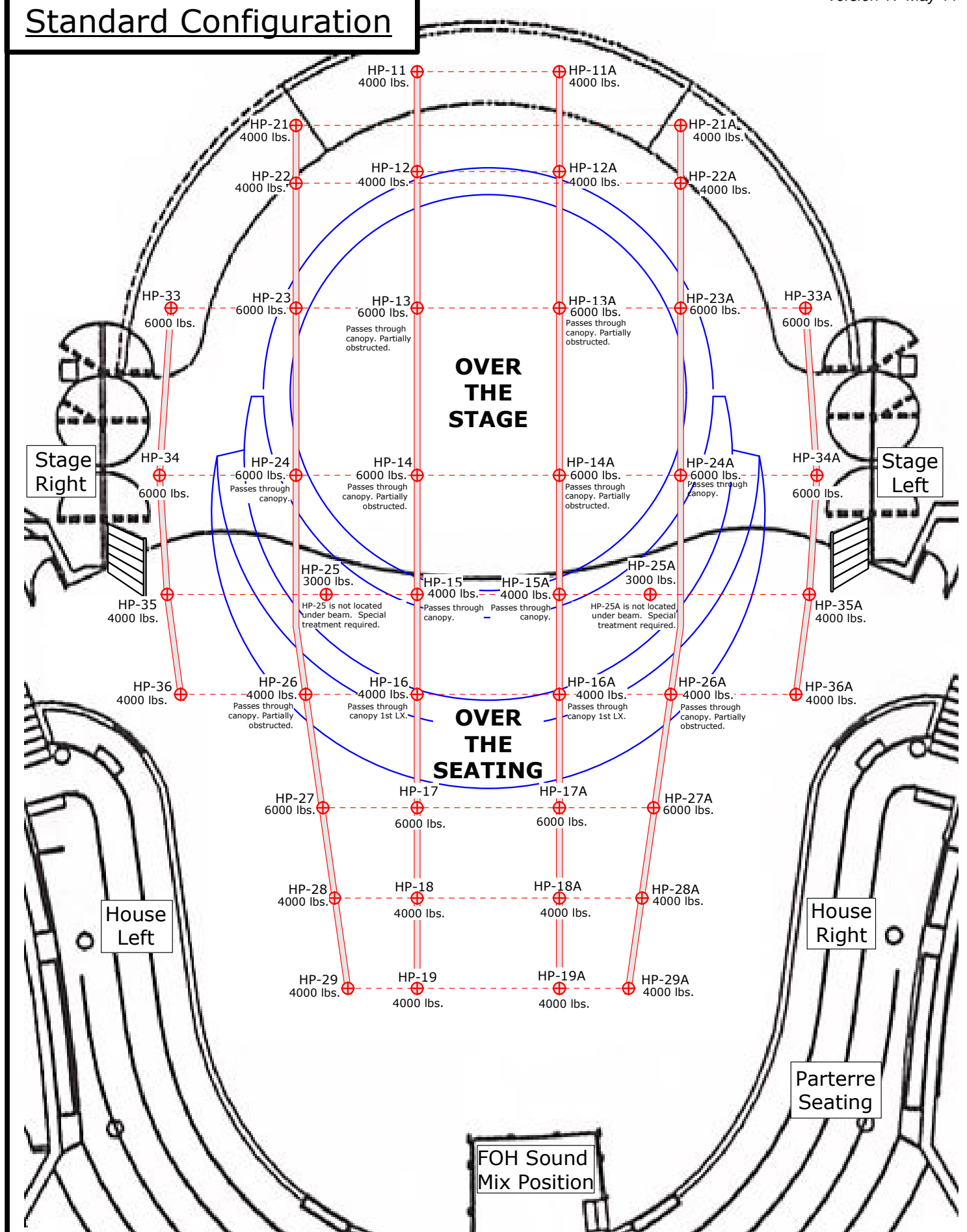


Chan Shun Concert Hall Standard Configuration

Concert Hall Rigging Ports and CanopyLocation
version 17-May-11



Rigging Points (HP's)	Distance in Meters from US Outside Building Wall	Distance in Feet	Distance in Feet and Inches (to nearest Inch)	Distance in Feet from Hard Stage DS Edge	Distance in Feet and Inches (to nearest	Notes
11, 11A	8.40	27.56	27' - 7"	43.31	43' - 4"	
21, 21A	9.80	32.15	32' - 2"	38.72	38' - 9"	
12, 12A	11.00	36.09	36' - 1"	34.78	34' - 9"	
22, 22A	11.30	37.08	37' - 1"	33.79	33' - 9"	
13, 13A, 23, 23A, 33, 33A	14.55	47.74	47' - 9"	23.13	23' - 2"	
14, 14A, 24, 24A, 34, 34A	18.90	62.01	62' - 0"	8.86	8' - 10"	Opera "Box Boom" Lx Trusses
15, 15A, 25, 25A, 35, 35A	22.00	72.18	72' - 2"	1.31	1' - 4"	
16, 16A, 26, 26A, 36, 36A	24.60	80.71	80' - 9"	9.84	9' - 10"	
17, 17A, 27, 27A, 37, 37A	27.55	90.39	90' - 5"	19.52	19' - 6"	
18, 18A, 28, 28A, 38, 38A	29.90	98.10	98' - 1"	27.23	27' - 3"	
19, 19A, 29, 29A, 39, 39A	32.25	105.81	105' - 10"	34.94	34' - 11"	
US Concrete Wall of stage	4.65	15.26	15' - 3"	55.61	55' - 8"	
DS Edge of Chorus Loft in US position	6.90	22.64	22' - 8"	48.23	48' - 3"	
DS Edge of Chorus Loft in DS position	9.50	31.17	31' - 2"	39.70	39' - 8"	
US Canopy (Cyc) Pipe @ CL	10.95	35.93	35' - 11"	34.94	34' - 11"	
US Canopy Catwalk Handrail @ CL	11.85	38.88	38' - 11"	31.99	31' - 0"	
Canopy Centre (radius) Point	16.75	54.96	54' - 11"	15.91	15' - 11"	
Hard Stage DS Edge	21.60	70.87	70' - 10"	0.00	0' - 0"	
Orchestra Pit Lift DS Edge	24.55	80.55	80' - 7"	9.68	9' - 8"	
Canopy 1st Lx Pipe	25.15	82.52	82' - 6"	11.65	11' - 8"	

