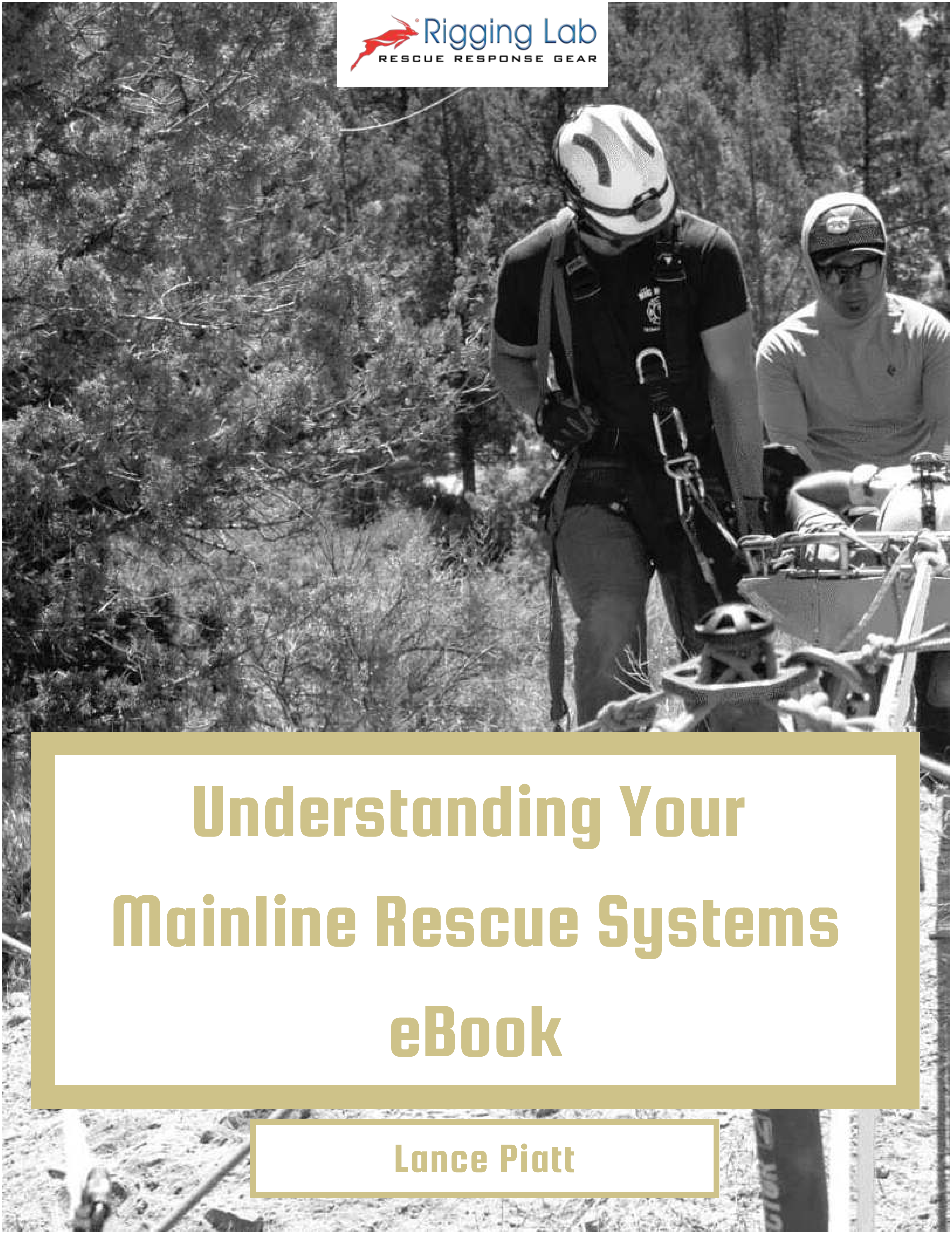


Rigging Lab
RESCUE RESPONSE GEAR

Understanding Your Mainline Rescue Systems eBook

Lance Piatt

Table Of Contents

1.1 Understanding Your Mainline Systems

Mainline rescue and rigging systems are a complex yet essential set of skills that require both theoretical knowledge and practical proficiency. These systems are employed by various professionals, including firefighters, search and rescue teams, industrial workers, and arborists, to ensure the safety of individuals in hazardous situations and to manage heavy loads with precision and care. Proper training and ongoing practice are crucial for mastering these techniques and performing successful rescue and rigging operations.

Here's a quick run down as to what will be covered:

1. Understanding Forces and Friction on Mainline Systems: This foundational concept involves recognizing the various forces acting on a system, including tension, compression, and shear forces. Understanding friction is vital for minimizing energy losses within the system.

2. Mechanical Advantage Theory: Mechanical advantage (MA) is a fundamental concept that relates to the amplification of force achieved through mechanical systems. It's important to understand how to calculate and apply MA to optimize force exertion.

3. Terms and Definitions of Mechanical Advantage Systems: Familiarity with the terminology used in mechanical advantage systems, such as input force, output force, and effort, is essential for effective communication and operation.

4. Types of Pulley Systems: Different types of pulley systems, including single, double, and compound pulleys, play a significant role in mainline systems. Knowing when and how to 1.1 Understanding Your Mainline Systems use each type is critical for efficient rigging.

5. How and When to Use Long Line MA Systems: Long line mechanical advantage systems are employed in scenarios where there's a need to cover a substantial distance while maintaining mechanical advantage. Understanding their applications is crucial for rope rescue operations.

6. How and When to Use "Block and Tackle" Systems: Block and tackle systems are used to achieve a high level of mechanical advantage by incorporating multiple pulleys. Knowing when and how to deploy these systems is vital for heavy lifting and load management.

7. Calculating Tension Force Using the T-Method: The T-method is a method for calculating the tension in rope systems. It involves considering the angles and forces involved, providing an accurate way to determine load distribution.

8. How Forces are Generated: Understanding how forces are generated in various rigging scenarios, such as tension forces in ropes or cables, is essential for safe and efficient operations.

9. Moving Systems: Techniques for moving systems efficiently, including horizontal or vertical movement, are crucial for performing successful rescues or rigging tasks.

