UNDERGROUND ACCESS TECHNICAL SPECIFICATIONS

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VERSION CONTROL

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Jason Connot	01	01/14/2020	Initial release; previous specs not under document change control.

1. Introduction

The Yates and the Ross Shafts are the two shafts which are used for accessing the underground lab at SURF. Each shaft can access multiple levels within the facility, however, the primary destination is the Science Campus located at the 4850L. This paper will define the current and expected future operating parameters from which planning for construction and operation of current and future labs can be performed.

2. Ross Shaft

The Ross Shaft is a steel furnished shaft originally constructed in the early 1930s. It is currently undergoing a major refurbishment. The project involves the complete removal of all existing steel shaft sets and replacement of new steel. Once the Ross Shaft refurbishment is complete, it is intended to serve as the main access for personnel, materials and equipment to host construction and operation of future labs as well as provide for waste rock removal. The shaft also serves as a conduit for electrical, communication and piping utilities. Although there are existing utilities in the shaft that are necessary for current operation, the design of the new furnishings allows for the support of additional utilities for future operation. The shaft also provides access for maintenance to the main pumping stations located at the 5000L, 3650L, 2600L, 2450L and 1250L. In addition, it also provides for emergency egress in the event of a loss of primary egress through the Yates Shaft.

The operation of the shaft during refurbishment is restricted to support refurbishment activities as well as provide for emergency egress. Therefore, the operating parameters presented will focus on what will be provided from a completely refurbished shaft, rather than one that is undergoing refurbishment.

Figure 1: Ross Shaft Typical Set General Arrangement Plan View – New Furnishings

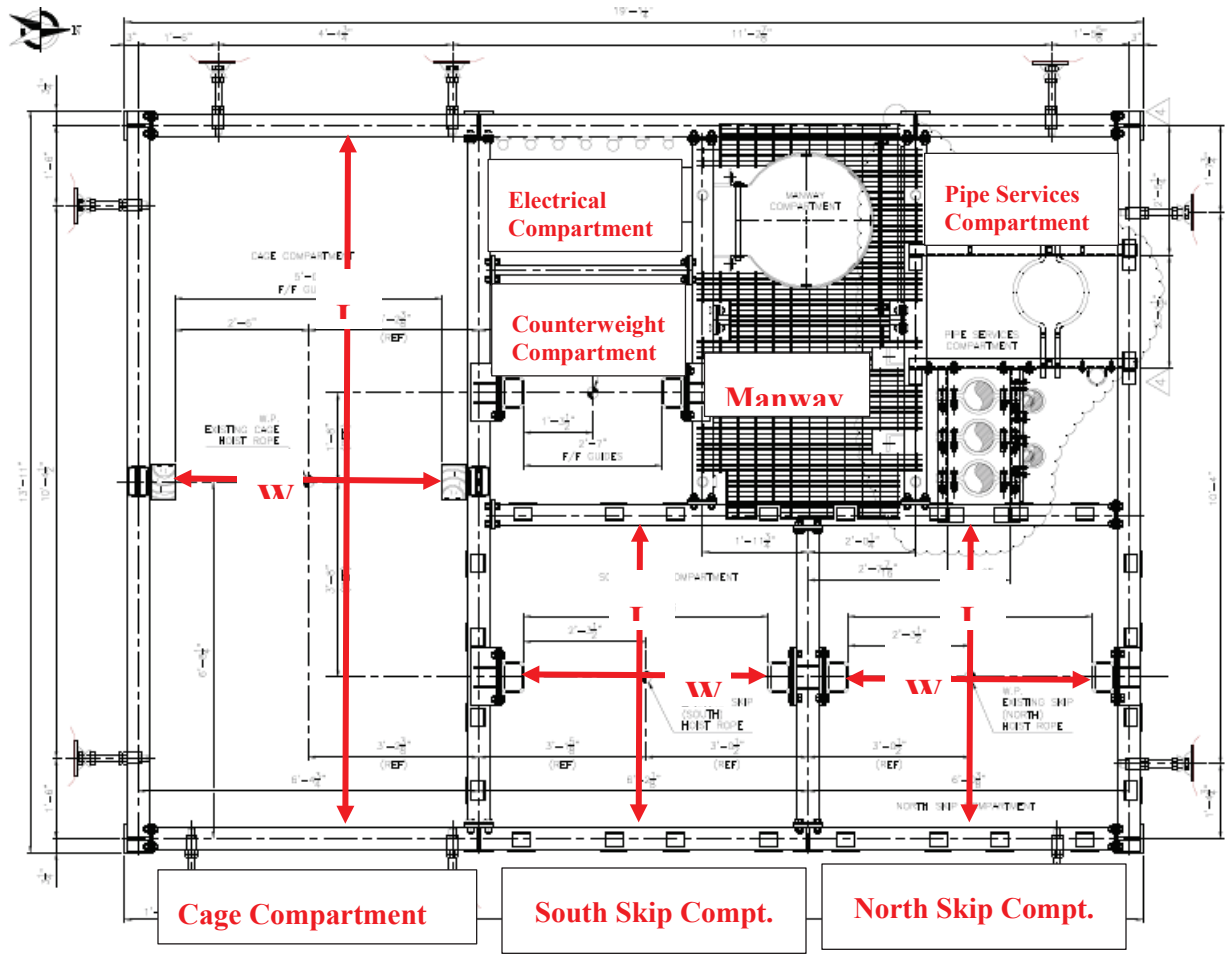


Table 1: Ross Compartment Dimensions

Ross	Length 'L'	Width 'W'
Cage Compartment	12' 10 ½" [3.92m]	5' [1.52m]
South Skip Compt.	5' 7 ¼'' [1.71m]	4' 7" [1.40m]
North Skip Compt.	5' 7 ¼" [1.71m]	4' 7" [1.40m]

2.1. Conveyances

The current conveyances operating in the Ross Shaft during shaft refurbishment consist of a work deck in the Cage and the North Skip compartments and a Skip in the South Skip compartment. Once the shaft is refurbished, a new cage and new skips will be installed. Given that the compartment dimensions and hoist lifting capacities will not change for the operation of the refurbished shaft, it is assumed that skip conveyances will be installed that are of similar overall dimensions and capacity as what was utilized previously. This report will detail a proposed single deck cage as opposed to the historic double deck

cage, however, there will always be restrictions that are related to the available space in the headframe as well as the lifting capacity of the hoists.

The cage conveyance is utilized for the transportation of personnel, materials and equipment to the underground lab. It operates in counterbalance with a series of weights that are attached to a conveyance that travels in the Counterweight compartment. The graphic below shows a design for a cage that was previously in operation at the Ross Shaft. This cage was a double deck cage.

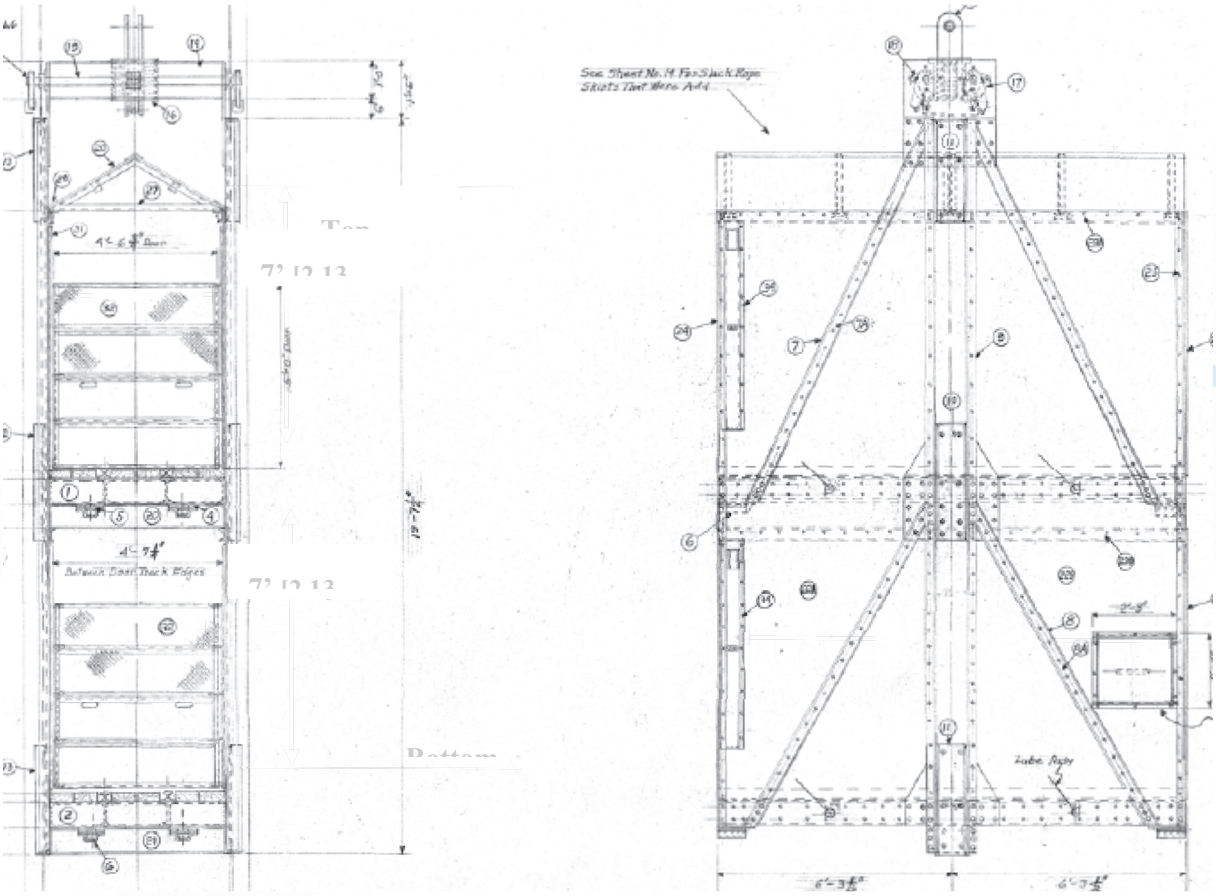
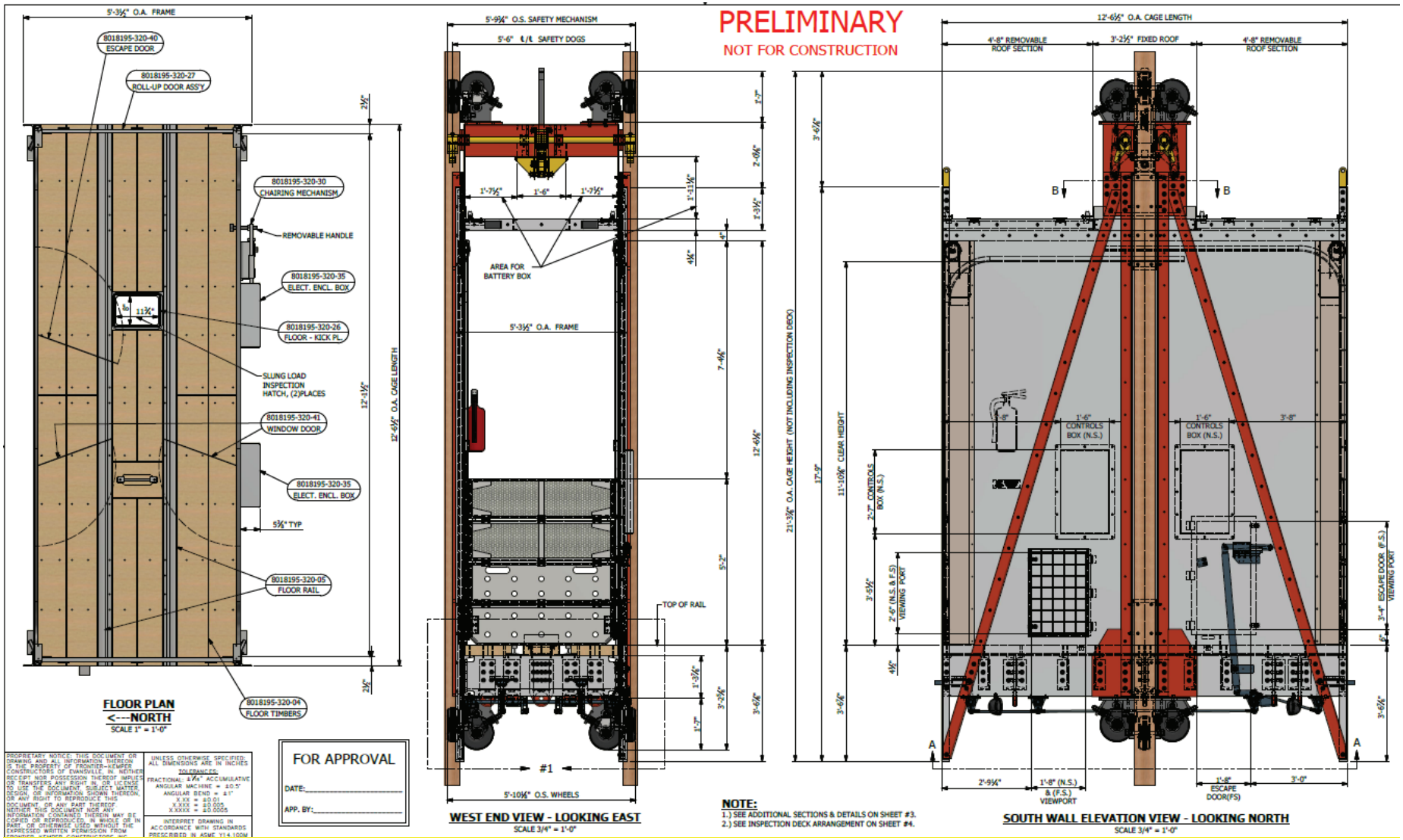


