

# STRESS MITIGATION IN AVALANCHE WORK

## INTERNATIONAL SNOW SCIENCE WORKSHOP 2023, BEND, OREGON

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**ABSTRACT:** Stress is an inevitable aspect of avalanche work and occurs through both chronic and acute stress exposure. Exposure to stress can lead to “stress injury.” Stress injury is terminology utilized by the US Marine Corps to describe the physical and emotional impact of operational stress and is depicted on a continuum. The Responder Alliance modified the stress injury continuum for wilderness users and first responders.

We built on this work to establish a framework for risk assessment in language familiar to avalanche workers. We present codified workplace procedures that identify and define terms related to psychological risk of avalanche work and outline a process to recognize and treat stress injuries early to prevent them from becoming critical injuries.

Two avalanche work groups, the Colorado Avalanche Information Center (CAIC) and the Snowmass Ski Patrol (SSP), implemented stress injury tools and procedures for the 2022/23 avalanche season. The goals of these programs are: 1. Identify stress injury as a common, predictable occupational workplace phenomenon in snow work with screening procedures. 2. Establish systems to treat predictable reactions of stress injury. 3. Prevent stress injury by promoting self-awareness and a culture that supports positive mental health choices. 4. Establish and implement after-incident support systems to encourage exposure risk identification and mitigation.

Initial results suggest establishing and implementing these procedures allows avalanche workers and their managers to quantify stress, identify what incidents and team members may require stress mitigation, and adjust daily task complexity for team stress level and readiness.

**KEYWORDS:** stress, injury, avalanche work, stress continuum

### 1. INTRODUCTION

Exposure to stress can lead to “stress injury.” Stress injury is terminology utilized by the US Marine Corps (USMC) to describe the physical and emotional impact of operational stress, and is depicted on a continuum, which has been modified for wilderness users and first responders by Responder Alliance (McGladrey, 2019[a,b]; Reddy, 2021) Figure 1. The USMC built a framework (Nash et al., 2010) on the concept that stress is not binary, but ranges from operational readiness and capacity to respond, noted in green, to overwhelming stress associated with incapacitating reactions to trauma. The latter criteria are related to depression, anxiety, PTSD, and substance use disorder.

There is growing evidence (Tucky and Scott, 2014, Rose et al., 2003; Devilly et al., 2001) that incident support through one-time debriefing

alone may not serve the needs of a mobile workforce to decrease incidents of stress injury formation.

Workplace programs such as peer support and screen-and-treat models (VA/DoD, 2021; Bisson et al., 2018; Brewen et al., 2008) following traumatic stress are utilized to decrease stress impact and injury. The framework developed by Responder Alliance and utilized in other wilderness contexts has been procedurally applied in the form of the incident support tool (IST) and 3-3-3 exposure protocol (McGladrey, 2020). These efforts were first undertaken by groups such as the Eldora Ski Patrol, Rocky Mountain National Park, Denali National Park, and Portland Mountain Rescue. However, this approach had not been specifically applied to avalanche workers.

Stress is an inevitable aspect of avalanche work and occurs through both chronic and acute stress exposure. Chronic exposure occurs with the daily wear and tear of “decision stress” in avalanche forecasting. Acute stress often occurs in response to traumatic events.

Snow workers are regularly exposed to factors with the potential to cause stress injury. Factors

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may include witness and investigation of fatal accidents, near-miss accidents, and contact with friends and family of victims of avalanches. Exposure can be compounded by the fact that snow workers often recreate in the same areas where they may respond to fatalities and serious injuries, occasionally investigating accidents of friends and colleagues. In addition, there is growing recognition that cumulative workplace stressors may predispose snow workers to further injury (Dolan et al., 2018). Factors may include depletion from task saturation, the continuous decision-making required through the operational season, uncertainty related to snowpack conditions and/or changing storm patterns, and human factors related to a changing public demographic and user base.

Here we present how tools used to support stress disorders in other wilderness settings, such as search and rescue, ski patrol, guiding operations, and aviation have been applied to the avalanche context, highlighting two case studies.