10. Lowering Systems - Low to Mid Angle: Lowering systems are used to safely lower a load or a person from an elevated position. Knowledge of how to set up and operate these systems, especially in low to mid-angle situations, is important.

11. Lowering Systems - Mid to Steep Angle: In more challenging terrain, such as steep slopes or cliffs, understanding how to set up and operate lowering systems becomes even more critical for rescue operations.

12. Twin Tension Rope Systems: Twin tension rope systems involve using two ropes or cables to provide redundancy and stability in rescue or rigging scenarios. Knowing when and how to employ these systems is vital for safety.

13. Winch & Capstan: Winches and capstans are mechanical devices used for controlled and powerful pulling or lifting operations. Understanding their operation is essential in many rigging contexts.

This course is designed as an overview of topics and elements that will be examined in greater detail. As you can imagine, raise and lowering systems, twin (two) tension systems, and mechanical advantage are expansive and deserve their own place within the course lineups.

So let's jump into "working the plan"... And as with all teaching methods, we'll endeavor to have as many options and manners of consideration in order to develop the best comprehension... not everyone learns in the same way nor at the same rate.

1.2 Pre-plan the Working Line

Pre-plan the Working Line Pre-planning" in the context of technical rope rescue mainline systems involves thorough preparation and consideration of key factors before executing a rescue operation. Here are the essential aspects of pre-planning for technical rope rescue mainline systems:

1. Risk Assessment: Identify potential hazards and risks associated with the rescue scenario. Evaluate the environment, terrain, weather conditions, and any potential complications.

2. Objective Clarification: Define clear and specific objectives for the rescue mission. Determine the number of victims, their locations, and the desired outcomes.

3. Resource Assessment: Assess available resources, including personnel, equipment, and tools. Ensure that all necessary gear is in good condition and readily accessible.

4. Communication Plan: Establish a communication plan to ensure effective coordination among team members. Define communication protocols and backup systems.

5. Scene Safety: Prioritize the safety of both rescuers and victims. Implement safety measures, secure the scene, and establish hazard zones if necessary.

6. Anchor Points: Identify suitable anchor points for rope systems. Ensure their integrity and calculate their load-bearing capacity. 1.2 Pre-plan the Working Line

7. Equipment Selection: Select appropriate ropes, harnesses, carabiners, pulleys, and other rigging equipment based on the specific requirements of the rescue.

8. Mechanical Advantage: Determine the mechanical advantage systems needed for lifting, lowering, or hauling operations. Calculate the required force and adjust mechanical advantage accordingly.
9. Rope Management: Plan how ropes will be deployed, maintained, and stored during the operation to prevent entanglements and ensure smooth movement.

10. Rescue Team Roles: Assign specific roles and responsibilities to each team member, including a team leader, belayer, and victim attendant.

11. Victim Packaging: Plan the method of packaging victims, ensuring their safety and comfort during the rescue.

12. Contingency Plans: Develop contingency plans for unexpected scenarios, such as equipment failure, changing weather conditions, or additional victims.

13. Medical Considerations: Address any medical needs of victims and ensure the availability of necessary medical supplies and personnel.

14. Time Management: Establish timeframes for different phases of the rescue operation to maintain efficiency and prevent unnecessary delays.

15. Briefing and Debriefing: Conduct thorough briefings before the operation to ensure everyone understands their roles and responsibilities. After the rescue, conduct a debriefing to identify lessons learned and areas for improvement.

16. Documentation: Keep detailed records of the pre-planning process, including risk assessments, equipment checks, and communication plans.

Pre-planning is a critical phase in technical rope rescue mainline systems, as it lays the foundation for a safe and successful rescue operation. It minimizes risks, optimizes resources, and ensures that the rescue team is well-prepared to respond to emergencies effectively.

1.3 Analyzing a Rope Rescue System

A rope rescue system is a critical piece of equipment for those in the emergency services industry. It consists of multiple components that link together to allow personnel to safely move an injured person or other load from a hazardous location quickly and efficiently. Ensuring safe operations requires conducting a rigorous system analysis so you can identify the weakest areas in the chain and take corrective action if needed. This analysis is especially important when members of the public are depending on your system for their safety and well-being. It's vital to know where the weakest point in a system is, so you can be sure it won't fail in any situation.

Catastrophic failures can be devastating. When a component fails and the load is released, it can cause enormous damage to the system as a whole, much less 'the human effect".

When a component fails and the load is not released, the system may stop working, which can have terrible consequences for the patient if it takes a long time to fix the issue.

Analyzing a rope rescue system is essential to ensure safety. We must look at the entire system, not just the individual parts, and each component has a "minimum breaking strength" or MBS that has been determined by a specific test method. However, these methods may not always accurately reflect the way it is being used in the system.

Rope Rescue System Analysis

The analysis of a rope rescue system has three parts: critical point analysis, whiteboard analysis and the whistle test. Critical point analysis involves assessing the potential risks or points of failure within the system. Whiteboard analysis is a step-by-step review of the entire system, providing an opportunity to visualize any possible problems before actually operating in real-world conditions. The whistle test is a way to assess the performance of the system under simulated or actual operational conditions, allowing for troubleshooting and adjustments before implementation. By analyzing all aspects of the rope rescue system before implementing it, potential risks can be reduced and overall safety increased.

Critical Point Analysis

Critical point analysis is a method of assessing the safety of a system by looking into each individual component. It determines if any certain part failing would cause catastrophic failure to the whole system. If a critical point is identified, it needs to be addressed and resolved with either a redundant component or some other form of backup. Additionally, if there's an additional system meant to act as a backup for the main one, like a belay system, it should be taken into account when assessing safety. It's essential to consider each element of a system and its potential failures in order to ensure that catastrophic failure can be avoided. Critical point analysis is an effective way to do this.

