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Standard Forest Service Designs for Rappel Towers

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In 2005, the Missoula Technology and Development Center (MTDC) began a project to develop standard plans and specifications for towers used to train firefighters who rappel from helicopters. The project was to be completed in three phases:

- Phase one—Review current towers.
- Phase two—Assemble a rappel tower design advisory committee.
- Phase three—Develop a set of standard rappel tower plans and specifications.

The tower would have to meet all U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) standards, be easily reconfigured to simulate a variety of different helicopter cabins, and be suitable for expansion for academy-style training (figure 1). Academy-style training is when rappel bases schedule joint training at a rappel tower.

Highlights...

- Forest Service rappel bases need safe towers where rappellers can practice their skills.
- A standard design has been developed for a rappel tower with a helicopter cabin simulator that meets appropriate safety standards.
- The example drawings and additional resources for operation, maintenance, and inspection of the standard rappel tower and the helicopter cabin simulator are available on the Technology and Development Program's password-protected Internet site at *http://www.fs.fed.us/t-d/pubs/htmlpubs/htm08572354/tower.htm* (Username: t-d, Password: t-d).

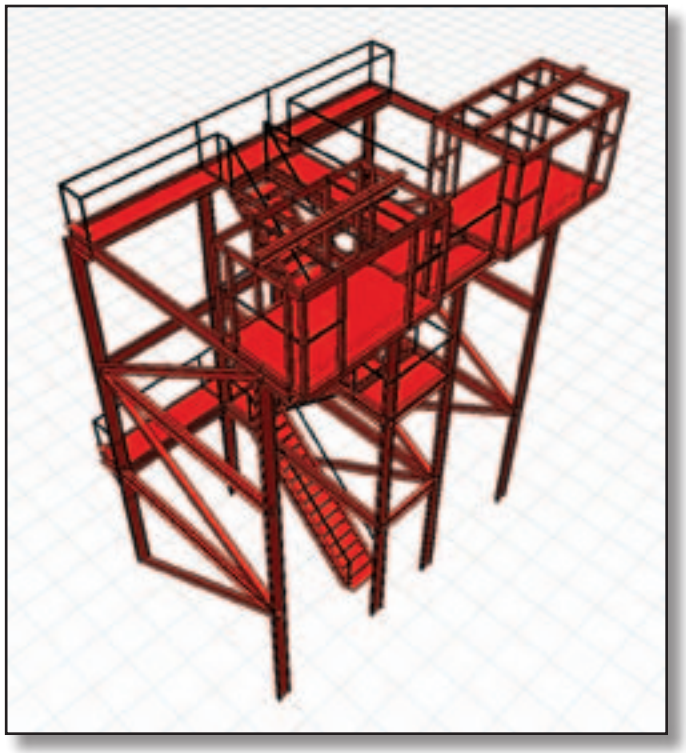

Figure 1—Rappel tower with dual helicopter cabin simulators for academy-style training.

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The Rappel Tower Project

In the spring of 2006, an advisory committee of rappellers, rappel spotters, safety specialists, and engineers was assembled to develop the requirements for a rappel tower with a helicopter cabin simulator. Before the first meeting, a questionnaire was sent out to the advisory committee members to learn the attributes they felt were needed for the tower and helicopter cabin simulator. A meeting was arranged at Boise, ID, near the Lucky Peak Rappel Tower (figure 2), which had most of the desired attributes. In addition, the authors visited the John Day Rappel Tower (figure 3) at John Day, OR, to gather additional ideas for academy-style training needs.

Figure 2—Lucky Peak Rappel Tower.

Figure 3—John Day Rappel Tower.

During the advisory committee meeting, the group reached a consensus on the design of the rappel tower with a helicopter cabin simulator. The final tower design has two levels for rappelling. The lower level is 10 feet above the ground to allow new rappellers to become familiar with the rappel rope. The upper level is 30 feet above the ground with a helicopter cabin simulator that allows trainees to become familiar with different helicopter cabin configurations.

The helicopter cabin simulator is 6 feet wide by 10 feet long by 6 feet 3 inches high, with sliding doors on the side of the simulator where rappellers exit. MTDC established specifications that meet OSHA standards and material codes.

