



Cryo-Assembly Shipping

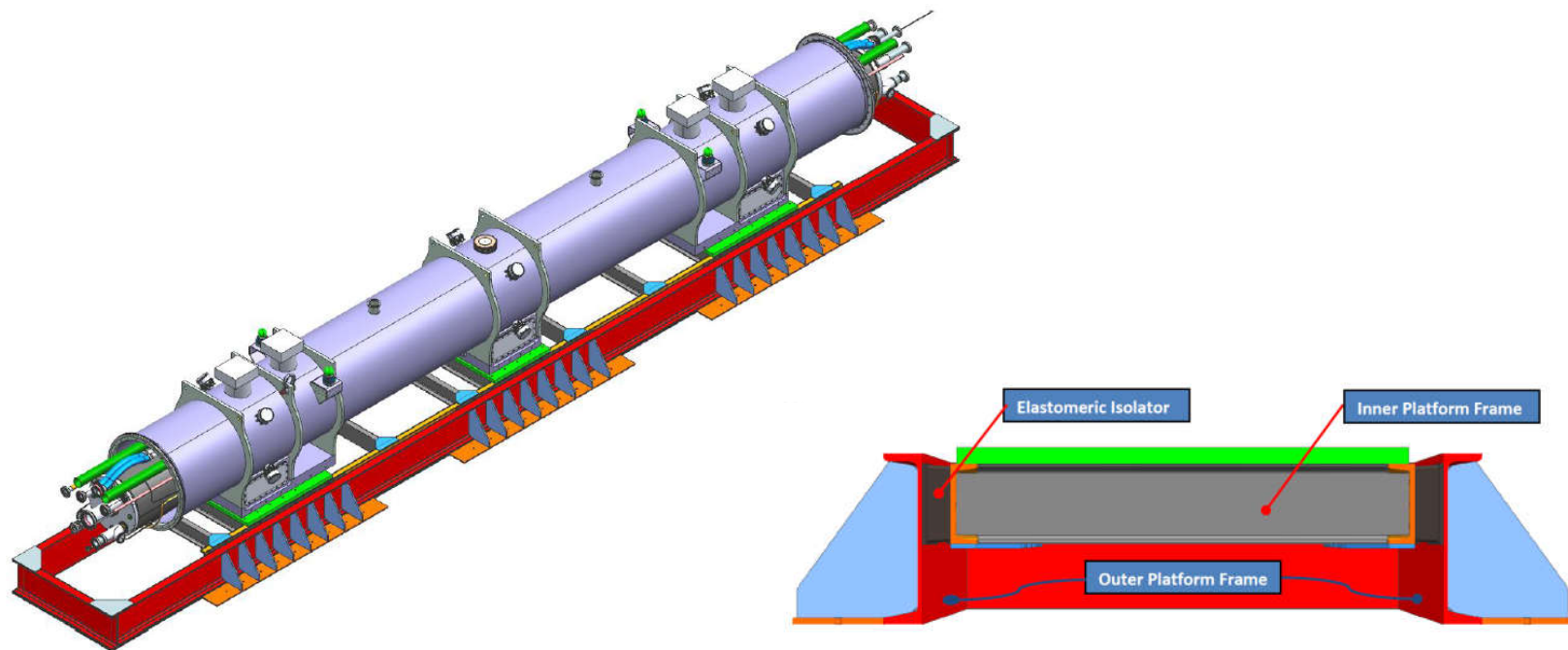
Roger Rabehl

October 12, 2018

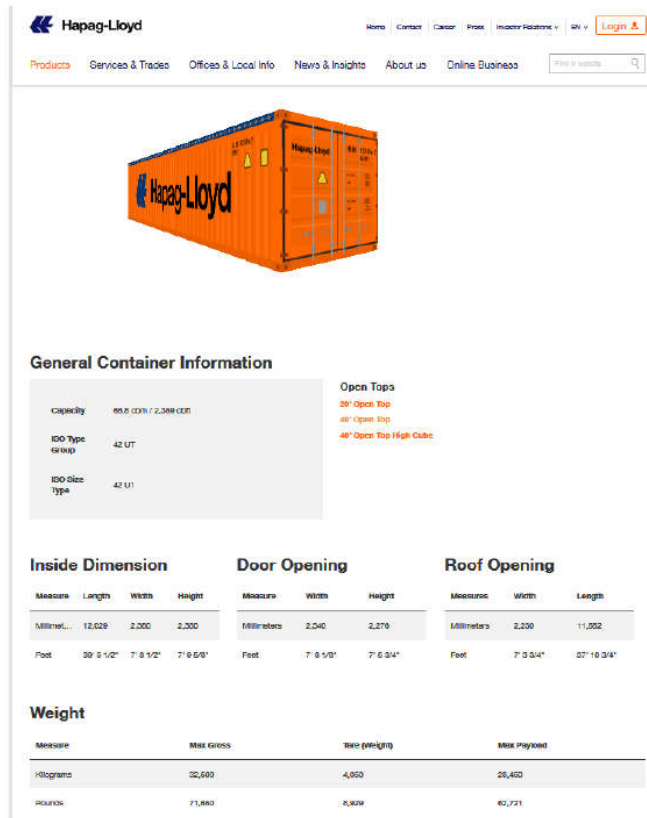
Preliminary design of the shipping frame has been completed.



