Core Facility Revitalization (CFR)

Critical Decision -1 (CD-1) Independent Project Review

Project Overview, Scope, Schedule, & Cost

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Modernization Project Office
January 19th, 2017

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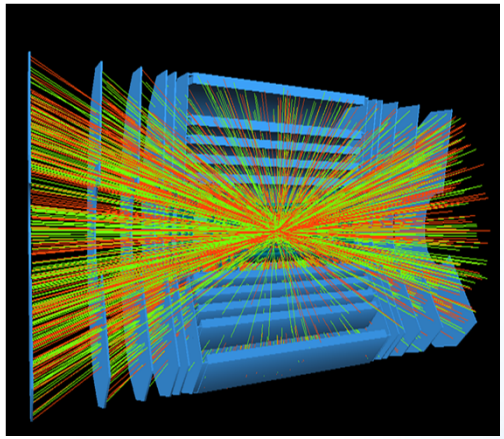
U.S. DEPARTMENT OF ENERGY | Office of Science

Core Facility Revitalization - CFR

- CFR – Scope Review
- Changes Since August 2016 IPR
  - Enhanced Core Mission Capabilities
  - Funding Considerations
- IPR Charge Questions
- Performance Requirements
- Cost / Schedule
- Analysis of Alternatives/LCCA
- Project Documentation

CFR – Scope Review



- **CFR Mission:**
  - Address the capability gaps that will impact the mission readiness of the RHIC/ATLAS Computing Facility (B515) and will impose risk on research funded by NP and HEP, as well as other BNL Laboratory programs
- **Mission Capability Gaps:**
  - **Existing B515 Computing Facility**
    - Constructed in 1960's: Limited space, limiting configuration and antiquated power distribution and cooling systems
    - Functionally obsolete relative to the ability to meet near term and future reliability requirements
  - **Lack of resources to respond to rapid growth of BNL's Scientific Core Mission computational and data storage needs**

CFR – Scope review

- **The Preferred Alternative:**
  - **Renovate & Revitalize B725 for use as a new data center. Deploy an *Incremental* approach to address BNL's core mission computing needs…**
    - Deliver Adequate Day-one and Future IT Power (Computing Power)
    - Provide Modern Cooling and Back-up Capabilities
    - Lowest Life Cycle cost and TPC
    - Address Future Growth & Expansion Needs

An incremental approach allows for future flexibility, "right-size" deployment of equipment, and minimizes risk of equipment underutilization.

CFR – Changes Since August 2016 IPR

A successful IPR was completed August 2016 with no recommendations. The following is proposed to address additional project requirements and new funding considerations…

- **Enhance Core Mission Computing Capabilities**
  - Accelerated deployment of an additional 1.2 MW of IT power
  - Provide for greater Laboratory-wide computing capabilities
- **Address Funding Considerations**
  - Revised project milestones and develop the preliminary schedule based on updated DOE funding guidance

CFR – Committee Charge

- Have performance requirements been appropriately and sufficiently updated?
- Is the analysis of alternatives credible and has it been updated appropriately?
- Based on the changes, are the cost and schedule ranges credible and realistic for this stage of the project?
- Have the project documents (e.g., Acquisition Strategy, Preliminary Project Execution Plan, etc.) been updated and ready for approval?

CFR – FY16 Conceptual Design

(3) Distinct sets of design drivers identified…

1. Power, Cooling, and Reliability Requirements

- User/Program Generated Power, Cooling, and Reliability Requirements (ATLAS Service Agreement)

2. Power Efficiency, Mandates, and Metering

- E.O. 13693 – Planning for Federal Sustainability in the Next Decade & Data Center Optimization Initiative (DCOI)
  - PUE Requirements
  - Automated Infrastructure Requirements
  - Advanced Metering/monitoring

3. Flexibility

- Incremental growth and expansion capabilities
  - Power
  - Cooling
  - Physical expansion/growth