During the development stages, a wooden mockup of a helicopter cabin simulator (figure 4) was constructed at MTDC to help the advisory committee determine whether the proposed dimensions would allow simulation of all the different helicopter cabins and the locations of anchor points for rappel ropes and tether straps. The advisory committee

Figure 4— A wooden mockup of a helicopter cabin simulator.

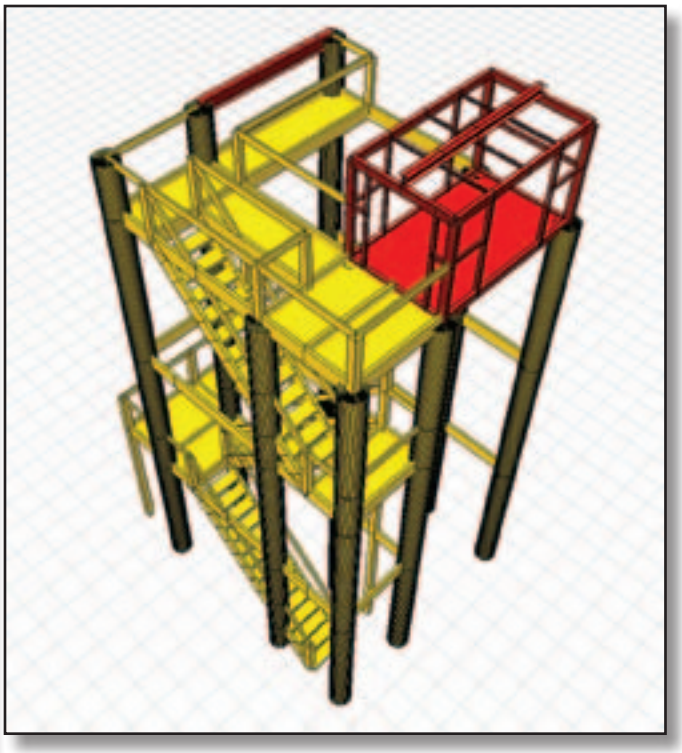

Figure 5—Wood rappel tower with a helicopter cabin simulator (wooden components are yellow).

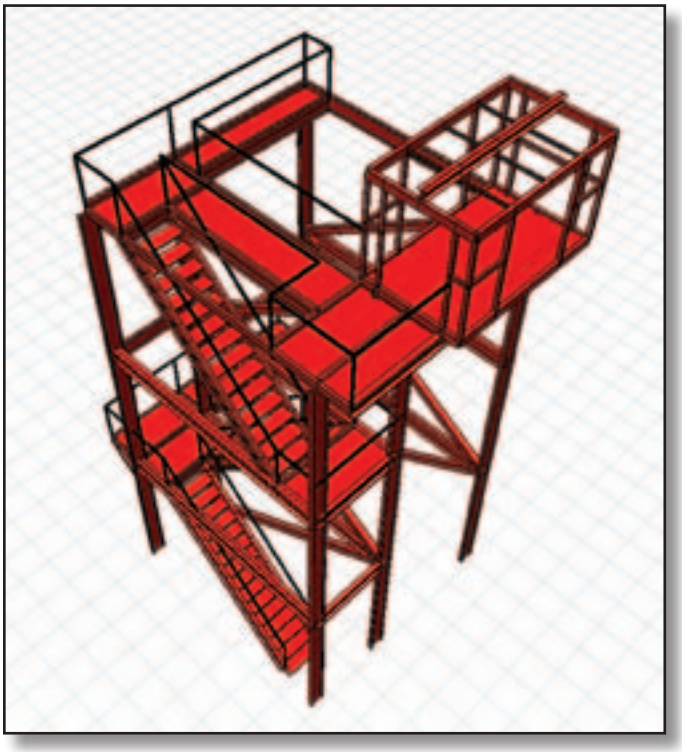

Figure 6—Steel rappel tower with a helicopter cabin simulator.

reviewed the helicopter cabin simulator mockup and made recommendations for the final design.

The new tower design has a central stairway with six columns and three levels, allowing better traffic flow during rappel training.

A tower with a single simulator is most appropriate for training by a single rappel base. The central stairway allows the tower to be expanded easily by adding another simulator and a lower platform for academy-style training. Some regions may opt to construct an academy-style tower at a centralized location rather than to construct towers with single simulators at individual rappel bases.