**red values are counting into the house from stage edge.*

Rigging Points (HP's) about Centreline	Distance in Meters from Centreline	Distance in Feet	Distance in Feet and Inches (to nearest inch)
11-19, 11A-19A	1.85	6.07	6' - 1"
21-25, 21A-25A	5.00	16.41	16' - 5"
26, 26A	4.75	15.58	15' - 7"
27, 27A	4.30	14.11	14' - 1"
28, 28A	4.00	13.12	13' - 1"
29, 29A	3.65	11.98	12' - 0"
33, 33A	8.25	27.07	27' - 1"
34, 34A	8.55	28.05	28' - 1"
35, 35A	8.35	27.40	27' - 5"
36, 36A	8.00	26.25	26' - 3"

Chan Shun Concert Hall
Rigging Point Measurements
Upstage/Downstage and Cross-Stage

Scaled from 1:50 Architectural As-Builts

Chan Shun Concert Hall Rigging Points – Detailed Notes

- ⊕ HP 11/11A (4000 lbs / 1800 kg)
 - ❑ Attic Level
 - ◆
 - ❑ Canopy Level
 - ◆
 - ❑ Chorus Loft/Stage Level
 - ◆
- ⊕ HP 21/21A (4000 lbs / 1800 kg)
 - ❑ Attic Level
 - ◆
 - ❑ Canopy Level
 - ◆
 - ❑ Chorus Loft/Stage Level
 - ◆
- ⊕ HP 12/12A (4000 lbs / 1800 kg)
 - ❑ Attic Level
 - ◆ HP-12 is 20% obstructed by fret cable just below ceiling
 - ◆ HP-12A is 40% obstructed by fret cable just below ceiling
 - ◆ Therefore chains must be dead vertical to avoid rubbing on fret cables
 - ❑ Canopy Level
 - ◆
 - ❑ Stage Level
 - ◆
- ⊕ HP 22/22A (4000 lbs / 1800 kg)
 - ❑ Attic Level
 - ◆
 - ❑ Canopy Level
 - ◆
 - ❑ Chorus Loft/Stage Level
 - ◆
- ⊕ HP13/13A (6000 lbs / 2700 kg)
 - ❑ Attic level
 - ◆
 - ❑ Canopy level
 - ◆ Passes inside railing
 - ◆ Passes through glitter glass
 - ◆ Glitter light bulb infringes on port
 - ◆ Access to main fat structural pipe for local rigging
 - ◆ No collar installed
 - ❑ Stage Level
 - ◆
- ⊕ HP23/23A (6000 lbs / 2700 kg)
 - ❑ Attic level
 - ◆
 - ❑ Canopy level
 - ◆
 - ❑ Stage Level
 - ◆