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Other aspects of the shipping system are just underway.



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42 UT

Capacity: 68.6 CBM / 2,368 CBM

ISO Type (or eqv): 42 UT

ISO size type: 42 U1

Open Tops

- 30' Open Top
- 40' Open Top
- 40' Open Top High Cube

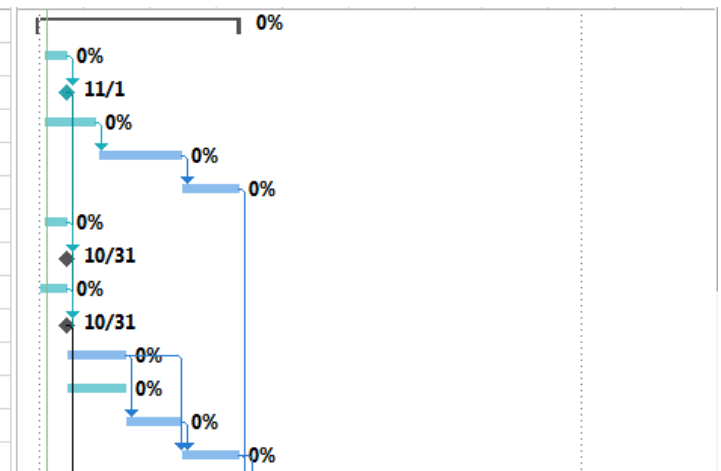
Inside Dimension				Door Opening			Roof Opening		
Measure	Length	Width	Height	Measure	Width	Height	Measure	Width	Length
Millimeter	12,020	2,200	2,300	Millimeter	2,040	2,270	Millimeter	2,200	11,502
Foot	39' 5 1/2"	7' 0 1/2"	7' 6 5/8"	Foot	7' 0 1/8"	7' 6 3/4"	Foot	7' 0 3/4"	37' 10 3/4"

Measure	Max Gross	Max payload	Max payload
Kilograms	30,500	4,000	26,500
Pounds	71,800	8,900	62,721



A resource-loaded schedule has been generated out to the April 2020 prototype shipment.

SHIPMENT	Days	Start	End	Resources
SHIPMING FRAME DESIGN/ANALYSIS - FERMILAB	152 days	Mon 10/1/18	Tue 4/30/19	
Write/review shipping frame Technical Requirements Specification (TRS)	18 days	Mon 10/8/18	Wed 10/31/18	
Technical Requirements Specification (TRS) approval	0 days	Thu 11/1/18	Thu 11/1/18	2
Vendor identification for shipping system evaluation	40 days	Mon 10/8/18	Fri 11/30/18	
Procurement of shipping system evaluation	64 days	Mon 12/3/18	Thu 2/28/19	4
Shipping system evaluation	43 days	Fri 3/1/19	Tue 4/30/19	5
Write/review shipping frame Engineering Risk Assessment (ERA)	18 days	Mon 10/8/18	Wed 10/31/18	
ERA approval	0 days	Wed 10/31/18	Wed 10/31/18	7
Write/review shipping frame Engineering Design Specification (EDS)	23 days	Mon 10/1/18	Wed 10/31/18	
EDS approval	0 days	Wed 10/31/18	Wed 10/31/18	9
Shipping frame mechanical/structural analysis	43 days	Thu 11/1/18	Mon 12/31/18	
Cryo-assembly vibration/resonance analysis	43 days	Thu 11/1/18	Mon 12/31/18	
Shipping frame vibration/resonance analysis	43 days	Tue 1/1/19	Thu 2/28/19	11
Detailed design of shipping frame	43 days	Fri 3/1/19	Tue 4/30/19	11,13