Figure 2: Original Ross Shaft Conveyance Design – Double Deck Cage

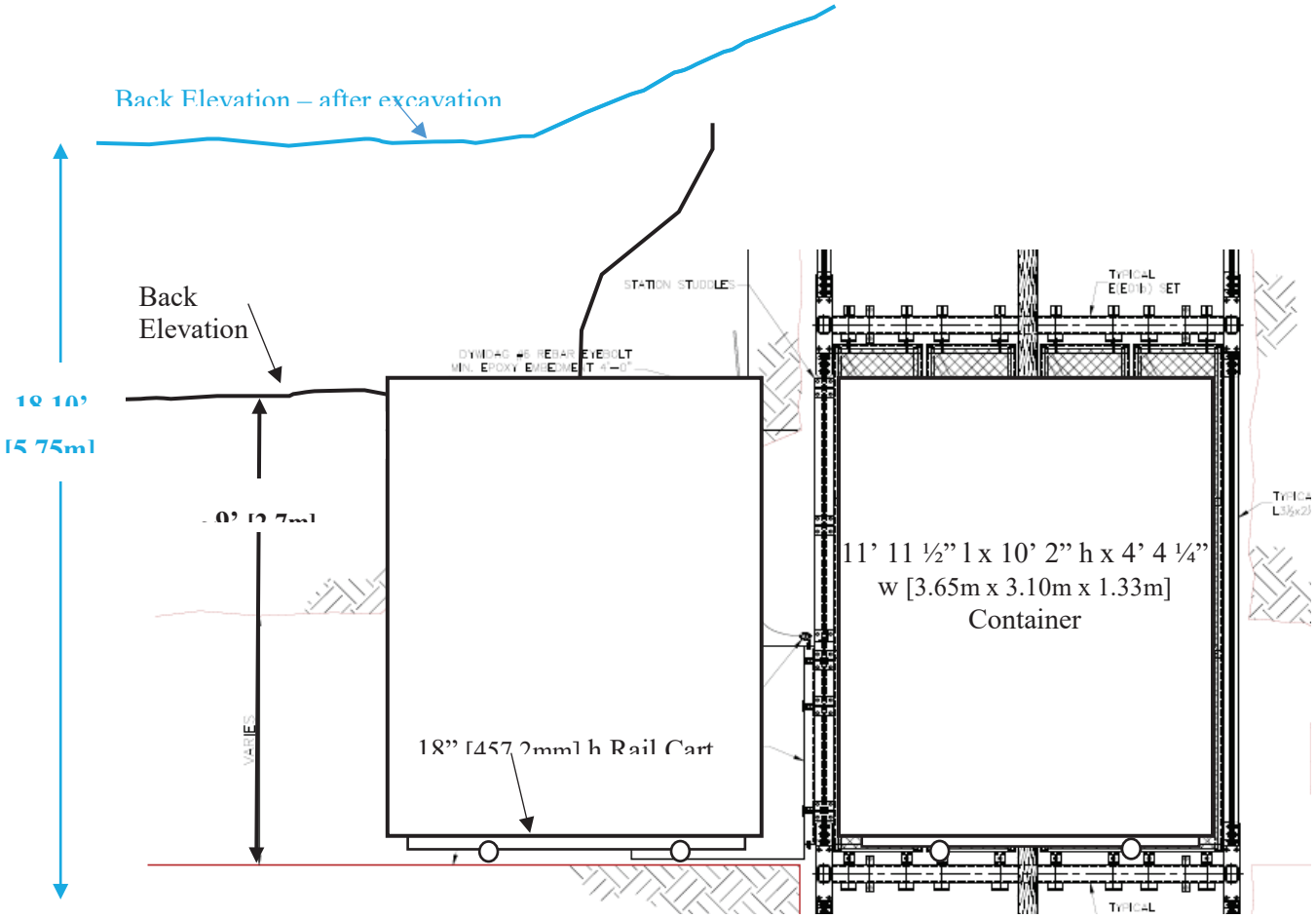
After evaluating all materials and equipment that will need to be transported to the underground, it was determined that a double deck design is no longer a feasible option. The Long Baseline Neutrino Facility (LBNF) equipment dimensions of 4ft 3 ½in x 9ft 2in x 24ft [1.31m x 2.8m x 7.32m] drove this decision. To be able to transport these larger items a Single Deck Cage is required. This proposed design is shown in the graphic below:

Figure 3: Proposed Ross Shaft Single Deck Cage



The operational space made is 4ft 7 1/4in wide x 11ft 10 3/8in high x 12ft 1½in long with a max weight of 10,000 pounds once the new cage is in use. When planning for equipment transport, it is important to include at least 1in [25.40mm] of clearance on all sides above the floor for ease of material handling. In addition, an allowance of 18in [457.20mm] should be included at the bottom of this space for standard rail car on which a container rests that could be rolled in and out of the cage for transportation in the underground drifts. Once on the 4850L, the load would be rolled out of the conveyance on to the station. From that point, it may be necessary to rotate the container to lay horizontally so that it could be more stable while travelling through the access drifts. In this case, it would be important to ensure that the access drifts are excavated wide enough for the container to pass through. This would require a space of 12ft 1½in [3.69m] + clearance of approximately 6in [152.4mm] on both sides = 12ft 7 ½in [3.85m] minimum. The unloading of the conveyance on the 4850L is shown in the graphic below:

Figure 4: 4850L Ross Station Back Elevation



2.2. 4850 Station at the Ross Shaft

The graphic above shows what is possible once the Ross Shaft refurbishment is completed and the brow at the station is excavated to a height of [18ft 10in (6m]. There are several issues that will need to be resolved before detailed plans can be made. They are as follows:

- The final height of the 4850L station and Access drift has not been finalized.

- The container geometry may be unstable at only 4ft 4 ¼in [1.33m] wide x 10ft 2in [3.10m] high, sitting on a rail cart that is riding in an 18in [457.2mm] gauge track.
- There are also different means of loading equipment into the cage that can be utilized if necessary, they are summarized in the table below. The maximum height of a component that can be transported using each option is also listed.

Table 2: Component Haulage Clearance and Component Max Height

Means of moving component into cage	**Required Clearance**		**Max height of component**	
	in	*mm*	*ft*	*mm*
Dragging or use of skid plate	0 - ¼	0 - 6.35	11’ 7 ¾”	3543
Air Bearing	1 ½	38.1	11’ 6 ½”	3511
Lowboy or Rail Cart	8	203.2	11’	3346
Standard Car	18	457.2	10’ 2”	3092

2.3. Slung Loads

In some cases, where loads do not fit in a conveyance, loads are conveyed to the underground by suspending them under a conveyance. These are called Slung Loads. In determining whether a load can be slung under a conveyance, there are several things to consider. They are:

1. The load needs to fit within the space available in the compartment with at least 2in [50.8mm] clearance on all sides Refer to Figure 3.
2. There needs to be enough space under the conveyance when the cage is at its highest location in the headframe for the load to be pulled into the compartment from the shaft collar.
3. There needs to be enough space at the unloading location (underground station) for the load to be pulled out of the compartment and on to the level. Note a winch/tugger are positioned at some shaft stations and can be used to help remove the slung load from the shaft, but should be verified for load capacity and presence at the station where it is needed.
4. Typical travel speeds for slung loads are limited to 150 feet per minute [0.762 m/s]. This can be somewhat controlled in special situations by installing guide shoes on the load. However, this process adds considerable time to the conveying process.
5. The load cannot exceed 10,000 lbs.

An analysis has been performed for Slung loads in the Ross shaft Cage Compartment based on the utilization of a new single deck Cage conveyance as shown in the previous graphics. The result of this analysis is shown in the Figure 5 below:

Ross Shaft Clearance Standard Sling (based on proposed single deck design dimensions)

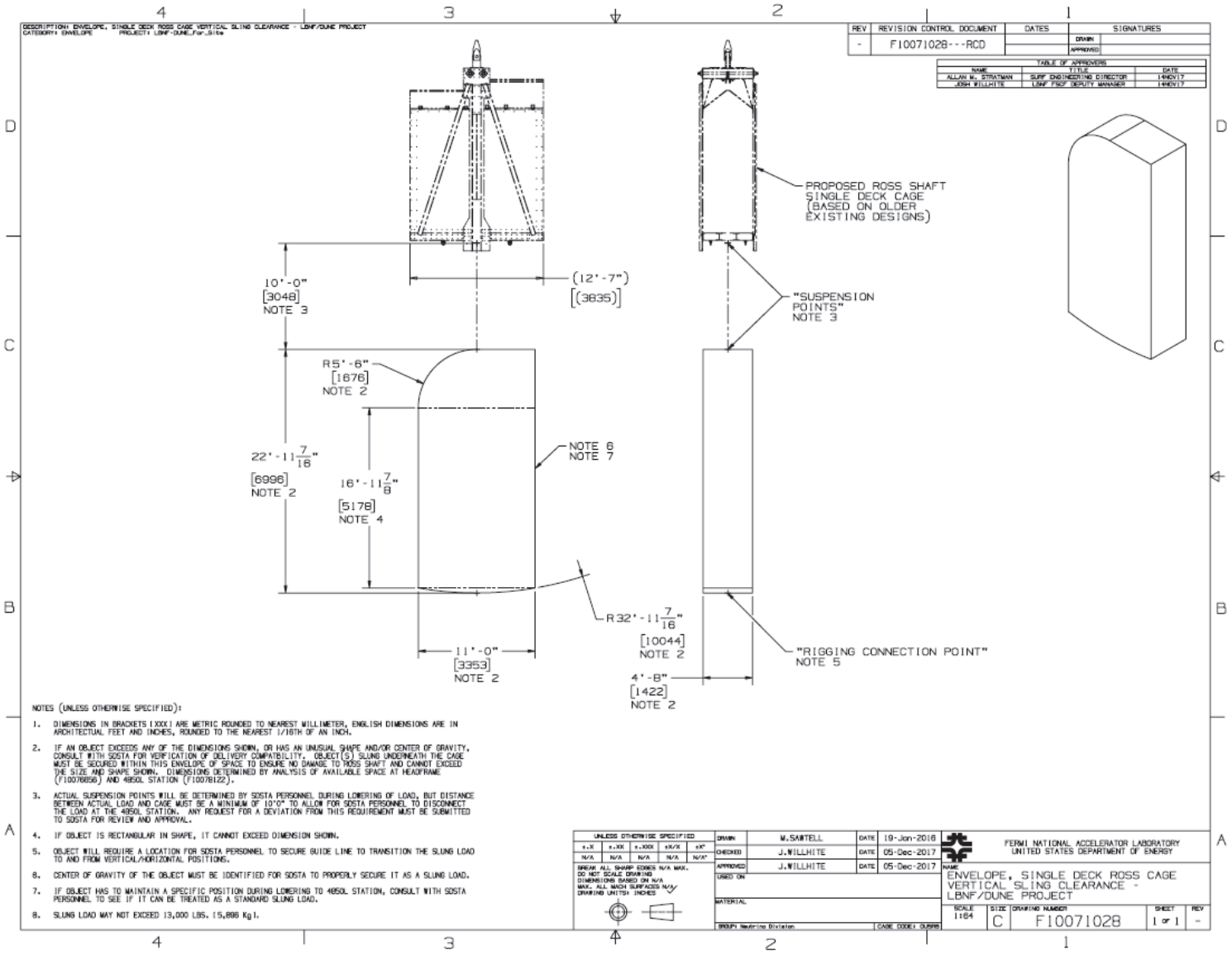


Figure 5: Ross Cage Sling Clearance Dimensions

The envelope above shows the following:

1. The longest load that can be slung under the Cage conveyance is 22ft 11 7/16in [6.99m]. At this height of load, the maximum length is 11ft [3.35m]. This is using an 18in standard car.
2. All loads must not exceed 4ft 8in [1.42m] in width. (For slung loads, 2in [50.8mm] clearance is required on all sides.)

