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1	2-7 to 8	Rack densities look reasonable for projected rack loads in 2021, but are these the worst case heat loads or was a level of load diversity considered? Designing to a worst case overall load may result in oversized equipment at the beginning of the cooling equipment's service life as well as being oversized once built out (both of which could impact operation and efficiency of the dry HXs).	High - CAPx, efficiency HDR – Day one design loads based on 80% of User's stated load criteria (10 kW/cabinet). This is approximately 100% increase over present day cabinet loads. Multiple units can allow for adjustment of capacities as we approach construction.
2	2-10	Supplementary cooling equipment – in row coolers (IRCs), rear door (RDHXs), and direct water cooled – (TBD). Keep in mind that depending on what technology will be used, it could impact the efficiency of the dry HXs. RDHXs and direct cooled equipment could lower the dry HX's return temperature. IRCs will likely need to be setup to run at a base load or interlocked with the operation of the dry HX to provide supplementary cooling when needed.	High – Efficiency HDR - Agree, IRC's to be base loaded which will allow for compatible RA temperatures with DAE units.
3	2-10	Hot Aisle Containment The design's inherent efficiency is dependent on high return temperatures. Operational considerations should be given to the fact that the hot aisle temperatures will be within a range that OSHA considers a health hazard. Special work controls may need to be enforced.	Low – Operations HDR – Agree, will require coordination with BNL facility manager.
4	2-15	Fire Protection Was a smoke removal system considered?	Low – Fire HDR – Has not been considered, but is an important suggestion and will be studied for incorporation during Preliminary Design.

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5	2-19	Climate Conditions – 2009 ASHRAE for Islip, NY Recommend reviewing the ASHRAE 2013 Climatic Data Sheet for Brookhaven, NY for any data that may be more relevant to this site.	Low – Design HDR – Islip, NY is closer to project site than Brookhaven, NY. Additional climate data has been provided by BNL and will used going forward with Preliminary Design.
6	2-20	ASHRAE TC9.9 Recommendation Inlet Conditions Recommend updating to 2015. If legacy equipment will be moving into this data center in 2021, then set points may need modified for the lower humidity control. If this data center will be getting new equipment in 2021, the recommended envelope should be consulted between now and then to see if any further updates may impact this data center.	Low – Design HDR – Agree and will consult with BNL.
7	2-25	Pressurization Criteria ASHRAE TC9.9 recommends controlling to 0.05inWG. Will a single dedicated makeup air unit serve VAVs to the different data center areas or will each area have its own makeup air unit? The data center areas should be made as “tight” as possible to minimize leakage. Depending on how the dry HX supply and return is delivered to each area, the general data center space pressure can vary (e.g. – raised floor, down flow CRAHs pressurize the subfloor area. If the subfloor area is not sealed well air could leave the data center. If the volume of pressurization air is not high enough, the CRAHs can actually pull air in through personnel doors)	Low – Design HDR – Two make-up air units (N+1) are anticipated. Agree with pressurization concept but there are no CRAH’s in the project. Air supply is overhead ducted.

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8	2-29	Hydronic System Pipe Sizes – consider calling out "per ASHRAE 90.1" or similar rather than specifying and risking a contradiction.	Low – Design HDR – Agree.
9	2-30	Fiberglass insulation – for durability, ease of installation, and cleanliness, we've found that using closed cell elastomeric foam insulation is advantageous. Non-halogenated within the data centers, regular outside – Fire AHJ should be consulted, and cost impacts considered.	Low – Design HDR – Agree, subject to application specific flame spread / smoke requirements.
10	General	Duct Many, very large ducts are required for providing airside economization for these rack densities. I didn't pick up on whether these ducts are routed on the roof or ceiling space. Either way operations should understand that this much duct will greatly burden any work in these areas. In a phased project, subsequent duct installation in a now operational data center will be challenging. It appears that all the ducts are to be installed during the first phase. If all ducts are to be installed on day one, will the return air be pulled from the return duct's entirety or will areas without load be blanked off? How will supply and returns be balanced to ensure the dT will be the highest throughout the data center's life cycle?	High - Operations, construction, efficiency HDR – Ducts are to be located above ceiling. All ducts to be installed during first phase. Future ducts that are in use would be blanked off with sheet metal blanks. Blanks to be removed as areas come on line. Each phase of construction will require rebalancing for temperature, airflows and pressurization.