CFR – Performance Requirements

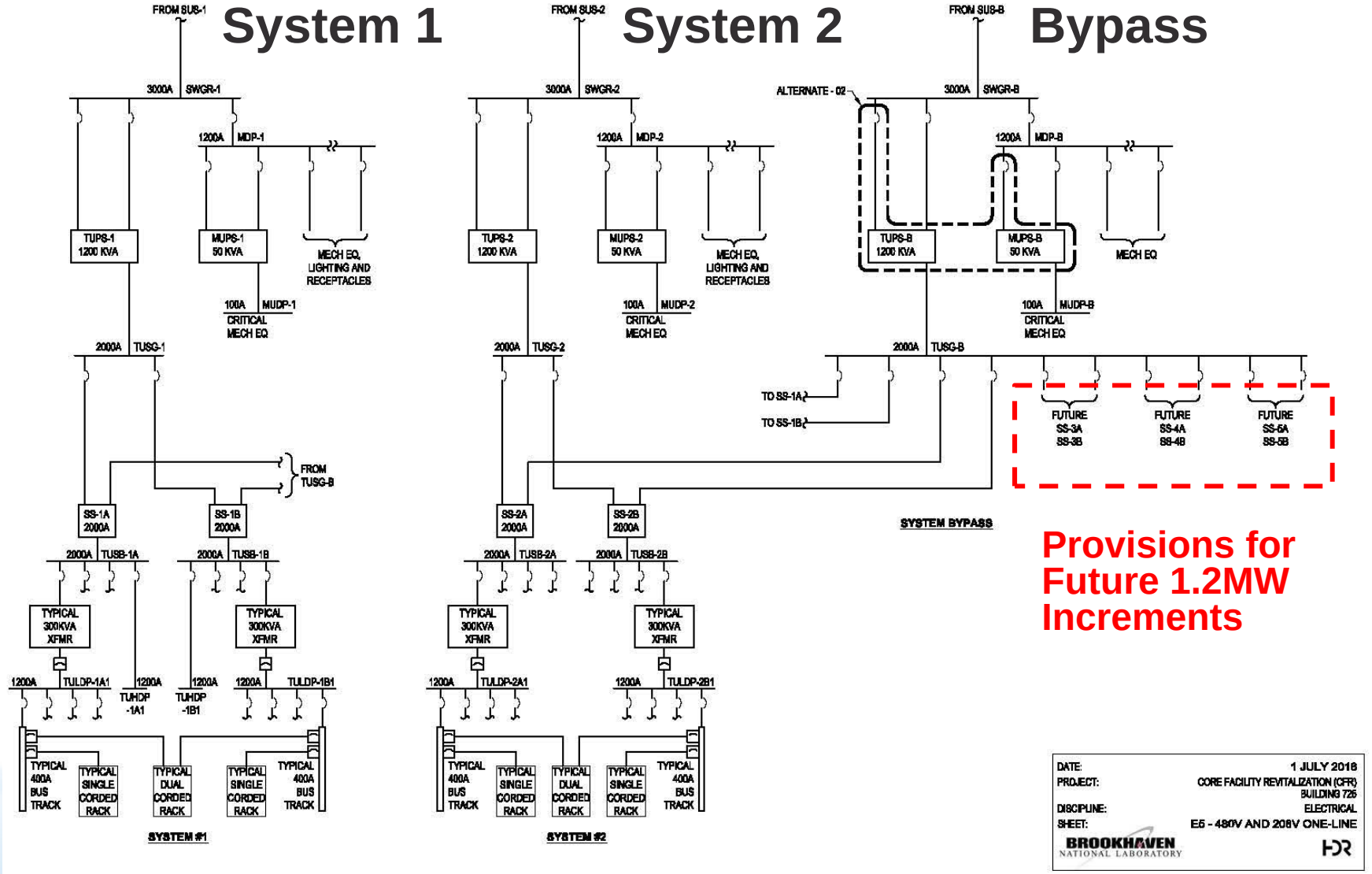
Performance requirements are appropriately aligned to address the *capability gaps* and support Mission Need:

- **515 Limiting Layout & Configuration**
  - Provide large/open computing floor areas
  - Provide appropriate (30”) raised floor
  - Provide flexible power/data distribution
  - Provide for incremental growth
- **515 Cooling Infrastructure Deficiencies**
  - Provide new, modern, and efficient cooling systems
  - Provide back-up chilled water service and air handling capabilities
  - Employ state of the art air management strategies (Hot aisle containment system) to meet sustainability goals
  - Provide for incremental growth