The main restriction for slung load dimensions in the Ross Shaft is the available space between the bottom of the Cage conveyance and the collar of the shaft with the Cage at the maximum height in the Head frame. This space is 33ft [10.06m]. The only height restriction at the 4850L is the space between the shaft sets which is 17ft 5in [5.31m].

2.4. Hoisting Parameters

The following table outlines the Hoist Operating parameters that are expected following the completion of the shaft refurbishment. These parameters assume a new single deck cage design.

Table 3: Ross Hoisting Parameters

Specifications		Ross Shaft (Imperial)			Ross Shaft (metric units)	
		Service Hoist	Production Hoist		Service Hoist	Production Hoist
		Conical DD	Conical DD		Conical DD	Conical DD
Payload	Mass (lbs)	13,000	22,000	Mass (kgs)	5,897	9,979
	Personnel	60	N/A		60	N/A
Rope mass	Mass (lbs)	21,785	31,415	Mass (kgs)	9,882	14,250
Conveyance mass	Mass (lbs)	8,200	15,000	Mass (kgs)	3,720	6,804
Number of ropes		1	1		1	1
Rope size	inch dia.	1.625	1.875	mm dia.	41.275	47.625
Rope strength	lbs	258,000	348,000	kgs	117,029	157,853
Cage inside dimensions	No. of Decks	1	N/A		1	N/A
	No. of Cages	1	N/A		1	N/A
	height (ft)	11' 10 3/8"	N/A	height (m)	3.62	N/A
	width (ft)	4'-7 1/4""	N/A	width (m)	1.40	N/A
	Length (ft)	12'-1½"	N/A	Length (m)	3.70	N/A
Slinging Dimensions Under Cage	height (ft)	See Chart on	N/A	height (m)	See Chart on	N/A
	width (ft)	Slung Load	N/A	width (m)	Slung Load	N/A
	Length (ft)	Work Sheet	N/A	Length (m)	Work Sheet	N/A
Guides		wood	wood		wood	steel
Shaft	Length (ft)	5,129	5,129	Length (m)	1,563	1,563
	From	surface	surface		surface	surface
	To	5000L	5000L		5000L	5000L
Typical Set spacing	ft	18	18	m	5.49	5.49
Hoisting speed	ft/min	1300-2500	1300-2500	m/sec	6.60-12.70	6.60-12.70
Hoist Power Rated	HP	1,500	2,400	KW	1,119	1,790
Motor Speed	rpm	340	375	rpm	340	375
Skip cycle time (one-way)	mins	N/A	3.60	mins	N/A	3.60
Cage travel time (one-way)	mins	3.50	N/A	mins	3.50	N/A
Cage load/unload time	mins	5.00	N/A	mins	5.00	N/A
Cage total time (one-way)	mins	8.50	N/A	mins	8.50	N/A
Cage total time (return)	mins	17.00	N/A	mins	17.00	N/A
Slinging capacity at 150fpm	tons	6.5		Tonnes	5.90	
Slung Load travel time (one-way)	mins	33.00	N/A	mins	33.00	N/A
Slung Load load/unload time	mins	15.00	N/A	mins	15.00	N/A
Slung Load total time (one-way)	mins	48.00	N/A	mins	48.00	N/A
Slung Load total time (return)	mins	66.50	N/A	mins	66.50	N/A
Availibility (after all planned maintenance)	hours/day	20	20	hours/day	20	20
Production capacity	tons/day	N/A	3,000	Tonnes/day	N/A	2,722

Scheduled and Non-Scheduled Ross Shaft Downtime

The Ross Shaft requires several routine maintenance tasks to ensure reliable operation as follows:

- Daily checks include a visual inspection of the shaft 30 minutes at the beginning of each shift (6:00-6:30 AM and PM) to inspect shaft structure. An additional 30 minutes per shift is spent doing an unmanned operational test of the conveyances by cycling the cage through the shaft top to bottom, checking the dogging system, and the slack rope limits are working properly.
- Weekly sheave deck inspection.
- Once per week, a more thorough 6-hour shaft inspection is performed, and it is expected that another 12 hours would be spent on an average week to address issues found. There is also a more thorough weekly inspection of the conveyance that typically lasts for 3 hours.
- Every month, two full 12-hour shifts are spent performing thorough inspections of the hoists and adjustments of all control limits.
- Once per quarter, the ore (skip) hoist drums are cleaned and inspected in a 4-hour period to monitor existing cracks in the drum.
- Every 6 months, all ropes are inspected ultrasonically. This takes a full 12 hour shift for all four ropes.
- Once per year, the hoists are given a full inspection, including using ultrasonic testing for cracks in shafts, inspecting electronics, etc. This takes one full 12-hour shift. Another 12-hour shift is spent once per year performing acceleration testing of the conveyance travel through the shaft.

Depending on the results of the accelerometer tests, there may need to be adjustments made to the shaft alignment. This work could take as much as 5 days. In addition to the planned maintenance activities described above, the shaft has historically experienced 4 days of down time for large storm events and several other days for unplanned maintenance. Several improvements have been completed to reduce the likelihood of these events, but it must be recognized that future interruptions may be experienced, and therefore anyone working on the site should have a plan for managing activities when shaft access is not available.

This information is summarized in the following table.

Ross Shaft Hoists Conveyance Scheduled & Non-Scheduled Downtime					
	Daily	**Weekly**	**Monthly**	**Yearly**	**Annualized**
Total Daily Checks (hrs.)					
Daily Hoist checks - visual	1				365
Daily Conv checks - visual					
Daily Conveyance Checks - operational	1				365
Total Weekly Checks (hrs.)					
Weekly Shaft Inspection, cage/skip		6			312
Weekly Shaft Maintenance cage/skip		12			624
Weekly Conv checks - hands on		3			156
Weekly Hoist checks - hands on					
Total Monthly Checks (hrs.)					
Monthly Hoist checks, set limits			12		144
Total Yearly Checks (hrs.)					
Yearly Hoist NDT				12	12
Rope NDT for cage and skips				24	24
Accelerometer Testing				12	12
Ore Hoist Drum Crack Inspection				16	16
Total Daily, Weekly & Yearly Checks	**2**	**21**	**12**	**64**	**2030**

23.20%	Percent of total unavailable hours per year
18.44	Average Availability Hours/day

Table 4: Ross Hoist Scheduled and Non-Scheduled Downtime

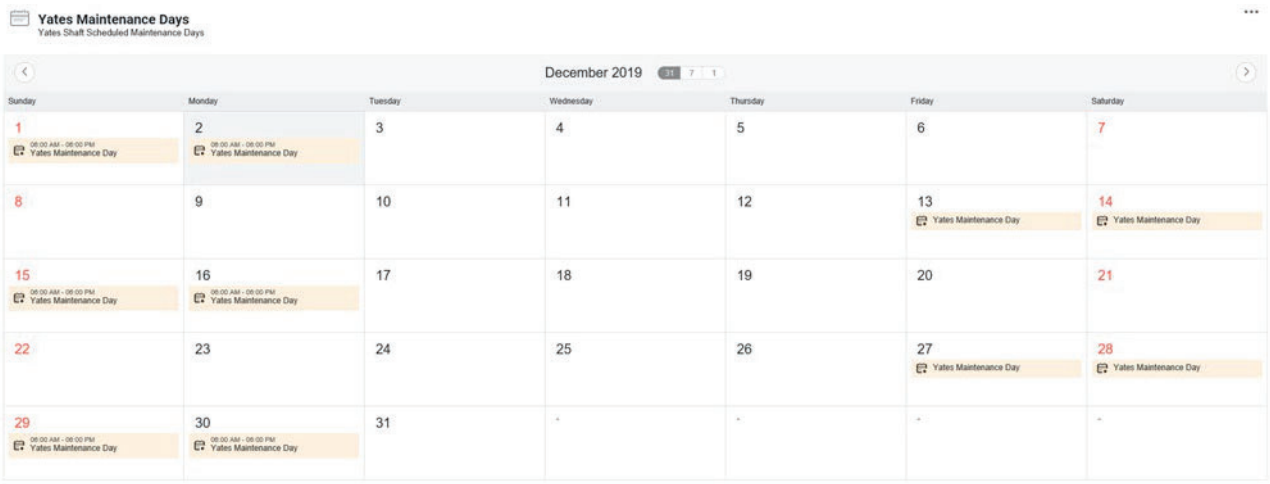
The above numbers show that the Ross Shaft is down for 2030 hours in a year, or 23.20%. Therefore, on average the Ross Shaft is available for transporting equipment and personnel 18.44 hours per day.

3. Yates Shaft

The Yates Shaft is a timber furnished Shaft constructed in the late 1930s after the completion of the Ross Shaft. It is currently being utilized as the primary access and egress for SURF. This shaft is similar to the Ross Shaft in layout with the exception that there are two cage compartments with two cages that operate in counterbalance with each other. The skips and skipping compartments are similar in dimension and capacity to the Ross Shaft, however, the skips are currently being utilized for shaft maintenance and are not planned to be utilized for muck haul in future lab development.

Although the Yates Shaft is currently the primary access and egress for the lab, the shaft requires heavy maintenance and is only available for 11 hours. per day, 4 days per week. The rest of the time, the shaft is restricted to shaft maintenance personnel access only. Currently, the maintenance in the shaft is on a four-day weekend rotation, every other week, such as the example below where they are marked on the calendar below.

Figure 6: Yates Shaft Maintenance Schedule Example



Upon the completion of the refurbishment of the Ross Shaft, the Ross shaft will become the primary access and egress for construction-related activities. The Yates Shaft will also be available to support existing Science experiments, new experiment outfitting and equipment installation to the extent of time that is available after supporting existing experiments. The available shaft time is not expected to change from the current schedule since the shaft will require continued heavy maintenance until such time as the shaft can be completely refurbished. In this scenario, the shaft would be available only for emergency egress.

The following is a typical plan view of the Yates Shaft.

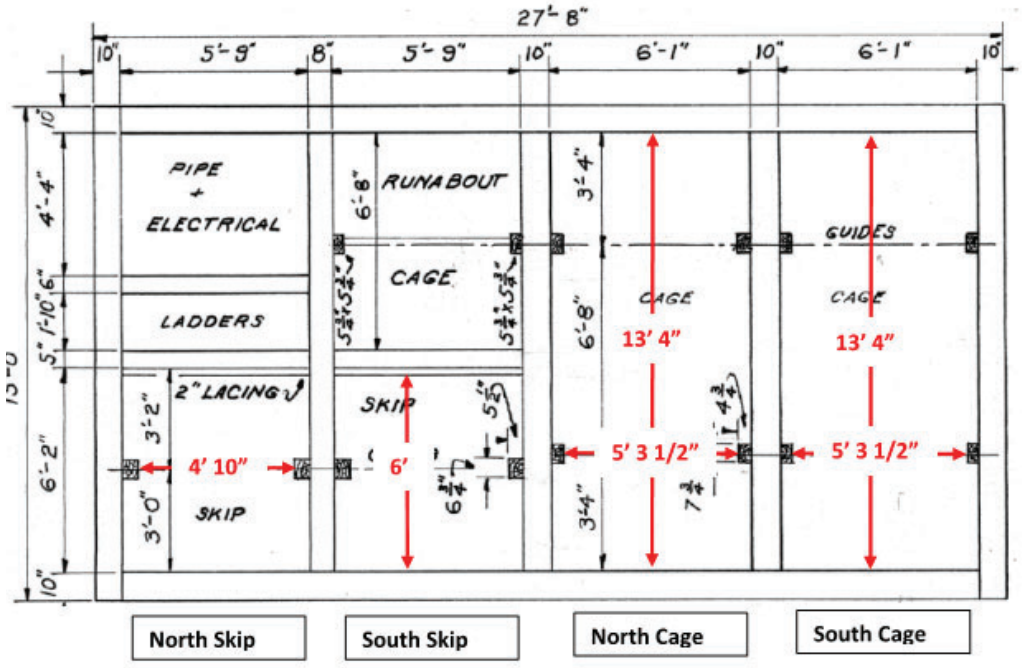


Figure 7: Yates Shaft Plan View Typical Set

3.1. Cage Conveyances

The current operating conveyances in the Yates Shaft consist of a cage which operates in the South Cage compartment, a Cage work deck which operates in the North Cage Compartment, a South Skip and North Skip work deck which operate in the skip compartments. All personnel, material and equipment are currently being serviced through the South Cage. The North Cage work deck is also used for some material and equipment conveyance but is not available for routine manpower conveyance.