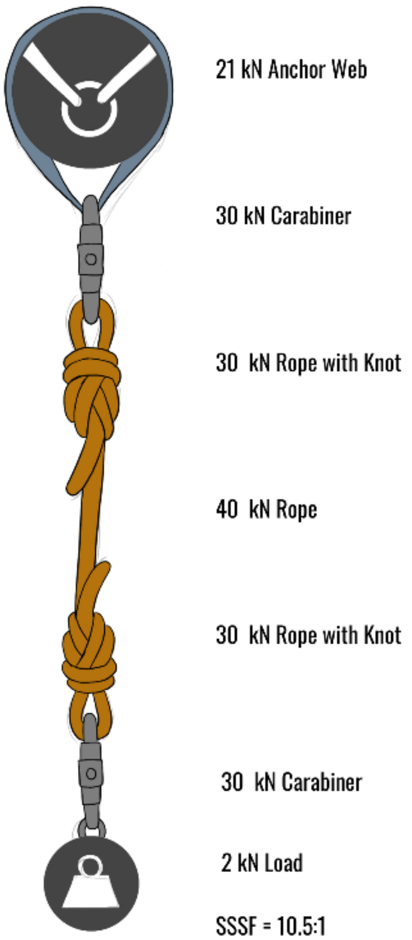
Whistle Test

The whistle test is an important part of any system setup. It's a theoretical test that determines the safety measures in place if all the operators let go at once. A "swarm of hornets or bolt of lightning" could distract both the haul team and belayer, causing them to release their lines unexpectedly. The tandem prusik is an example of a system that should pass the test, however a munter belay would not. Even though these tests are theoretical, they should still be taken seriously as they could potentially save lives. Ensure you are familiar with the systems being used and that your team is prepared for any eventuality.

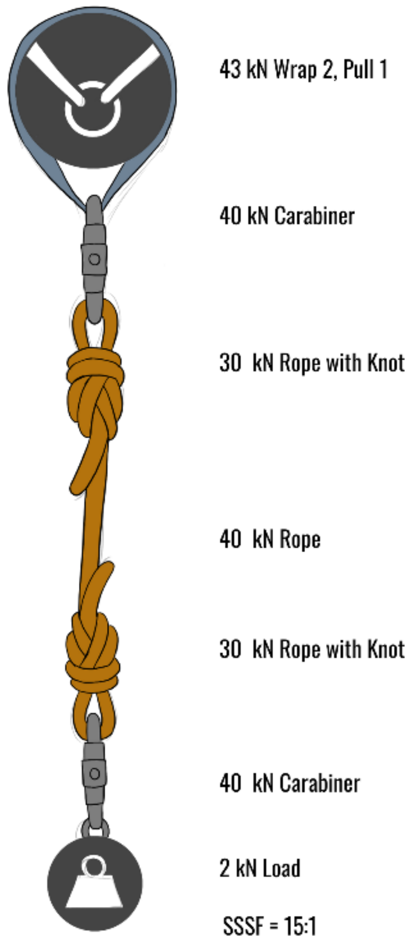
Whiteboard Analysis

The whiteboard analysis is a crucial step in evaluating the safety and strength of a rescue system. It requires identifying all components of the system, assessing their relative strength, and determining how they are used. The way each link is rigged and its individual strength will determine the overall system strength, which is represented by the System Safety Factor (SSF). Both static and dynamic loads must be evaluated in a whiteboard analysis to ensure that the system can withstand anticipated forces. The information gathered will help determine if the system is suitable for its purpose or whether changes need to be made for improved safety. It's critical to understanding how each piece of equipment works together as part of an overall rescue system.

Whiteboard analysis is an essential tool for understanding and solving mechanical systems. It involves drawing out the system on a whiteboard or other large surface, including angles, change of directions (pulleys or gears) 1.3 Analyzing a Rope Rescue System and any factors that could affect the forces on the system. To get started, let's look at a simple static system as an example. We can use this system to walk through the process of whiteboard analysis and understand how various elements affect each other, in order to determine an overall solution. By studying the position, direction, and magnitude of different forces and components within a system, it's possible to get a better grasp on what iscausing problems or inefficiencies.



Example 1 of a Simple System 1:1



Example 2 of a Simple System 1:1

When it comes to whiteboard analysis, the anchor point is one of those factors that can be hard to anticipate ahead of time. Depending on the rescue task at hand, the anchor point may vary from location to location. Knowing this information beforehand will help inform your decision-making and allow you to make more accurate predictions about possible outcomes for each situation you encounter. Tie-off points are an example of fixed points that can be incorporated into a whiteboard analysis. In this context, a tie-off point is an anchor that is part of the landscape or structure and remains in place for repeated use. For instance, on a rescue truck, the same point may be used over and over to secure the vehicle during operations.

The below begs the questions now... what is your SOP for SSF (SSSF)?

Example 1 10.5:1

Webbing with a water knot around BFR

Interior angle is 90° - anchor strength is 21 kN

Aluminum carabiners 30 kN - meets NFPA 1983 T

12.5mm rope rated at 40 kN - meets NFPA 1983 G

Rope strength at 30 kN due to knot (25%)

Load is 2 kN force - standard for testing

No other deflection or pulleys - Simple System 1:1

Example 2 15:1

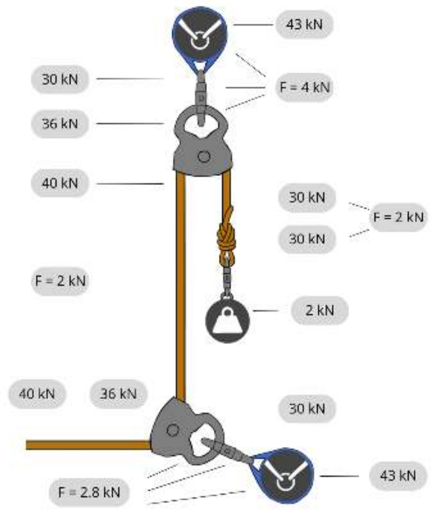
Installing a Wrap 2 -Pull 1 webbing anchor

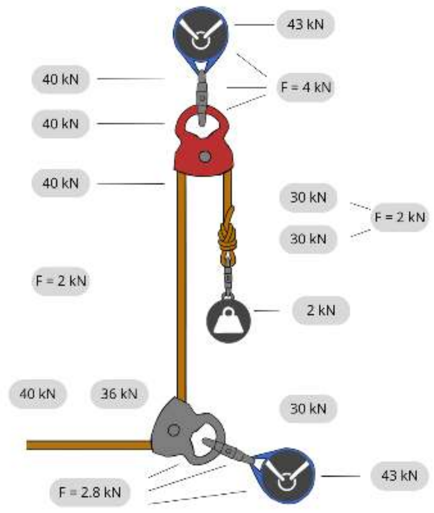
- 43 kN High rated carabiners at both ends - 40 kN

Having the information of what could be the weakest link in a system before going out on a rescue mission is invaluable. Knowing exactly what type of knot to use, and how tight it should be, can help ensure that nothing goes wrong during the mission. By using an SOP requiring a doubled loop when tying anchor with one inch webbing, and making sure that the interior angle of the loop is no more than 90 degrees, rescuers can be confident that their anchor point will be strong and secure. This analysis helps keep everyone safe in the field and is an important part of any mission.

