

## Executive Summary

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The intent of this report is to determine and document the structural capacities of structural systems that involve rigging of show equipment. Although the initial mandate was to evaluate the potential of hosting the Lion King, Walt Disney play production, the scope of work was expanded to include an analysis of the stage structure using a structural analysis program; capable of predicting the forces and deflections of the entire structural system that houses the stage, stage roof, grid steel, and mechanical penthouse. A three dimensional schematic representation of the stage structure is shown on Figure E.1, and the members shown on this figure have been included into the structural model.

The structural program used in the analysis portion of our work is S-Frame – S-Frame uses the displacement (stiffness) method in the analysis for frames structures composed of prismatic straight members. The use of the computer program is warranted and has future benefits in solving complex and rigorous load combinations. The stage structure is very complex, and because members are interconnected, the load paths become very difficult to predict without the use of a computer program. The advantage of the S-Frame model is any future analysis of load cases can be reviewed by an engineer with minimal effort.

The analysis focused not only on the structure as a whole; but also determining capacities of individual members such as the line set system, grid steel, roof trusses and hangers linking the roof trusses to the grid steel. The loads shown in the report have been recorded in both imperial and metric systems of measure.

The report has identified limitations of the rigging system, including the structure in both facilities, to determine the safe load capacities of individual components and the structure as a whole. The structural analysis was also extended to include a load case for the Lion King show, which will visit the Edmonton facility during the month of July and the Calgary facility during the month of August. The limitations of both facilities have been summarized below with recommendations as follows:

1. The Lion King show has been determined from analysis that it can be suspended in both facilities during the summer and fall months with the exception of the single hangers in the Edmonton facility. The single hangers in the Edmonton facility have been upgraded as described in this report.

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2. The steel grades, used in both facilities, have been tested by Exova to determine the design steel grades that can be used for evaluating the capacities of the structural steel. The test results for the steel grades have been included in the appendix of this report. In summary the following grades of steel have been used for various sections:
  - a. Wide flange beams 260 mPa (38,000 ksi)
  - b. Channel section 345 mPa (50,000 ksi)
  - c. Angle section 345 mPa (50,000 ksi)
3. The Edmonton facility is very limited in capacity during the winter and early spring months for hosting any shows with significant hanging loads. The secondary roof trusses should be fortified to allow capacity equivalent to the Calgary facility for hosting similar shows during winter months.
4. All loads suspended from the grid steel should be supported from either the loft well channels (C15) or the secondary C8 framing members. The C3 walking grid steel should not be used to support any suspended loads other than noted in the report.
5. Loads supported using bridals should be avoided since the horizontal resultant force from the bridal diminish the capacity of the carrying member. It is recommended that bridal loads are not used at all on any grid steel member.
6. A 20% impact load has been used in determining the load capacity of individual structural steel members. The 20% reduction factor has been applied to compensate for the potential impact loads from electric hoist motors.
7. The advice of an engineer shall be used for all shows that contain concentrated loads within a panel area (panel area is defined as the area between loft wells and C8 channels – 10'-0" x 10'-0") exceeding 5000 lbs, and/or the combined suspended load between grid lines exceeds 30 psf (this load is achieved by summing all the suspended loads confined by a set of grid lines or 20'-0" and the useable building width or 40'-0"). A total suspended load of 24,000 lbs confined between a set of grid lines would achieve the 30 psf loading – this load applies all year round in both NAJA and SAJA facilities."
8. The advice of an engineer shall be used for concentrated load cases that do not conform to the load cases shown for the individual member cases given in this report.