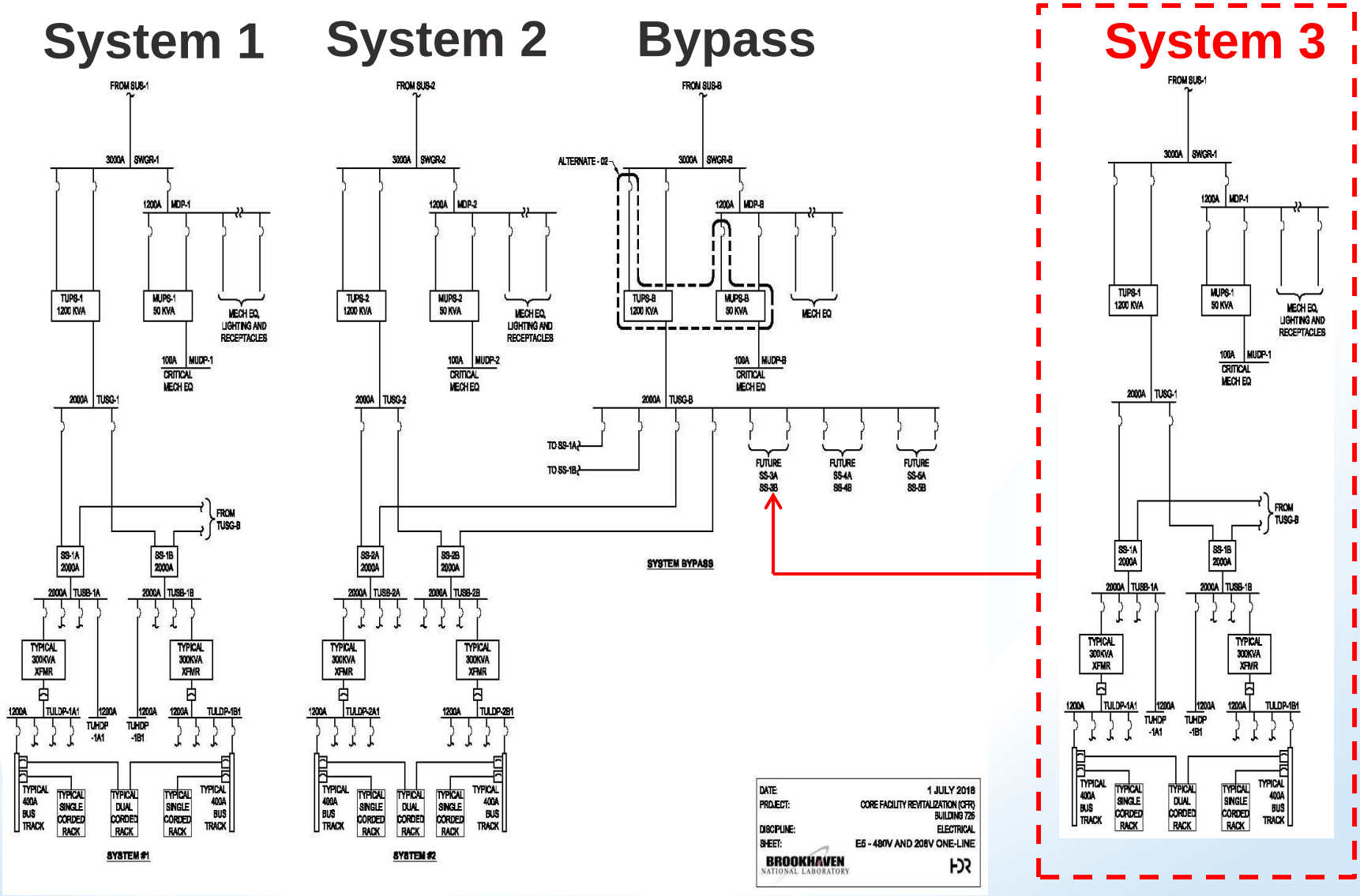
CFR – Performance Requirements

- **515 Power System Deficiencies**
  - Deploy an IT power strategy to satisfy day-one power requirements with adequate provision for short and long term growth and expansion while meeting sustainability goals
  - Provide enhanced reliability through deployment of UPS and back-up power generating systems. Provide a by-pass power system to allow for concurrent maintenance
  - Provide for incremental growth
- **Inadequate/Limited Physical Space**
  - Take advantage of efficiencies and productivity gains by co-location of the computational staff and their resources to a new, state of the art, modern facility
  - Execute roof replacement, window replacement, life safety system upgrades