Despite replacing the 30 kN T-use carabiners with g-use 40 kN carabiners to match the NFPA rope being used, the safety factor (SSF) revealed that the weakest link in the system was still the knotted rope. This meant that while adjusting SSF did increase safety levels, it didn't address the weak link in the system. Therefore, more needs to be done to ensure safety for any rigging system.

In the diagrams below we have actual systems that would be deployed in any given operation.





First Example SSSF of 7.5:1

Second Example SSSF of 10:1

We've adjusted the system as compared to the first couple of examples.

The top of the system now has fixed pulley rated at 36 kN meeting the NFPA G. The pulley is a force multiplier x2

A fixed pulley with a 0°interior angle doubles the load Carabiner is the weak link at 30 kN

The 90° angle at the COD will put a 1.41 x the load making it 2.8 kN but does not reduce the SSSF

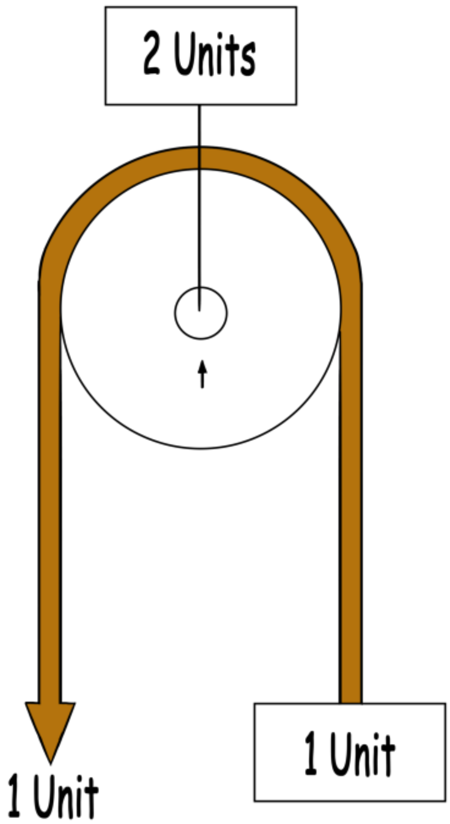
Replacing the 30 kN carabiner with a 40 kN (G rated) makes the 36 kN pulley the weak link making this a SSSF of 8.75:1 at this point

Replacing the pulley with a 40 kN G pulley would bring the SSSF to 10:1

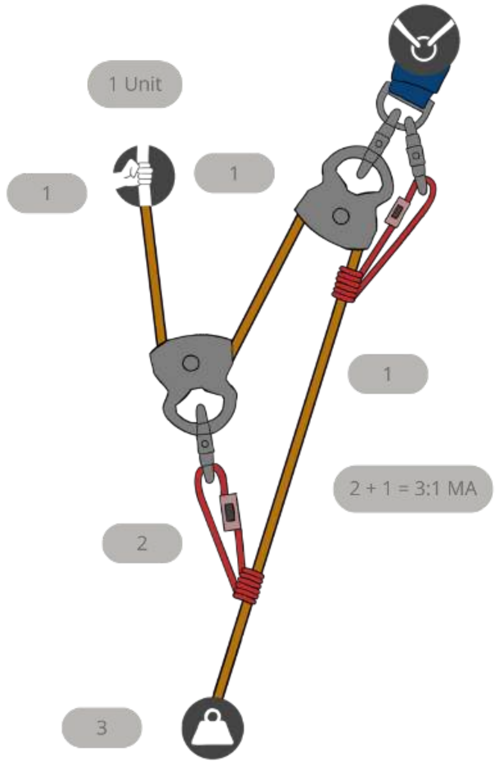
The 90° angle at the COD will put a 1.41 x the load making it 2.8 kN but does not reduce the SSSF

1.4 The T-Method For Calculating Mechanical Advantage

Intro to The T-Method For Calculating Mechanical Advantage



To calculate the tension in each segment, the T-method uses a number of different equations and calculations. These include a calculation for the total input force, which is then divided by the number of segments in order to find out how much tension is on each segment. This value can then be used to calculate the actual force in each segment based on the input and output forces. By taking into account the actual forces, it is possible to determine a more accurate value for each unit of tension.



Step 1: At the end ofthe haul line, the unit force will be 1.

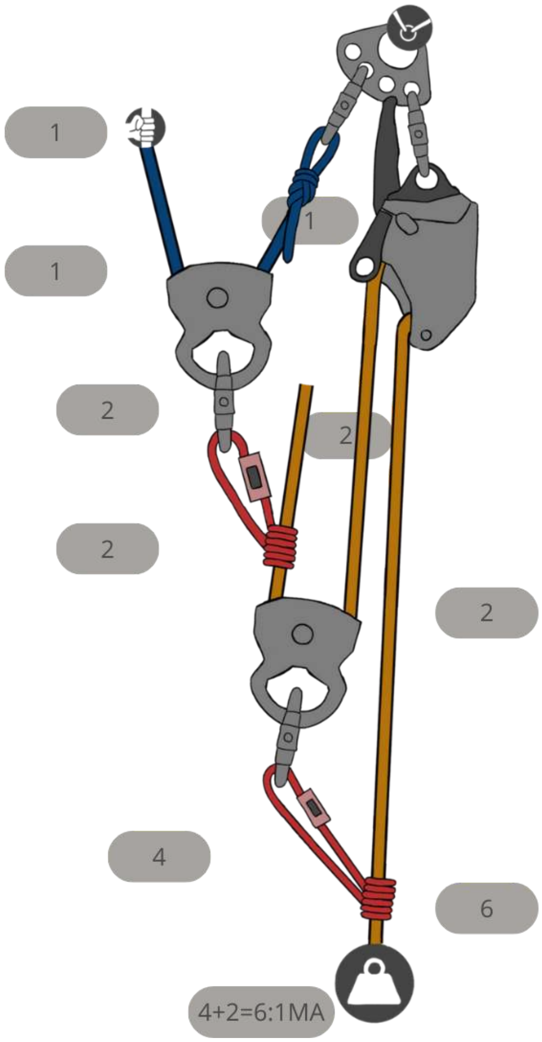
Step 2: Follow the haul line (rope) to where it meets the pulley. 1 unit enters the pulley, 1 unit exits the pulley. 1+1=2 at the top of the pulley which is connected via a prusik onthe load line.

