PRINCIPLES OF HAZARD TREE RISK MANAGEMENT

Hazard Tree and Tree Felling (HTTF) Task Group - Working Paper: February 27, 2008

"The dynamic wildland fire suppression environment is complex and possesses inherent hazards therefore we will do our best to aggressively manage the risk because no resource or facility is worth the loss of human life". ***HTTF Task Group***

Historical Risk Severity

Falling dead (snags) and green trees remain a persistent threat to wildland firefighter safety. The severity of this risk is potentially catastrophic as documented in a recently published study on "Deaths on Wildfire from 1990 to 2006" (Mangan). Moreover, hazard trees account for a high percentage of serious/disabling injuries on fires.

Fatalities by Cause:

1. Vehicle Accidents: 71 (23.2%)
2. Heart Attacks: **67** (21.9%)
3. Aircraft Accidents: **69** (22.5%)
4. Burnovers: 64 (20.9%)
5. Miscellaneous: **17** (5.5%)
6. **Falling Snags/Rocks: 11 (3.6%)**
7. Other Medical: 7 (2.3%)

- Total: 306

Risk Probability

The conditional probability that a firefighter could be injured from a hazard tree is more likely because of changing forest health conditions, and due to increase exposure as more firefighters are called into action in response to record breaking numbers of wildfires across forested landscapes. It is recognized that the outcomes of accidents are largely unpredictable, so it helps to concentrate on the probable rather then the possible.

Risk Management Concept and Rating

In this discussion, risk management is defined as a cognitive process of identifying, assessing, and mitigating a threat to firefighter safety. The degree or expressed level of "risk" is determined by two factors:

1. How likely is it that a hazard, danger or threat will occur (probability)?

2. How serious the potential consequences are if it does occur (severity)?

In this context, risk is characterized or labeled as extreme, high, medium, or low. Clearly, this methodology to rate risk is subjective and strongly influenced by individual

perceptions, experience, and a complex mix of human factors. In any event, to move risk management beyond a vague concept/term requires an understanding of basic process and use of common terminology in order to effectively communicate degrees of concern and the need for counter measures or safe guards. A meaningful effort to professionally manage risk necessitates a shared understanding of some foundational principles on how to conduct a risk assessment.

Strategic Risk Assessments and Mitigation (Enclosure 1)

Top agency officials must continue to assist incident management teams (IMT) or fireline supervisors perform an initial assessment of hazard tree risks. Experienced agency officials familiar with the ground can provide valuable initial hazard tree "snag intelligence" such as unique stand/fuel type conditions, problem areas, and share lessons learned. Agency representatives advising IMTs or fireline supervisors during suppression plan development should support proposed strategic hazard tree risk management plans such as:

- Alternative containment lines/management action points/point protection
- Safe mop up standards and expectations to limit exposure
- Facilitate road/area closures and traffic control
- Provide contact information on local fallers, blasters/explosives, and specialized heavy equipment/operators (feller-buncher)
- Provide advanced approval of power saws in wilderness to manage hazard trees
- Establish clear priority for safety if conflicts with resource objective surface
- Encourage assertive hazard tree abatement efforts along roads, around infrastructure, ICP/spike camps, and helispots

When Incident Commanders or fireline supervisors communicate leader intent and safety expectations they should constantly promote hazard tree mitigation actions in briefings. In potential extreme or high risk hazard tree environments leaders are a critical link to ensure that the priority of firefighter safety and confinement/resource protection objectives are not misunderstood, or act in conflict. An incident plan of action should emerge from an initial assessment of hazards tree risk so that the success and safety of the operation does not solely rest with firefighters on the line. The outcome of a strategic hazard tree risk assessment and prescribed defenses must be prominently addressed in the Incident Action Plan, (IAP), ICS 215-A (incident risk assessment form), Risk Decision Matrix, and reinforced in written/oral safety briefings.

Finally, emergency and medical plans (form - ICS 206) should plan for the unexpected so the team can effectively respond in the event of a hazard tree injury. Emergency response plans should:

- Identify/develop Medevac sites in advance

- Outline specific injury report and communication protocols, including cell phone use

- Develop special treatment/evacuation standards of care for head, neck, and spinal injury common in hazard tree accidents

- Identify and assign an appropriate number and location of qualified medical personnel

- Provide medical supplies/equipment necessary to treat spinal/head type injury (stretchers/cervical collars)

- Describe options/capabilities of ground/air transport – Evaluate the likelihood that steep angle or short haul extraction could come into question?

