

Version as of 22 FEBRUARY 2018

ID	Type	Parents	Object Heading	Object Text	Rationale	Notes	Reference	Old ID	Old Parents
FSCF-Engr-115	requirement	FDmod-gen-001, FDmod-gen-002, FDmod-gen-003, cryostat-003, cryosys-001, cryosys-002, cryosys-003,	Far Detector Conventional Facilities	The FSCF shall provide conventional facilities that include spaces for Far Detector modules and for Cryogenics Equipment and systems to construct and operate the Far Detector		This is stated here so that a proper interface document can be prepared.		fscf-l2-prog-12	
FSCF-Engr-001	requirement	cryostat-005, cryostat-041	AHU's	FSCF shall provide AHU(s) underground as needed to meet air-quality requirements.				FSCF-Engr-19	FD-engr-14
FSCF-Engr-002	requirement	cryostat-005	Air ducting in caverns	FSCF shall provide air ducting to avoid interference with the monorail cranes				FSCF-Engr-15b	
FSCF-Engr-003	requirement	cryostat-018	Anchorage on rock septum for bridge support	FSCF shall provide anchorages into rock for cryostat supplied bridges to be placed between each cryostat and the septum to allow future access to top of cryostat	Anchorage to the rock pillar and/or the side walls to support a bridge of whatever size necessary for the detector assembly.			FSCF-Engr-10b	
FSCF-Engr-004	requirement	Cryosys-074	Booster Compressor Cooling	FSCF Shall provide 100 kW cooling capacity to each of (4) nitrogen booster compressors through use of a liquid to liquid heat exchanger.	The heat load estimates are available in docdb-251.	The cryogenics group provides the "hot" side plumbing.	Docdb-251	FSCF-ENGR-65	
FSCF-Engr-005	Requirement	Glo-prog-2 and 3	Cable fire rating	FSCF shall provide all cable to meet code and be low smoke zero halogen. The low smoke zero halogen requirement can be omitted if cable is completely enclosed and smoke from a burning cable cannot escape into occupied space. Any variance to this requirement shall be communicated to the LBNF/DUNE ESH Manager for discussion with the SURF ESH Director and the Fermilab AHJ.	There are three categories of cable installation placement modes: riser, installed vertically; plenum, installed in an air supply plenum space; and general. By code, cable must meet the fire rating associated with where it is installed. LBNF will have cable installed vertically and, by code, it must be riser rated. LBNF does not anticipate any cable being installed in air supply plenums; therefore, all other cables must meet the code requirements for general. In addition, SDSTA requires that all cable be low smoke zero halogen	Resolve ARUP recommendations with AHJ		FSCF-Engr-X11	
FSCF-Engr-006	requirement	cryostat-033	Cavern Height	FSCF shall ensure that the detector cavern extends vertically above the 4850 L, a minimum distance from the bottom of the monorail support beams as defined in drawing F10043159. Also, the vertical distance from the bottom of the monorail beam to the top of the pit concrete floor slab shall be consistent with the minimum distances as shown in drawing F10043159.	To provide adequate clear space for rigging and lifting components.	Per EDMS identifier 1551658 (LBNF Cranes Requirements)	Drawing F10043159 (docdb 464)	FSCF-Engr-4c	
FSCF-Engr-007	requirement	cryostat-036	Cavern Moisture	FSCF shall provide drainage and sumps sufficient to prevent standing water accumulation on cavern slabs on grade. Visible moisture appearing after the application of shotcrete does not require mitigation.	The interior of cavern shotcrete walls and concrete slabs on grade shall provide systems to manage water penetration to inner surfaces. Some moisture is acceptable and will be managed locally by the experiment as necessary.	required by all Far Site LBNF/DUNE		FSCF-Engr-9	FD-engr-10

FSCF-Engr-008	requirement	FDmod-gen-017	Cavern Walls, Concrete Floor, Cryostat and Far Detector Electrical Grounding	FSCF shall provide separate grounding systems between the detector/associated DAQ system and the balance of the facility. These systems shall be isolated using inductors. Non-conductive reinforcement shall be provided in the detector cavern side walls and in the detector cavern floors.	Due to the 600 electron noise limit, the power supplied to the front end electronics and the DAQ system located on the top plate of the cryostats will require a power/ground system which is electrically isolated from cavern power/ground. A controlled safety ground will be installed between cavern and detector ground. Electrically isolated Ufer Ground systems will be installed for each of the four cryostat pits and the upper space of the detector hall - no conductive paths (rebar, anchors, etc.) shall connect these isolated systems.	required by DUNE Far Detector	doc-285	FSCF-Engr-29	FD-engr-16, LArFD-L2-se-7
FSCF-Engr-011	requirement	FDmod-gen-026, glo-prog-003	Central Rock Platform, air-tight isolation	FSCF shall provide air-tight isolation below the rock septum floor elevation between the two detector module chambers in a cavern, both during excavation phasing and after construction.	This protects cryostat construction during excavation and ensures that an issue with one detector does not affect another during operation.	required by DUNE Far Detector; Rock septum will be used.		FSCF-Engr-10	FD-engr-11