Step 3: Continuing on from the pulley, the ropenext passes through a fixed pulley. This pulley is stationary and therefore does not add any extra force to the mechanical advantage. The single unit of force then continues down towards where the first prusik hitch is attached. It should be noted that while hauling, this prusik hitch remains unloaded and therefore is not part of the system at this point in time.

Step 4: The MA pulley is a system of two pulleys and a prusik hitch, which together create a mechanical advantage of 3:1. The 1 unit of tension coming from the fixed pulley combines with the 2 units at the prusik hitch, resulting in 3 units of tension applied to the rope attached to the load. This system increases the amount of tension applied to the load,allowing for a greater lifting capacity than if only 1 unit of tension was applied. 1.4 The T-Method For Calculating Mechanical Advantage

The International System of Units (SI) is a modernized version of the metric system which serves as the foundation for measurements throughout the world. This system is based on the decimal system and uses a prefix to denote the different orders of magnitude for each base unit. SI has seven base units for measuring seven different types of physical quantities: length (meters), mass (kilograms), time (seconds), electric current (amperes), thermodynamic temperature (kelvin), amount of substance (moles), and luminous intensity (candela). The base units are then divided or multiplied by powers of ten to create derived units for use in measurements. For example, a millimeter (mm) is one thousandth of a meter; a kilogram (kg) is one thousand grams; and a megawatt (MW) is one million watts. This system provides the same units of measure regardless of a person's location, allowing for more precise measurements to be taken.

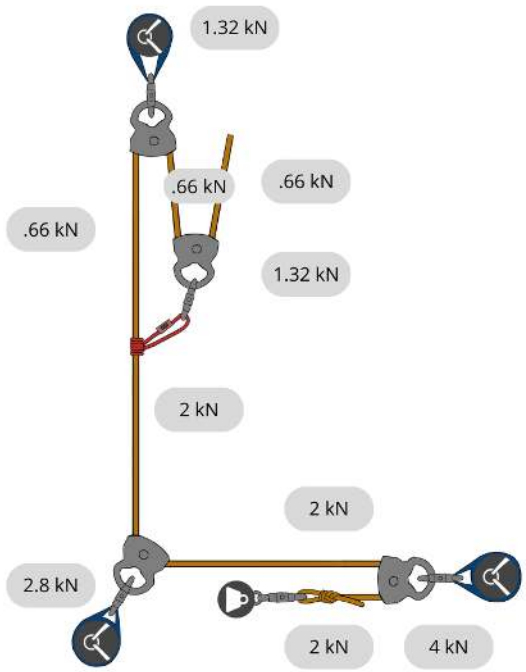
Equipment and Rescue Systems Strength Ratings Force (weight) - The weight of a body is mass and acceleration in a downward force (gravity). Mass - Quantity of matter (body) w/o acceleration Pound (lb) - US value for mass Kilogram - SI value for mass (1000 grams) Pound-force (lbf) - the US value of force Newton (N) - The SI value for force.



Kilonewton (kN) - 1000 newton or 220 lbs (some use 225) Acceleration - Acceleration is the rate of change of velocity with respect to time. It is a vector quantity, meaning it has both magnitude and direction. Load - Mass or force depending on the use. 6:1 Compound MA System

1.5 T-Method Calculation Within a Dynamic System Safety Factor

The force for each point in the system can be calculated by multiplying the total units of tension at each point by the calculated force for 1 unit of tension. This value will represent the amount of force being applied to that particular point in the system. It is important to consider all points when calculating forces, as this ensures an accurate representation of how much tension is being applied. With the correct measurements, it is possible to accurately calculate forces in a system for all points. This can be used to determine the best course of action and identify potential weak points in the system.



