FIRE
Engineering Meeting
PPPL – May 31- June 1, 2000

Site Facilities, Credits, and Safety Requirements

Dave Dilling

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Outline:

I. Facility and Site Layout Update
II. Hot Cell and Maintenance Facilities – Proposed Design Modifications
III. Cooling Systems Sizing
IV. Approach on Siting at PPPL – Arrangement and Strategy on Credit Development

Tokamak /Hot Cell Building Update

Change associated with FIRE tokamak: Elimination **of central tie-rod**

Reduces the height of the controlling lift during assembly. Assembly assumes sectors lifted only a small distance above their final elevation – central solenoid lift over TF sets crane height

This allows reduction in crane rail height.

Proposed changes:

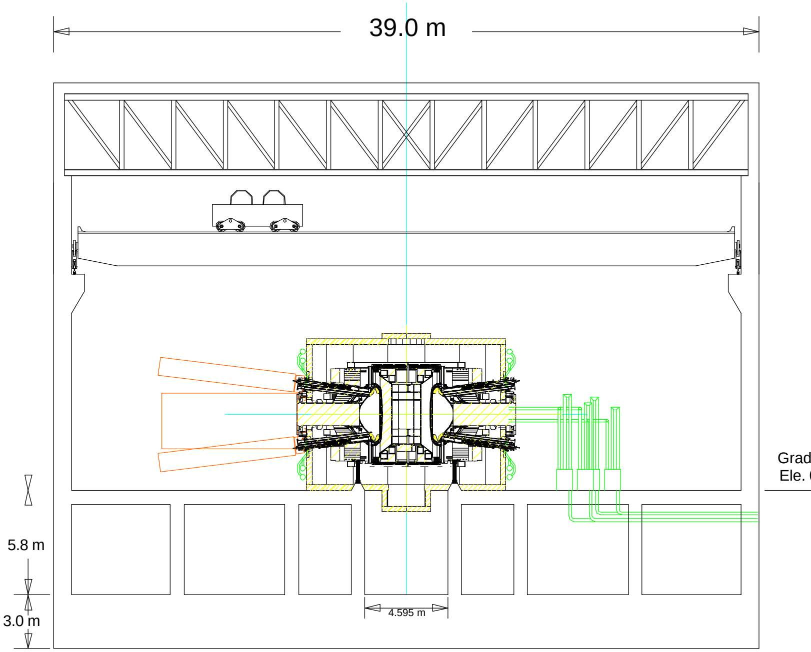
- Reduce overall height of tokamak building from 27.05 to 22.6 meters.
- Eliminate movable test cell roof shield (was similar to DIIID)
- Add movable shield wall sections to close test cell ends (similar to JET)
- Eliminate crane bay north of Cask Area.

Revised thinking on Hot Cell Configuration: Include **Divertor Repair**

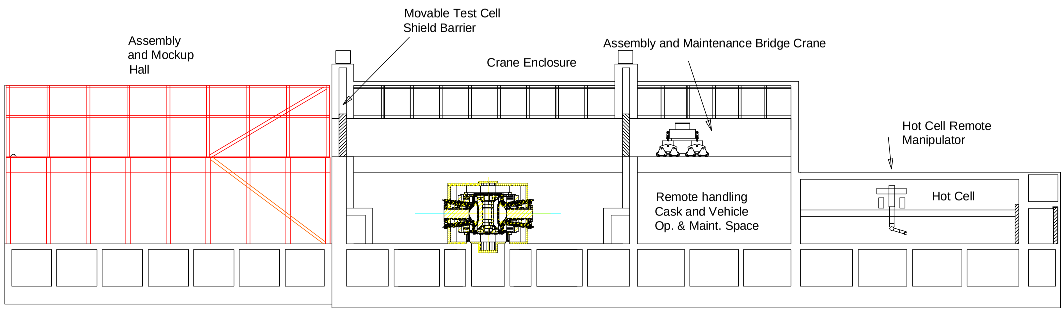
Access needed to Hot Cell Wall for operation of repair process. Additional storage space needed for port objects during divertor repair. Building shape not constrained by crane rails north of cask area.