FSCF-Engr-012	requirement	FDmod-gen-001, cryostat-037, cryostat-038	Central Utilities Cavern Space Allocation	FSCF shall construct the Central Utilities Cavern with space allocated for a control room, DUNE data room, CF mechanical, electrical and plumbing systems and Cryogenics Systems	Far Site Conventional Facilities allocates spaces according to its own requirements, Far Detector requirements and Cryogenics Systems requirements.	required by DUNE Far Detector, LBNF Conventional Facilities and LBNF Cryogenics Systems		FSCF-Engr-12	FD-engr-3, FD-engr-4, FD-engr-5
FSCF-Engr-013	requirement	cryostat-020, cryostat-042	Chamber slab on grade surface Tolerances	FSCF shall Provide OVERALL FF=25 (approximate +/- ¼ inch) and FL=20 (approximate +/- 5/16-inch) with LOCALIZED FF=17 (approximate +/- 3/8inch) and FL=15 (approximate +/-3/8inch) in compliance with ACI 117, 4.8.5 as determined by the ASTM 1155 test procedure	This means that that maximum point deviation from the assumed datum or elevation is +/- 3/8 inch and the maximum stacked or cumulative deviation is also +/- 3/8 inch		Docdb-1784	FSCF-Engr-11	FD-engr-13
FSCF-Engr-015	requirement	cryosys-002, cryosys-003, FDmod-gen-004	Component Delivery to chambers	FSCF shall design facility geometry to allow delivery of equipment and materials as follows: All cryostat components shall be delivered from the Ross shaft to the east and west ends of the detector caverns. All detector components shall be delivered from the Ross shaft through the central detector cavern accesses, including passing through the CUC. All equipment to be used in the CUC shall be delivered through either the east end of the CUC or the central drift leading to CUC.		The far detector components are found in docdb-3051. The cryostat components in CERN EDMS 1531746, v.1	Docdb-3051	FSCF-Engr-55c	
FSCF-Engr-016	assumption	FDmod-gen-022	Components Delivery Access	SURF shall provide space for a forklift to lift off a container up to 8' x 8'6 x 40 of Far Detector components from delivery trailers directly to the Ross Headframe according to the planned delivery schedule.	The clean TPC components will be delivered to the site in clean trailer or container trucks.	required by DUNE Far Detector		FSCF-Engr-39	FD-engr-17
FSCF-Engr-017	requirement	cryosys-041, cryosys-042, cryosys-044	Compressor Heat Exchangers - 1 (surface)	FSCF shall provide a fluid-based cooling system to remove heat from the nitrogen compressors supplied by the cryogenics group, including all plumbing to connect the system to the compressors.				FSCF-Engr-51	
FSCF-Engr-018	requirement	cryosys-041, cryosys-042, cryosys-044	Compressor Heat Exchangers - 2 (surface)	FSCF shall provide redundancy in the cooling system to allow maintenance to be performed on the system without shutting down more than one compressor at a time				FSCF-Engr-51a	
FSCF-Engr-019	requirement	cryosys-041, cryosys-042, cryosys-044	Compressor Heat Exchangers - 3 (surface)	FSCF shall design the cooling system to allow operation of 0-4 compressors in all weather conditions				FSCF-Engr-51b	
FSCF-Engr-020	requirement	cryosys-041, cryosys-042, cryosys-044	Compressor Heat Exchangers - 4 (surface)	FSCF shall design the cooling system to manage heat from up to four (4) Emerson VSS3001 compressors			Doc 259	FSCF-Engr-51c	

FSCF-Engr-021	requirement	cryostat-005, cryostat-041, Cryosys-046	Condensation	FSCF shall ensure a minimum of 15,000 cfm per detector module or one air change per hour per cavern for both detector caverns (four chambers) and the CUC	Analysis work indicates that this will prevent condensation formation along the bottoms and sides of the cryostats		DUNE docdb-519	FSCF-Engr-15a	
FSCF-Engr-022	requirement	cryosys-003	Cryo building -1	FSCF shall provide space adjacent to the compressor building for five (5) 114" diameter x 466" tall dewars, Four for LAr, one for N2		Need info from cryo on spare space for additional dewars		FSCF-Engr-49a	
FSCF-Engr-023	requirement	cryosys-003	Cryo building -2	FSCF shall provide space adjacent to the compressor building for five (5) 5' x 6' x 14' tall vaporizers, with 4' clearance on all sides, four for argon, one for nitrogen.				FSCF-Engr-49b	
FSCF-Engr-024	requirement	cryosys-003	Cryo building -3	FSCF shall provide space for a 6' x 6' purity checking building, supplied by cryo, adjacent to the LAr dewar				FSCF-Engr-49c	
FSCF-Engr-025	requirement	cryosys-047	Surface Compressor Building HVAC	FSCF shall provide the LBNF Surface Compressor building with an HVAC system to ensure air temperature within the range from 40-104 degrees Fahrenheit.		required by LBNF Cryogenics Systems		FSCF-Engr-45	FD-engr-4, FD-engr-5, FD-engr-17
FSCF-Engr-026	requirement	cryosys-002	Cryogenics Building	FSCF shall provide a surface building to accommodate LBNF cryogenics equipment and associated infrastructure.		required by LBNF Cryogenics Systems	doc-248	FSCF-Engr-43	FD-engr-4, FD-engr-5, FD-engr-17