The following graphics provide dimensions for the South Cage Conveyance:

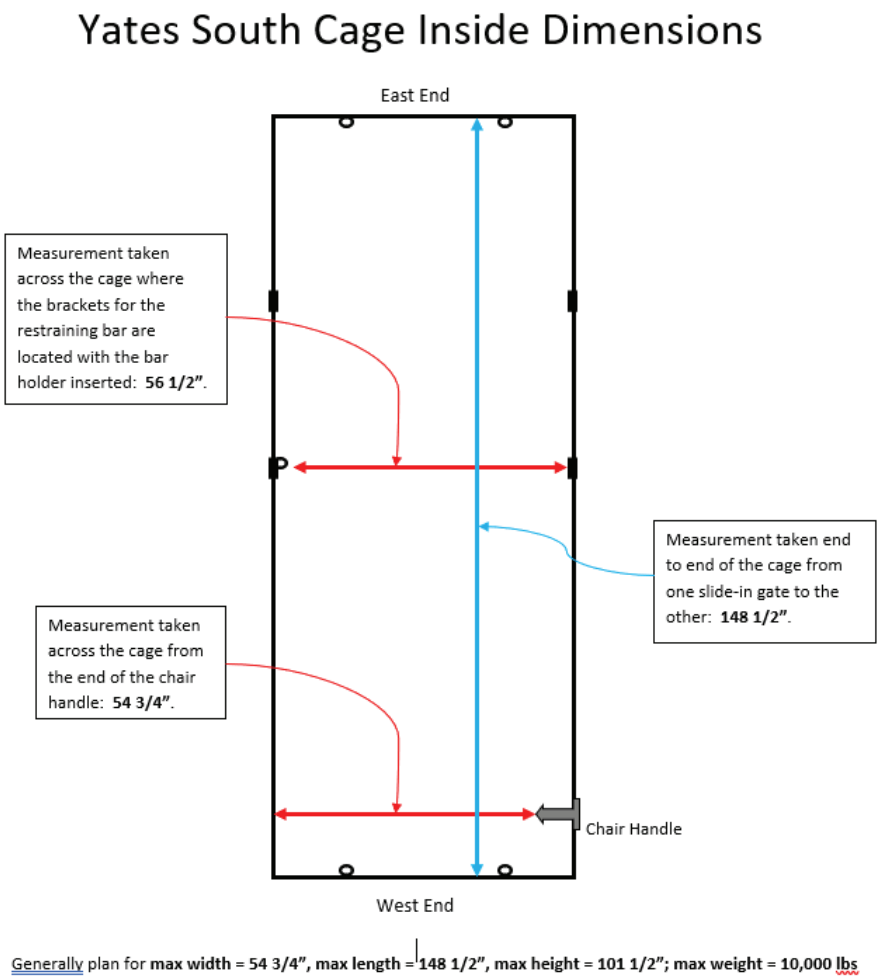


Figure 8: Yates South Cage Inside Dimensions

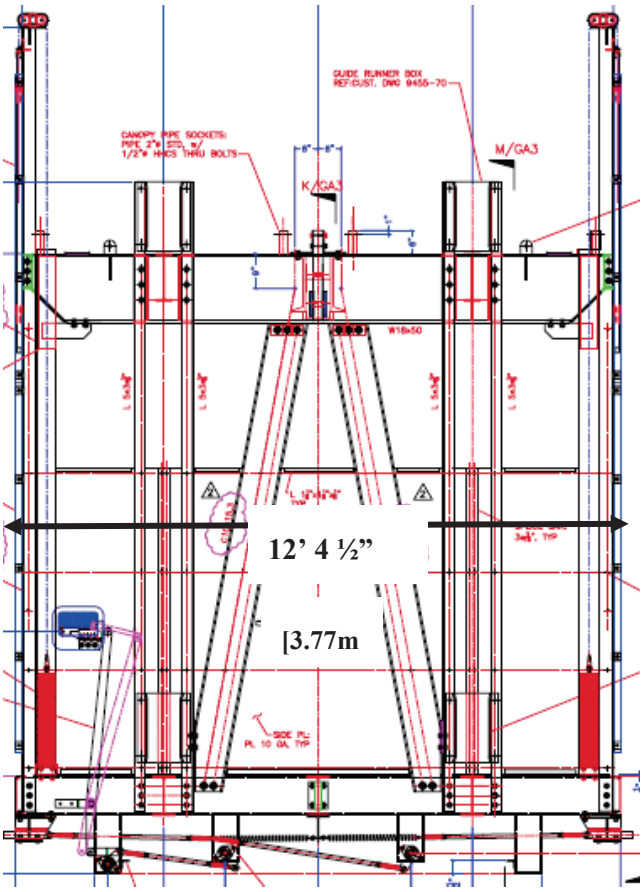


Figure 9: Yates South Cage Side View

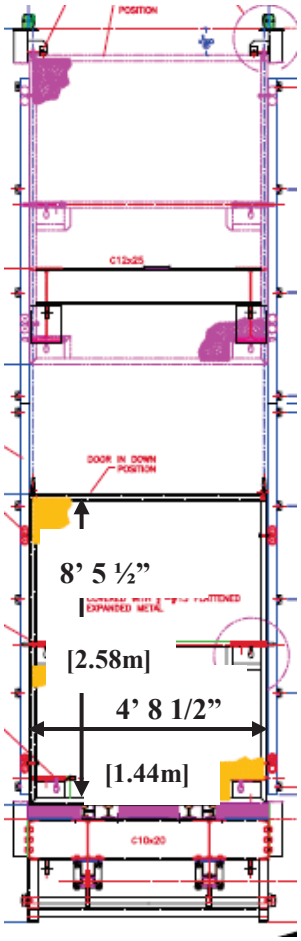


Figure 10: Yates South Cage Front View

The current cage that is in operation could be replaced by a new cage that could provide additional height space. Further engineering and analysis is required before revised space dimensions and capabilities are published.

The following are graphics for the North Cage Work Deck. Dimensions are shown for the bottom deck only as it is this deck that is used for equipment and materials conveyance.

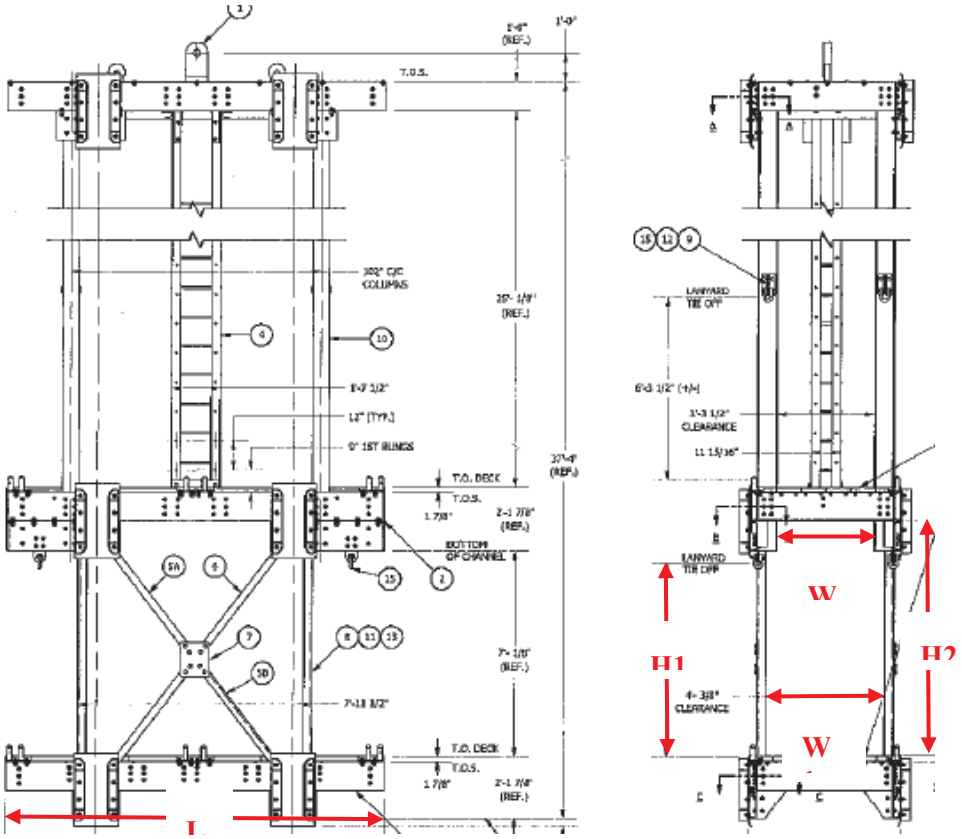


Figure 11: Yates Shaft North Work Deck

	Arrangement 1	**Arrangement 2**
Length (L)	12’ 10” [3.91m]	12’ 10” [3.91m]
Height (H)	7’ 0 1/8” [2.14m]	7’ 11 7/8” [2.44m]
Width (W)*	4’ 0 3/8” [1.23m]	3’ 3 ½” [1.00m]

* For loads inside the cage, 1” [25.4mm] clearance is required on all sides.

Table 5: North Work Deck Bottom Deck Dimensions

3.2. Slung Loads

In the Yates Shaft, there is opportunity to sling loads under the South Cage. An analysis has been performed on slung load limitations. The slung load is attached to the center of the bottom of the conveyance for stability purposes as shown in the schematic below:

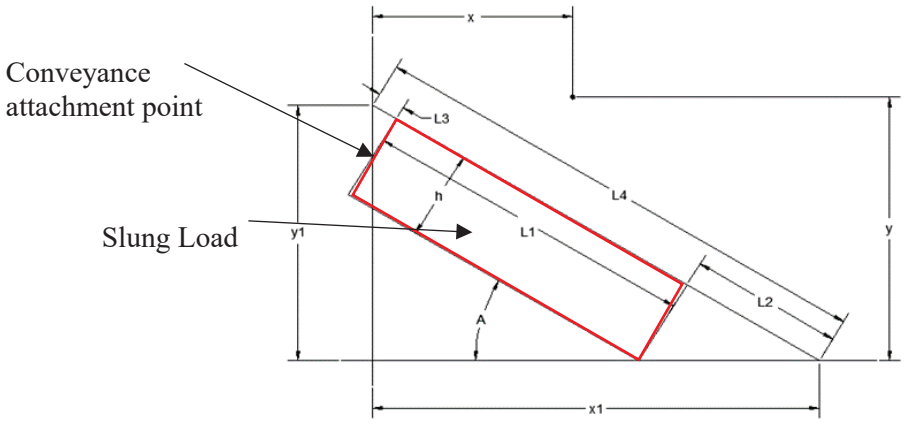


Figure 12: Slung Load Parameters

Factors that are considered in determining slung load parameters include the following:

1. The load needs to fit within the space available in the compartment with at 1in [25.4mm] clearance on all sides refer to Table 5.
2. There needs to be enough space under the conveyance when the cage is at its highest location in the head frame for the load to be pulled into the compartment from the shaft collar.
3. There needs to be enough space at the unloading location (underground station) for the load to be pulled out of the compartment and on to the level.
4. When lowering a slung load, the travel speed needs to be greatly reduced to ensure that the load does not swing into shaft infrastructure. This can be somewhat controlled in special situations by installing guide shoes on the load. However, this process adds considerable time to the conveying process. Typical travel speeds for slung loads are limited to about 150 feet per minute [0.762 m/s].
5. For the South Cage, the maximum weight of the slung load is 10,000 lbs [4,536kg].

In the Yates Shaft, the space limitation occurs at the 4850L rather than at the headframe.