- Include Operations Section staff in development and buy off of ICS 206

When relying on air ambulances support (Medevac), they should be contacted in advance to verify availability, capability, and limitations. Things to discuss include altitude/LZ requirements, GPS coordinates, range, night vision capability/support needs, and availability of backboards etc. on the ship. In addition, anticipate environmental conditions such as wind, rain, and smoke/inversion in the risk assessment and contingency plan. Advanced planning for the unexpected has proven invaluable when emergency assistance is requested from outside emergency service organizations.

Tactical Risk Assessments

A subjective, qualitative risk rating (Extreme, High, Medium, or Low) based on informed professional judgment is a useful risk evaluation and communication tool. The precision of the rating is not as important as the deliberate application of a familiar process designed to help improve hazard communication, risk decisions, and counter measure identification. Fireline supervisors, sawyers, safety officers, and falling coordinators should work towards a shared understanding of the perceived degree of risk for a specific work area or assignment before engagement:

Assess the existing conditions

- What are the number, density, and height of hazard trees/snags?
- What is the anticipated snag/tree(s) burn-out time based on observation and knowledge of tree species and stand health/burning condition – how much material is on the ground and/or continues to fall down?
- How visible are the hazards – are the hazards easy to observe or easy to overlook?

Determine the existing and potential exposure

- Is the proposed fireline or position of firefighters on the ground/slope located in dangers zones given tree height/lean, and potential domino effect?
- What are the numbers of firefighters that could be exposed to a hazard?
- What is the potential frequency and duration of exposure?
- Human factors – What is the experience level and competency/training in exposure recognition and hazard avoidance of the firefighters available/assigned?
- Human Factors – What is the physical, and mental (alertness/fatigue) condition of the firefighters engaged in the mission?

Tactical Risk Mitigation and Defenses

Develop tactical hazard tree defenses based on an assigned risk rating (E, H, M, L). Fireline supervisors responsible for mission success should discuss and agree on an identified and tolerated level of risk. **In most cases, the goal should be to reduce the risk to moderate or low.** An example of a limited tolerance for high risk could be for emergency retreat to an escape route/safety zone, a single pass through a high risk area, or during initial size up/assessment. In some cases, low values at risk, limited benefits/gains, or the unlikely chance for completing the mission would logically dictate that only work in low risk hazard tree environments be tolerated.

The following defensive safe guards should be considered, applied, and communicated to the extent required to **reduce the potential threat to a desired moderate or low rating**:

- Eliminate the hazards with qualified sawyers, blasters/explosives, or heavy equipment prior to personnel entering the area.

- Avoid the hazards by designating "No Work Zones" (NWZ). Communicate the hazard with flagging, signs, and designate on maps. Involve experienced fireline supervisors, sawyers, falling bosses, and safety officers in establishing NWZ.

- Modify suppression tactics or reposition confinement line location/point protection to avoid extreme/high risk areas.

- Post lookouts to ensure firefighters do not enter identified danger zones and to help maintain secure areas (e.g. 2-1/2 tree lengths during felling operations).

- Eliminate, secure, or fire proof potential hazard trees on indirect line before they could become a high risk problem due to ignition from an advancing fire or burnout operations.

- Initiate effective road/area closure and traffic control measures in high hazard areas.

- Insist that firefighter stay out of the danger zones and clear of drops during bucket work around trees/snags.

- Provide supplemental on-the-line training/supervision on how to identify/avoid dangers zones and maintain hazard tree situational awareness.

- Establish trigger points for withdraw to secure areas in response to high wind forecast and unexpected wind events.

- Continue to evaluate potential workload, complexity and capabilities to eliminate hazard trees with existing resources. Provide timely upward reports (hazard tree intelligence) and anticipate needs/orders for additional fallers, falling coordinators, blasters/explosives, and heavy equipment for upcoming operational periods.

- Finally, assign lookouts, swampers, and line safety to help maintain situational risk awareness and monitor the hazard tree environment as the mission progresses and conditions change.