FSCF-Engr-027	requirement	cryosys-005	Cryogenics piping	FSCF shall provide (2) 16" nitrogen gas pipes (Low pressure), (2) 8" nitrogen gas pipes (high pressure) and (1) 8" argon gas pipe from the trench entrance at the compressor building through the Ross shaft to the associated cryogenics-supplied equipment in the CUC	Per cryogenics design	The gas pressure ratings are as follows: 8" GN2 at 200 psig, 16" GN2 at 50 psig and 8" GAR at 75 psig each		FSCF-EGR-25a	
FSCF-Engr-029	requirement	cryosys-003, cryosys-051	Cryogenics Systems Space and Mounting	FSCF shall provide space and unistrut type mounting in detector and central utilities caverns so as to accommodate the LBNF cryogenics systems piping. FSCF shall provide vertically mounted pipe support system in the drifts.		required by LBNF Cryogenics Systems		FSCF-Engr-26	FD-engr-3, FD-engr-4, FD-engr-5
FSCF-Engr-030	assumption		Cryostat Perimeter Volume Hazard Designation	The space between the cryostat sides and the rock walls is not considered occupied space.	LBNF Conventional Facilities has no responsibility for this requirement. LBNF cryostat and cryogenics system is responsible for analysis and hazard designation.	required by DUNE Far Detector, LBNF Cryostat and LBNF Cryogenics Systems for inspection and maintenance. The access will be limited by administrative controls before and after filling.		FSCF-Engr-17	FD-engr-14, 15
FSCF-Engr-033	requirement	Cryostat-004	Detector Cavern Dimensions	FSCF shall ensure that the detector Cavern width, height and length are in agreement with drawing F10043159	Cryostat size plus minimum 1 foot clear space annulus defines minimum cavern size		Drawing F10043159 (docdb 464)	FSCF-Engr-4a	
FSCF-Engr-034	requirement	FDmod-gen-017	Electrical Power - Detector and Central Utilities Caverns	FSCF shall provide separate shielded transformers and gear for the detector electronics and general circuits in order to minimize electromagnetic interference.		required by DUNE Far Detector		FSCF-Engr-27	LArFD-L2-se-7, FD-engr-16
FSCF-Engr-035	requirement	cryosys-004, cryosys-005	Electrical Power Cryo Building	FSCF shall ensure that the LBNF Cryogenics surface building accommodates electrical power type and capacity set by cryogenics.		required by LBNF Cryogenics Systems	doc-208	FSCF-Engr-48	FD-engr-4, FD-engr-5, FD-engr-17
FSCF-Engr-036	requirement	FDmod-gen-001, cryosys-001, cryosys-057	Electrical Power Distribution	FSCF shall provide electrical power distribution in the caverns to meet FD and cryo systems needs		required by DUNE Far Detector	doc-208	FSCF-Engr-31	FD-engr-15
FSCF-Engr-037	requirement	cryosys-043	Equipment Structural/foundation support in CUC	FSCF shall satisfy equipment support requirements, such as weight and footprint of cryogenics equipment (compressors, turboexpanders, dewars, etc.) and detector DAQ equipment including racks in the CUC.			DUNE docdb-248, 259	FSCF-ENGR-58	
FSCF-Engr-038	requirement	FDmod-gen-001, cryosys-001	Far Detector and Cryogenics Systems Electrical Power	FSCF shall provide electrical power capacity in the FD caverns and CUC to meet FD and cryogenics needs.		required by DUNE Far Detector and LBNF Cryogenics Systems	doc-208	FSCF-Engr-30	FD-engr-15

FSCF-Engr-039	requirement	FDmod-gen-019	Far Detector Caverns Orientation	FSCF shall ensure that the Far Detector caverns are aligned to within +/- 1.0 degree of the Fermilab beam as measured in a 4850L horizontal plane.	The tolerance value is intended not to be finer than can be achieved by precision engineering survey.	This should trace back to DUNE Far Detector requirement. The beam azimuth (clockwise) from true North in global coordinate system is Az = 287-43-10.96596 deg-min-sec.		FSCF-Engr-3	glo-sci-17, FD-engr-2, FD-engr-3
FSCF-Engr-041	requirement	FDmod-gen-016	Far Detector Installation	FSCF shall ensure that a portion of the area above the rock septum, a volume defined as 14.4m W x 5m H x 10m L, with the 15m side aligned with the cavern transverse centerline, shall remain clear of utilities to allow installation of a temporary clean room.	Cannot have any utilities passing through this space to allow installation of the clean room.	Have Bill Miller, Jack Fowler validate this requirement (1/12/17: no progress yet on validating these dimensions; hoping for info by summer 2017 -JF). Need a new clearance envelope drawing. Check with Matt 10/30/2017.	Drawing F10043159 (docdb 464)	FSCF-Engr-19a	
FSCF-Engr-042	Requirement	FDmod-gen-017	Fiber cable tray grounding	FSCF shall provide a cavern grounding system for the grounding of all cable trays	This allows separate grounding scheme for the detector components and the fiber cable trays			FSCF-Engr-X10	
FSCF-Engr-043	Requirement	Cryosys-033, FDmod-DAQ-008	Fiber cable tray location	FSCF shall provide unistruts for cable trays in the caverns that run along the entire length of the wall closest to the CUC	This will allow easy access to the mezzanine components			FSCF-Engr-X9	
FSCF-Engr-044	Specification		Fiber Connector Specification	FSCF shall provide fiber connectors at both the surface data room and the underground data room for each fiber using MTP/MPO connectors (mass connector, up to 48 per connection).	Needs verification method				