Chan Shun Concert Hall Rigging Points – Detailed Notes

- ⊕ HP33/33A (6000 lbs / 2700 kg)
 - Attic level
 - ◆
 - Canopy level
 - ◆
 - Chorus Loft/Stage Level
 - ◆
- ⊕ HP14/14A (6000 lbs / 2700 kg)
 - Attic level
 - ◆
 - Canopy level
 - ◆ Passes inside railing
 - ◆ Passes through glitter glass
 - ◆ Glitter light bulb infringes on port
 - ◆ Access to main fat structural pipe for local rigging
 - ◆ No collar installed
 - Stage Level
 - ◆
- ⊕ HP24/24A (6000 lbs / 2700 kg)
 - Attic Level
 - ◆
 - Canopy level
 - ◆ Passes outside railing but reachable (right next to expanded steel catwalk section)
 - ◆ Passes between two chrome cans
 - ◆ No glass
 - ◆ Access to hand railings for light rigging
 - ◆ No collar installed
 - Stage Level
 - ◆
- ⊕ HP34/34A (6000 lbs / 2700 kg)
 - Attic level
 - ◆
 - Canopy level
 - ◆
 - Stage Level
 - ◆
- ⊕ HP15/15A (4000 lbs / 1800 kg)
 - Attic Level
 - ◆
 - Canopy level
 - ◆ Passes outside railing but reachable
 - ◆ Passes between two chrome cans
 - ◆ No glass
 - ◆ Access to hand railings for light rigging
 - ◆ No collar installed
 - Stage Level
 - ◆
- ⊕ HP25/25A (3000 lbs / 1350 kg ON TROLLEY BEAM, NOT WORK-AROUND POINT)
 - Attic level

Chan Shun Concert Hall Rigging Points – Detailed Notes

- ♦ Ports are not located under the motor track beam due to construction error
- ♦ They are 31" onstage of track and location on as-built drawings
- ♦ There is a roof steel beam roughly (8" further onstage still) over the actual port
 - The roof steel beam is a wide flange I-beam, 10 ¼" x 5 5/8"
 - Beam runs perpendicular to main Concert Hall roof trusses and supports canopy sheaves
 - Allows a motor to be rigged on a custom installed point if needed
 - Four workers are required to move the motor (2 on motor, 1 on chain, 1 on swivel hook)
- ❑ Canopy level
 - ♦ Passes inside railing
 - ♦ Passes through glitter glass
 - ♦ Glitter light bulb infringes on port
 - ♦ Access to hand railings for light rigging
 - ♦ No collar installed
- ❑ Stage Level
 - ♦
- ⊕ HP35/35A (4000 lbs / 1800 kg)
 - ❑ Attic level
 - ♦
 - ❑ Canopy level
 - ♦
 - ❑ Stage Level
 - ♦
- ⊕ HP16/16A (4000 lbs / 1800 kg)
 - ❑ Attic Level
 - ♦
 - ❑ Canopy level
 - ♦ Passes through gap of 1st LX
 - ♦ House LX hang must be modified to use points
 - ♦ No collar installed
 - ❑ House level
 - ♦
- ⊕ HP26/26A (4000 lbs / 1800 kg)
 - ❑ Attic Level
 - ♦
 - ❑ Canopy level
 - ♦ Passes outside railing on downstage-most canopy section
 - ♦ Passes through glitter glass
 - ♦ Glitter light bulb and raceway infringe on port; collar cannot be installed
 - ♦ No local rigging possibilities
 - ♦ No collar installed; cannot be installed until raceway relocated
 - ♦ Damage to glass on both sides & raceway on SR by chain hook tip catching
 - ❑ House level
 - ♦
- ⊕ HP36/36A (4000 lbs / 1800 kg)
 - ❑ Attic level
 - ♦
 - ❑ Canopy level
 - ♦
 - ❑ House level
 - ♦

Chan Shun Concert Hall Rigging Points – Detailed Notes

⊕ HP17/17A (6000 lbs / 2700 kg)

- ❑ Attic level
 - ◆
- ❑ Canopy level
 - ◆
- ❑ House level
 - ◆

⊕ HP27/27A (6000 lbs / 2700 kg)

- ❑ Attic level
 - ◆
- ❑ Canopy level
 - ◆
- ❑ House level
 - ◆

⊕ HP18/18A (4000 lbs / 1800 kg)