During the 2022/23 season, the Colorado Avalanche Information Center (CAIC) and Snowmass Ski Patrol now Safety Team (SSP SST) undertook a novel approach to modification and utilization of tools established in other operational cultures to embed workplace awareness and mitigation tools applied to the framework of snow safety, forecasting, and avalanche mitigation.

## 2. AVALANCHE ORGANIZATIONS DESCRIPTIONS

### 2.1 COLORADO AVALANCHE INFORMATION CENTER (CAIC)

The CAIC is a public safety avalanche forecasting group within Colorado's Department of Natural Resources. The program is a partnership between the Department of Natural Resources (DNR), Department of Transportation (CDOT), and the Friends of the CAIC (FoCAIC) a 501c3 group.

There are 25 staff members, four of which do not engage in field operations, avalanche forecasting, or mitigation. Of the remaining 21 staff members, about half have primary forecasting responsibilities for the state's highways and interstates. This group works in concert with CDOT to mitigate avalanche hazards along the state's transportation corridors using a variety of mitigation techniques, including the use of explosives, artillery, remote avalanche control systems (RACS), and preventative closures.

The other half of the forecasting team focuses primarily on weather and public backcountry avalanche forecasting covering all of Colorado's mountainous areas. They issue twice-daily weather forecasts and daily backcountry avalanche forecasts from November 1 through May 31.

### 2.2 SNOWMASS SKI PATROL (SSP) SNOW SAFETY TEAM (SST)

The SSP SST comprises seven members - a director, two coordinators, and four technicians. The Snowmass ski area has over 1,200 acres of avalanche terrain between 8,100 feet and 12,500 feet in elevation. Eighty five patrollers make up the rest of the SSP staff. A bootpacking program is employed early in the season (November - January), and explosives are used extensively throughout the duration of the season (typical closing is late April). The SST coordinates and executes all avalanche forecasting, mitigation, rescue, and training activities in the ski area together with the SSP. Typically four SST members work each day.

## 3. STRESS AWARENESS & INCIDENT SUPPORT TOOLS AND PROCEDURES

The stress mitigation framework relies on several tools to identify and respond to stress impacts for avalanche workers. A primary goal is to identify stress injury as a common, predictable occupational workplace phenomenon in snow work with screening procedures.

The CAIC and SSP SST created internal resilience teams and codified stress injury prevention responses into workplace manuals that provide definitions of the concepts in the stress framework and procedures to mitigate chronic and acute stress injuries. The resiliency program and supporting tools are reviewed at fall staff meetings before the busy operational season.

### 3.1 CHRONIC STRESS MONITORING

The CAIC, in collaboration with Responder Alliance, modified the USMC stress continuum in the style of the [North American Public Avalanche Danger Scale \(NAPADS\)](#) (Figure 2) by drawing on feedback from all CAIC staff members. This proved to be an apt metaphor for stress accumulation on a snowpack, a concept that needs no introduction to avalanche workers. Embedded into operational practices, the newly-developed North American Avalanche Stress Continuum (NAASC) tool was used

throughout the 2022/23 season as a common language to identify, monitor, and mitigate stress

levels in avalanche workers through the season and at the moment and aftermath of fatal and/or critical event.

### RESPONDER STRESS CONTINUUM

READY	REACTING	INJURED	CRITICAL
Sense Of Mission	Sleep Loss	Sleep Issues	Insomnia
Spiritually & Emotionally Healthy	Change In Attitude	Emotional Numbness	Hopelessness
Physically Healthy	Criticism	Burnout	Anxiety & Panic
Emotionally Available	Avoidance	Nightmares	Depression
Healthy Sleep	Loss Of Interest	Disengaged	Intrusive Thoughts
Gratitude	Distance From Others	Exhausted	Feeling Lost Or Out Of Control
Vitality	Short Fuse	Physical Symptoms	Blame
Room For Complexity	Cutting Corners	Feeling Trapped	Hiding Out
	Loss Of Creativity	Relationships Suffering	Broken Relationships
	Lack Of Motivation	Isolation	Thoughts Of Suicide
	Fatigue		

ADAPTED FROM COMBAT AND OPERATIONAL STRESS FIRST AID BY LAURA MCGGLADREY | RESPONDERALLIANCE.COM

Figure 1. Responder Alliance stress continuum, modified from the U.S. Marine Corps stress continuum.