Proposed changes:

- Re-orient Port Object Repair Cell – add more docking/storage points
- Re-arrange tools storage space by moving east
- Provide operator access and viewing windows through shield walls
- Provide airlock – exit pathway from Hot Cell



Building 11 - Tokamak and Hot Cell Building
Figure 5.15.3-1



Tokamak - Hot Cell Building - NS Elevation View
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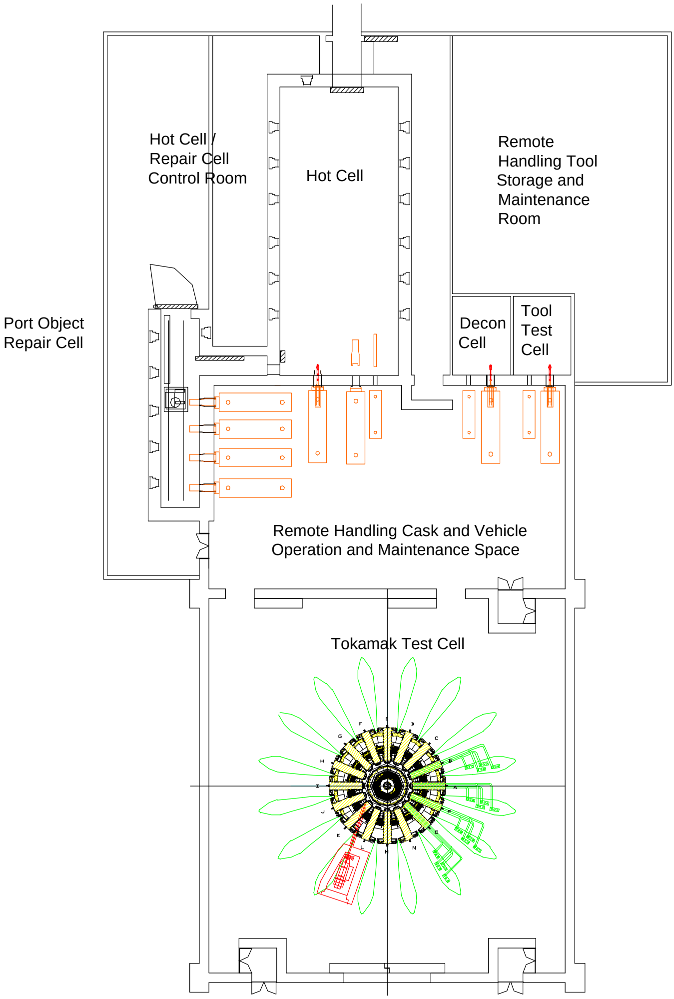