- ❑ Attic level
 - ◆
- ❑ Canopy level
 - ◆
- ❑ House level
 - ◆

⊕ HP28/28A (4000 lbs / 1800 kg)

- ❑ Attic level
 - ◆
- ❑ Canopy level
 - ◆
- ❑ House level
 - ◆

⊕ HP19/19A (4000 lbs / 1800 kg)

- ❑ Attic level
 - ◆
- ❑ Canopy level
 - ◆
- ❑ House level
 - ◆

⊕ HP29/29A (4000 lbs / 1800 kg)

- ❑ Attic level
 - ◆
- ❑ Canopy level
 - ◆
- ❑ House level
 - ◆

Miscellaneous Information:

- ◆ There are two CM Series 633 1-Ton chain hoist trolleys on each of the six trolley beams. DO NOT MOVE THESE TROLLEYS BETWEEN BEAMS AS THEY HAVE VERY SPECIFIC SPACING TOLERANCES – MOVING THE TROLLEYS IMPROPERLY COULD CAUSE FAILURE.

Chan Shun Concert Hall Rigging Points – Detailed Notes

- ◆ There are six CM Lodestar Model L Series 627 1-Ton chain hoists in the attic (originally one per beam, but they can be moved around as needed. For maximum safety and efficiency this operation requires four workers; two to hold the motor, one to hold the chain bag, and one to manipulate the swivel hook on the motor.
- ◆ There is no in-house motor control unit; each motor must be individually operated with its own pickle.
- ◆ The motor control lines are equipped with 15A twistlock-style connectors (NOT multipin style connectors) that allow certain rental houses' motor control to be used.
- ◆ The motors are wired in 3 phase.
- ◆ The six 1-Ton motors are equipped with Square D gravity contactors. These motors CANNOT be run inverted (i.e. climbing) as a result.
- ◆ Standard limit settings for Chan Centre motors are: Upper limit – bottom of chain hook level with bottom of chain bag. Lower limit – bottom of dead end chain swag level with bottom of chain bag. Note these are NOT factory-default limit settings.

File: 10100

March 31, 2008

The University Of British Columbia

Chan Centre for the Performing Arts
6265 Crescent Road
Vancouver , BC
V6T 1Z1

FAX: 604-822-3036

Attention: Mr. Cameron McGill

Dear Mr. McGill:

Re: **Chan Centre, Load Assessment**

We have now concluded our analysis of the various components of the main Concert Hall and Studio Theatre to assess the loadings from Fall Arrest / Fall Protection systems, and for rigging loads. The results are summarized in this report and on the accompanying sketches that include key plans and tables.

We have endeavoured to provide loads for hanging rigging equipment that is practical to apply, specifically when one or more loads may be applied to a single structural member. Therefore, these are not always the very maximum load that could be supported at a specific point if only a single load was being applied.

We have indicated a means to improve the capacity, should higher loads be required for a specific application, should the loads listed herein not be adequate. Such details would need to be developed for a specific point load, and may not be applicable in combination with other loads.

As this is a working theatre, under the requirements of WorkSafe BC the requirements for fall arrest attachments are considered to be "permanent" elements, much like those used for window washing fall arrest systems used for the exterior of buildings. We note that the design loads for these types of systems, at a load of **5000 lbs (22.2 kN)** are higher than where "temporary" fall arrest systems are employed, such as on a construction work site. This is the load we have used for our analysis of the existing structures where fall arrest requirements have been requested. We have suggested an alternate location for support points, where the existing positions do not meet the minimum load requirements.