NORTH AMERICAN AVALANCHE STRESS CONTINUUM		
Stress Level	Behaviours, Traits or Feelings	Travel Advice
4 High	Inability to sleep without sleep aid No possible time to take a break Avoid forecasting/don't care No exercise No Desire for growth Avoid Communication	Seek Professional Help
3 Considerable	Sleepless nights thinking about problems Checking workplace chats and email when on break Barely on time/late for forecasting/don't care Minimum exercise needed for the job CEs only when expressly ordered Communication aggressive and defensive	Talk with spiritual advisor/counselor/trusted friend Schedule some personal time
2 Moderate	Getting tired but still able to sleep Occasional short breaks Just enough preparations for forecasting Occasional exercise as time allows Take part in minimum of CEs Defensive communication, shorter fuse	3-3-3 Check-in after action review Create a plan to make more green choices
1 LOW	Well rested and ready Scheduling and taking good breaks Psyched, early and well prepared for forecasting Exercising and healthy Seek out personal development Communicate openly and professionally	Continue to make green/good choices Exercise, Meditation, Journaling, Socialization etc

Adapted from North American Public Avalanche Danger Scale by CAIC & Responder Alliance

Figure 2. North American Avalanche Stress Continuum (NAASC).

The CAIC and SSP SST used the NAASC to help prevent and monitor chronic stress injury by promoting self-awareness and a culture

that supports positive mental health choices using regular surveys and check-ins with peers and supervisors.

The CAIC modified a survey developed by the Eldora Ski Patrol to get a monthly snapshot of the team's mental health status. Staff answered a series of status questions on a scale of one (less stress) to ten (more stress), along with two questions requiring written responses. CAIC staff would anonymously complete the survey in less than ten minutes at the beginning of each month, and responses were automatically archived in a spreadsheet. This allowed the group to review responses together at monthly staff meetings.

The SSP SST created a mobile app to facilitate daily check-ins of stress levels. The app allows SST members to anonymously check in with their daily assessment of where they lie on the NAASC by selecting a stress rating. SST members would check in on their mobile devices during the morning planning meeting. The check-in process took under a minute for the entire team. The app displays the team's history each day for the past week and records data for the entire season. Members can see these data in real time. (Figure 3)



Figure 3. SSP SST Daily app responses for a week.

### 3.1 ACUTE STRESS MONITORING

The CAIC and SSP SST established and implemented after-incident support systems to encourage exposure risk identification and mitigation as a result of exposure to potentially traumatizing events (PTEs) (Figure 4).

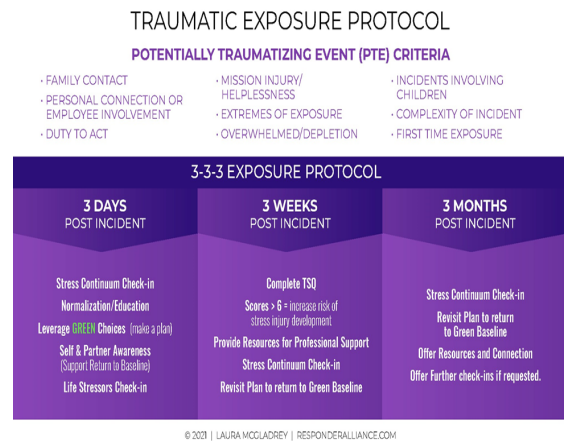


Figure 4. The Traumatic Exposure Protocol including the PTE criteria and 3-3-3 protocol

The IST and accompanying scoring guide (not shown) is an appraisal tool for incident commanders and workers designed to support increased awareness of risk exposure following PTEs, such as avalanche accidents and investigations (Figure 5).