FSCF-Engr-045	Requirement	FDmod-daq-008	Fiber Count Expansion Capability	FSCF shall provide means to allow for expansion to up to 960 total fibers (480 pairs) along both routes through the Ross and Yates.	Allows for Dual Phase Option, which requires 96 pairs per detector, while retaining the original 96 pairs			FSCF-Engr-X3	
FSCF-Engr-046	Specification	FSCF-Engr-045	Fiber Data Rate	FSCF Shall provide fiber meeting a minimum specification of G.652	Provides capability to support 100 Gbps				
FSCF-Engr-047	Parameter	FSCF-Engr-045	Fiber for Detector Data	FSCF Shall provide a minimum of 15 fiber pairs per detector (60 pairs total) for data	Based on assumed data compression within CUC, comfortable number				
FSCF-Engr-048	Parameter	FSCF-Engr-045	Fiber for Detector Slow Control	FSCF Shall provide a minimum of 1 fiber pair per detector (4 pairs total) for slow control	Each detector requires independent control				
FSCF-Engr-049	Parameter	FSCF-Engr-045	Fiber for FSCF	FSCF Shall provide a minimum of 4 pairs of fiber for FSCF use.	1 BMS, 1 Fire, 1 GPS, 1 Miscellaneous				
FSCF-Engr-050	Parameter	FSCF-Engr-045	Fiber for GPS	FSCF shall provide a minimum of 2 fiber pairs for GPS timing	Based on experience at MINOS				
FSCF-Engr-051	Parameter	cryosys-053	Fiber for LAr	FSCF shall provide a minimum of 4 pairs of fiber for use by LAr cryogenics					
FSCF-Engr-052	Parameter	cryosys-053	Fiber for LN2	FSCF shall provide a minimum of 4 pairs of fiber for use by LN2 cryogenics.				FSCF-Engr-X12	
FSCF-Engr-053	Requirement	FDmod-daq-008, cryosys-048, FDmod-gen-024	Fiber Infrastructure	FSCF shall provide fiber from the surface data room (connected to the SURF network) to the underground data room using only fusions splices, with ends terminating into connectors only, within the CUC and the Surface Data Room	fusion splices limit attenuation			FSCF-Engr-X1	
FSCF-Engr-054	Parameter	FDmod-gen-025, cryosys-053	Fiber or SURF Network	FSCF shall provide a minimum of 2 pairs of fiber for general access to the SURF based network. These fibers may connect to the SURF network at the 4850L	These will be used for internet network connection, either via wall jacks or WAP's				
FSCF-Engr-055	Requirement	FDmod-daq-008	Fiber Spare Capacity	FSCF shall provide redundant fibers for data, GPS, and slow control via both the Ross Shaft and Yates Shaft	Allows quick recovery from damaged fiber through one route.			FSCF-Engr-X2	
FSCF-Engr-057	Requirement	glo-prog-2	Fire and life safety control station	FSCF shall provide space in the underground control room for a control station with monitors and keyboards, etc for fire and life safety					
FSCF-Engr-058	requirement	FDmod-comm-003, fscf-l2-prog-3	Fire Suppression Systems	FSCF shall provide fire-suppression sprinklers in the Far Detector caverns of the pre-action type for protection of the electronics.		required by all Far Site LBNF/DUNE during Projects. pre-action type is required by DUNE Far Detector during operations to reduce risk of damage to equipment		FSCF-Engr-20	FD-engr-15

FSCF-Engr-059	requirement	cryosys-005	Gas pipe arrangement	FSCF shall arrange all gas piping (with adequate spacing) so as to allow maintenance/replacement of pipe sections without removal of any other pipe.	To allow maintenance without interfering with other (or redundant) systems.			FSCF-EGR-25c	
FSCF-Engr-060	requirement	cryostat-003, cryostat-018	Height of Cryostat	FSCF shall ensure that the elevation of the top of the warm cryostat structure will be located at the 4850L +/- a distance defined by cryostat in the warm condition (prior to cooldown)	The +/- vertical tolerance should be driven by equipment roll-on/roll-off capability			FSCF-Engr-??	
FSCF-Engr-061	requirement	cryostat-005	HVAC systems	FSCF shall maintain the Far Detector chambers at a temperature between 67 to 85 degrees F, a relative humidity level between 15 and 85 percent, and a maximum dewpoint of 48 F	Temperature and RH range set by environmental requirements for computers and worker comfort. Maximum dewpoint set to keep moisture from condensing on the cryostat or electronics racks.	required by DUNE Far Detector and LBNF cryostat		FSCF-Engr-16 (FOR SURF)	FD-engr-14, 15
FSCF-Engr-062	requirement	cryosys-004, cryosys-005	Industrial Water Cryo Building	FSCF shall ensure that the LBNF surface cryogenics building accommodates an industrial water supply capacity of 10 gpm.		required by LBNF Cryogenics Systems		FSCF-Engr-46	FD-engr-4, FD-engr-5, FD-engr-17
FSCF-Engr-063	requirement	cryostat-035, cryosys-054, FDmod-gen-028	Industrial Water at 4850L-CUC	FSCF shall provide industrial water to the north central entrance of the CUC at the 4850L to accommodate 10 gpm.	A nominal amount of water will be required for wash down of parts and replenish equipment supply.	required by DUNE Far Detector, LBNF Cryostat, and LBNF Cryogenics Systems		FSCF-Engr-22	FD-engr-15
FSCF-Engr-064	requirement	cryostat-035, cryosys-054, FDmod-028	Industrial Water at 4850L-caverns	FSCF shall provide industrial water to each detector module chamber at the 4850L to accommodate 10 gpm.					