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11	General	Dry HX capacity sizing Having large dry HXs makes sense given the available real-estate, but getting the efficiency out of these units is largely dependent on matching the air flow requirements and having the design loads that are expected. Depending on the answer to the question posed in comment #1 regarding heat loads, the efficiency and capacity of the Dry HXs could be impacted. Expecting 100°F off all the hot aisles may be the ideal situation. Air flow at the Dry HXs should match that required by the racks within a Dry HX's "zone". More than likely, more air flow will be required for a given load which will reduce the return air temperature.	High - Design, efficiency HDR – Load assumptions will continue to be scrutinized during subsequent phases of design.
12	General	Direct Water Cooled Loop By establishing the flows and temperatures for this system today, what confidence is there that the liquid cooled HPC systems of 2021 will fit flow, temperature, dP, and water quality wise? These HX can get cooling water from either the CTs or CHs. Will connecting the open system water with the closed loop cause issues with each system's water quality controls?	High – Design HDR – Quantity, type, and load characteristics of HPC environment not known at the time of this report. Requirements to be evaluated during subsequent phases of design. The reasoning for the plate & frame heat exchangers was due to use of the campus chilled water system as a backup system. The campus chilled water is considered too dirty to use in computer equipment; if the local system included the required redundancy water quality could be addressed being a new system.

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13	General	Dry HX – gaseous contamination What level of cross over is there with the heat wheels, that is what volume of outside air carries over to the data center air stream? Does the site location have known issues with gaseous contamination from the surrounding environment (e.g. – with SO2 or H_2S)? If scavenger air precooler is not used, consider MERV 13 or HEPA 99.97% filters on any air that could be introduced to the datacenter.	Low – Design HDR – Our experience with heat wheels is that the carryover is very low. In fact, we have used in some projects on fume hood exhaust. No gaseous contamination has been identified but will address with local BNL staff in Preliminary Design phase. All air which would enter the actual Data Center areas will be as a minimum filtered with MERV 13 filters or better.
14	General	Makeup Air Units If not already spec'd, consider MERV 13 or HEPA 99.97% filters on any air that could be introduced to the datacenter. Locate away from diesel generators and use ultra-low sulfur diesel fuel. Generator exhaust stack should be properly designed for location.	Low – Design HDR – Agree will review actual fuel quality with local BNL staff.
15	2-31	Standby Power Pumps and fans should be programmed for auto-restart. UPS power for pumps and fans may or may not be required if only momentary interruptions are expected and restart is automatic. Depending on controls and redundancy and HPC heat exchanger design, UPS on direct water cooled equipment pumps may be justified.	Medium - CAPx, design, operations HDR - Agree. UPS for pumps and BMS controls are included; fans will naturally flywheel and catch themselves on the fly upon generator power energizing.

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16	General	Cooling Plant Design Ph1 is two include 2 310ton chillers as "N" and campus CHW as "+1" (or more). Review package include drawings that show both a primary-secondary and variable-primary cooling system – I believe the variable-primary is the current design path. The way that the direct cooled HX are integrated will take flow away from the chillers which will reduce the available chilled water capacity. What is known about these direct water cooled loads (e.g. - Temperatures, flows, load)? Was water-side economization considered?	High – Design, operation, efficiency HDR - Variable primary is the intent. Very little is known about direct water cooled loads at this time but those loads are included (as shown in our load table) in the total capacity of the chillers. Water side economization is anticipated.
17	M-4 Flow Diagram	With the Campus being the backup, the piping connections show that you'll still be reliant on the CHW pumps. The electrical design for the bank of pumps should be hardened enough to ensure pump availability. If failing to the campus CHW system, will chillers have fail closed valves to maintain CHWS temperature? Transitioning to and from different cooling sources must be thoroughly thought through to ensure continued chiller availability.	Med. – Design HDR - Agree. UPS for pumps and BMS controls are included. Agree on sequencing of chilled water system from one to another. It will also require extensive commissioning to prove and adjust sequence as needed to ensure a quick change-over.