Summary

As we have learned, successful management of risk on wildland fires demands commitment and leadership from top management to the smart firefighters on the line. We must continue to work towards agreement on how we define and manage tolerable risk and discourage attitudes of apathy or fatalism. Clearly we cannot completely eliminate the risk of being struck by hazard trees and associated falling material. Moreover, sardonic remarks that the only way to avoid the danger is to stay out of the woods do not add value to the discussion. On the other hand, we must not engage full on with heads down and surrender our fate to so called luck, or simple dismiss the concern as an inherent, unavoidable part of a risky job. We have more experience and capability to safely manage hazard trees then any other profession in the world therefore we are obligated to seize every opportunity to do better.

The challenge is to learn how not to fall victim to a fatal lack of situational awareness due to risk desensitization and battlefield fatigue while surrounded by an arsenal of snags day in and out. Most experience firefighters can recount a personal story of a close call with a snag and acknowledge the value of possessing hazard tree survival and management skills. Experience, constant vigilance, and a sustained effort to manage hazard tree risks are essential to avoid another tragic story or lessons learned the hard way.

Enclosure 1

RISK ASSESSMENT MATRIX

A problem when you have a number of possible risks is to decide which ones are worthy of further attention. The Risk Assessment Matrix is a simple graphical tool widely used in many professions world wide to help prioritize risks.

There are two main dimensions to risk: (a) How likely it will occur (probability) and (b) The impact/effect (severity) that it would have, should it occur. One familiar model of quantifying risk is to assign a numeric value to these risks and to multiply these together. However, a problem with this quantitative approach is that high-probability/low-impact risks get the same score as high-impact/low-probability risks. The following Risk Assessment Matrix is a widely recognized and more effective method to assess risk.

The Risk Assessment Matrix simply puts Probability (likelihood) and Severity (effect/impact) on two sides of an x-y chart and then the risk are placed within this two-dimensional space (see chart below). This gives several advantages:

- High-probability/low-impact and high-impact/low-probability risks are differentiated.
- You can visually compare risk, thus asking the question 'is this one more or less likely then that one?' This plays to the human cognitive preference for paired comparison rather than absolute evaluation.
- Then the risks can be addressed from top right down to bottom left. High-probability/low-impact and high-impact/low-probability risk of equal risk exposure score will tend to be evaluated at around the same time.
- The process can be done on the wall with flipchart-paper, on a paper or computer format, or in many cases in your head while on the fireline.

Risk Assessment Matrix			HAZARD PROBABILITY (Likelihood)				
			Frequent	Likely	Possible	Seldom	Unlikely
			A	B	C	D	E
Severity Effect/Impact	**Catastrophic:** Fatal, life threatening or permanent disability	I	Extreme (4)	E	H		M
	Major: Severe injury or illness. Long term disability and/or Lost time	II		H		M	L
	Moderate: Medical treatment-no permanent injury or illness, and/or restricted duty	III	High (3)	M		L	
	Minor: First aid - Minor cuts, bruises, or sickness. No lost time/restricted duty	IV	Medium (2)	Low (1)			

Risk Tolerance Rating Criteria			
Extreme - 4	**High - 3**	**Medium - 2**	**Low - 1**
Unacceptable: Likely harm from an event must not be accepted. Must be reduced with administrative barriers of protection and/or engineering controls. Eliminate or avoid risk to ensure sufficient safeguards.	**Intolerable:** Should be reduced with administrative and/or engineering controls. Risk should not be tolerated save in special/limited circumstances.	**Tolerable:** Tolerable if further risk reduction (cost, time, effort) would be grossly disproportionate to improvement gained.	**Acceptable:** Negligible given common safe job procedures are applied. Continual vigilance necessary to maintain assurance that risk remains at this level.

Benefits Beyond Decision-Making

Figure 2

- It is a common experience in performing a risk assessment that the process of performing an assessment yields greater benefits than the final risk results produced.
- The much larger importance of the process arises from the creative yet systematic thought process that is necessary to produce risk estimates.
- The process provides reassurance and a record that important and reasonably practical step has been taken to anticipate what might go wrong and what could be done to prevent it (enclosure 2).
- The risk assessment is not intended to give a clear-cut decision about safety measures but aids in a more complex decision by paying attention to the benefits of learning from the process.
- The risk decision matrix is designed to be primarily used as a tool to aid in strategic plan development (figure 2). It is not intended as another so-called checklist paper exercise for the tactical worker to fill out and filed away. However, the basic principles used to evaluate risk should be kept in mind to improve the reliability of risk informed tactical decisions. A copy of the risk matrix can be carried in an IRPG to provide a visual reminder of the process/concept.