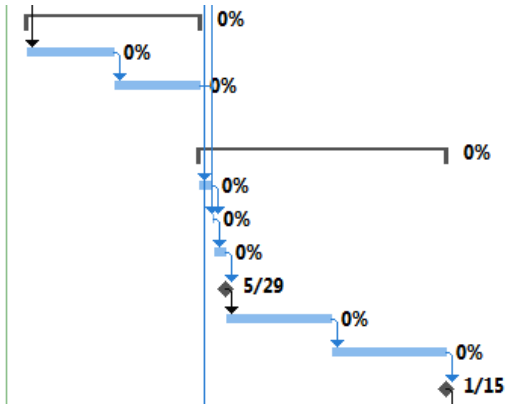


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- Write Shipping Frame specifications and risk analyses (October 2018))
- Vendor evaluate of shipping system (March-April 2019)
- Analyses (November 2018-February 2019)
 - Mechanical/structural (Shipping Frame)
 - Stress analysis of individual members based on shear and bending moments
 - Stress analysis of lifting lugs and welds
 - Vibration/resonance (Shipping Frame, Cryo-Assembly)
 - Damping
 - Resonant frequencies
 - Finalize quantity of Shipping Frame isolators
- Detailed Shipping Frame design (March-April 2019)

A resource-loaded schedule has been generated out to the April 2020 prototype shipment.

SHIPPING FRAME DESIGN/ANALYSIS - VENDOR	130 days	Thu 11/1/18	Wed 5/1/19	
Procurement of vendor design & analysis of shipping frame based on TRS	66 days	Thu 11/1/18	Thu 1/31/19	3,10
Vendor shipping frame design, mechanical/structural analysis, vibration/resc	64 days	Fri 2/1/19	Wed 5/1/19	17
SHIPPING FRAME PROCUREMENT, SHIPPING SYSTEM EVALUATION	186 days?	Wed 5/1/19	Wed 1/15/20	
Preparation for design review	10 days	Wed 5/1/19	Tue 5/14/19	14
Design reviews of Fermilab and vendor shipping frames	1 day	Wed 5/15/19	Wed 5/15/19	14,18,21
Design reviews follow-up	10 days	Thu 5/16/19	Wed 5/29/19	22
Selection of shipping frame design	0 days	Wed 5/29/19	Wed 5/29/19	23
Procurement of shipping frames	78 days	Thu 5/30/19	Mon 9/16/19	24
Shipping frame fabrication oversight	87 days	Tue 9/17/19	Wed 1/15/20	25
Receive shipping frames	0 days	Wed 1/15/20	Wed 1/15/20	26

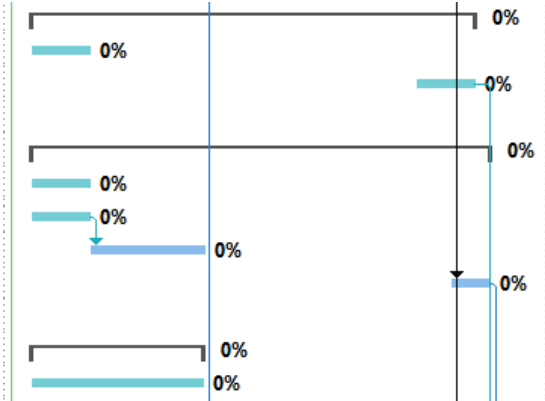


A resource-loaded schedule has been generated out to the April 2020 prototype shipment.

- Vendor design and analysis of a second Shipping Frame design, independent of the Fermilab design (February-April 2019)
- Review both designs and select one (May 2019)
- Receipt of two fabricated Shipping Frames (January 2020)

A resource-loaded schedule has been generated out to the April 2020 prototype shipment.