System forces during dynamic loading in a controlled environment

1.6 Determining Potential Forces in a System

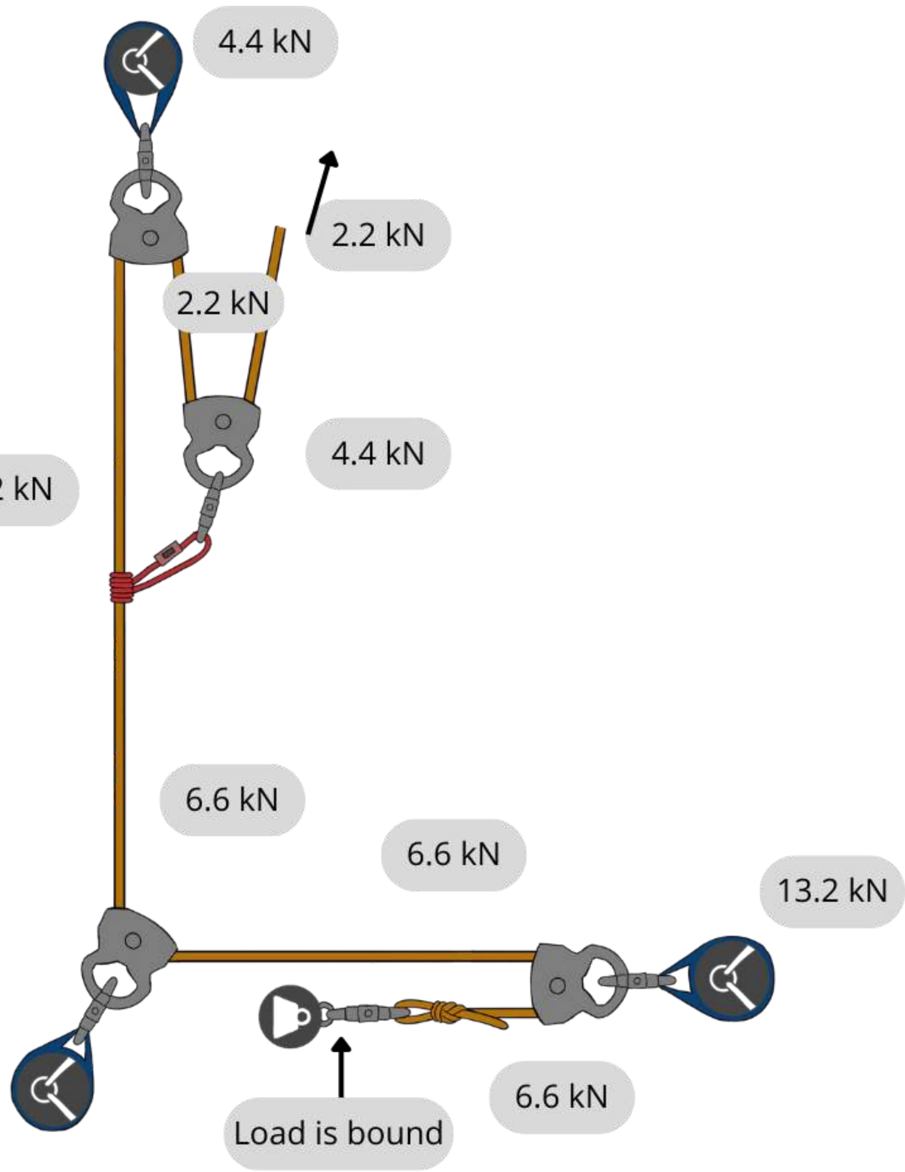
Can we determine potential force in a system in advance? Getting bound up is not something people normally plan for but they should.

When a load is either bound or stuck, the forces on the system are determined by the force applied by the haul team. To calculate these forces, tension units can be used to measure how hard they are exerting their efforts.

The composition of the team is an important factor in determining the total force generated. The collective strength of the personnel contributes to the overall force, as does the grip on the surface beneath their feet and the gloves they wear.

Field tests have been conducted to estimate the average forces that can be applied to a rescue system. The results of these tests provide valuable data which can be used to calculate the potential forces on the system and inform its design. Knowing the forces acting upon the system helps us ensure it is reliable and able to withstand extreme conditions in order to perform its duties successfully.

When a person is pulling on a haul line, they could apply a sustained force of 27 kN over time. If the load hangs up during the raise, it is important for the hauler to stop and work out why this has happened before continuing. 1.6 Determining Potential Forces in a System

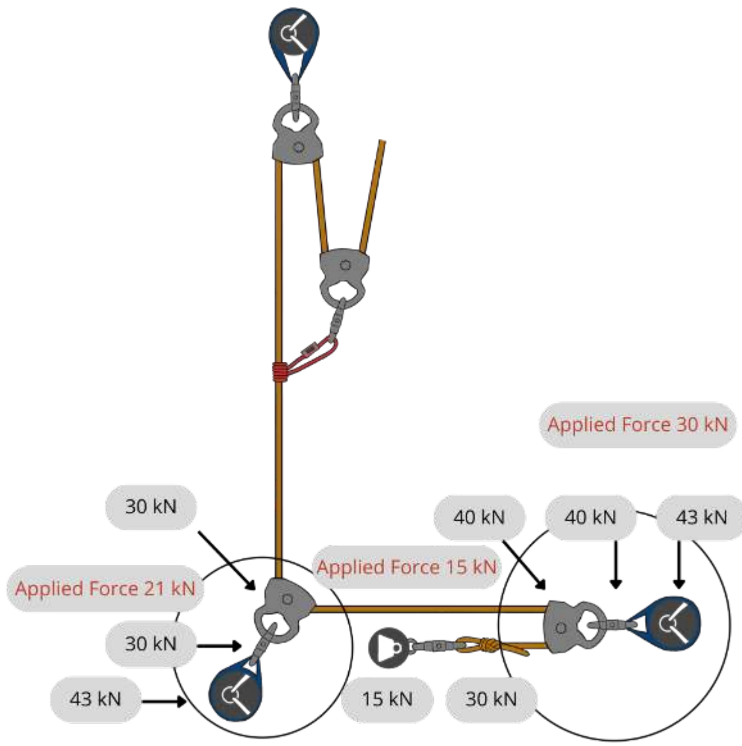


Input force increased by the haul team effects system forces

Using a 2.2 kN as 1 unit of tension for a three person haul team, the T-method can determine potential forces exerted on the system and while not always sustained having a moment in time snapshot helps. It is here that perception and kinesthetics (feel) will be the bulwark between catastrophe and safety should something get hung up and bound. The moment something "feels off... STOP!"

1.7 Shock Loading

Shock loads can result in significant damage to equipment and potential injury to personnel if the load is not managed effectively. In order to mitigate these risks, it is important that dynamic loading be carefully monitored and controlled. This includes ensuring an adequate safety factor for peak loads, as well as setting up effective systems to prevent accidental shock loading of belay lines. Additional precautions such as using dynamic rope for belay lines can also help reduce the risk of shock loading. Proper training and awareness of the hazards associated with uncontrolled dynamic loading is essential for safe rigging operations. By taking these steps, personnel can help ensure that their work is conducted safely and without risk to themselves or others.



System Forces with a 15 kN Shock Load 1.7 Shock Loading

It is important to consider the force of dynamic loading when selecting a system component, such as a pulley, carabiner or anchor. When applying this load, additional forces are placed on these components which must be taken into account in order to ensure that the system can safely accommodate shifts and changes in direction. In most cases, it is recommended to engineer the system to withstand a maximum of 15 kN force in order to ensure safe operation. Although dynamic forces can be difficult to predict, engineers should always strive to develop systems that are robust enough to handle any potential shifts in loading. By taking these steps, technicians will be able to guarantee the safety and reliability of their system.

