISA discusses:**
  - **Radiological hazards**
  - **Chemical hazards**
  - **Natural Phenomena hazard**

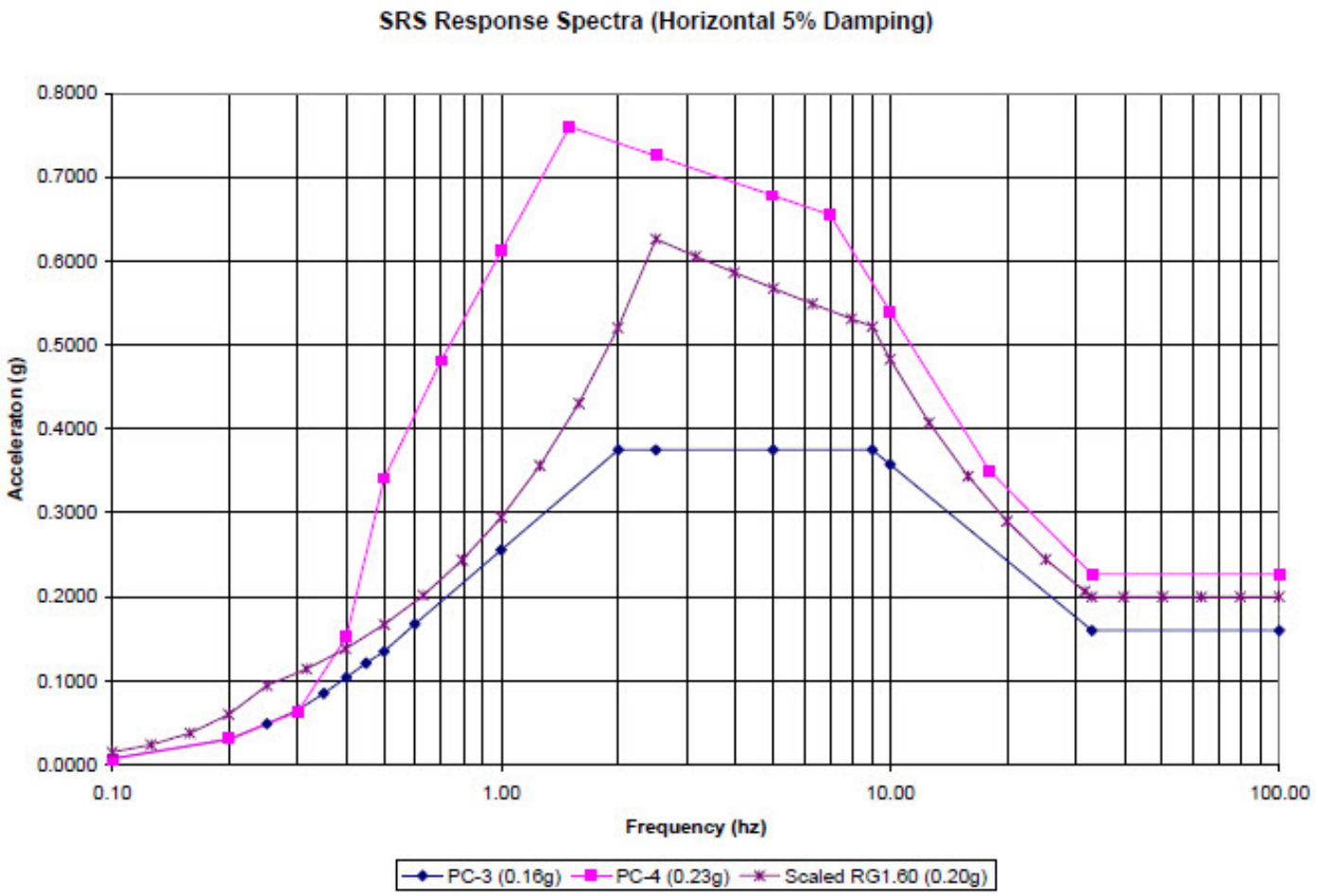
NRC License cont.

- Design criteria – Individual Outside Controlled (IOC) Area during normal operations doses well below 100 mrem/yr TEDE
- IOC is the maximally exposed individual outside the controlled area
- Controlled Area – 68 m from the BSW & 160 m from MFFF stack
- A DSA would use Site Boundary approx. 9 miles for MOI (IOC)

Backup Slides

Structural and Seismic Design

Figure 2.6-21. Comparison of 0.2g RG 1.60 Spectrum to PC-3 and PC-4



Structural and Seismic Design

Fig. 8.50 Z-Direction FRS Envelopes at Slab on Grade and BAP/BSR Basements