SHIPPING FRAME TEST - FERMILAB	333 days	Thu 11/1/18	Mon 2/10/20	
Write shipping frame Fermilab test plan	43 days	Thu 11/1/18	Mon 12/31/18	
Planning and execution of on-site testing of shipping frame	44 days	Wed 12/11/18	Mon 2/10/20	
SHIPPING FRAME TEST - VENDOR	345 days	Thu 11/1/18	Wed 2/26/20	
Vendor identification for DOT testing of shipping frame	43 days	Thu 11/1/18	Mon 12/31/18	
Write shipping frame vendor test plan	43 days	Thu 11/1/18	Mon 12/31/18	
Procurement of shipping frame vendor test	87 days	Tue 1/1/19	Wed 5/1/19	35
Vendor testing of shipping frame	30 days	Thu 1/16/20	Wed 2/26/20	27
SHIPPING CONTAINER	129 days	Thu 11/1/18	Tue 4/30/19	
Evaluate existing BNL shipping containers or procurement of new container	129 days	Thu 11/1/18	Tue 4/30/19	

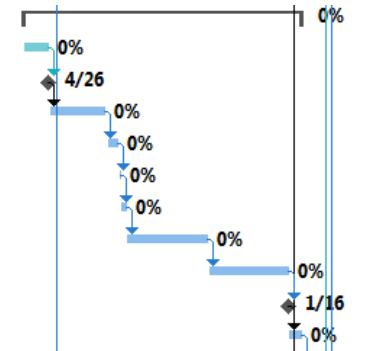


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- Testing of Shipping Frames after receipt (January-February 2020)
 - Fermilab on-site test to address transport of Cryo-Assemblies between the assembly building and the test facility.
 - Vendor test to address transport of Cryo-Assemblies between Fermilab and CERN
 - A market survey conducted by Fermilab Procurement to identify vendors who can test large shipping fixtures
 - Profit from past experience, such as the g-2 magnet shipping fixture
- Shipping container evaluation/selection (April 2019)

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SHIPPING POSTS AND COLD MASS RESTRAINTS		219 days	Mon 4/1/19	Thu 1/30/20
Write/review shipping posts and cold mass restraints Engineering Design Spe	20 days	Mon 4/1/19	Fri 4/26/19	
EDS approval	0 days	Fri 4/26/19	Fri 4/26/19	43
Design of shipping posts and cold mass restraints	45 days	Mon 4/29/19	Fri 6/28/19	44
Preparation for design review	10 days	Mon 7/1/19	Fri 7/12/19	45
Design review of shipping posts and cold mass restraints	1 day	Mon 7/15/19	Mon 7/15/19	46
Design review follow-up	5 days	Tue 7/16/19	Mon 7/22/19	47
Procurement of shipping posts and cold mass restraints	64 days	Tue 7/23/19	Fri 10/18/19	48
Fabrication of shipping posts and cold mass restraints	64 days	Mon 10/21/19	Thu 1/16/20	49
Receive shipping posts and cold mass restraints	0 days	Thu 1/16/20	Thu 1/16/20	50
Inspect shipping posts and cold mass restraints	10 days	Fri 1/17/20	Thu 1/30/20	51

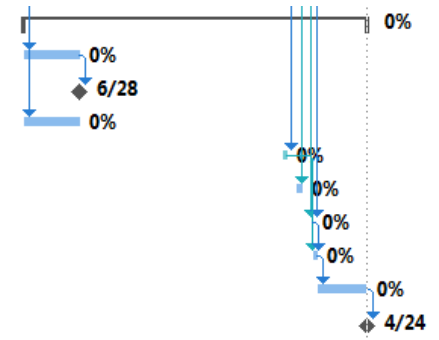


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- Receipt of shipping posts and shipping restraints (January 2020)

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SHIPMENT	258 days	Wed 5/1/19	Fri 4/24/20	
Write/review Cryo-Assembly Crating & Shipping Specification	43 days	Wed 5/1/19	Fri 6/28/19	6
Crating & Shipping Specification approval	0 days	Fri 6/28/19	Fri 6/28/19	55
Develop/review detailed shipping procedure and checklist	43 days	Wed 5/1/19	Fri 6/28/19	6
Install shipping posts and cold mass restraints	5 days	Mon 1/27/20	<u>Fri 1/31/20</u>	52
Install shipping frame into shipping container	5 days	Tue 2/11/20	Mon 2/17/20	31
Secure shipping frame to shipping container	1 day	Thu 2/27/20	Thu 2/27/20	31,37
Secure cryo-assembly to shipping frame	3 days	Fri 2/28/20	Tue 3/3/20	60,58
Shipment of prototype	38 days	Wed 3/4/20	Fri 4/24/20	61
Shipment of prototype	0 days	Fri 4/24/20	Fri 4/24/20	62



A resource-loaded schedule has been generated out to the April 2020 prototype shipment.

- Assembly of shipping system (February 2020)
- Shipment of Prototype Cryo-Assembly (April 2020)