1.8 Actual Mechanical Advantage

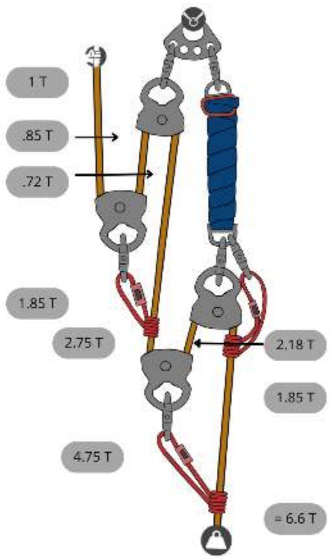
The T-method of analysis allows us to account for the friction in the pulleys and calculate a more accurate mechanical advantage. The efficiency of each pulley is calculated by measuring the difference between its theoretical output force, from our original system analysis, and its actual output force, determined experimentally. The efficiencies are then multiplied together to calculate the total efficiency of the system, and the actual mechanical advantage is found by dividing this total efficiency into the theoretical mechanical advantage. Knowing the actual mechanical advantage allows for more accurate calculations to be made when designing a hauling system. By accounting for friction in its analysis, the T-method provides a greater degree of precision when predicting how much output force will be produced by a given haul team. This can be an invaluable tool when dealing with complex hauling systems.

There are two main sources of friction in a pulley. The first is caused by the rotational force of the sheave on the axle, which can be greatly reduced by using sealed ball bearings or Oilite bushings. Sealed ball bearing pulleys use a special oil-impregnated alloy bushing to minimize rotational friction, but they are slightly less efficient than sealed ball bearing pulleys when new. As the bushing in a bushing pulley wears or accumulates dirt and grime, its efficiency will decline.

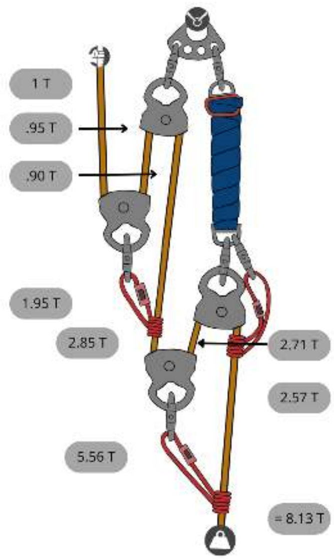
The degree of friction in a pulley system depends on the characteristics of the rope used and how it interacts with the sheave. Different ropes have different coefficients of friction, which will affect the efficiency of the pulley system. Tests have indicated that this difference can cause up to 15% reduction in efficiency, depending on the type of rope used.

The mechanical advantage of a pulley system is highly dependent on its overall efficiency. As the number of pulleys in the system increases, so does the cumulative effect of inefficiencies. In a single pulley system with one change of direction, losses can be as high as 5%. With four pulleys, such as that found in a 9:1 MA system, the losses can be as high as 20%. To maximize the efficiency of your pulley system, it is important to ensure that all components are of a high-quality and that they are properly maintained. Additionally, a well-designed pulley system should also have fewer changes in direction to minimize any potential losses. By taking these steps, you can ensure that your pulley system is as efficient as possible.

Determining Actual MA using T-Method 1.8 Actual Mechanical Advantage

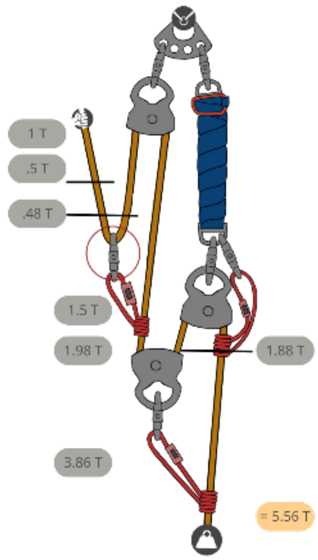


4 - .85 Efficient Pulleys

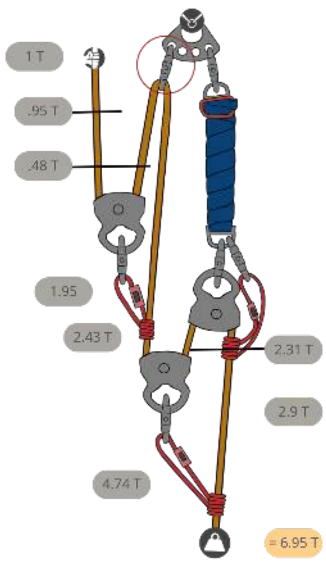


4 - .95 Efficient Pulleys

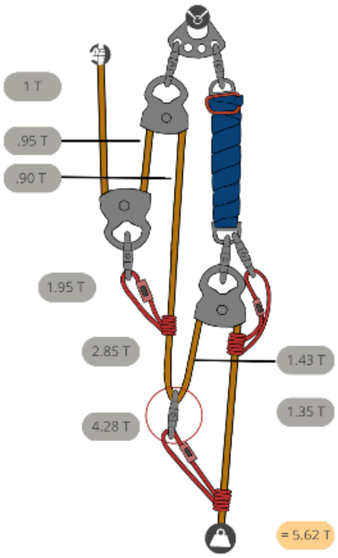
Best Place to Place Carabiners in a 9:1 MA as Determined Through T-Method



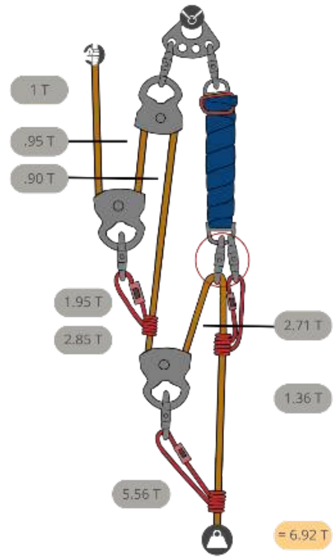
Carabiner-Pulley in the #1 Position



Carabiner-Pulley in the #2 Position



Carabiner-Pulley in the #3 Position



Carabiner-Pulley in the #4 Position

Environmental Concerns

When performing a system analysis, it is important to consider the environmental factors that may cause force multiplying or strength reducing situations. These conditions occur when a rigging system is set up in an environment that has irregular features; for example, uneven surfaces, slopes, or obstructions can all affect the tension and load on components of the rig. Such environmental factors can be difficult to eliminate and must therefore be accounted for in the system analysis. Taking into account environmental conditions prior to setting up a rigging system will help ensure its safety and effective use. If such conditions are not taken into account, they can lead to increased strain on components of the system and put workers at risk of injury or death. As such, it is essential to factor in environmental conditions during system analysis for the safety of workers and the successful completion of a task.