One consideration during the project was whether to create designs for wood construction (figure 5), steel construction (figure 6), or both. A wood rappel tower would cost less to build, but would require more maintenance. If the maintenance were not performed, the wood tower's service life could be reduced. Creating both designs would have added significantly to the cost and time required to

complete the project. Based on a recommendation from the Interagency Helicopter Rappel Working Group and the Interagency Helicopter Rappel Equipment and Procedures Committee, the National Aviation Office decided to develop just the steel design.

A contract was let to Aegis Engineering, PLLC, in August 2007 for design of a steel rappel tower at the Northern Region Aerial Fire Depot in Missoula, MT. The geotechnical investigation was completed in August 2007. The final design for the rappel tower was completed in September 2008. Early versions of the standard plans were sent to the Sequoia National Forest to help design the new rappel tower for the Peppermint Helibase and to the Los Padres National Forest to help the forest apply for funds to design and construct a new rappel tower.

Safety Regulations and Applicable Codes

A search revealed no Federal regulations, material codes, or guidelines that apply specifically to rappel training towers. However, "Occupational Safety and Health Standards" (29 CFR Part 1910) establishes requirements for stairway dimensions and slope, sizes of openings, loads, railing systems, and fall arrest anchor points.

Rappel towers are not covered by the International Building Code (IBC). They will not be open to the general public and will have to be signed "For Administrative Use Only." Because rappel towers are not covered by the IBC, the most applicable standard was "Minimum Design Loads for Buildings and Other Structures" (ASCE/SEI 7-05). This standard gives minimum design load values in pounds per square foot for wind, seismic, snow, and live loads.

Rappel Tower and Helicopter Cabin Simulator Loads

Rappel towers need to withstand environmental, live, and dead loads. Environmental loads are site specific and change with each new tower location. Environmental loads include snow, wind, and seismic loads that depend on snowfall, wind exposure, and soil conditions. Live and dead loads are typically the same for all towers. The minimum live load is 100 pounds per square foot (from ASCE/SEI 7-05). The required loads for safety are 1,000 pounds for a moving point load on stairways and 5,000 pounds for fall arrest anchor points (from OSHA regulations). Dead loads, or the weight of the tower structure, will be about the same for all towers, unless beams or columns have to be larger to handle increased snow, wind, or seismic loads.

Designing, Maintaining, Inspecting, and Using Rappel Towers

The following information is provided to help helibase managers, fire management officers, and national forest managers plan and construct a rappel tower with a helicopter cabin simulator for rappel training. A geotechnical investigation and report are required to determine soil conditions. The standard drawings MUST be reviewed (and possibly modified) for site-specific conditions. Once this is completed, the plans can be stamped by the consulting firm contracted to make the plans site specific.

The design allows managers to change some tower attributes, such as steel type, steel corrosion protection, and paint color. The tower preferences are listed on the "Checkoff List for Rappel Tower Options To Be Included in Design." Documents were developed to provide guidance for operating, maintaining, and inspecting the rappel tower and the helicopter cabin simulator.

The following materials are available on the Technology and Development Program's password-protected Internet site at *http://www.fs.fed.us/t-d/pubs/htmlpubs/htm08572354/tower.htm* (Username: t-d, Password: t-d).

Tower Design

- Example Drawings for the Missoula Aerial Fire Depot Rappel Tower
- Example Specifications for the Missoula Aerial Fire Depot Rappel Tower
- Tower Loading Information
- Checkoff List for Rappel Tower Options To Be Included in Design
- Example Geotechnical Investigation Task Specifications
- Example Rappel Tower Design Specification for Making Tower Site Specific
- Estimated Construction Costs

Tower Operation

- Example Operating and Maintenance Plan for the Missoula Aerial Fire Depot Rappel Tower
- Example Generic Operating Instructions
- Example Model-Specific Simulator Configuration and Operating Instructions
- Example Job Hazard Analysis (JHA)
- Example Rescue Procedures

Maintenance and Inspections

- Rappel Tower Initial Inspection Checklist Form
- Rappel Tower Engineering Inspection Report and Checklist Form
- Rappel Tower Maintenance Record Form
- Rappel Tower Annual Pre-Use Condition Assessment Checklist Form
- Rappel Tower Daily Pre-Use Condition Assessment Checklist Form
- Rappel Tower Unit Log Form

Estimated Construction Costs

The rising cost of steel, remoteness of the tower sites, and other factors make it difficult to provide accurate estimates of the construction costs for a rappel tower with a helicopter cabin simulator. The geotechnical investigation could cost $3,000 to $5,000 or more, depending on the remoteness of the site. Engineering review to make the standard plans site specific could cost $5,000 to $25,000 or more. Construction could cost from $120,000 to $185,000 or more. The academy-style tower design could add another 50 percent to the project's cost.