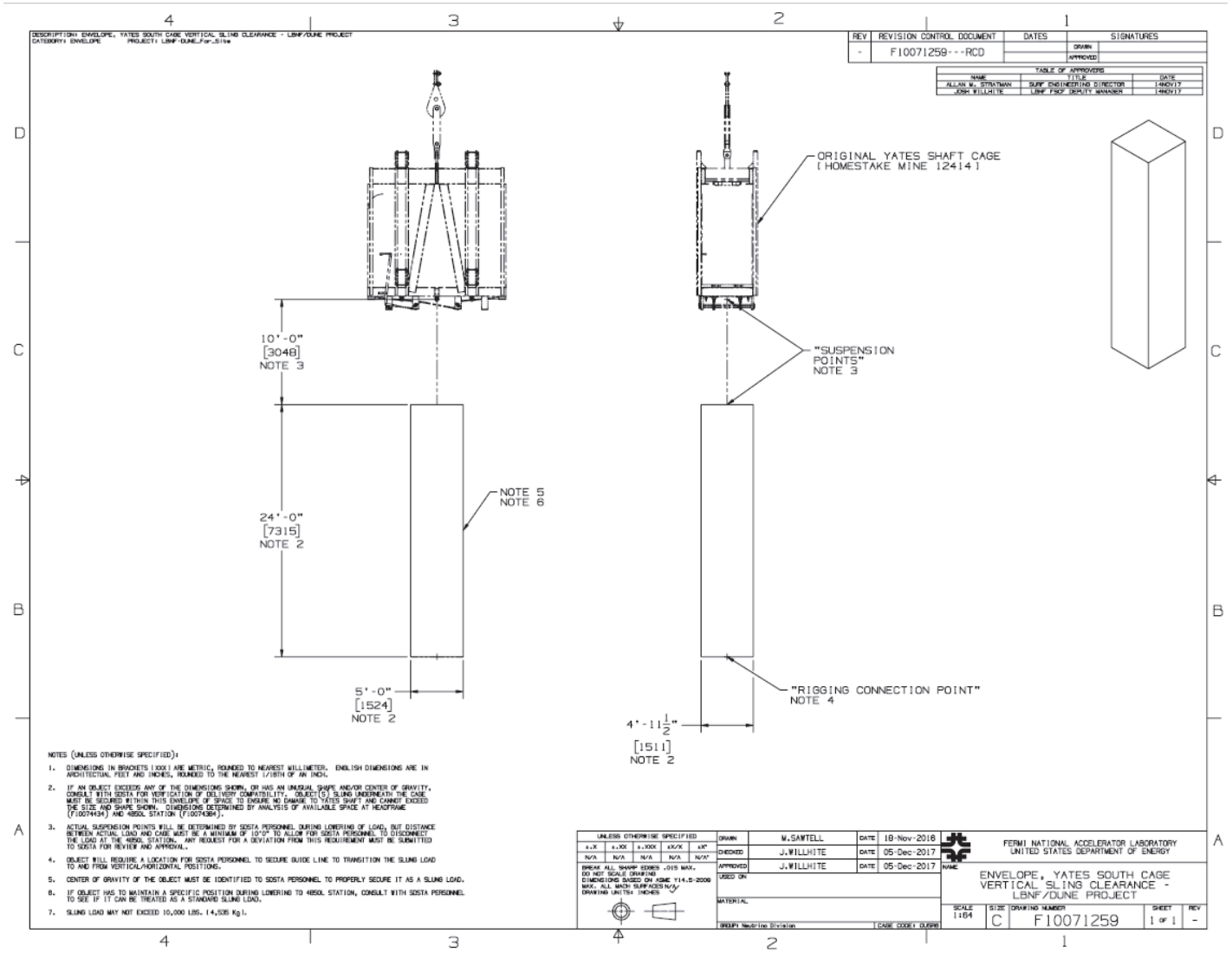


Figure 13: Yates South Cage Compartment Shaft Clearance Standard Sling

3.3. 4850L Station at the Yates Shaft

It is important to analyze components traveling to the 4850L as well as components travelling through the 4850L where different obstacles arise. The layout below shows details of the 4850L near the Yates Shaft station that are referenced in subsequent photos:

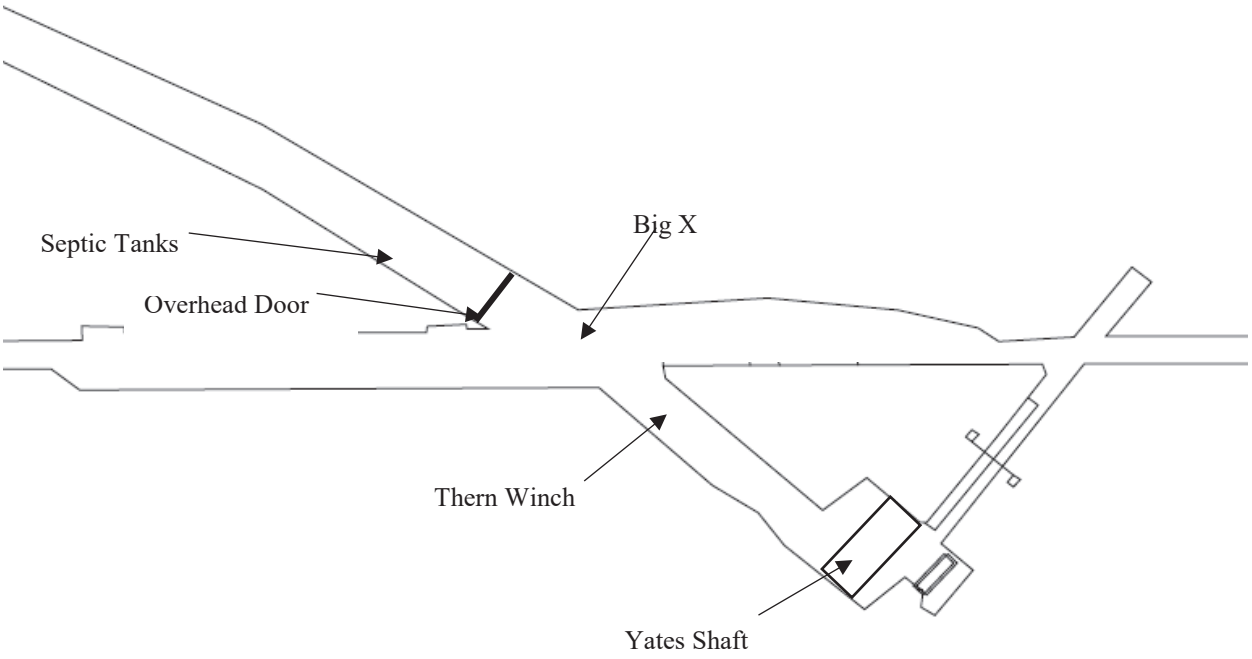


Figure 14: Plan View at 4850L Yates Shaft Station

The lowest clearance occurs at the Big X intersection where there is a utility hanger that supports ductwork for the Davis Campus. The clearance at this location is 7ft 10in or 94in [2.39m]. Given that an object is expected to be loaded on a rail flat car that is 18in [457.2mm] high, the maximum height of any load going under the duct hanger is 94 – 18 = 76in or 6ft 4in [2387.60mm – 457.20mm = 1930.40mm or 1.93m]. The picture below shows the infrastructure and its dimension restrictions:

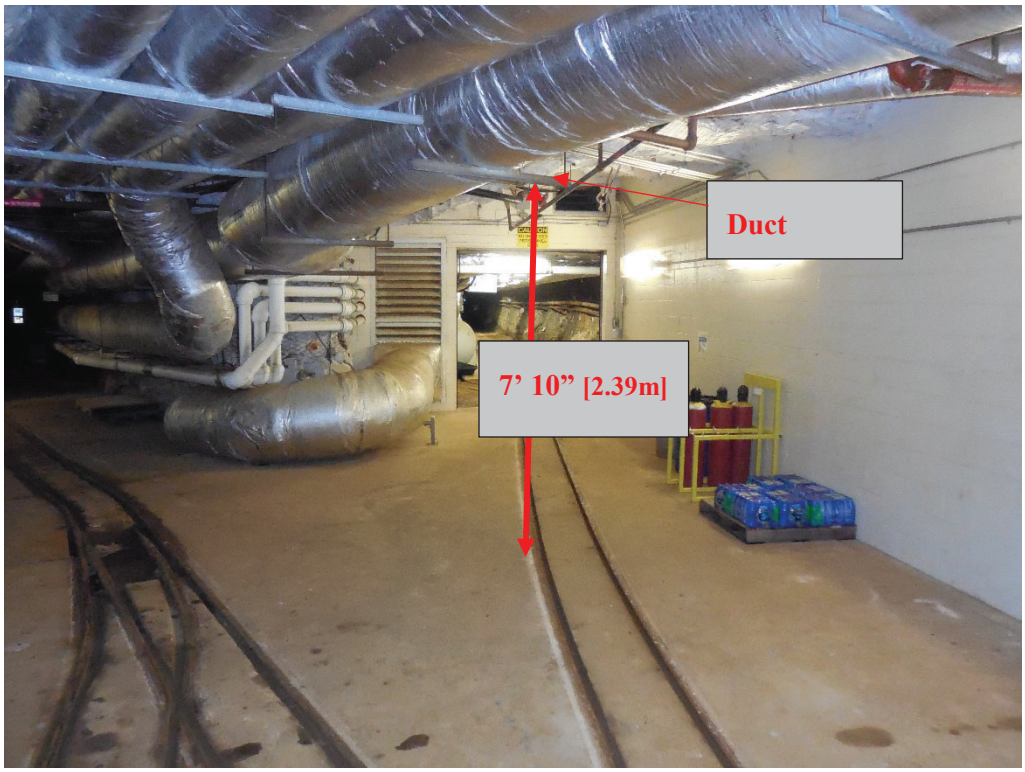


Figure 15: Lowest Clearance at the Yates Shaft Station

The paragraph on page 25 shows the clearances for this area on different transport methods. These are loads that will only fit under the duct hanger if the load is rotated 90° after being pulled out of the shaft and rested on the floor horizontally. This could be performed using the existing winch, which is shown in the photo below:

Figure 16: Thern Winch Installed in the back at the Yates Shaft Station

The Thern winch that is shown in the photo above is used to pull slung loads out of the Yates Shaft. It has a capacity that varies between 1,900 lbs. [862kg] and 4,000 lbs. [1,814kg], depending on the layer of wrap on the drum. This winch could be used for lifting a slung load to be rotated. Additional rigging would be required to rotate the load. The photo below shows the location of this winch relative to the shaft station:

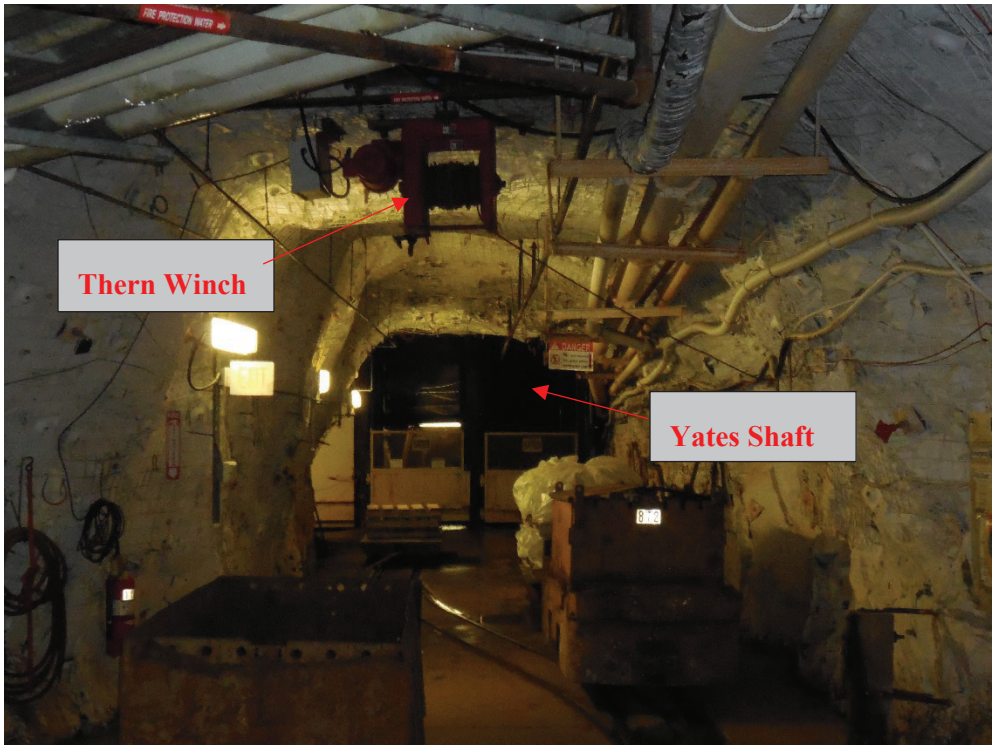


Figure 17: Thern Winch looking to the Yates Shaft

Additional load obstructions exist in the West Access just past the Overhead Door. This obstruction is created by a jog in the track that will cause a load to rotate while passing through an overhead door.