Tokamak-Hot Cell Building Plan View at Grade
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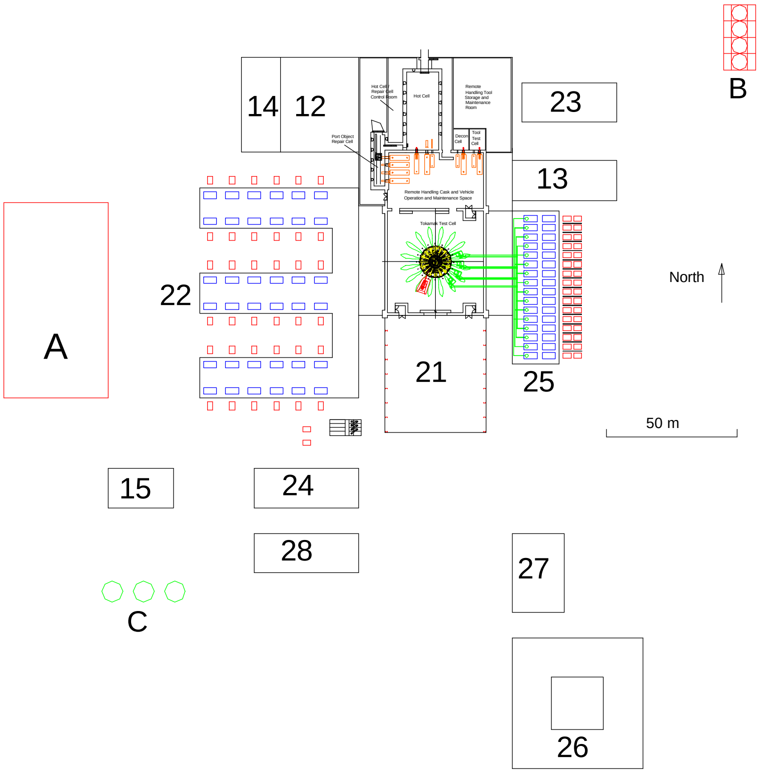
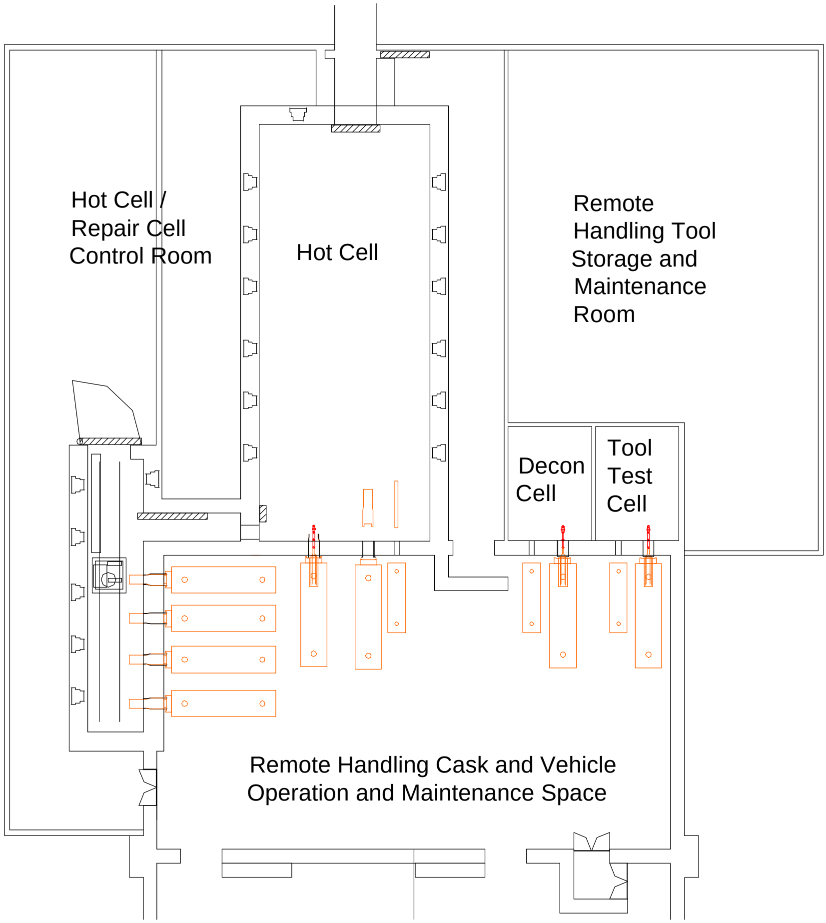


Key: 11 – Tokamak & Hot Cell Building
12 – Rad. System Management Building (includes Change Facilities)
13 – Vacuum Pumping & Tritium Facility
14 – Low Level Radwaste Systems Building
15 – Emergency Power Supply Building
21 – Assembly & Mockup Building
22 – Magnet Power Supply Building
23 – Water Cooling Systems Building
24 – Cryogenic System Building
25 – ICRF Power Supply Building
26 – Laboratory Office Building
27 – Control Room Building
28 – Utility Systems Building