FSCF-Engr-065	assumption		Lavatory Facilities	Lavatory facilities shall be provided by SURF in or adjacent to the Far Detector Hall to accommodate cryostat, cryogenics systems and far detector construction occupancy rates.				FSCF-Engr-53	
FSCF-Engr-066	requirement	FDmod-gen-017	Lighting	FSCF shall install no lights that incorporate ballast or spark circuits in or within 50' of the Far Detector Caverns due to EMI considerations.	Due to EMI considerations, the 600 electron noise limit, and relatively thin tank wall, Avoid all types of lighting that use ballast or spark start circuits.	required by DUNE Far Detector		FSCF-Engr-33	LArFD-L2-se-7, FD-engr-16
FSCF-Engr-067	requirement	fscf-l2-prog-3	lighting levels	FSCF shall provide a minimum lighting level of 50 foot candles (500 Lumens) in the control room, conference room and office spaces and 40 foot candles (400 Lumens) elsewhere			BSI Prelim Design Report docdb 136	FSCF-Engr-33a	
FSCF-Engr-068	requirement	cryosys-055	LN2 Dewars space	FSCF shall provide space for (24), approximately, 1.45m diameter x 9.0m long LN2 dewars at the 4850L		to be located as far downstream in the air exhaust path as possible. The size, shape and fit, pending final design. Reference drawing F10061421 in docdb-4070 v2		FSCF-ENGR-64	
FSCF-Engr-070	assumption		Material Radioactivity	Materials used in FSCF construction do not have to be specified to minimize background radiation levels.	Naturally occurring background radiation levels in concrete and other construction materials do not exceed the levels in the soil and rock, and therefore low-radioactivity construction materials are not needed.			FSCF-Engr-14	FD-engr-13
FSCF-Engr-071	requirement	cryosys-027, cryosys-076	Mezzanine support	FSCF shall provide attachment point for the mezzanine platform for installation of proximity cryogenics in each chamber and also provide lifting eyes (1 m X 1 m pattern, with each having a capacity of minimum 10 metric tons) in the crown over the mezzanine as per requirements specified by cryo systems			DUNE docdb-464	FSCF-ENGR-59	
FSCF-Engr-073	Requirement	FDmod-comm-001, Cryostat-034, cryosys-049	Monorail Controls	FSCF shall ensure that the monorails are equipped with radio controls that provide individual or simultaneous controls for the 3 monorails, i.e. all 3 or a combination of 2 shall be wirelessly controlled simultaneously	This is a wireless control mechanism that will prevent interferences during travel of hoists				

FSCF-Engr-074	Assumption	Cryostat-034	Monorail Design	The lifting beam and the spool piece design shall be provided by cryostat taking into consideration the space availability	Due to restricted space availability an optimal design of the beam and spool piece is necessary				
FSCF-Engr-075	Requirement	FDmod-comm-001, Cryostat-034, cryosys-049	Monorail Extension	FSCF shall ensure that the monorails extend 3m into the eastern-most and western-most drifts to facilitate loading of the cryostat pieces, and that they extend over the rock septum to the extent shown in the minimum clearance definition drawing F10043159.			DUNE docdb-464		
FSCF-Engr-076	Requirement	FDmod-comm-001, Cryostat-034, cryosys-049	Monorail Height Capacity	FSCF shall ensure that monorail hoists are equipped so that the hook reaches the floor of the detector pit.	This is necessary to provide maximum flexibility of use.				
FSCF-Engr-077	Requirement	FDmod-comm-001, Cryostat-034, cryosys-049	Monorail Hoist Power	FSCF shall ensure that all hoists are equipped with back-up power capable of supplying power for 10 minutes in the event of a power failure	If the power goes out while a load is in the air, the hoists should operate to allow load to be lowered to the ground in a safe manner				
FSCF-Engr-078	Requirement	FDmod-comm-001, Cryostat-034, cryosys-049	Monorail Hoists Capacity	FSCF shall ensure that two sets of three monorail hoists each have a minimum capacity of 15 metric tons (16.54 US short tons).	These two sets are to be installed in caverns 1 and 2. Hoists for caverns 3 and 4 will be provided at a later date; however, monorail beams shall be provided in all four caverns. This capacity provided by cryostat takes into account the weight of the largest piece to be assembled. The intent is that IF multiple hoists operate on the same beam the minimum design capacity of 15 metric tons is not exceeded.				