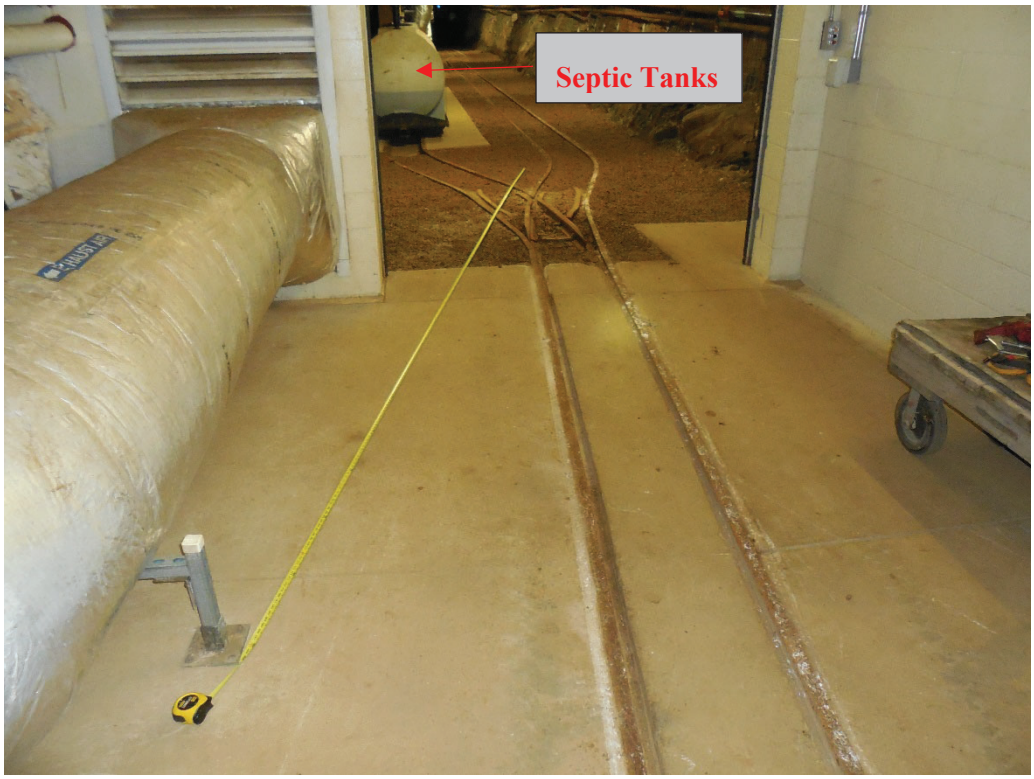


Figure 18: Jog in Rail at the Septic Tank

As is shown in the photo above, the rail takes a jog to the left to get around a septic tank system and Dehumidifier. The tape measure that is shown is extended 25ft [7.62m]. The jog in the track will cause the back end of a long load to swing to the left, possibly striking the Dehumidifier exhaust duct. This obstruction could possibly be mitigated through re-design of the duct or by designing a rail flat car with a rotating top or by relocating the septic tanks and re-aligning the track. It is assumed that any one of these possible solutions could be implemented such that this will not be a restriction for the longer loads that fit through the Yates Shaft.

3.4. Hoisting Parameters

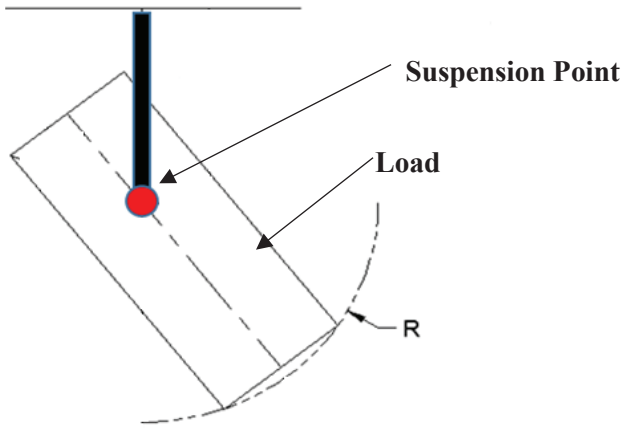
Table 6: Hoist Operating Parameters for the Yates Shaft.

Specifications		Yates Shaft			Yates Shaft	
		South Cage	North Work Deck		South Cage	North Work Deck
		Conical DD	Conical DD		Conical DD	Conical DD
Payload	Mass (lbs)	10,600	3,000 lbs top deck 4,000 lbs bottom deck	Mass (kgs)	4,808	1,119 kgs top deck 1,493 kgs bottom deck
	Personnel	30	16		30	16
Rope mass	Mass (lbs)	32,441	32,441	Mass (kgs)	14,715	14,715
Conveyance mass	Mass (lbs)	12,800	14,300	Mass (kgs)	5,806	6,486
Number of ropes		1	1		1	1
Rope size	inch dia.	1.875	1.875	mm dia.	47.625	47.625
Rope strength	lbs	338,000	338,000	kgs	153,317	153,317
Cage inside dimensions	No. of Decks	1	2		1	2
	No. of Cages	1	1		1	1
	height (ft)	8' 5 1/2"	Varies per deck See Drawing	height (m)	2.58	Varies per deck See Drawing
	width (ft)	4'-8 1/2"		width (m)	1.43	
	Length (ft)	12'-4 1/2"		Length (m)	3.77	
Slinging Dimensions Under Cage	height (ft)	See Chart on Slung Load Work Sheet	See Chart on Slung Load Work Sheet	height (m)	See Chart on Slung Load Work Sheet	See Chart on Slung Load Work Sheet
	width (ft)			width (m)		
	Length (ft)			Length (m)		
Guides		wood	wood		wood	wood
Shaft	Length (ft)	4,934	4,934	Length (m)	1,504	1,504
	From	surface	surface		surface	surface
	To	4850L	4850L		4850L	4850L
Typical Set spacing	ft	6	6	m	1.83	1.83
Hoisting speed	ft/min	500-800	500-800	m/sec	2.54-4.06	2.54-4.06
Hoist Power Rated	HP	2,500	2,500	KW	1,865	1,865
Motor Speed	rpm	360	360	rpm	360	360
Skip cycle time (one-way)	mins	N/A	N/A	mins	N/A	N/A
Cage travel time (one-way)	mins	10.00	10.00	mins	10.00	10.00
Cage load/unload time	mins	5.00	5.00	mins	5.00	5.00
Cage total time (one-way)	mins	15.00	15.00	mins	15.00	15.00
Cage total time (return)	mins	30.00	30.00	mins	30.00	30.00
Slinging capacity at 150fpm	tons	5	2	Tonnes	4.54	1.81
Slung Load travel time (one-way)	mins	33.00	33.00	mins	33.00	33.00
Slung Load load/unload time	mins	15.00	15.00	mins	15.00	15.00
Slung Load total time (one-way)	mins	48.00	48.00	mins	48.00	48.00
Slung Load total time (return)	mins	73.00	73.00	mins	73.00	73.00
Availibility (after all planned maintenance)	hours/day	11hrs/dy - 4 dys/wk	11hrs/dy - 4 dys/wk	hours/day	11hrs/dy - 4 dys/wk	11hrs/dy - 4 dys/wk
Production capacity	tons/day	N/A	N/A	Tonnes/day	N/A	N/A

4. Additional Potential Conveying Scenarios

Further analysis and engineering may result in expanded load dimension opportunities for both the Ross and Yates Shafts conveyances. The following areas can be further investigated:

1. Utilization of space between shaft dividers rather than guides for special loads. This may be possible for circular loads that could be located between guides in the Yates Shaft, increasing the maximum width up to 4in [101.6mm]. This specific load case was used for LUX-ZEPLIN (LZ).
2. Design of pivotal slings for loads suspended below the cages. These slings could be designed to attach to the side of the loads rather than the top of the load which would enable the top of the load to rotate out towards the back of the shaft, rather than at the center. The graphic below shows this:



Contact the SDSTA Engineering Department to pursue any of these scenarios.

Ross North & South Skip Compartment Loads

The North and South skip compartments at the Ross Shaft will be used for long, narrow components that cannot utilize a standard or special sling. If it is desired to use the skip compartments, the SDSTA should be consulted due to the complexity involved with loading components into the shaft.

5. Conveyance Restrictions at the 4850L

In addition to shaft and shaft station restrictions previously discussed in this document, restrictions exist along the various horizontal travel ways located on the 4850L. The map below shows locations of various doors that need to be considered when planning the horizontal transportation of materials and equipment:

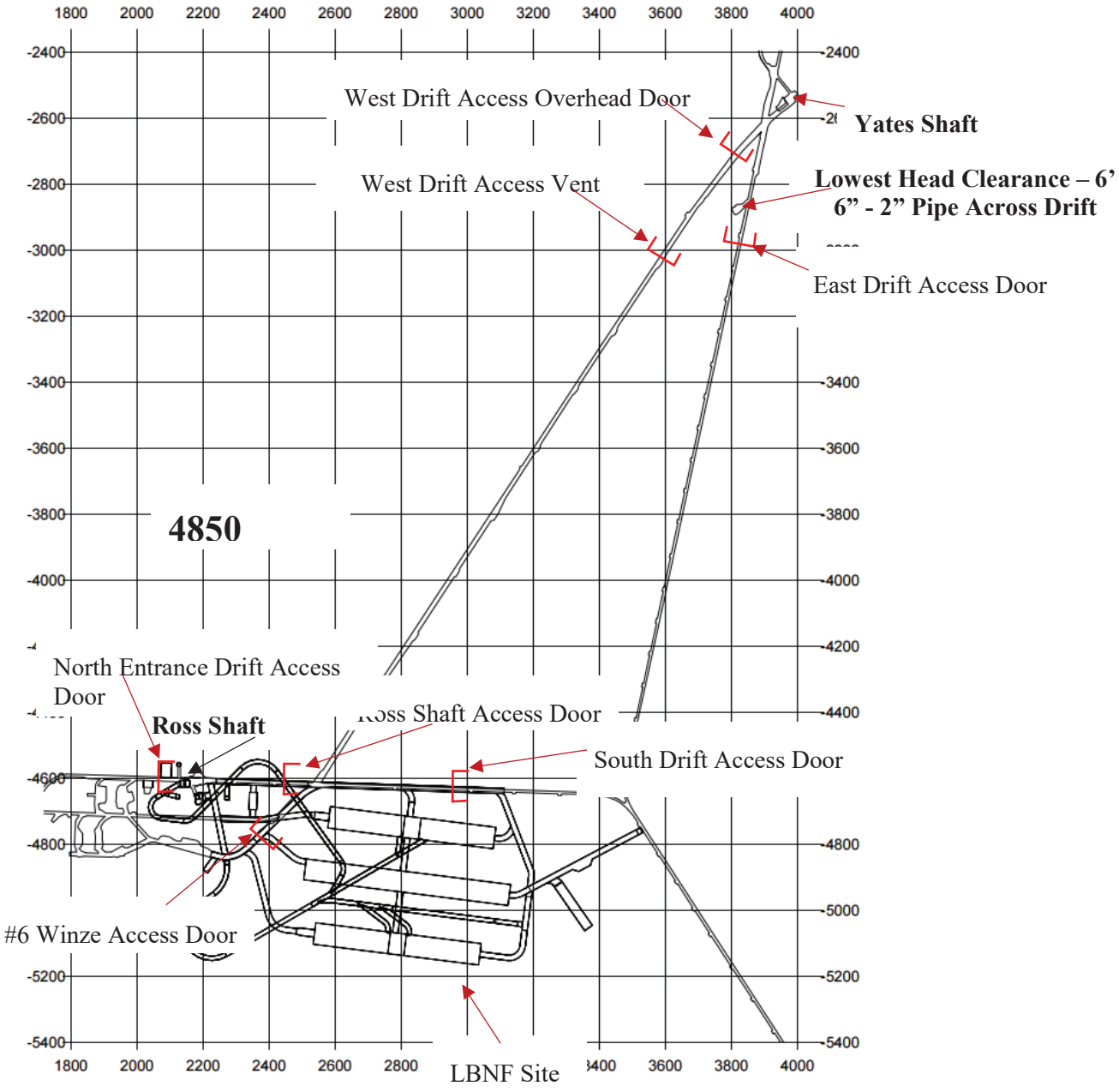


Figure 19: Map View of Conveyance Restrictions on the 4850L

5.1. West Drift Access Overhead Door

Figure 20: West Drift Overhead Access Door

5.2. East Drift Access Door

Figure 21: East Drift Access Door

5.3. South Drift Access Door

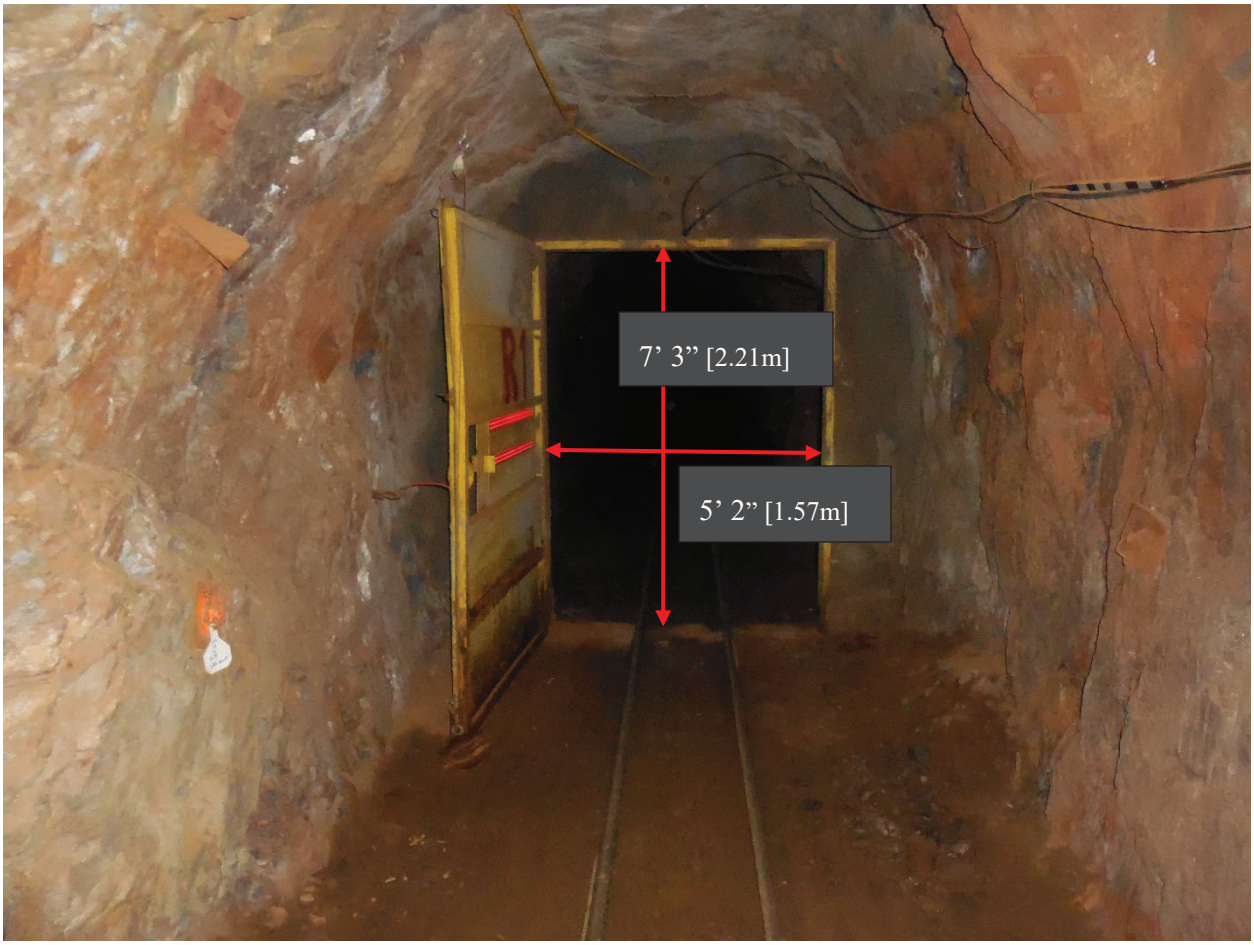


Figure 22: South Drift Access Door

5.4. Ross Shaft Access Door

Figure 23: Ross Shaft Access Door

5.5. #6 Winze Access Door

Figure 24: #6 Winze Access Door

5.6. West Drift Access Vent Door

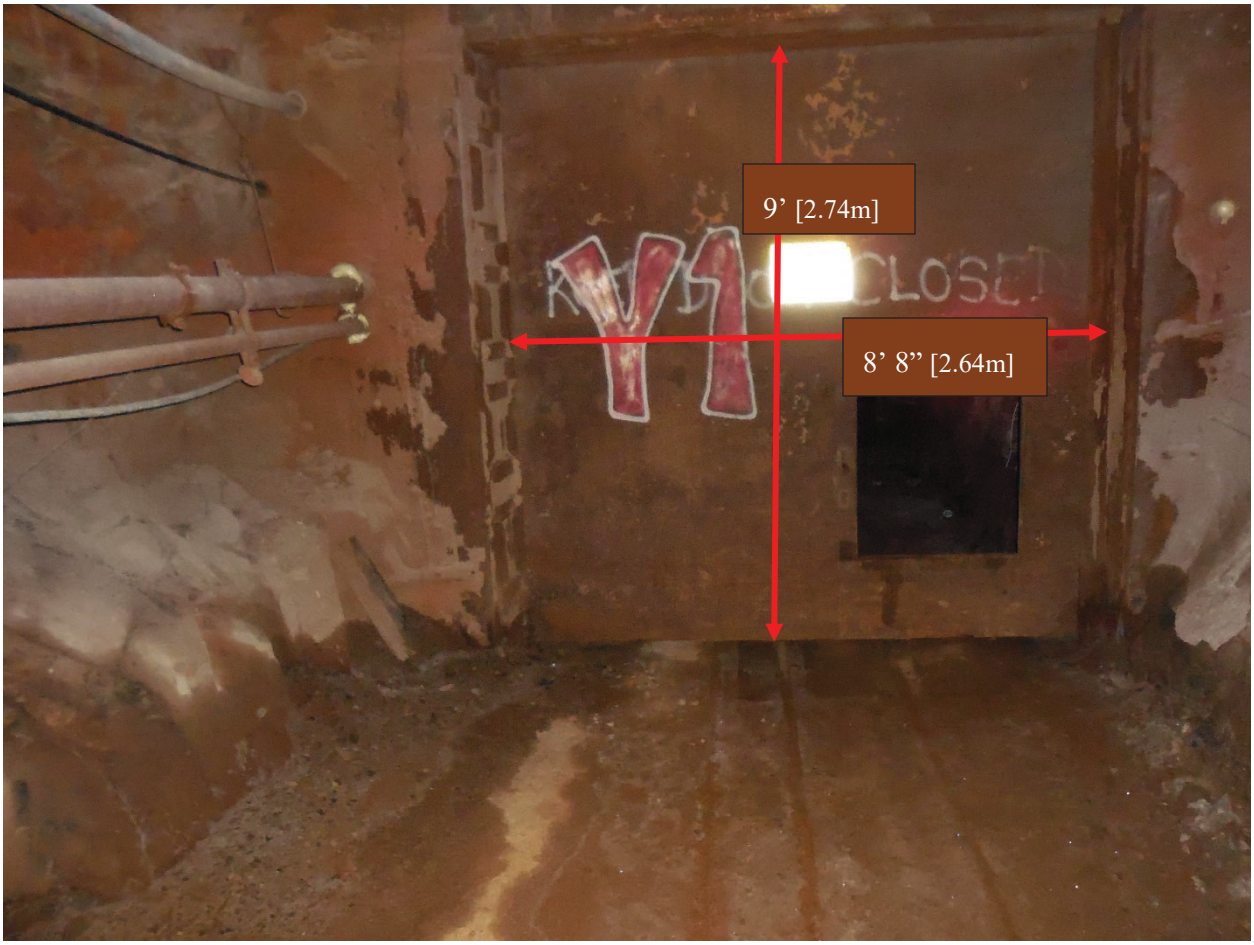


Figure 25: West Drift Access Vent Door

5.7. North Entrance Drift Access Door

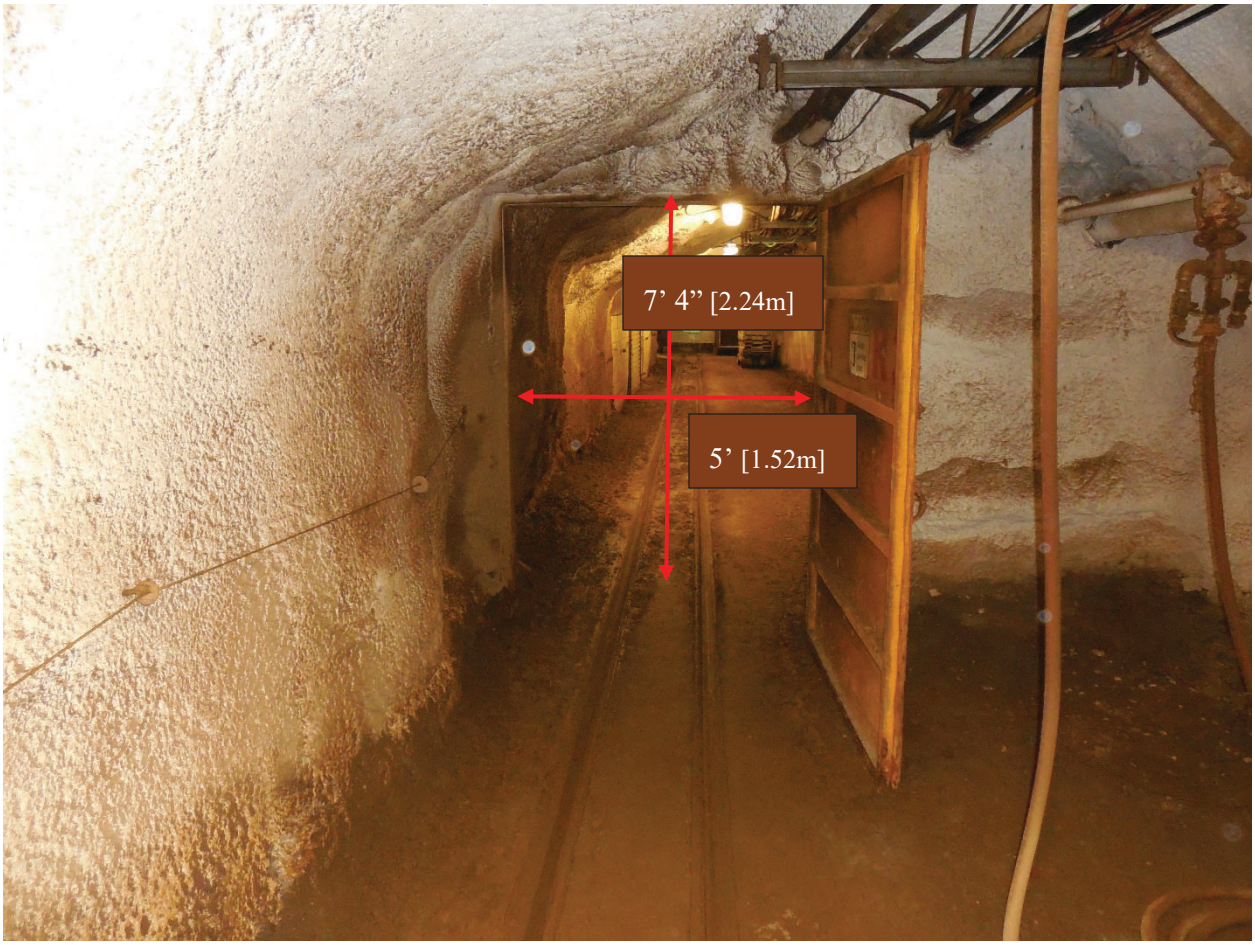


Figure 26: North Entrance Drift Access Door

6. Additional Reference Drawings

The following drawings were used in the slung load analysis for the Ross and Yates Shafts. They are provided here **for reference only**.