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18	General	Chiller Loads I believe the chiller loads include the MAUs, Dry HXs, supplementary cooling equipment, and the direct cooled HPC (when CTs aren't outputting cool enough water). If possible cooling systems should be dedicated to specific types of loads where it makes sense temperature and water quality wise. TCO should be determined and taken into consideration.	Med. – Design, Efficiency, Operations HDR - Agree.
19	General	PUE Calculation – Shown in table just before section 2.3.5 PUE calc should include approximations on lighting, UPS/XFMR losses, transmission losses, mechanical room support power (e.g. – ventilation) Annual PUE should be 1.2-1.4 (Annual Total kWh/Annual IT kWh).	Low – Design, efficiency HDR – Method of calculating PUE and Executive Order mandates regarding values are understood and will be included as part of Preliminary Design phase.
1	2.2.3, Para. 5	Delete dry pipe from the description of the pre-action sprinkler system.	HDR – Understood.
2	2.3.2, Occupancy Class	Was previous occupancy really H-3 (rated corridors, 150 ft travel distance, less allowable building area than Group B, etc.). Also stated in Section 8.1.	HDR - Previous building assessments have identified the facility as an H-3 occupancy. We anticipate the occupancy classification to change to B.
3	2.3.2, Construct Type	Increasing construction type to Type IIA would require SFRM on steel throughout, including second floor office areas. SFRM in data centers should be avoided if not required. As an alternative to Type IIA, consider indicating measures to meet the requirements for a 2 story unlimited area building (NYSBC Section 507.4) may be required.	HDR – The existing facility can comply with the requirements for a 2 Story Unlimited Area Building; therefore, an increase in construction type is not required. The existing construction type designation Type IIB (unprotected) can remain unaltered. The existing structure will not be required to be protected.

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4	2.3.3, Para. 2	Indicate hot aisle containment system will be integrated with sprinkler and detection system as required by NFPA 75.	HDR – Exact configuration to be determined during Preliminary Design.
5	2.3.3, Para. 2	Indicate sprinkler system to be installed at ceiling and below raised floors.	HDR – Not required below raised floor per BNL Fire Protection.
6	2.3.3, Para. 2	Indicate early warning smoke detection system to be installed at ceiling and below raised floors.	HDR – Not required below raised floor per BNL Fire Protection.
7	2.3.3, Para. 4	Clean agent is listed as ALT-11 but described for Network Room. NET is in base build, not ALT-11 (NSLS II/BES Fitout).	HDR – Clean agent for the Network room should be identified as ALT-12.
8	2.3.3, Para. 4	Delete ECARO-25.	HDR – Understood.
9	2.3.3, Para. 4	Clean agent should be listed/described for within the tape library units (AISS) in the “TAPES” room, as required by 8.1.4 of NFPA 75.	HDR – Will conform to NFPA 75.
10	2.3.3	Provide some description of fire barrier provisions as generally depicted on the Wall Rating drawing.	HDR – Will develop in more detail during Preliminary Design.
11	2.3.4, Ventilation Page 2-24	Describe smoke removal provisions (or lack thereof) of ventilation system. See FM Data Sheet 5-32.	HDR – Will consider addition of smoke evacuation system during Preliminary Design.
12	2.3.4, Cooling Towers Page 2-33	Marley website does not list a type “NT” tower. Is this supposed to by type “NC”.	HDR – “NC” is the correct designation.
13	2.3.4, Cooling Towers Page 2-33	Cooling tower selection should be FM Approved type and indicated as such.	HDR – Understood.
14	2.3.5 Page 2-42	FM Data Sheet 5-4, transformers should be listed as one of the standards.	HDR – Understood.