CFR – Conceptual Electrical Plan - August

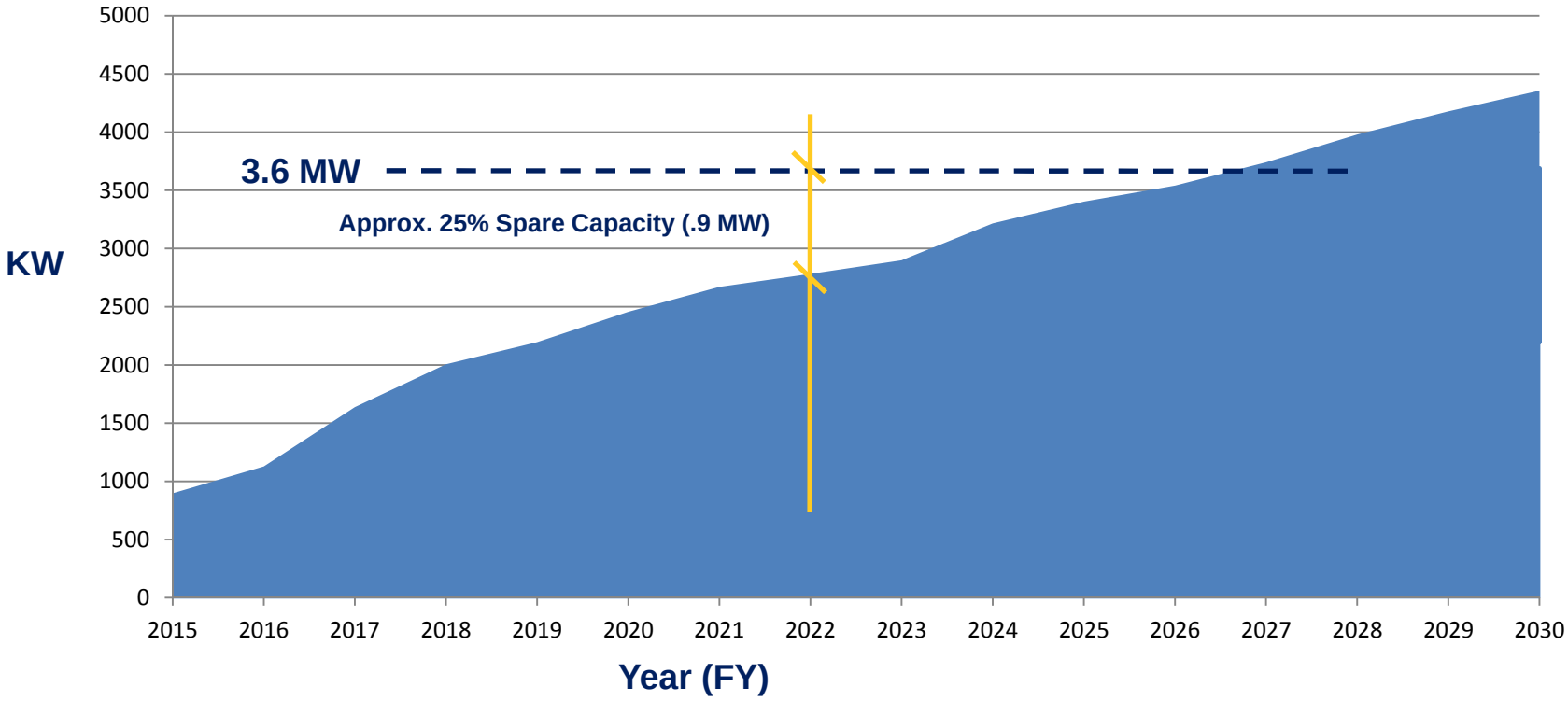


CFR – Conceptual Electrical Plan - January



CFR – Total Project IT Power (KW)

Initial deployment to be 3.6 MW followed by incremental 1.2 MW future deployments as determined by program need



CFR – Updated Cost Range

CFR Preliminary Key Performance Parameters (KPPs)

Threshold KPP	Objective KPP
3.6 MW IT Power	3.6 MW IT Power
1.2 MW Emergency Back-up Capability	2.4 MW Emergency Back-up Capability
$68.5M Low Cost Range	**$84.5M** High Cost Range
Assumptions: 20% Total Contingency - $11.3M Cost Escalation @ 2%/Yr. AE Fees (Design & CA) - 9% Const. Contract Reduced CM Fee/Commissioning Fee	Assumptions: 30% Total Contingency - $19.3M Cost Escalation @ 3%/Yr. AE Fees (Design & CA) - 11.5% Const. Contract 25% increase in Site Preparation Cost

CFR – Cost Range Summary

	Low Range K$	Point Estimate K$	High Range K$
Total Estimated Cost (TEC)			
Preliminary and Final Design	$4,700	$5,520	$6,412
Construction	$45,963	$48,066	$51,840
Project Support	$5,745	$5,808	$6,071
Direct TEC	$56,408	$61,394	$64,323
Contingency (% TEC)	$11,282 (20%)	$12,606 (20%)	$19,297 (30%)
Subtotal TEC	$67,689	$74,000	$83,620
Other Project Costs (OPC)			
Conceptual Design - OPC	$850	$850	$850
Total Project Cost (TPC)	$68,539	$74,850	$84,470

- Preliminary point estimate = $74,850K (TPC) representing “optimal” scope forms the basis of the cost range.
  - 3.6 MW IT Power w/ By-pass system
  - 2.4 MW Emergency Back up power - (2) Generators
  - (3) 300T. Chillers w/ Back-up CW – Central Plant
  - Approx. 20,000 GSF computing floor area, plus Network Rm. (Ready for occupancy)