Site Plan – Greenfield



Detail 1 of Hot Cell Building Areas
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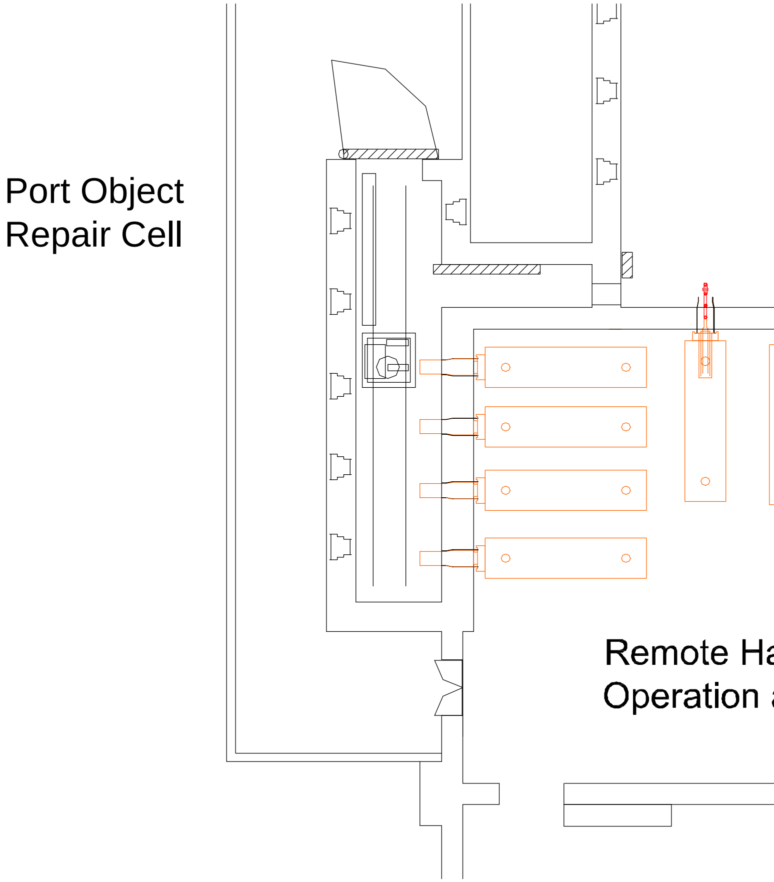
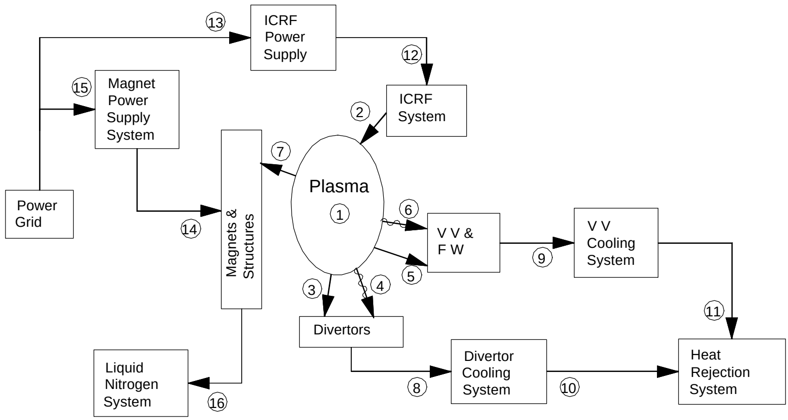


Hot Cell Building Detail – Port Object Repair Cell

Auxiliary System Sizing



FIRE Energy Balance Diagram

Agreement reached (Site Requirements):

Design Basis for cooling:

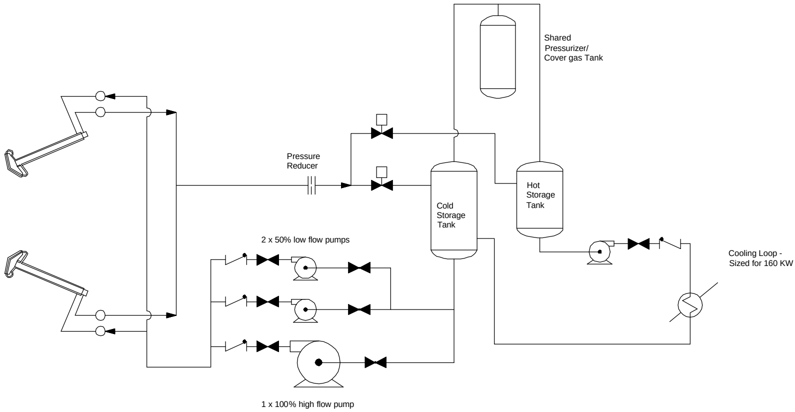
Shot Duration	20 seconds
Shot Interval	3 hours
Maximum Shots per Day	4
Maximum Shots per Week	20