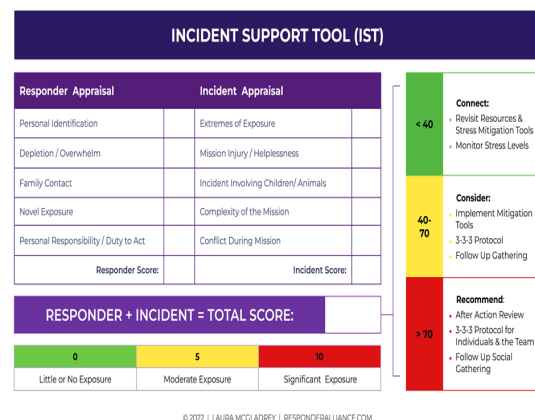


Figure 5. The Incident Support Tool (IST).

Following an exposure to a PTE, the event is appraised based on factors that increase exposure to traumatic stress (e.g., disturbing images, conflict during the mission, perception of helplessness, involvement of children or animals). Individual responders then rate personal factors associated with increased risk of stress injury (e.g., family contact, depletion, personal connection with the event or victim, novel exposure, perception of responsibility for

the event.) The IST allows for individualized assessment of exposure risk, differentiated numerically.

If IST appraisal scores reached or exceeded values considered “moderate exposure” ( $\geq 40$ ), and/or if staff expressed a desire, this triggered the implementation of the 3-3-3 exposure protocol (See Figure 4). Used in conjunction with the IST, the 3-3-3 protocol was designed as Treat-and-Screen protocol to allow for scheduled review and mitigation at the three day, three week, and three month waypoints. The protocol promotes awareness and mitigation of depletion stress, forwards connection, and validates the predictable trajectory of exposure stress. Those with high-risk exposure profiles completed the Trauma Screening Questionnaire (TSQ) (Figure 6) at the three week point, with recommendation of clinical support for scores over six (Brewin, et al., 2002).

TRAUMATIC STRESS QUESTIONNAIRE		
COMPLETE AT THE 3 WEEK CHECK-IN. ASKING THE QUESTION: HAVE YOUR RECENTLY EXPERIENCED ANY OF THE FOLLOWING?		
(AT LEAST TWICE IN THE PAST WEEK)	YES	NO
1. Upsetting thoughts or memories about the event that have come into your mind against your will?		
2. Upsetting dreams about the event?		
3. Acting or feeling as though the event were happening again?		
4. Feeling upset by reminders of the event?		
5. Bodily reactions (such as fast heartbeat, stomach churning)?		
6. Difficulty falling or staying asleep?		
7. Irritability or outbursts of anger?		
8. Difficulty concentrating?		
9. Heightened awareness of potential dangers to yourself and others?		
10. Feeling jumpy or being startled by something unexpected?		

Traumatic Stress Questionnaire, C.R. Brewin et al. 2002 | Used with permission

Figure 6. Traumatic Stress Questionnaire

#### 4. PRELIMINARY RESULTS AND INCIDENT EXAMPLES

##### 4.1 COLORADO AVALANCHE INFORMATION CENTER (CAIC)

The CAIC gathered monthly survey data during pre-season training and for the seven operational months that followed. A large majority of working staff responded every month. Responses revealed that, on average, staff members trended towards the healthy side of the stress continuum across categories (Figure 7). There were notable increases in

stress responding to: “How do you feel when you arrive at work on a typical day?” between November and February; “How do you feel about going out to do fieldwork?” after February; and “How is our teamwork and communication?” between December and March as the busy mid-winter operations took their toll.

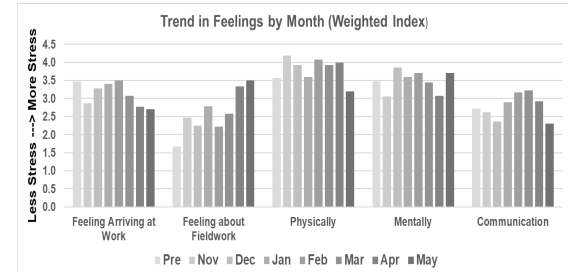


Figure 7. CAIC staff average responses to monthly stress surveys for a subset of question categories.