CFR – Updated Preliminary Funding Profile

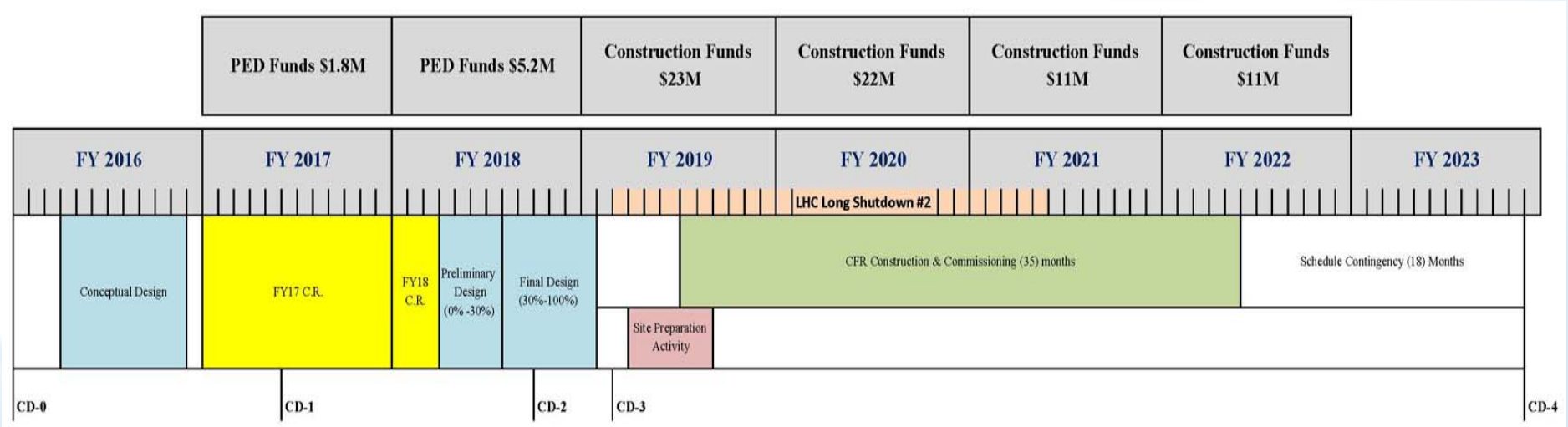
	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Total
OPC	$850							$850
TEC PED		$1,800	$5,200					$7,000
TEC Construction				$23,000	$22,000	$11,000	$11,000	$67,000
Total Project Cost	$850	$1,800	$5,200	$23,000	$22,000	$11,000	$11,000	$74,850

CFR – August 2016 Funding Profile

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	Total
OPC	$850					$850
TEC PED		$1,800	$5,200			$7,000
TEC Construction			$10,000	$30,000	$20,023	$60,023
Total Project Cost	$850	$1,800	$15,200	$30,000	$20,023	$67,873

