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Section: 04 - Special Operations	
SOG Number: 04.20	**Effective Date:**
Subject: Use of Aerials in Rope Rescue Systems	
By Order of Fire Chief Derek Libby	

I. Purpose:

The purpose of this guideline is to provide parameters and considerations for the safe use of aerials as a fixed high directional or as a fixed crane, for the movement of people and/or equipment.

II. Scope:

The scope of this guideline pertains to all situations, to include both incidents and training situations, where members of the Burlington Fire Department are utilizing aerials as a part of a rope system or for the movement of people or equipment suspended in a fixed manner beneath the platform or tip of an aerial device. This guideline identifies the only permissible methods of rigging aerials for use in a rope system (excluding use of the vehicle as an anchor in a typical manner).

III. Definitions:

Fixed Crane: Method in which the load is suspended directly beneath the aerial platform or tip and movement of the load is performed using the aerial hydraulics.

Fixed High Directional: Method in which the aerial ladder is utilized as a high directional, where the rope system is directed from the load, through the tip of the aerial, and then to the ground.

TTRRS: Two-Tensioned Rope Rescue System

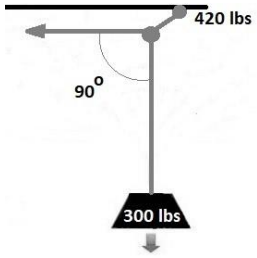
IV. Guidelines:

A). GENERAL CONSIDERATIONS

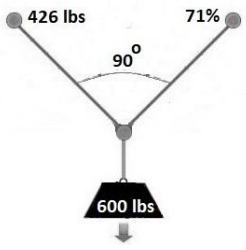
1. Aerial Apparatus Characteristics

a. Tip Load: Anticipated loads should never exceed the aerial tip load.
b. Apparatus Connection Points: It is preferred that connections to the aerial be made using attachment points with known load ratings (i.e. manufacturer identified anchor points). It is permissible to wrap the beams of the aerial to create attachment points. Redirect anchors should ideally be made as close to the turntable as possible. Members should be aware that the rated load capacity for the anchor points at the platform (375 lb each) on T1 is less than the aerial tip load (1000 lb). Notably, the attachments at the far end of the bed section on T1 are rated at 2000 lbs each.

2. Rigging Calculations
   a. Included Angle on Change of Direction: Change of direction pulley are force multipliers and must be taken into consideration. Example: An aerial set at the horizontal will result in an internal angle (angle formed by the rope running through the pulley) of 90^0. This will result in a load multiplier of 1.4 (See Appendix A for attached Table 1: Included Angle on COD). If a 300 lb load is suspended from the aerial, with the aerial being used as a high directional at 0 degrees, the tip will feel a force of 420 lbs. (300 lbs x 1.4 = 420 lbs)



   b. Included Angle for Anchor Vector Forces: Anchor vector forces are critical to consider, especially when rigging an aerial as a high directional. Example: If a 2-person load (assumed to be 600 lbs) is suspended below the bucket of T1 using a multi-point anchor (load share between the 375# rated attachment points) and the internal angle is 90^0 (multiplier of 0.71 – See Appendix A for attached Table 2: Included Angle for Anchor Vector Forces), each attachment point is experiencing a 426 lb force.



3. Rigging Principles
    a. Limit the load: Avoid unnecessary loads (i.e. members in the bucket or at the tip of aerial) and, if possible, avoid using a litter attendant, as this would effectively double the load.
    b. Avoid dynamic loading.
    c. Avoid loading system using aerial hydraulics.
4. Personnel: Utilize the appropriate personnel who have the technical expertise for utilizing an aerial for a technical rescue.
5. Tag lines should always be used. Avoid pulling vigorously on tag lines, as this introduces additional forces.

B). OPERATIONS

For the Burlington Fire Department, there will be two permissible methods for rigging the aerial for rope rescue operations.

1. Fixed Crane:
    a. Load is fixed directly to the tip of aerial; suspended beneath aerial.
    b. Connection between load and tip shall be (2) sets of fours. This will allow for redundancy.
    c. Keep load as close to the aerial as possible.
    d. Once loaded (using the set of fours), all movement is with aerial hydraulics.
2. Fixed High Directional:
    a. Aerial rigged and then moved into positioned to be used as a fixed high directional. All movement of load is with rope system, not aerial hydraulics.
    b. Preferred method is use of a TTRRS to ensure redundancy and reduce likelihood of significant dynamic event.
    c. Rig in line with aerial ladder to avoid lateral and/or torsional loading.
    d. Avoid anchoring to aerial stabilizers and outriggers.

V. Responsibility:

It is the responsibility of all members to read, understand and follow this Standard Operating Guideline. The incident commander and/or the aerial apparatus company officer are responsible for ensuring properly trained personnel are involved in any evolution where an aerial is used as either a fixed high directional or as a fixed crane.

Revision History			
Revision Date	Section	Summary	Principal Author
A	TBD	TBD	Lt. S. Petit

Appendix A

Table 1: Included Angle on Change of Direction

Angle	Force Multiplier	Angle	Force Multiplier	Angle	Force Multiplier
0	**2**	65	1.688	130	0.845
5	1.998	70	1.638	135	0.765
10	1.992	75	1.587	140	0.684
15	1.983	80	1.532	145	0.601
20	1.970	85	1.474	150	0.518
25	1.953	**90**	**1.414**	155	0.433
30	**1.932**	95	1.351	160	0.347
35	1.907	100	1.286	165	0.261
40	1.879	105	1.217	170	0.174
45	**1.848**	110	1.147	175	0.087
50	1.813	115	1.075	**180**	**0**
55	1.774	**120**	**1.0**		
60	**1.732**	125	0.923		

Table 2: Included Angle for Anchor Vector Forces

Angle	Force Multiplier	Angle	Force Multiplier	Angle	Force Multiplier
0	**0.500**	65	0.593	130	1.183
5	0.501	70	0.610	135	1.306
10	0.502	75	0.630	140	1.462
15	0.504	80	0.653	145	1.668
20	0.508	85	0.678	150	1.932
25	0.512	**90**	**0.707**	155	2.310
30	**0.518**	95	0.740	160	2.879
35	0.524	100	0.778	165	3.831
40	0.532	105	0.821	170	5.737
45	**0.541**	110	0.872	175	11.469
50	0.552	115	0.931	**180**	**∞**
55	0.564	**120**	**1**		
60	**0.577**	125	1.089		