FSCF-Engr-079	Requirement	FDmod-comm-001, Cryostat-034, cryosys-049	Monorail Hoists Operation	FSCF shall ensure that monorail hoist motors have a heavy (H5) duty cycle	This is due to possible 24 hrs/day, 7 days/week, multiple year initial usage planned				
FSCF-Engr-082	Requirement	FDmod-comm-001, Cryostat-034, cryosys-049	Monorail Power Supply	FSCF shall ensure that the monorails are provided with a shoe-style power supply strip that runs along the length of the monorail beam	The shoe-style power supply will help prevent interference caused by the use of festoon power supply wires during travel				
FSCF-Engr-083	Requirement	FDmod-comm-001, Cryostat-034, cryosys-049	Monorail Quantities	FSCF shall ensure that each excavated chamber is equipped with 3 monorail beams, the locations of which shall be as specified in the minimum clearance definition drawing F10043159	This quantity is needed for the installation of cryostat pieces				
FSCF-Engr-085	assumption		Personnel Occupancy	SURF shall accommodate a maximum LBNF/DUNE personnel underground occupancy of 50 during concurrent cryostat construction, cryogenics system construction and Far Detector installation. LBNF/DUNE campus occupancy shall be 4 during operations.	Concurrent activities is required to increase schedule efficiencies. Occupancy rates may require temporary refuge facilities or certain activities suspended.	required by DUNE Far Detector and LBNF Cryostat and Cryogenics Systems		FSCF-Engr-5	FD-engr-8
FSCF-Engr-086	requirement	cryosys-005	Gas Piping Safety	FSCF shall install all cryogenic gas piping so as to avoid potential damage from traffic.	To avoid potential damage from traffic.			FSCF-EGR-25b	
FSCF-Engr-088	assumption		Shop Space	There will not be dedicated space for a temporary machine shop at 4850L; Far Detector, cryostat and cryogenics systems will plan and negotiate use of available space to accommodate their installation activities.	LBNF Conventional Facilities has no responsibility for this requirement. The shop space will be required during the installation of the FD cryostat and cryogenics system.	required by LBNF Conventional Facilities to limit excavation		FSCF-Engr-8	FD-engr-9
FSCF-Engr-093	Requirement	FDmod-gen-023	Surface data transfer room	FSCF shall provide a surface data transfer room with space, power (30 kVA), and cooling for a minimum of 6 data racks		Requirements need to be clarified by DAQ group (June 2017). This is per Eric James direction 7/13/2017		FSCF-Engr-X6	
FSCF-Engr-094	assumption		Surface Site Security	The existing facility security fencing with locked gates prevents unauthorized personnel from accessing surface facilities including cryogenic equipment. No additional fencing is required.	Uncommon safety hazards exist in these areas and the public must be kept safe.			FSCF-Engr-40	FD-engr-17

FSCF-Engr-095	requirement	FDmod-gen-017	Transformer Shield	FSCF shall provide power transformers that come with double faraday shields to all Far Detector Front End/DAQ Electronics in order to satisfy noise limit.	Due to the 600 electron noise limit, the power supplied to the front end electronics and the DAQ system located on the top plate of the cryostats will require a power/ground system which is electrically isolated from building ground. A controlled safety ground will be installed between building and detector ground.	required by DUNE Far Detector		FSCF-Engr-32	FD-engr-15, 16
FSCF-Engr-096	requirement	cryosys-003, cryosys-004	Truck Access at fill stations	FSCF shall ensure that the space is available for the fill station cryogenic dewars to accommodate two cryogen tractor-trailer delivery units simultaneously.	The delivery of liquid argon for filling the detector is a critical path schedule item. As such, provisions need to be made for multiple deliveries at the same time. Liquid cryogen transport trailers without tractor are 2.5 m wide x 10 m long x 3.3 m high and weigh 44,000 kgf.	required by LBNF Cryogenics Systems		FSCF-Engr-38	FD-engr-17
FSCF-Engr-097	requirement	cryosys-004, cryostat-032, FDmod-gen-022	Truck Site Access	FSCF shall ensure that the site construction accommodates access by standard WB-67 over-the-road transport tractor-trailers. Any restrictions regarding weights of trucks, wheel loads, axle loads, etc will be governed by state, county and local ordinances for bridges and roads and should not show up as an LBNF requirement because all designs must comply with all federal, state, and local laws and ordinances.		required by DUNE Far Detector, LBNF Cryostat and LBNF Cryogenics Systems		FSCF-Engr-37	FD-engr-17
FSCF-Engr-108	requirement	Cryostat-035	Waste Water Cryo Building	FSCF shall ensure that the LBNF surface Cryogenics building accommodates water drainage capacity of 10 gpm.	Waste water is composed of water, rock sediment, and at times during construction, non-toxic, biodegradable cleaner such as Simple Green. Power washer capacity typically less than 4 gpm.	required by LBNF Cryogenics Systems		FSCF-Engr-47	FD-engr-4, FD-engr-5, FD-engr-17
FSCF-Engr-109	requirement	Cryostat-036	Water Drainage Far Detector Caverns	FSCF shall ensure that the Far Detector caverns have water drainage capacity of 10 gpm plus natural ground water infiltration rate	This water is composed of water, rock sediment, and at times during construction, non-toxic, biodegradable cleaner such as Simple Green. Power washer capacity typically less than 4 gpm. The water drainage capacity of 10 gpm does not account for fire suppression system discharge which should be reconsidered during design. (this may be req for cryo)	required by LBNF Cryostat		FSCF-Engr-23	FD-engr-15
FSCF-Engr-111	Requirement	FDmod-gen-025, cryosys-048	Wireless Connectivity	FSCF shall provide wireless connectivity to the SURF network for general use in the path from the Ross Shaft to all three main caverns, including all entrances to each cavern except the mucking ramp		This is a communications requirement not a fiber requirement. Need clarification if this could be deemed to supersede the scope option for leaky feeder. 10/30/2017: Ask Jack regarding this item.		FSCF-Engr-X8	
FSCF-Engr-112	requirement	FDmod-gen-016	Clean room	FSCF shall make available a space with sealed concrete surfaces on the rock septum to accommodate the Far Detector group's construction of a class 100,000 clean room.	The clean room environment inside the detector caverns, enveloping the cryostat loading area will be supplied by the Far Detector group.	required by LBNF Conventional Facilities to limit cost, DUNE Far Detector is responsible for environmental regulatory and contamination class conditions within its installation clean room environment. Check the class of the clean room and verbiage of this requirement.		needs number; was fscf-l2-prog-14	
FSCF-Engr-114	requirement	glo-prog-004	Surface Grade	FSCF shall ensure that the grade of any surface used for transport does not exceed 15%.					