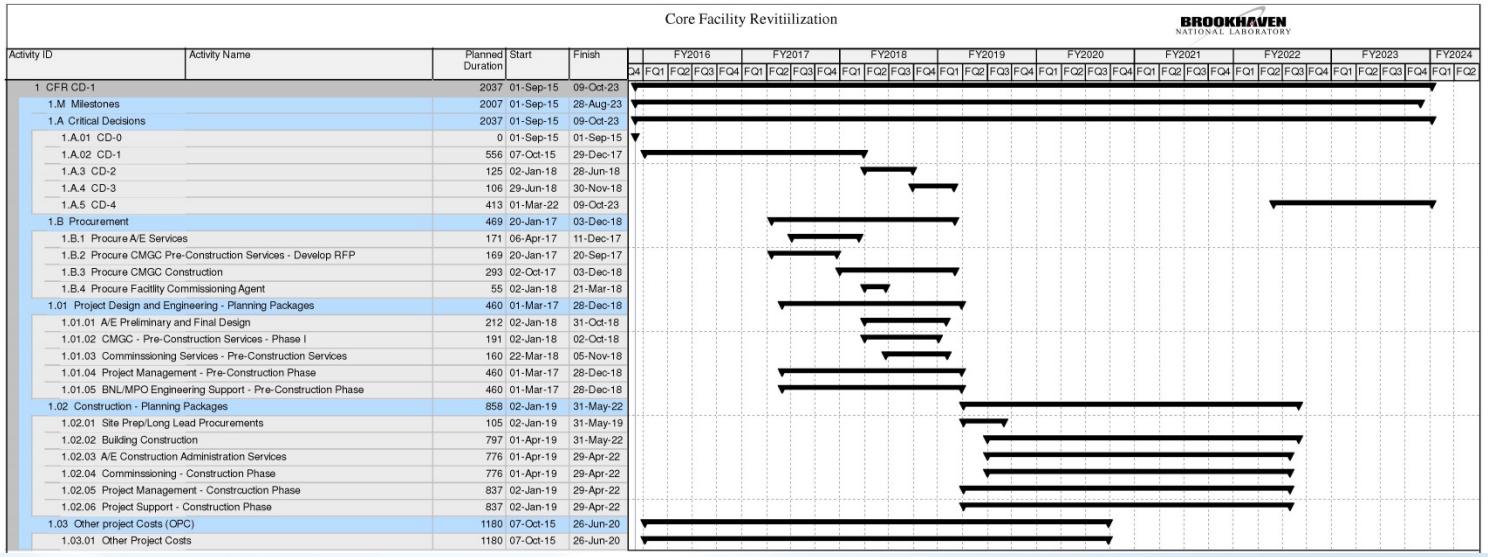
CFR – Schedule

- CFR Preliminary Schedule Assumptions
  - Plan for 1 yr. FY17 and 3 mos. FY18 Continuing Resolution
  - 35 mos. Construction & Commissioning
  - 18 mos. Schedule Contingency
  - Site Prep. 5 mos. (Incl. schedule contingency)
  - Move-in is “Off-project Cost”



CFR – Schedule

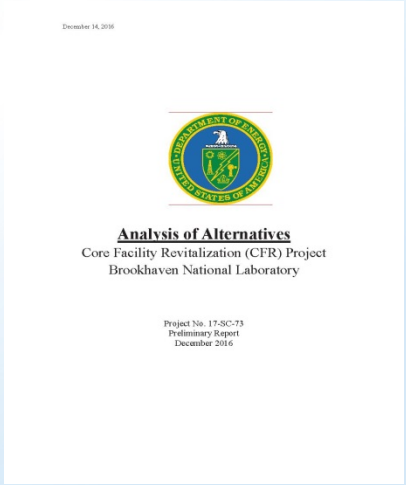
- "Updated" Preliminary Schedules are available for review:
  - Milestone Schedule
  - Summary Schedule
  - Critical Path
  - Detailed Schedule
  - Resource-Loaded Schedule
  - Acumen Fuse reports generated based on Preliminary Schedule



Activity ID	Activity Name	Planned Duration	Start	Finish
1	CFR CD-1	2037	01-Sep-15	09-Oct-23
1.M	Milestones	2007	01-Sep-15	28-Aug-23
1.A	Critical Decisions	2037	01-Sep-15	09-Oct-23
1.A.01	CD-0	0	01-Sep-15	01-Sep-15
1.A.02	CD-1	556	07-Oct-15	29-Dec-17
1.A.3	CD-2	125	02-Jan-18	28-Jun-18
1.A.4	CD-3	106	29-Jun-18	30-Nov-18
1.A.5	CD-4	413	01-Mar-22	09-Oct-23
1.B	Procurement	469	20-Jan-17	03-Dec-18
1.B.1	Procure A/E Services	171	06-Apr-17	11-Dec-17
1.B.2	Procure CMGC Pre-Construction Services - Develop RFP	169	20-Jan-17	20-Sep-17
1.B.3	Procure CMGC Construction	293	02-Oct-17	03-Dec-18
1.B.4	Procure Facility Commissioning Agent	55	02-Jan-18	21-Mar-18
1.01	Project Design and Engineering - Planning Packages	460	01-Mar-17	28-Dec-18
1.01.01	A/E Preliminary and Final Design	212	02-Jan-18	31-Oct-18
1.01.02	CMGC - Pre-Construction Services - Phase I	191	02-Jan-18	02-Oct-18
1.01.03	Comminssioning Services - Pre-Construction Services	160	22-Mar-18	05-Nov-18
1.01.04	Project Management - Pre-Construction Phase	460	01-Mar-17	28-Dec-18
1.01.05	BNL/MPO Engineering Support - Pre-Construction Phase	460	01-Mar-17	28-Dec-18
1.02	Construction - Planning Packages	858	02-Jan-19	31-May-22
1.02.01	Site Prep/Long Lead Procurements	105	02-Jan-19	31-May-19
1.02.02	Building Construction	797	01-Apr-19	31-May-22
1.02.03	A/E Construction Administration Services	776	01-Apr-19	29-Apr-22
1.02.04	Comminssioning - Construction Phase	776	01-Apr-19	29-Apr-22
1.02.05	Project Management - Construction Phase	837	02-Jan-19	29-Apr-22
1.02.06	Project Support - Construction Phase	837	02-Jan-19	29-Apr-22
1.03	Other project Costs (OPC)	1180	07-Oct-15	26-Jun-20
1.03.01	Other Project Costs	1180	07-Oct-15	26-Jun-20