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15	2.3.5	Indoor and outdoor transformers should be indicated as either being dry type or FM approved if oil filled is anticipated.	HDR – Understood. Indoor cast coil transformers are indicated on page 2-46.
16	2.3.5 EPO System Page 2-47	Consider deleting requirement that EPO automatically activate on fire alarm (subject to false alarms) as allowed by NFPA 75 and FM Data Sheet 5-32 where prompt manual activation is available.	HDR – EPO configuration dictated by BNL Fire Protection.
17	2.3.5 Fire Alarm System Page 2-49	Consider deleting requirement that EPO automatically activate on fire alarm (subject to false alarms) as allowed by NFPA 75 and FM Data Sheet 5-32 where prompt manual activation is available.	HDR – EPO configuration dictated by BNL Fire Protection.
18	2.3.5 Fire Alarm System Page 2-49	Change “dry-pipe” to “pre-action”	HDR – Understood.
19	2.4 Drawings Wall Ratings	Review requirements and/or owner preferences for fire barriers around electrical rooms. Fire barriers are not required by code if dry and/or FM approved oil filled transformers are provided. Fire barriers are costly, both for initial construction and long term maintenance.	HDR – Fire barriers provided to establish compartmentalization, protection of assets, and minimize damage potential from failure/fire events.
20	2.4 Drawings Wall Ratings	Fire barriers around data centers should also be indicated as smoke barriers.	HDR – Agree.
21	2.4 Drawings Mechanical	DAE supply/return ducts are significant penetrations through data center fire /smoke barriers. Costs associated with these major penetrations need to be captured.	HDR – Agree.

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22	2.4 Drawings Mechanical	DAE supply/return ducts are significant penetrations through data center fire /smoke barriers. As such, routing of DAE ducting through unrelated areas having fire barriers needs to be minimized (i.e. RHIC/ATLAS DAE routes through TAPES room).	HDR – Agree.
23	2.4 Drawings Mechanical	Is DAE warranted for Tape Room (libraries are low heat output).	HDR – DAE is most energy efficient cooling solution.
1		Users indicated that they could take an annual 2 day outage for maintenance, but it was reported in the CDR that this would not be enough time so the configuration was changed to a UPI Tier IV, which is a pretty good leap. I suggest that the system be designed to allow maintenance outages to be done in 2 day window by segregating loads (e.g. HPC on one electrical distribution system without generator/UPS backup and business, disk, network, and other critical systems with generator/UPS backup on a separate electrical distribution system.) At ORNL we have four systems we do separate outages on and we typically get all work done in one work day. Recently we did some extensive equipment changeouts on primary side of system that took two days. One system that supplies our HPC systems has (8) 2.5/3.3MVA unit subs with 4000A switchboards, approximately 250 feeder breakers and circuits, two 1500T chillers and associated pumps and cooling towers. We also do thermal scans periodically and before each outage to identify hot spots.	Electrical System Configuration HDR – Users indicated that they could not perform required maintenance within the available outage allowed by their ATLAS service level agreement, in the context of a Tier I or Tier II system configuration. CDR is based on providing a Tier III system, generally as described by the Uptime Institute. This configuration provides a series of primary systems supporting the IT load, and a “Bypass” system (Isolated Redundant typology) capable of assuming the load of any of the primary systems to allow for extended maintenance windows as well as protection against failure of any of the primary systems. Per the Tier III standard, the bypass system may or may not be provided with UPS. Our configuration is also based on flexibility and growth to allow any load to be served by any of the primary systems, now and in the future.