Human Factors

Systems analysis must take into account the human element, which cannot be quantified in numerical terms or used as part of the system safety factor estimate. Despite this, human behaviour must still be considered when designing and evaluating systems. Human error is one of the leading causes of accidents and incidents within any given system, so identifying potential sources of errors and designing mitigation strategies is essential.

The human factor is a critical element of the rescue operation. The level of training and experience of the team plays a significant role in the ability to manage complex systems, while also adapting to changing conditions. It is important that all members are well-versed with system operations and maintain a high degree of competence when facing potentially unpredictable circumstances. Furthermore, the systems and personnel must be able to perform reliably in spite of distractions that may occur throughout the course of the mission. Proper planning and ample preparation are essential for a successful rescue operation.

1.9 Selecting a System Safety Factor

When it comes to ensuring safety, there are a number of factors that need to be taken into consideration. During training sessions, the safety standards could be lower than during rescue operations as trainees may not have the same level of experience and expertise. However, this does not mean that training sessions can be conducted without any regard for safety - instead, there should be an appropriate balance between safety and challenging the trainees. Furthermore, redundancy is also an important factor when considering safety - it is wise to have multiple backup plans in case of any unexpected events or hazards that occur during a training session or rescue operation. Ultimately, how much safety is enough will depend on the situation, but it is paramount that all safety protocols are strictly adhered to.

Currently there is set SSSF. Highly trained mountain teams have been known to use a 4:1 SSSF. Other teams have opted for 5:1, 7:1 or 10:1 SSSF. Still others, such as legacy teams might still be attempting a 15:1 SSSF (which just about impossible and still get anything done).

Then there is something many teams still haven't grasped yet... the "dynamic" end of things. A minimum of 2:1 DSSF factor has been suggested as a place to camp for a bit. Because the relationship between dynamic and static SSFs is still being and tested, caution, data and knowledge is the best guide of all.

Common strengths

40 kN - NFPA General use carabiners

36 kN - NFPA G pulleys, anchor plates

22 kN - NFPA Technical use carabiners

20 kN - NFPA Technical use rope

22.2 kN - (5,000 lbf) OSHA

18 kN - NFPA Technical use pulleys

Rope Rescue Calculations

Mass - 2.2 lbs / 1 kg = 220 lbs (person) / 100 kg (person).

Acceleration makes the 220 lbs load = 1 kN load.

Two person load (rescuer and patient) is 2 kN load.

It is essential that you are knowledgeable in the concepts and can effectively use them with your equipment and systems. Knowing how to apply these concepts correctly will ensure that your equipment and systems function efficiently.

The rope rescue and rigging industry has come a long way in its development of equipment that meets the needs of those who rely on it. Manufacturers have implemented robust Quality Control programs to ensure that their products are up to the task, with performance requirements and testing standards having been greatly improved over the years. As such, rather than simply aiming to make their systems as strong as possible, manufacturers are now able to focus on whether or not a particular system is capable of performing the task at hand. This helps ensure that everyone involved in rope rescue and rigging operations can trust their equipment to perform reliably and safely when they need it most.

Static safety factor (SSF) is an important concept in rope rescue and rigging. Essentially, it is a measure of the strength of the system relative to the anticipated load. To calculate SSF, you must first identify the weakest link in the system - typically, this will be a component such as a carabiner or webbing loop - and then divide this by the anticipated load. The higher the SSF, the stronger and safer the system.

Raising Systems

In rope rescue and rigging, the T-method is a useful tool for determining the highest load points in complex raising systems. It can help prevent dangerous scenarios from occurring when lifting heavy loads.

For example, if a 3:1 haul system were used to lift an object or person, the component that would see the greatest dynamic load during the raise would be the haul rope grab. If the load were to become hung up while still being raised, a potentially worse case scenario could occur. By using the T-method, one can identify which point in the raising system sees the greatest load at any given time and make adjustments accordingly. This way, operators can ensure that their rescue or rigging operations are as safe as possible.

Lowering System

The original belay competency test was developed to ensure that individuals have the necessary skills and experience to safely and effectively perform rope rescue and rigging in a variety of environments. By simulating a worst case scenario during an edge transition, the test is designed to assess a person's ability to use their knowledge and expertise in order to execute complex maneuvers while managing risk:

* A rescue system set up relatively close to the edge with 3m of rope.
* A main line failure occurs during an edge transition resulting in a 1m drop on a non-tensioned belay line .
* The original performance criteria based on a 2kN load included a maximum system extension (stopping distance) of 1m and a maximum peak impact force of 15kN.

The current NFPA criteria has established rigorous safety standards for rope rescue and rigging. In order to ensure that a rescue system is certified, the belay device must be designed in such a way that limits the peak impact force to 15kN. This is achieved by having a 60cm drop on a 3m of rope plus a maximum system extension of 1m of rope. It is important for the belay device to be designed with this criteria so that peak impact force does not exceed 15 kN.

Dynamic forces generated by a descending load in rigging and rope rescue operations can be substantially greater than typically expected static loads, due to the additional force that is exerted during its fall. This magnitude of force can reach its peak in a very short period of time, usually during the arrest phase. In order to ensure a successful outcome, it is crucial that proper preventive measures are taken to adequately manage these dynamic forces.

When rigging or performing a rope rescue, it is might be good to factor in load limiting equipment and make sure that all components used are rated and certified above the applicable weight limit. This is done to ensure safety of both the rescuer and the subject. Staying up-to-date on regulations and best practices for rope rescue is also important in order to guarantee a successful and safe outcome.

For those who are new to rope rescue, it’s important to take the time to study the process, understand the fundamentals of rigging, and always be conscious of your surroundings and the materials you are working with. Doing so will help ensure that any rope rescue you are involved with goes as safely and smoothly as possible.