Individual response scores did reveal that four to 19% of staff responses were at the upper end of the stress continuum ( $\geq 7$ ), depending on the month and specific survey question. The most pronounced was 17% and 19% of staff responding that they felt close to “Exhausted yet unable to sleep. Distracting injuries and ailments impair my ability to work.” when asked how they were feeling physically in February and March, respectively.

The anonymity of the survey protected the identity of these individuals, but it did alert staff and managers that at least a small portion of the team was experiencing unhealthy stress levels in one or more categories. This would prompt increased check-ins from managers and stress “buddies” to gauge the status of the people with whom they work most closely, and additional follow-up was initiated if needed.

The CAIC responded to eight PTEs during the 2022/23 season, involving nine staff members. Five staff members responded to more than one PTE. Two fatal accident responses resulted in IST scores that triggered a 3-3-3 follow-up.

One accident required a CAIC staff member to engage directly with the victim and provide CPR, while the other CAIC staff member had direct interactions with the family members. The CAIC staff member who performed the

CPR required a 3-3-3 follow-up. This individual reported healthy TSQ responses at the three-week check in and did not require additional clinical support.

Another accident involved a complicated multi-agency response for three victims who were friends of the responding CAIC staff members. The recovery involved prolonged exposure to, and manual transport of, the deceased victim, and subsequently, extended time with the victim’s family members. Both CAIC staff members reported IST scores that triggered a 3-3-3 follow up (see example in Figure 8). Both CAIC staff reported healthy TSQ responses at three weeks and did not require additional clinical support.

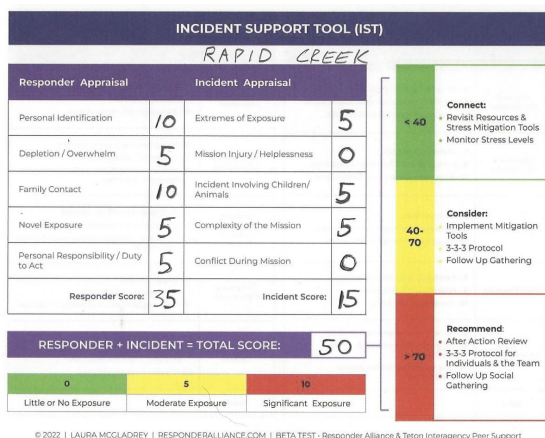


FIGURE 8. CAIC staff member’s IST score after a PTE.

#### 4.2 SNOWMASS SKI PATROL SNOW SAFETY TEAM (SSP SST)

The SSP SST mobile app recorded 262 responses from December 2, 2022, through April 19, 2023. Out of these 138 days, responses were recorded on 79 days. The most missed days were at the end of March and in mid-April. The data show a general wave of rise and fall in stress levels among the SST over the course of the season (Figure 9).

Breaking down the season into three periods, it is possible to notice some trends:

#### Period 1 - early season, November - January 1

Unfortunately, data were not captured during the early season bootpacking efforts (beginning November 7) as the mobile app was not completed. Gated avalanche terrain in Snowmass typically opens in late December to early January after preparation, including boot compaction and explosives mitigation. The data show stress levels increased in mid-December as this work began and decreased towards the end of December as the SST team gained confidence in the preparation and mitigation efforts.

#### Period 2 - mid season, January - March 1

Stress levels of the team increased through January as continued snowfall, cold temperatures, and sustained winds required significant work to mitigate the avalanche hazard in the ski area. After a brief drier period at the end of January and beginning of February, stress levels again increased mid-February through March.

#### Period 3 - late season, March - April 19

Stress levels decreased towards the end of the season until the end of April when an avalanche in closed terrain in the ski area required a search and SST response.

### 5. DISCUSSION

This study presents newly-developed tools and procedures for addressing stress injury for avalanche workers. The case studies presented showcase only one avalanche season with a limited number of avalanche workers. Despite these limitations, our work demonstrates advantages to implementing a stress resiliency program in avalanche-centered work environments. The tools and approaches presented here can be adapted and applied to other similar workplaces.