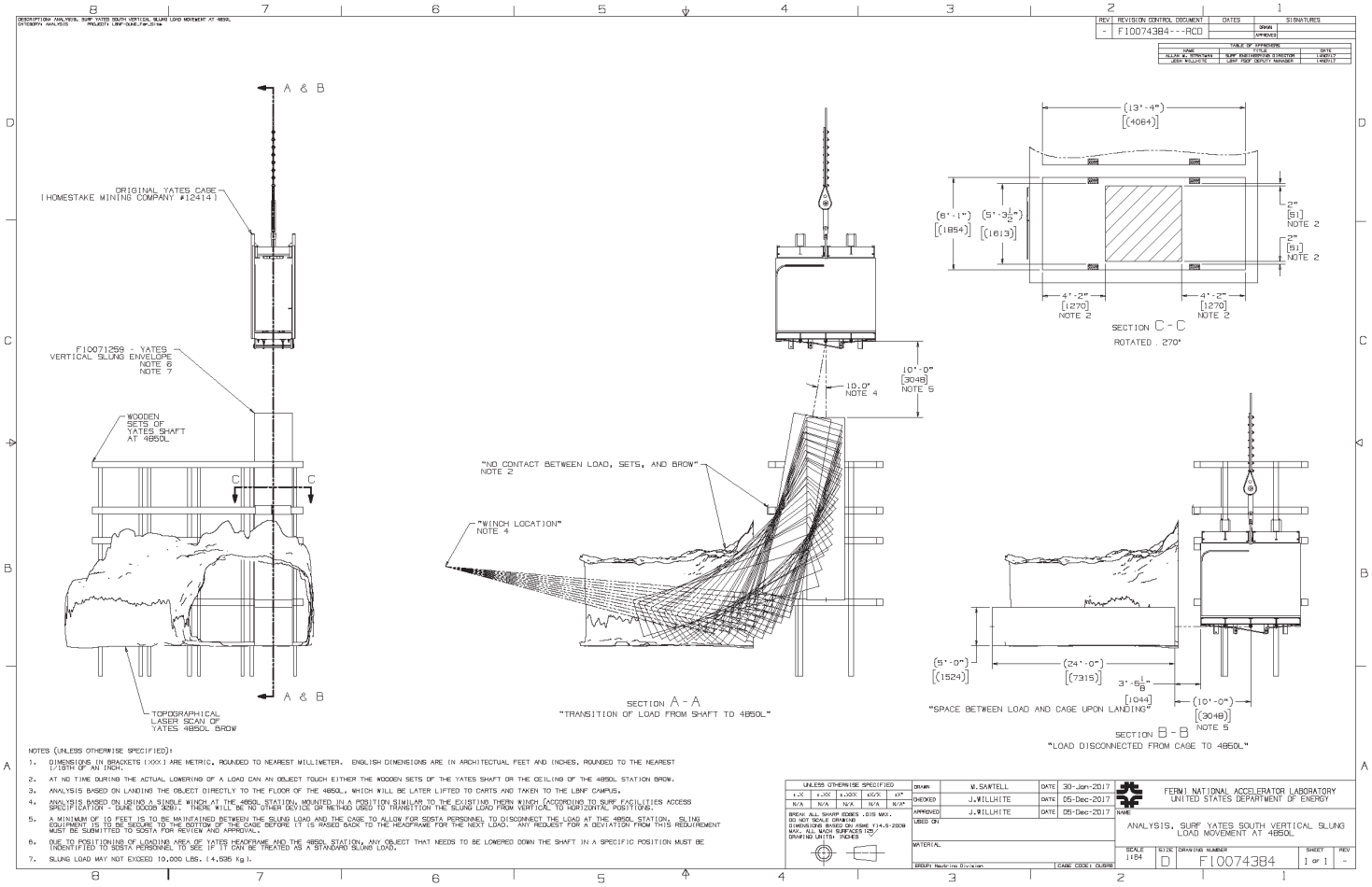


Figure 27: Yates South Cage Vertical Slung Load Analysis at the 4850L

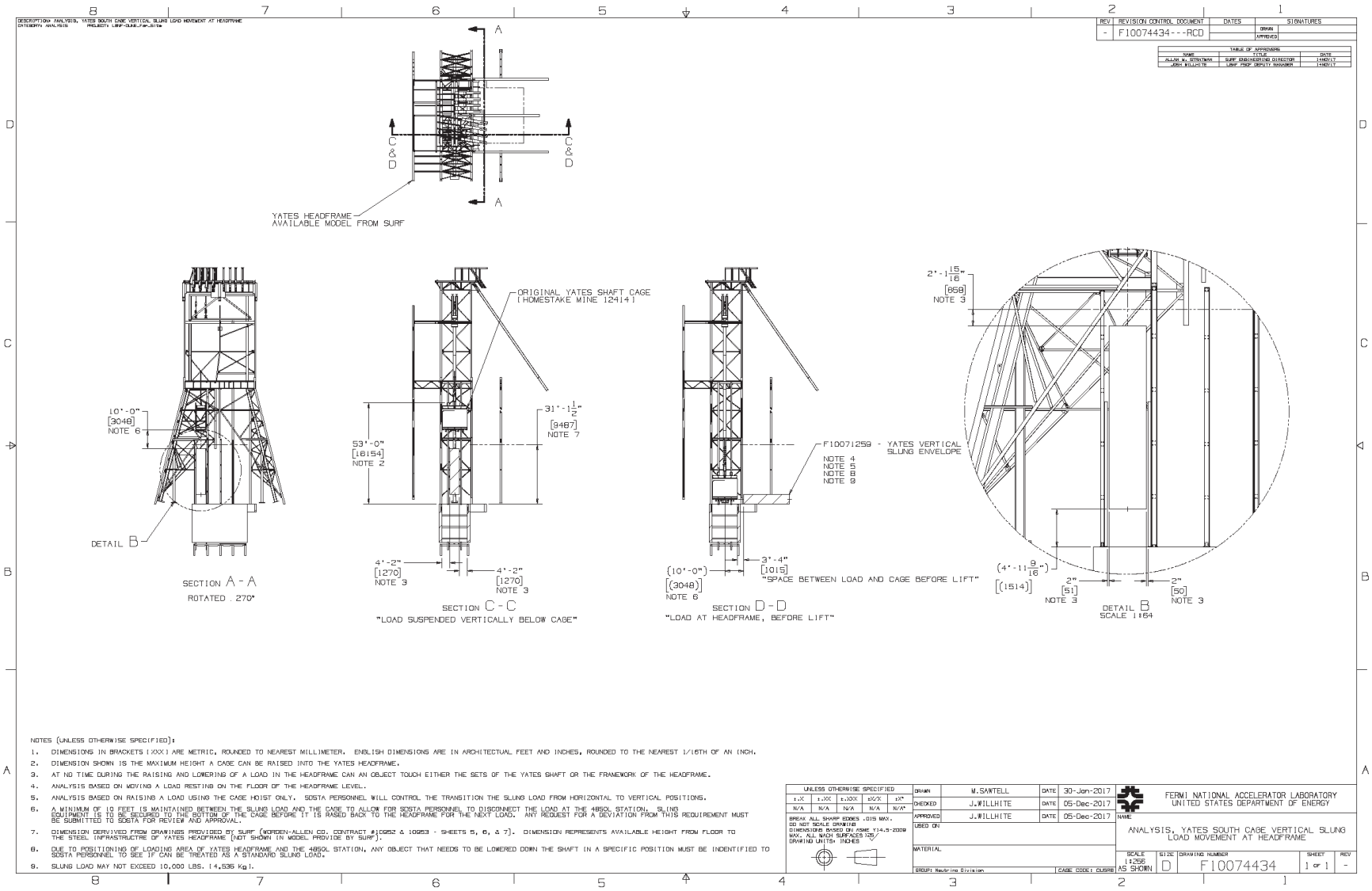


Figure 28: Yates South Cage Vertical Slung Load Analysis

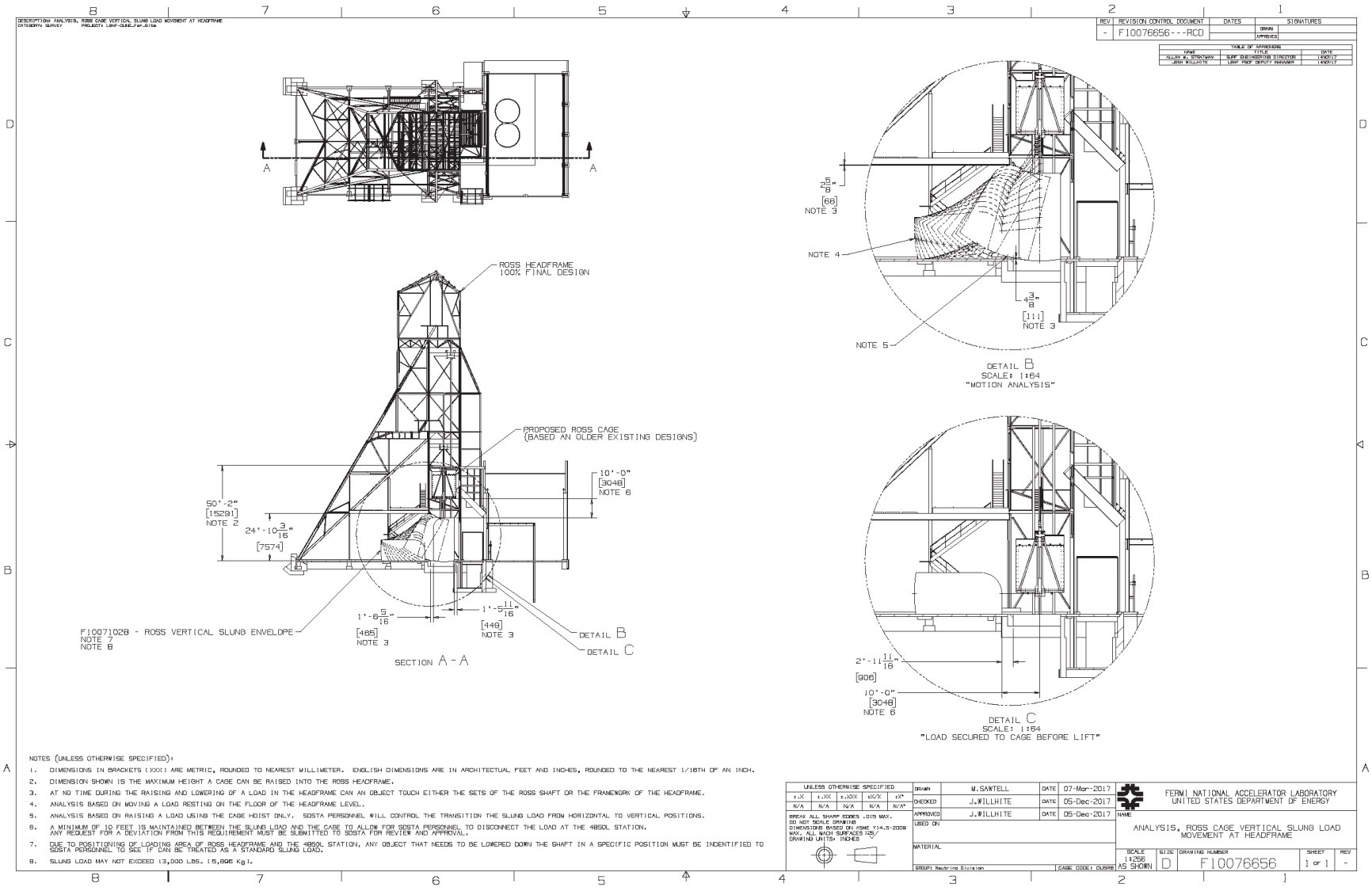


Figure 29: Ross Cage Vertical Slung Load Analysis

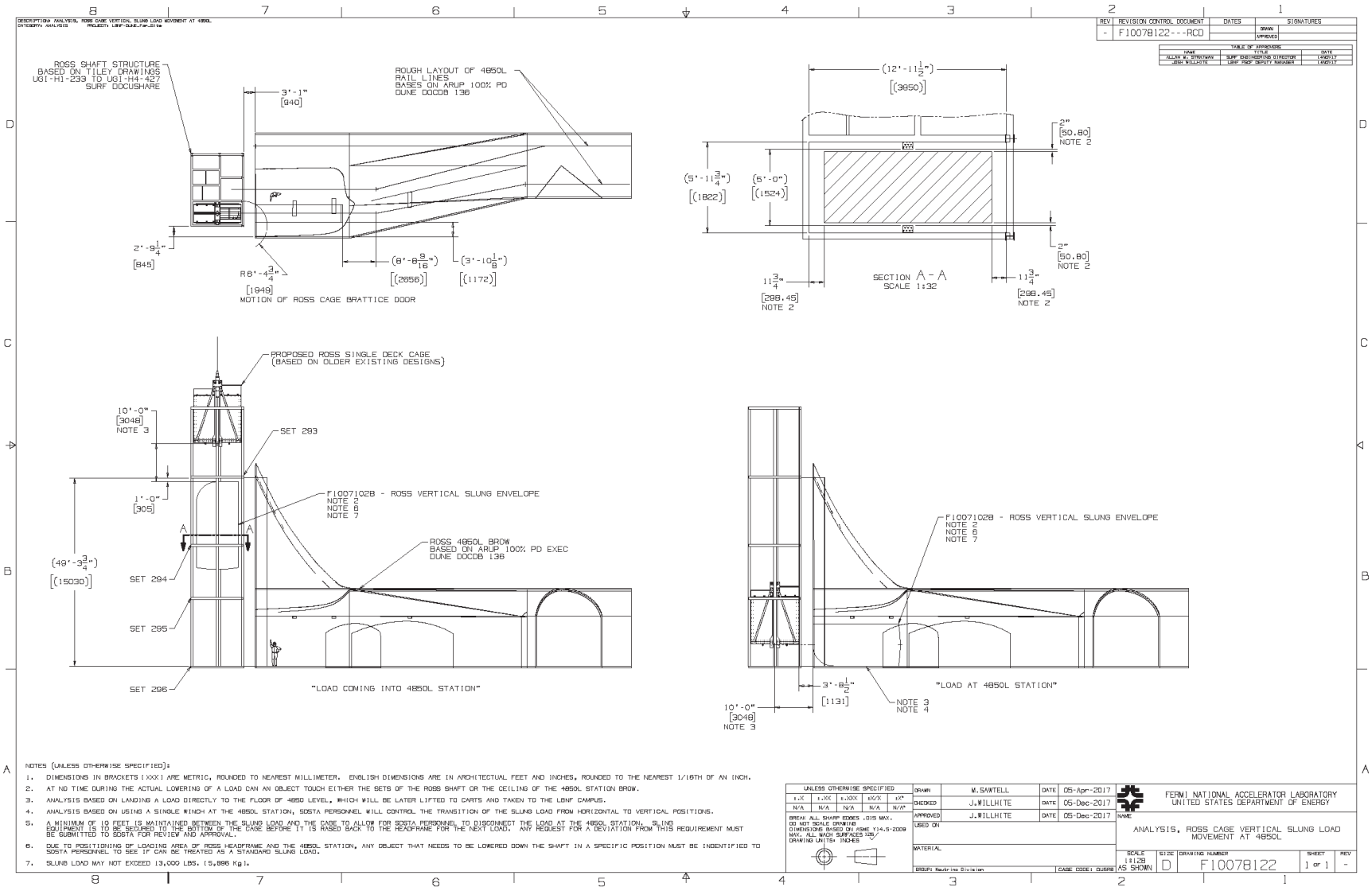


Figure 30: Ross Cage Vertical Slung Load Analysis at the 4850L