Additional heat loads to be considered:

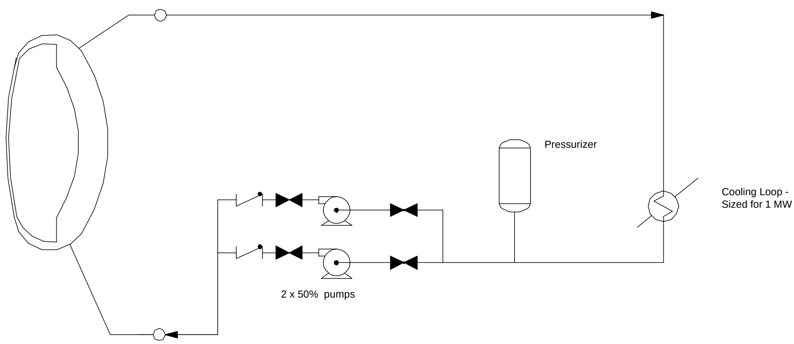
Cryoplant for cryopumps, assuming regeneration between shots, and cycle between 4^{o}K and 25^{o}K. Refrigerator efficiency 400W/W.

House loads for heating, cooling, diagnostics, etc.

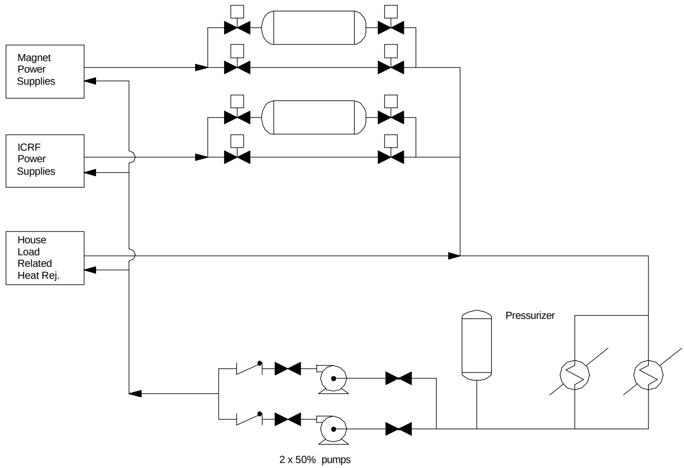
Energy Flow Description		Partion Factor	Rate (MW)	Duration (s)	Total Energy (MJ)
1	Fusion Power	100%	200	20	4000
1a	Neutron Power	80%	160	20	3200
1b	Alpha, Gamma Power	20%	40	20	800
2	ICRF Heating		30	20	600
Subtotal	Plasma Energy		230	20	4600
Subtotal a	Neutron Power		160	20	3200
Subtotal b	Radiant & Charged Particle Power		70	20	1400
3	Neutron Power to Divertor	17%	27.2	20	544
5	Neutron Power to FW, VV	51%	81.6	20	1632
7	Neutron Power to Magnets	32%	51.2	20	1024
Subtotal a		100%	160	20	3200
4	R&CP Energy to Divertor (A)	80%	56	20	1120
6	R&CP Energy to FW (A)	20%	14	20	280
Subtotal b	Mode A	100%	70	20	1400
4	R&CP Energy to Divertor (B)	20%	14	20	280
6	R&CP Energy to FW (B)	80%	56	20	1120
Subtotal b	Mode B	100%	70	20	1400
8	Divertor Cooling System (A)		83.2	20	1664
8	Divertor Cooling System (B)		41.2	20	824
9	VV Cooling System (A)		0.956	2000	1912
9	VV Cooling System (B)		0.949	2900	2752
10	Divertor System Heat Rejection		0.154	10800	1664
11	Vacuum Vessel Heat Rejection		0.956	2000	1912
12	Power To ICRF System	100%	60	20	1200
12a	Delivered to Plasma	50%	30	20	600
12b	Losses (to CCW System)	50%	30	20	600
13	Grid Power to ICRF Power Supplies	100%	66.7	20	1333.3
	Delivered to ICRF System	90%	60	20	1200
	Losses (to CCW System)	10%	6.7	20	133.3
14	Power to Magnet System		575	24	13800
15	Power used by Magnet PS System	100%	638.9	24	15333.3
15a	Power to Magnet System	90%	575	24	13800
15b	Losses (to CCW System)	10%	63.9	24	1533.33
16	Heat Removed by LN2 System		1.37	10800	14824