CFR – Analysis of Alternatives

- ***Updated*** detailed LCCA on the following alternatives:
  - **Maintain Status Quo (Base Case)**
  - **Renovate Existing Facility**
    - Renovate B725
  - **Construct New Facility (Line Item)**
    - Construct a new facility at BNL, demo equivalent SF
- Addressed in AoA
  - **Construct New Facility (Alternative Financing)**
  - **Cloud Services**


December 14, 2016

Analysis of Alternatives
Core Facility Revitalization (CFR) Project
Brookhaven National Laboratory

Project No. 17-SC-73
Preliminary Report
December 2016

CFR – Updated LCCA Results

	Alternative 1 Maintain Status Quo (Base Case)	Alternative 2 Renovate Existing Facility	Alternative 3 Construct New Facility
Total Life Cycle Cost	$109,328,869	$153,522,892	$175,037,059

	Alternative 2 Renovate Existing Facility	Alternative 3 Construct New Facility
Capital Investment	$74,892,686	$112,524,496
Net Cost Saving vs. Do Nothing	-$44,194,023	-$65,708,191
Simple Payback	>25 years	>25 years
Adjusted Internal Rate of Return	-2.25%	- 3.56%

- Alternative 2 life cycle cost is **$22M** less than Alternative 3

CFR – Schematic Floor Plan

SPACE LEGEND	PROGRAM NET AREA (NSF)	DELINEATED AREA (NSF)
DATA HALL A	10800	9271
DATA HALL B	3450	2988
DATA HALL C	1950	2238
DATA HALL D	3600	4159
NETWORK EQUIPMENT	1000	1156
OFFICES	1680	1156
MECH/ELEC	20200	25007
IT TECH AREA	500	643
STORAGE	1200	1200
LOADING / UNCRATING	560	2579
OPERATIONS	150	132
TOTAL NET AREAS	48090	50529

0 16' 32'

N

DATE:	01 AUGUST 2016
PROJECT:	CORE FACILITY REVITALIZATION (CFR) BUILDING 725
DISCIPLINE:	ARCHITECTURE
SHEET:	2.4.1.2 FIRST FLOOR PLAN

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HDR

CFR – Risk Management

- 31 risks identified and evaluated that are common construction risks and are particularly unique to renovations
  - Working in occupied buildings
  - Working with existing building systems
  - Concealed conditions
  - Hazardous materials
- Risk Registry re-visited prior to January IPR
- Preliminary Risk Analysis Results…
  - Recommend 8.3 months / Maintain 18 months
  - Recommend $8.1M / Maintain/Hold $12.6M

CFR – Updated Documentation and IPT

- The following CFR documents have been updated to support the January IPR…
  - Preliminary Project Execution Plan
  - Acquisition Strategy
  - Analysis of Alternatives / Life Cycle Cost Analysis
  - Preliminary Project Schedule
  - Preliminary Cost Estimates
  - Risk Registry

- A Certified Data Center Energy Practitioner (DCEP) has recently been integrated with the project team.