Program managers and supervisors must strike a balance between providing support where needed without adding additional work tasks to an already very busy operational season. Encouragingly, the implementation of

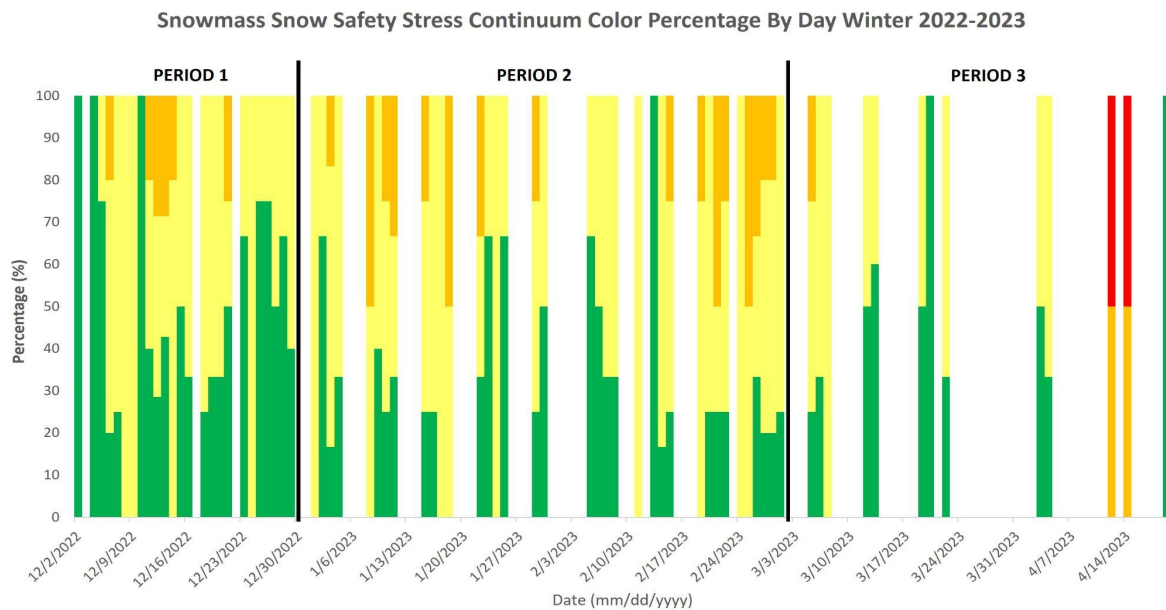


Figure 9: Team self-reported stress continuum color level percentage by day, Snowmass Snow Safety team, 2022-2023

stress resiliency programs proved to be easily manageable.

A related concern is that every workplace event or PTE would require a laborious after-action review. This proved not to be the case. The majority of events did not qualify as PTEs. Even among the PTEs, the majority did not require even a 3-3-3 follow-up. Indeed, only a fraction of PTEs lead to stress injury. This highlights that the utility of the resiliency programs lies in identifying the few periods and instances of concern. Most of the time, programs can proceed normally, even after PTEs.

CAIC and SSP SST staff reported appreciation that the resiliency programs were in place and that the teams had a common language and tools for mitigating workplace stress. It was evident that the younger staff members are more comfortable and fluent using this new language around stress management, but even the veterans picked it up quickly, if more reluctantly.

The CAIC collected monthly data on chronic stress while the SSP SST collected less detailed daily data. Given the low time commitment, initial results suggest it would be useful for programs to collect both data types if feasible. Indeed, more data in future years will be instrumental in understanding correlations between weather, hours worked, avalanche events, and other factors to stress levels of the team.

This will allow supervisors and managers to better forecast when accumulating or activated stress might reach critical tipping points and better prepare them to mitigate stress before it results in stress injury.

Staff from both organizations commented that even though they personally might be in a “green state,” they did not realize that other members were in the yellow or orange “states” and the reviews made them aware of team members that could use support.

## ACKNOWLEDGEMENTS

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