FSCF-Engr-117	requirement	FDmod-gen-017	Isolated Ground	To mitigate noise, FSCF shall ensure that no conductive/copper connections of any phone or network system are made to the isolated detector ground in the Far Detector Hall.	Conductive connections to building ground is acceptable. If phones are to exist on or near Cryostat (near DAQ installation), VoIP (Voice over Internet Protocol) should be implemented with fiber optics.				
FSCF-Engr-118	Specification	glo-prog-014	Noise Abatement	FSCF shall ensure that cryogenic equipment noise is reduced to a maximum 55 dB building exterior noise level for equipment located on the surface.	This is a "joint" requirement for CF and Cryo, since it can be solved by either insulating the building or the compressors				
FSCF-Engr-119	Specification	glo-prog-002	Secondary Containment	FSCF shall provide the FD Cryogenics building with secondary containment capacity	Oil filled machinery requires secondary containment capability. Cryosys expects to handle 220 gallons of oil for each of the 4 nitrogen screw compressors.				
FSCF-Engr-121	assumption		Parking	The facility shall provide space for parking of 4 cars in proximity of the control room during the operations phase of the detector.					
FSCF-Engr-122	requirement	Cryosys-034, Cryostat-049, FDmod-gen-029	Components geometry and weight	FSCF shall accommodate components from detector, cryostat and cryogenics in the shaft as a cage or slung load as per size and weight constraints described in docdb-328			Docdb-328		
FSCF-Engr-123	requirement	FDmod-comm-002	Underground experimental work area	FSCF shall provide an underground experimental work area within the underground control room that will be able to accommodate up to 5 people/workstations		This is per Eric James direction 7/13/2017			
FSCF-Engr-124	requirement	FDmod-comm-002	Underground data processing room	FSCF shall provide space for an estimated 52 racks for the DAQ systems, along with power and cooling for the racks	Number of racks are to be specified according to the DAQ model adapted. Currently estimated 50 racks for detectors and 2 racks for CF use	This is per Eric James direction 7/13/2017			
FSCF-Engr-125, (TBD later, 13 July 2017)	requirement	cryosys-050	Underground cryogenics work area	FSCF shall provide an underground cryogenics work area within the underground control room that will be able to accommodate up to 4 people/workstations		This is per David Montanari direction 7/13/2017			
FSCF-Engr-127	requirement	Cryosys-075	Lifting eyelets for LAr Pumps	FSCF shall provide lifting eyelets grid (1 m X 1 m with each eyelet having a minimum capacity of 2 metric tons) in the crown of the caverns above the LAr pumps to aid LAr pumps installation/maintenance			Docdb-464		
FSCF-Engr-129	requirement		Peak particle velocity	FSCF shall ensure that the peak particle velocity during blasting and air over pressure, measured at nearest surface property boundary and nearest experiment underground, comply with the limits described in docdb-1655			Docdb-1655		
FSCF-Engr-147	requirement	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross Cage Requirements	FSCF shall provide a cage for the Ross shaft for the transportation of personnel and components/equipment from the surface to the 4850 L			Docdb-3582 v4		
FSCF-Engr-130	Specification/parameter	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage specifications	The Ross Cage shall have minimum internal clearance height of 3.6m (11' 10")					
FSCF-Engr-131	Specification/parameter	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage specifications	The Ross Cage doors shall be removable to allow full use of this height.					
FSCF-Engr-132	Specification/parameter	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage specifications	The Ross Cage shall have minimum internal clearance length between doors of 3.69m (12' 1.5")					
FSCF-Engr-133	Specification/parameter	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage specifications	The Ross Cage shall have minimum internal clearance width between any protrusions of 1.38m (4' 6.25")					

FSCF-Engr-134	Specification/parameter	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage specifications	The Ross Cage shall have minimum load capacity inside the cage of 5,450 kg (12,000 lb) at full speed					
FSCF-Engr-135	Specification/parameter	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage specifications	The Ross Cage shall have minimum slinging capacity beneath cage 5,900 kg (13,000 lb) at reduced speed					
FSCF-Engr-136	Specification/parameter	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage specifications	The Ross Cage shall have minimum of 6 connection points beneath the cage, one at each corner, on at the midpoint of each long side					
FSCF-Engr-137	Specification/parameter	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage specifications	The Ross Cage shall have maximum overall height to allow slinging components 7.6m (25 ft) beneath the cage					
FSCF-Engr-138	Specification/parameter	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage specifications	The Ross Cage shall have minimum designed travel speed 12.7 m/s (2,500 fpm)					
FSCF-Engr-139	Specification/parameter	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage specifications	The Ross Cage shall have a flat work deck above cage capable of supporting a minimum of 1000 kg (2,200 lb) on each side of the emergency stop system.					