FIRE Divertor Cooling Water System Scheme



FIRE VV- First Wall Cooling Water System Scheme


Magnet
Power
Supplies
ICRF
Power
Supplies
House
Load
Related
Heat Rej.
Pressurizer
2 x 50% pumps

Site Requirements and Credits at PPPL

- **Site Requirements document issued.**

- **FIRE could be installed at PPPL**

Key points to consider:

1. FIRE would fit in the TFTR Test Cell
2. TFTR Power Conversion Systems could be upgraded to serve FIRE needs (Bob Woolley to confirm)
3. FIRE ICRF systems would (probably)fit in the TFTR NBI areas
4. “Averaged” cooling loads could be accommodated with some upgrade to PPPL cooling systems.
5. LN_2 Service via Rt. 1, or by local plant is feasible (may conflict with local zoning)
6. Existing control room, LOB, and site infrastructure would be sufficient for FIRE.

Some New Construction would be required:

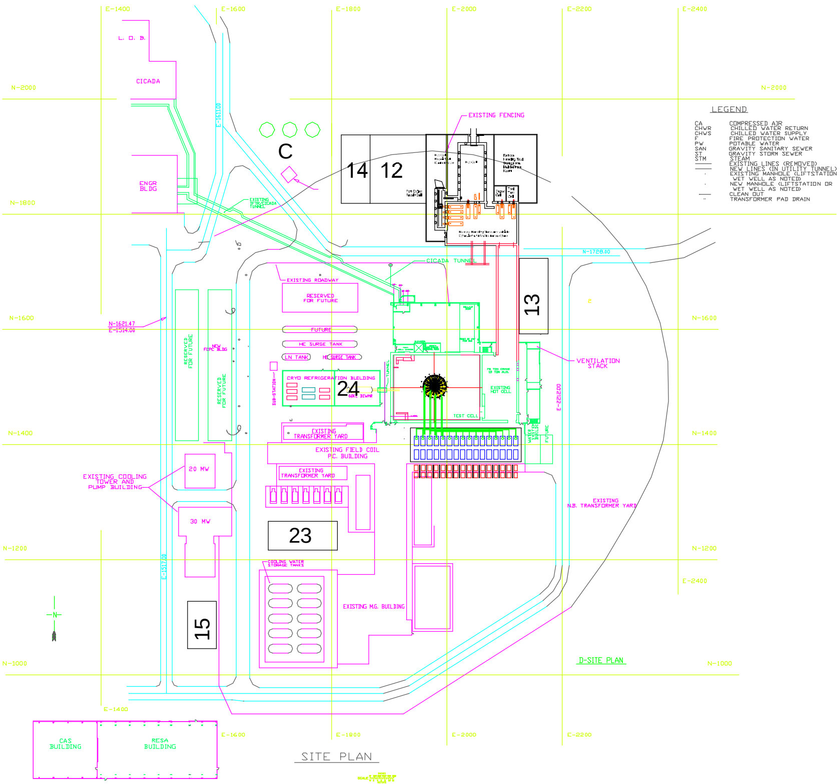
1. Remote Handling and Hot Cell Facilities
2. Connection between Test Cell and RH/Hot Cell Facilities
3. Radwaste and Radioactive Management Facilities

Layout Issues to be dealt with or avoided:

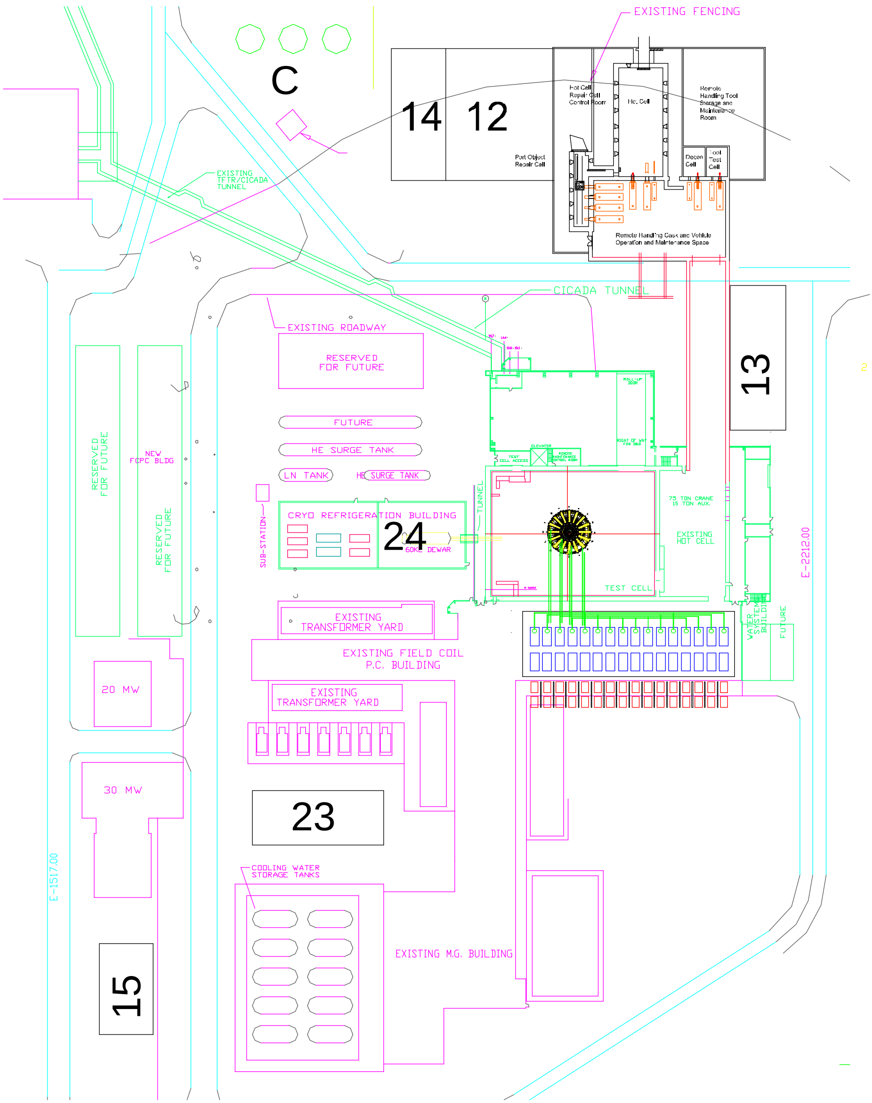
1. Local “wetlands” designation
2. On Site Tritium Inventory
3. University Planning/Expectations
4. Exclusion of other projects (NSTX, Stellarator, TBD)

Approach on Credits

Straightforward: Identify WBS areas where PPPL site affects cost up or down, estimate increment. - In preparation.



FIRE at PPPL – Overlaid on TPX Design


EXISTING FENCING
C
14
12
Hot Cell Repair Cell Control Room
Hot Cell
Remote Handling Tool Storage and Maintenance Room
Port Object Repair Cell
Decon Cell
Tool Test Cell
Remote Handling Cask and Vehicle Operation and Maintenance Space
EXISTING TFTR/CICADA TUNNEL
CICADA TUNNEL
EXISTING ROADWAY
RESERVED FOR FUTURE
13
FUTURE
HE SURGE TANK
LN TANK
HE SURGE TANK
RESERVED FOR FUTURE
NEW FCPC BLDG
RESERVED FOR FUTURE
SUB-STATION
CRYO REFRIGERATION BUILDING
24
60K DEWAR
TUNNEL
TEST CELL
75 TON CRANE 15 TON AUX.
EXISTING HOT CELL
E-2212.00
EXISTING TRANSFORMER YARD
WATER SYSTEMS BUILDING
FUTURE
EXISTING FIELD COIL P.C. BUILDING
20 MW
EXISTING TRANSFORMER YARD
30 MW
23
E-1517.00
COOLING WATER STORAGE TANKS
EXISTING M.G. BUILDING
15