Summary

Standard plans and specifications for a rappel training tower and helicopter cabin simulator will help fire management officers and national forest managers plan, design, and construct rappel training towers that meet current OSHA regulations and applicable codes and guidelines.

References

American Society of Civil Engineers. 2006. Minimum design loads for buildings and other structures. Standard ASCE/SEI 7-05: including supplement No. 1. Reston, VA: American Society of Civil Engineers.

U.S. Department of Labor, Occupational Safety and Health Administration. [no date]. Part 1910: occupational safety and health standards. Washington, DC: U.S. Department of Labor, Occupational Safety and Health Administration. Available at *http://www.osha.gov/* (click on "Standards" under the "Laws and Regulations" link on the right side of the page).

Acknowledgments

The authors would like to acknowledge Tom York (Pacific Southwest Region) for proposing this project. The project relied heavily on members of the ad hoc Rappel Tower and Simulator Advisory Committee who helped formulate the tower and simulator design criteria, design concepts, and final configuration. Their efforts attending and participating in project meetings and reviewing the specifications and drafts of drawings helped keep the final design user friendly. Their help in developing the operation and maintenance plan and the tower rescue procedures was also appreciated.

The spotter/rappeller representatives on the committee were Dave M. Redman (Northern Region), Jim Lawson (Rocky Mountain Region), Scott McKelvey and William Balcom (both of the Southwestern Region), Pierre "T.T." Cain (Intermountain Region), Sean Aidukas (Pacific Southwest Region), and Aaron Schoolcraft, Kevin Brown, and Courtney Fent (all of the Pacific Northwest Region). The engineering representatives on the committee were Tom Gillins (Intermountain Region) and Steve Oravetz (Northern Region). The health and safety representatives on the committee were Gary Hoshide (MTDC) and Ralph Revello (Northern Region).

The authors also want to thank the Interagency Rappel Working Group and Interagency Helicopter Rappel Equipment and Procedures Committee for reviewing recommendations and helping focus the final design configuration.

About the Authors

James "Scott" Groenier began working for MTDC in November 2003 as a civil engineering project leader. Groenier earned a bachelor's degree from the University of Wisconsin at Madison and a master's degree from Montana State University. He has worked for the Wisconsin and Illinois State Departments of Transportation before starting his career with the U.S. Department of Agriculture Forest Service. He worked as the east zone structural engineer for the Eastern Region and as a civil engineer for the Ashley and Tongass National Forests.

Keith Windell is a project leader for reforestation, fire, and residues projects. He has a bachelor's degree in mechanical engineering from Montana State University. He has worked for the California Department of Forestry; U.S. Department of the Interior, Bureau of Land Management; and the U.S. Department of Agriculture, Forest Service.

Library Card

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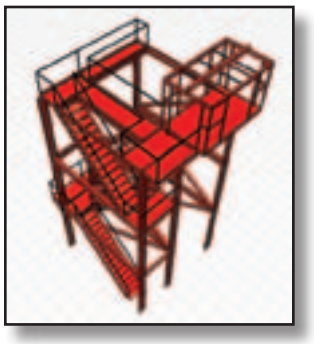
Standard drawings have been prepared for the rappel towers and helicopter cabin simulators used to train firefighters who rappel from helicopters. The drawings (which MUST be reviewed and possibly modified for site-specific conditions) and additional documents for operation, maintenance, and inspection of the standard rappel tower and helicopter cabin simulator are available on the Technology and Development Program's password-protected Internet site at *http://www.fs.fed.us/t-d/pubs/htmlpubs/htm08572354/tower.htm* (Username: t-d, Password: t-d).

Keywords: drawings, fire fighting, firefighting, helicopters, rappelling, safety at work, training



For additional information about rappel towers with helicopter cabin simulators, contact Scott Groenier or Keith Windell at MTDC:

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Electronic copies of MTDC's documents are available on the Internet at:

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http://fsweb.mtdc.wo.fs.fed.us/search/