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2		A Tier IV system will have a certain level of inefficiency built in due to light loading of UPS's under normal conditions. UPS's are much more efficient today under light loads but UPS's could be operating at 15-25% loaded at the outset and efficiency will suffer. I suggest that ECO mode UPS's that operate in bypass mode then switch to UPS if there is a power quality event (PQE) be called for. This may not be feasible with paralleled UPS's. These can be provided in either LV double conversion type or S&C makes a MV version that can provide protection for whole system. This will keep efficiency in the 95%+ range. ORNL has a 6MW MV UPS supplying a chiller plant with four 1500T chillers. It was tested by loading chillers up to 80% and opening and closing input to UPS. This test was also done with one chiller at 60% load. ORNL has a low voltage version of this kind of UPS to supply computers and over the past 8 years of service these UPS's have never failed to provide ride through for PQE's. The MV UPS are installed in outdoor rated enclosures and can be mounted on pads external to the building. This is a big advantage when internal space is a premium. The MV UPS is expandable in 250kW modules with 2000kW per group of 8 at which time another enclosure has to be added for additional 250kW modules. These UPS's typically have 1 min ride through.	Electrical efficiency HDR – See above. We do not anticipate light loading of the primary UPS systems. The bypass system will be unloaded under normal conditions. Options regarding UPS type and configuration can be explored during Preliminary Design, however BNL representatives have directed utilization of flywheels as UPS energy source.

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3		Consider calling for fix mounted power circuit breakers to supply loads. This saves space, completely eliminates possibility of breaker failure and arc flash during racking operation, and with arc chutes and contacts accessible from front of breaker doesn't impact maintenance that much. ORNL has 32 such installations that have been in service for 10 to 13 years and all have worked very well.	Reliability HDR - Fixed vs. draw-out breakers can be evaluated during Preliminary Design.
4		If a MV UPS is used and the double conversion LV UPS's are eliminated, consider using this extra space to install FM approved less flammable vegetable oil filled transformers inside utility building. This reduces installed cost for 480V distribution, losses associated with long runs of 480VAC circuits, and provides much better voltage regulation. Check with fire protection engineers on fire safety of these types of transformers, which is excellent.	Space requirements HDR – Medium Voltage UPS can be evaluated during Preliminary Design.
5		Where possible install dual corded loads to eliminate static transfer switches and for critical single corded loads use rack mounted STS's instead of large switches to minimize impact from single point failure.	Reliability HDR – Majority of IT equipment is anticipated to be dual cord, however, STS's are required to ensure loads from both IT power supplies are directed to the primary system, while allowing bypass system to assume load for maintenance or in the event of primary system failure.

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6		As an alternative to a Tier IV system, configure electrical distribution system with HPC systems supplied via radial circuits off Utility and critical system supplied from dual corded system that have UPS/generator on one side and radial fed utility power on the other side. This arrangement provides ride though during PQE's, backup during extended outages, and capability for concurrent maintenance on electrical distribution system supplying critical loads. HPC loads will still require an outage for annual maintenance. UPS's and generators could still be paralleled under this arrangement.	Cost and reliability HDR – Basis of Design is a Tier III system with characteristics similar to what is suggested, i.e., UPS and generator on primary system, utility (and generator) on Bypass system.
7		The HVAC system appears to be mostly fans with small percentage of cooling coming from chilled water. Configure fans to restart automatically after a PQE or momentary power interruption.	Reliability HDR - Agree. UPS for pumps and BMS controls are included; fans will naturally flywheel and catch themselves on the fly upon generator power energizing.
8		Diagram shows 300kVA PDU's supplying four 400A busways. Secondary bus for 480/208V PDU is typically rated for 830A. If each of the 400A circuits is lightly loaded and the multiple number of 400A circuits on a PDU is required to provide breaker space and load cannot exceed transformer capacity, no problem, but if there is potential to increase loads this may result in transformer over temperature alarm or worse trip.	Configuration HDR – Currently, PDU's are not being utilized, this is to keep transformer footprint and heat out of the Data Halls. The 400A busway is intended to allow flexibility in locating higher density loadings. The DCIM system will monitor loads and alarm when pre-set conditions are exceeded.