Item	Question Posed and Reply:
1.	Concert Hall Dress Circle Lighting Positions at House Left, Right and Centre Question: Confirm whether the LX positions (used in current practice) are adequate for Fall Arrest. This will require onsite inspection and non-destructive testing of existing welds by Elander Inspections Ltd. If the existing installation is proven to be non-viable, work to find an acceptable solution to the problem, probably in conjunction with Hazmasters. Reply: The existing LX positions are not adequate to support the fall arrest load of 5000 lbs (22.2 kN). The inadequacy is in the size of the pipe, as well as the plate attachments. Further non-destructive tests are therefore not required to verify the weld sizes. If fall arrest locations are required, separate anchorage points may be attached to the underside of the concrete elements. Although these would be less aesthetic than using the existing lighting bars, they can be designed properly for the required loads.
2.	Concert Hall Canopy Downstage Lighting Position Question: Confirm whether the railing in this area is adequate for Fall Arrest (used in current practice). This will likely involve a site visit with the Canopy down and Andrew's participation to demonstrate the requirements. In this location, it will be more important that the solution is elegant and non time-consuming to utilize due to event-related needs. Reply: The handrails around the canopy are not adequate to take the applied load of 5000 lbs (22.2 kN), either in a vertical direction, and especially in at an angle that could create a horizontal component to the force. The handrails are designed to act as guards as in the catwalk locations, to resist a horizontal load of 50 lb/ft. The guards have additional plastic capacity (meaning that they will bend and stay deformed), before they would break, but these elements were not designed to be part of a fall arrest system. Possible Fall Arrest anchors can be connected to the structural steel members, including the channels that support the railings, but not to the handrails themselves unless they are strengthened or braced in order to carry the loads, which could affect the functioning or may not be practical.
3.	Concert Hall Canopy Ladder Head Self-Retracting Lanyard Mount Question: Confirm that beam directly over ladder head is suitable for Fall Arrest. If so, confirm whether an off-the-shelf hardware component may be bolted through the lower flange to attach the SRL to, or whether a beam-clamp style is more appropriate. Reply: The beam over the ladder is suitable for fall arrest. If the load is directly vertical, a 3/4" diameter eye-bolted connection could be used for the connection. From a safety perspective, we would recommend a better alternative would be to use a 3/4" diameter "half-ring" welded to a plate that could be bolted to the underside of the beam with two bolts, one on each side of the web of the beam.

Item	Question Posed and Reply:
4.	Studio Theatre Tower Lighting Position Eye Bolts Question: Confirm that the structure where these eye bolts are currently attached is appropriate to be used at a minimum for Fall Restraint, and preferably for Fall Arrest. Reply: None of the ½" diameter eye bolts is adequate to resist the required Fall Arrest forces as a permanent installation system. In addition, the bolts as installed are partially subject to bending, undesirable force direction for eye bolts. The maximum allowable load for a ½" diameter eye bolt loaded in direct tension is typically 2600 lbs, but this load is reduced to 650 lbs if the force is at 45° to the centreline of the eye bolt. For an eye bolt loaded at 45° in this application, a 1" diameter eye bolt would be required - this would reduce the capacity of the beam as a large hole in the flange would be required. This is therefore not the best type of fastener for this particular application.
5.	Studio Theatre Catwalk Railing Fall Restraint Use Question: Confirm whether catwalk railings may be used for Fall Restraint purposes when leaning out to hang and focus lighting instruments. Reply: Similar to the Concert Hall Canopy railings, the catwalk railings were not designed for the forces needed to meet the requirements for Fall Arrest, although they are designed to resist a typical horizontal guardrail loading where fall is not possible. The floor beams supporting the catwalks do have adequate capacity for the Fall Arrest load, and if permanent anchorages are added they could be welded or bolted to the floor beams and channels in appropriate locations to provide the required load resistance. The types of anchors should be compatible with the fall-restraint system and fall arrest rigging equipment being used.
6.	Concert Hall Catwalk Railing Fall Restraint Use Question: Confirm whether catwalk railings behind lighting positions may be used for Fall Restraint purposes when leaning out to hang and focus lighting instruments. Reply: No, they do not have adequate capacity, similar to other catwalk railing situations.
7.	Concert Hall Motor Loft Capacities Question: - Confirm capacity per port (i.e. on trolley beam above each port) - Confirm aggregate capacity per trolley beam. - Confirm overall aggregate capacity for roof structure (i.e. on all beams). - Confirm whether we can continue to bridle a point to the misplaced ports (HP25 and HP25A) and if so, what is the load capacity.