FSCF-Engr-140	requirement	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage emergency stop requirement	The Ross Cage shall meet all code requirements for emergency stopping					
FSCF-Engr-141	requirement	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage chairing mechanism	The Ross Cage shall have a chairing mechanism compatible with existing systems					
FSCF-Engr-142	requirement	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage rails	The Ross Cage shall have embedded rail compatible with existing rail					
FSCF-Engr-143	requirement	FDmod-gen-029, Cryostat-049, Cryosys-034	Ross cage portholes	The Ross Cage shall incorporate portholes to allow visual monitoring of slung loads from inside the cage.					
FSCF-Engr-144	assumption		Surface Facilities command center	This space would centralize all facilities system monitoring (existing SDSTA and new LBNF) in one space. Therefore there are no CF requirements for this space.	This is where systems like fire alarm and HVAC are monitored. SDSTA is seeking funding to create this space at the Yates complex, perhaps in the existing E&O building.	This is consistent with "addendum notes" from control room workshop, docdb-937 and Mike Headley's email from 7/7/2017			
FSCF-Engr-145	assumption		Surface experimental control room	This space would centralize all experiment monitoring (existing LZ and new DUNE) in one space, much like ROC at Fermilab. Therefore there are no CF requirements for this space.	This is where DUNE would be monitored. SDSTA is seeking funding to create this space at the Yates complex, perhaps in the existing E&O building.	This is consistent with "addendum notes" from control room workshop, docdb-937 and Mike Headley's email from 7/7/2017			
FSCF-Engr-146	requirement	Cryosys-082	Bollards in CUC	FSCF shall provide removable type bollards in CUC with the in-ground sleeve flush with the floor finish surface to protect cryo equipment in CUC.	Additional requirements/specifications as per docdb-4751-v1				
FSCF-Engr-148	requirement	Cryostat-062, Cryosys-083	Compressed air supply	FSCF shall provide supply of dry compressed air in the caverns at a pressure of 120 psig	This utility will be needed to operate the pneumatic valves, air powered tools, clean pieces after machining before installation, etc.	Number of outlets, max. delivery flow rate, total delivery flow rate is TBD			
FSCF-Engr-149	assumption		Primary access	Primary access through Ross shaft, no modification to existing east or west lab access drifts					
FSCF-Engr-151	Requirement	FDmod-gen-016	Surface finish	FSCF shall provide all non-floor surface finishes as unpainted shotcrete. Floor of existing south access drifts and all new drifts will be concrete, except mucking ramps. Septum floor concrete is to be sealed.					

FSCF-Engr-153	requirement	glo-prog-049, fs-prog-001	Rock mass monitoring system	LBNF excavation design scope shall include design and cost estimation for installation of rock mass monitoring systems during construction through long-term operation including, but not limited to, blast vibration, piezometers, inclinometers, extensometers and convergence monitoring					
FSCF-Engr-154	requirement	Cryostat-064	Cryostat loading	FSCF shall provide a concrete floor for seating the cryostat that will withstand the cryostat loading		The cryostat loading information is available in EDMS-1531410 v.1. All loading is in metric tonnes. Weblink: https://edms.cern.ch/ui/#!master/navigator/document?P:1472009535:1879028512:subDocs			
FSCF-Engr-155	requirement	cryostat-049, FDmod-gen-029, Cryosys-085	Drift design and dimensions	FSCF shall construct all new drifts as recommended in the drift optimization study in docdb-1313 v2					
FSCF-Engr-156	requirement		Ross shaft transportation and brow requirements	The Ross shaft and brow shall allow the transportation of loads as shown in DUNE docdb-328, 4781, 4532					
FSCF-Engr-157	requirement		Access ways/Door ways	FSCF shall have doors with a minimum clearance when opened of 12' H X 8' 2.5" W according to docdb-136, UG-PDR-A-201 in all access ways from the Ross Shaft to the South, East and West passages to and between caverns					
FSCF-Engr-159	requirement		Ross Shaft work decks and Yates Shaft cage use	The Ross Shaft work decks and the Yates Shaft cage shall be used in compliance with the constraints described in DUNE docdb-5786-v1					
FSCF-Engr-160	requirement	Cryostat-069	Antechambers addition	FSCF shall provide an excavated space in the crown area above 4850 L at the West and East end of the detector chambers that is 3 m long as shown in interface drawing docdb-464	This antechamber will allow the bridge crane hook to reach the end of each chamber pit without interference		Docdb-464		
FSCF-Engr-161	requirement	FDmod-gen-037	Far detector rack cooling	FSCF shall provide chilled water to a distribution supply and return manifold along the length of each detector chamber with control valves every ~2.3m for a total of 25 connection points, each designed to support 3 electronics racks		All plumbing from the manifold to the electronics racks shall be provided by other sub-projects			