Summary

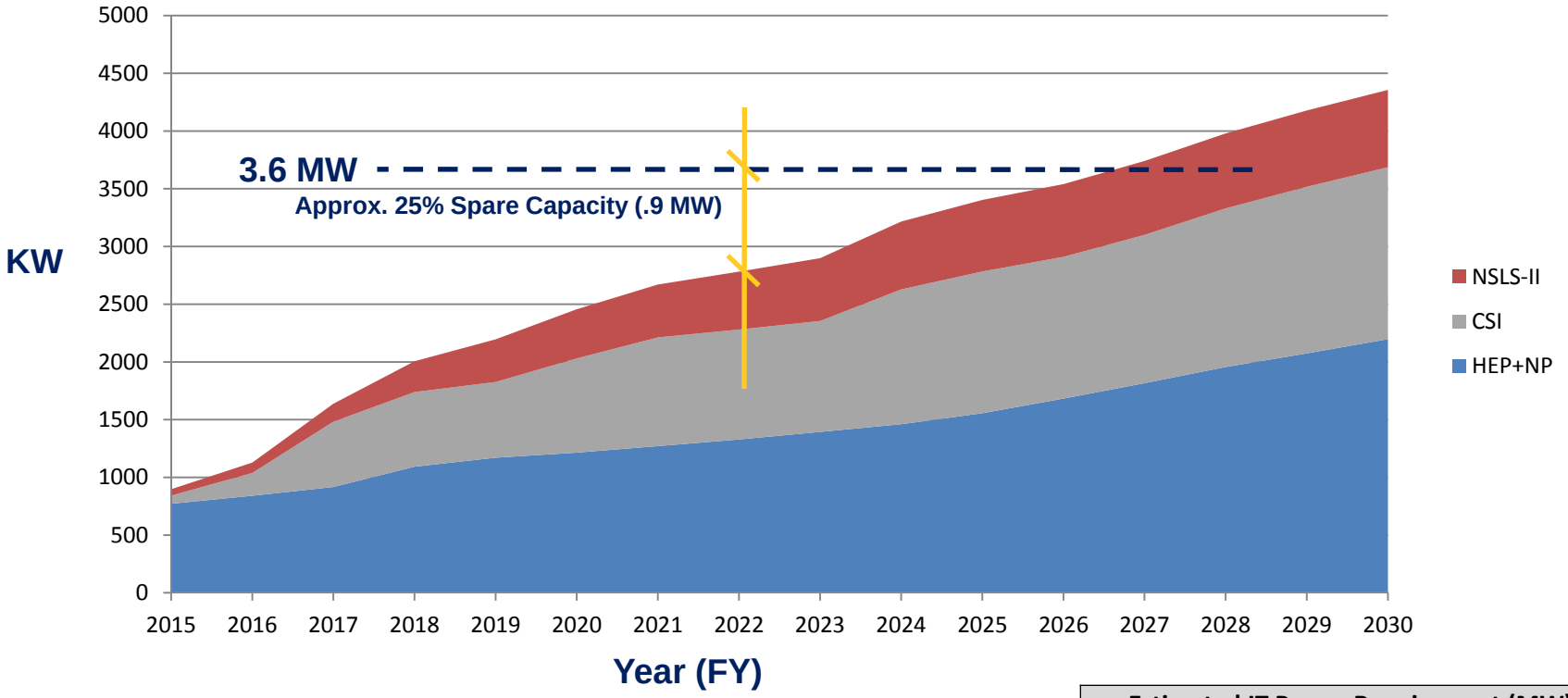
- The project has completed a successful August 2016 IPR with no recommendations
- All August and January IPR charge questions have been appropriately responded to. The preferred alternative, Renovate B725 has been validated and the cost range has been updated.
- An experienced project team is in place and ready to proceed
- The project is ready to proceed to CD-1 approval

Questions?

Back-up Slides

CFR - Total Estimated IT Power (KW)

Initial deployment to be 3.6 MW (vs. 2.4 MW) followed by incremental 1.2 MW deployments as determined by program need



	Estimated IT Power Requirement (MW)	
	FY22	**FY30**
HEP/NP	1.3 MW	2.2 MW
CSI	.9 MW	1.5 MW
NSLS-II	.5 MW	.7 MW
Spare Capacity	.9 MW (25%)	1.2 MW (Est. 25%)
Total	**3.6 MW**	**5.6 MW**

CFR – Conceptual Design - Mandates

- **Data Center Optimization Initiative (DCOI)**
  - Effective August 1st, 2016. Supersedes the Federal Data Center Consolidation Initiative. Reinforces requirements of E.O. 13693 – "Planning for Federal Sustainability in the Next Decade" 3/19/2015
  - New optimization policy effects all new/existing federal data centers
  - New optimization targets (metrics) established and prioritized for compliance by end of FY18
- **Power Usage Effectiveness (PUE)**
  - PUE is a key metric
  - PUE = Total Facility Power / IT Power
  - For new facilities… no greater than 1.4, encourage targeting 1.2
- **Automated Infrastructure Management**
  - Required for automated infrastructure management and reporting
  - Advanced monitoring and metering requirements
  - Multiple vendors/sources exist

CFR – Site Preparation

- Early Site Preparation – Address Residual Lead
  - The B725 Hazard Removal Project (HRP) completed 3/31/16.
  - TPC = $7.4M.
  - CFR to complete balance of first floor residual lead remediation
  - Cost estimated March 2016, re-validated August 2016
  - Environmental consultant retained to complete scoping study
  - Cost Range: $1.0M - $2M (direct cost) “+” Project Mgmt. & Oversight.
  - $2M included in point estimate
  - Duration: Approx. 2.5 – 3 Months

CFR – AoA Cloud Analysis Overview

	Storage (10% of existing requirements)	Compute (10% of existing requirements)
Amazon Web Services	$4,620,000	$1,178,707
In-house Services	$1,296,000	$580,500

Cloud vs. In-house

- Cloud storage more expensive by a factor of 3.6
- Cloud CPU more expensive by a factor of 2
- Only accounts for costs to host the data
  - Excludes costs to transfer and routine access of the data
- Unsatisfactory in terms of performance