Item	Question Posed and Reply:
	Reply: The attached diagram on SK1 shows a key plan to the port locations and the maximum loads that we recommend to be hung from the Trolley Beams through each port. These loads can all be applied concurrently to an individual trolley beam and can be applied to all of the trolley beams concurrently without having an undesirable effect on the roof system as a whole. The loads are limited by the individual beams and their connections, not in the capacity of the roof structures. Part c. of the question concerning the overall capacity of the roof structures is not relevant to the theatre loading. The loads shown are suitable for a clamped attachment to the bottom flange, but if a wheel-loaded hoist attachment is used, the maximum load per pair of wheels would be reduced to a maximum of 3600 lbs (16 kN) to account for the uncertainty in the position of the loads on the bottom flanges, in accordance with good practice for crane beam supports. At HP25 and HP25A where the holes are offset from the trolley beams, the lines can be bridled to deflect the line down the hole, but a reduced load of has been recommended on the diagram. The support point carrying the horizontal force from the bridling rigging, should be appropriately placed and anchored. If the bridle is relatively horizontal, this will not be a significant load. We could review this with you again to see how this system functions.
8.	Concert Hall Catwalk Upstage Centre Capacity (through Houselight openings) Question: Confirm whether there is sufficient discretionary load at this position on the catwalk to allow a truss with drape to be hung across the organ loft. If so, assist with practical application, i.e. what type and size of structural element is appropriate to use above the catwalk. Reply: A steel beam placed above the floor can be used to spread the load from a hanging curtain to the two adjacent steel channels for support of loads up to 1200 lbs (5.3 kN). The beam can be made of a HSS 3"x3"x0.188 x 6'-0" long, ensuring that both ends are over top of one of the 5" floor channels.
9.	Studio Theatre Catwalk loading information Question: Confirm capacity of the catwalk in general. This is in reference to heavy use shows such as films, where there may be 10-20 technicians, dimmer racks, control consoles, c-way cable, etc. in some quantity on the catwalk. Reply: The attached drawing on SK2 shows the typical uniform loads that can be applied to a catwalk. Concentrated loads of between 500 lbs (2.2 kN) and 1000 lbs (4.4 kN) could be applied, with the equivalent area around the equipment left empty and not used for other equipment loads. If concentrated loads exceeding 1000 lbs (4.4 kN) are desired, specific analysis should be made.

Item	Question Posed and Reply:
10.	Studio Theatre Roof Structure Capacities Question: Prepare a breakdown of useful capacities at predetermined intervals in the "theatre steel", i.e. head beam and loft beams; and in the "roof steel", i.e. the roof trusses and braces from which the loft and head beams are suspended. It could also include aggregate loads similar to item #7 above. It is understood that this would be informative rather than exhaustive. Reply: The attached sketch on SK3 shows the typical loads that can be applied to the loft and head beams for the Studio Theatre. The loads are shown at a maximum spacing of 7'-3" (2.2 m) in order to limit the load to an individual truss. However, multiple smaller loads can be applied at a shorter spacing, i.e. half the load at half the spacing, so as to keep the maximum load to the specific truss to the value indicated. Loads near mid-span of the roof trusses are lower due to interaction with the roof live and dead loads. If higher loads than those shown in the table were desirable, the higher loads could be obtained by locally strengthening the bottom HSS chord of the roof truss, between the points that have the vertical and diagonal members framing to them.
11.	Concert Hall Catwalk String Uplight Access Doors Fall Arrest Points Question: Confirm whether the existing welded Fall Arrest points meet code requirements. This may involve non-destructive testing by Elander Inspections Ltd. Reply: The existing welded Fall Arrest points that are welded eye bolts on the sides of the Uplight Access Doors do not meet the Fall Arrest requirements, as the bolts are currently used in bending and do not meet the load requirements in this condition.

Conclusions:

Based on our detailed analysis, we have found that many of the current elements presently being used for personal safety support do not meet the WorkSafe BC requirements for a permanent Fall Arrest system.

We would expect that the installation of a permanent Fall Arrest system can be done with purpose-made equipment attached to the steel beams and concrete elements in a manner that can meet the necessary requirements, but care will need to be taken to select system that does not impose loads on the existing handrails or other elements that causes undesirable axial or bending stresses. It is beyond the scope of this present assignment to design the elements of a Fall Arrest system or their connections, but we can be available to provide engineering input into a system if added to the building.

The attached diagrams for the Concert Hall and Studio Theatres presents allowable loadings to the various elements where rigging equipment can be safely supported. However, as noted above, this information is intended to provide general guidelines and may not preclude the application of higher loads at a specific location where this is required. A case-specific analysis using the higher loads would be necessary.

We would like the opportunity to discuss these results with you at the site which could be arranged later this week.

Yours truly,
C.Y. LOH ASSOCIATES LTD.



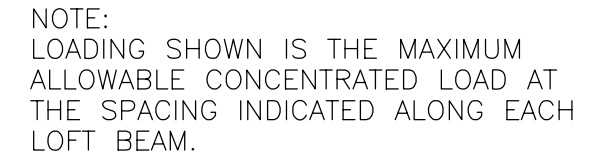
Kosta Marcakis P.Eng. Struct. Eng.
KM:LS/pc

10100-ChanCentre-Report.wpd



Lisa Sorensen, P.Eng.

Sheet No. SK3



LOFT BEAM 6 8000 lbs @ 7'-3" o/c