Incident Management Team (enclosure 2)
STRATEGIC RISK MANAGEMENT/ASSESSMENT WORKSHEET

Initial **life safety** risk assessment prior to 215_A

1. jurisdiction:	Location:	IMT:	2. Page _____of_____

3. Incident/Task	4. Initial Assessment Date:	5. Date of this assessment update:	6. Version of

7. Prepared by *(Name / Duty Position)* - Operations Section Chief and Safety Officer

8. Identified Hazards **Initial assessment to include the following top 8 recognized life safety threats to wildland firefighters:**	9. Assess the Hazards: Initial Risk rating from risk matrix				10. Initial Proposed Control Measures Developed for Identified Hazards/Risks*:*	11. Assess the Hazard's Residual Risk:				12. How to Implement the Controls:	13. Assigned to:
(Be Specific)	**L**	**M**	**H**	**E**	**(Be Specific)**	**L**	**M**	**H**	**E**	**(Be Specific)**	**(Be Specific)**
1. Fire: Entrapment: a. Fireline operations b. Camps (ICP/Spike) c. Public					a. Initial LCES safety system assessment to help execute a safe plan of attack (emphasis on existing safety zone). b. Evaluate ICP location – refer to enclosed tactical risk assessment - ICP example. Evaluate spike and other workstations as needed? c. Initial assessment of public evacuation needs and road/area closures?						

CONTINUED

8. Identified Hazards	9. Assess the Hazards: Initial Risk from matrix				10. Control Measures Developed for Identified Hazards: *(Specific measures taken to reduce the probability of a hazard/risks)*	11. Assess the Hazard's Residual Risk:				12. How to Implement the Controls:	13. Assigned to:
(Be Specific)	**L**	**M**	**H**	**E**	**(Be Specific)**	**L**	**M**	**H**	**E**	**(Be Specific)**	**(Be Specific)**
2**. Motor Vehicle Operations**: Collisions with other vehicles/objects, loss of control, equipment failure					Identified major road systems/traffic/travel hazards. Existing/potential heavy equipment operations?						
3. Hazard Trees: Overhead hazards – Forested area/roads with green, dead/dying trees/snags, and associated material. Injury from falling objects and falling operations.					Refer to Hazard Tree Risk Management principles documents.						
4. Aviation Operations: (pilots) Collisions with other aircraft/objects, loss of control, equipment failure, and hazards to ground personnel.					Reference specific prepared aviation risk assessment matrix						
5. Medical Emergencies - Heart Attacks and other life threatening medical situations					References ICS 206 – AED and evacuation resources						
6. **Rolling Material** – Struck by					Initial evaluation of terrain and conditions? Highlight risk rating based on geographical size up.						
7**. Drowning** – Operations in and around water					Identify any rivers and lakes near camps and/or needs for boats/crossing						
8. **Falls** – Operations on elevated surfaces and steep terrain					Structure protection – roofs? Fall protection, towers, facilities?						

CONTINUED

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(Be Specific)	**L**	**M**	**H**	**E**	**(Be Specific)**	**L**	**M**	**H**	**E**	**(Be Specific)**	**(Be Specific)**

14. Remaining Risk Level After Control Measures Are Implemented: (CIRCLE HIGHEST REMAINING RISK LEVEL)	**LOW** (Line Supervisor)	**MEDIUM** (Operations)	**HIGH** (IC)	**EXTREME** (IC/Agency Administrator)

15. RISK DECISION AUTHORITY: **(Approval/Authority Signature Block)** (If Initial Risk Level is Medium, High or Extremely High, Brief Risk Decision Authority at that level on Controls and Control Measures used to reduce risks) (**Note**: if the person preparing the form signs this block, the signature indicates only that the appropriate risk decision authority was notified of the initial risk level, control measures taken and appropriate resources requested; and that the risk was accepted by the decision authority.)

_____

(Signature)

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