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MEMORDANDUM

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To: Geographic Area Coordinating Group (GACG) Chairs
National IC/AC Council Chair

From: NWCG Chair

Date: June 12, 2012

Subject: Monitoring and Mitigating Exposure to Carbon Monoxide and Particulates at Incident Base Camps

In 2008, the NWCG Executive Board tasked the Risk Management Committee (known at that time as the Safety and Health Working Team) to develop monitoring protocols for smoke exposure in fire camps and recommend exposure baselines so Incident Management Teams can recognize potentially hazardous conditions and make appropriate management decisions (TM-2008-04).

After conducting extensive studies and consultation with smoke experts, NWCG accepts the Risk Management Committee's recommendations and endorses the attached guidance as a tool for fire managers and responders to recognize and mitigate exposure to smoke.

NWCG acknowledges the complex nature of this issue and will continue efforts to develop surveillance and monitoring plans.

Within Attachment A, *Guidance for Monitoring and Mitigating Exposure to Carbon Monoxide and Particulates at Incident Base Camps*, you will find:

- A table describing signs and symptoms at various CO exposure levels
- Mitigation measures to reduce smoke exposure
- Baseline exposure levels for both fireline operations and base camp personnel.

Please give this report widespread coverage with fire managers and agency administrators.

Attachment A: Guidance for Monitoring and Mitigating Exposure to Carbon Monoxide and Particulates at Incident Base Camps.

Attachment B: Information and Ordering Guidelines for Smoke Monitoring Kit, NFES #5840

cc: NWCG Executive Board
NWCG Committee Chairs
Program Management Unit (PMU)
Budget Advisory Unit (BAU) Chair
Roy Johnson, OWF Deputy Director
Rod Bloms, OWF Program Analyst
National Interagency Coordination Center (NICC)

Guidance for Monitoring and Mitigating Exposure to Carbon Monoxide and Particulates at Incident Base Camps

Current Status:

The current exposure levels of incident personnel to carbon monoxide (CO), particulate matter, and other respiratory irritants in wildfire smoke are similar to the levels quantified by Ottmar and Reinhardt in the early 1990s [reference – per previous doc: Reinhardt, T.E., and R.D. Ottmar. "Baseline Measurements of Smoke Exposure Among Wildland Firefighters". Journal of Occupational and Environmental Hygiene 1:593-606 (2004)]. Recent data collected by Broyles and colleagues (San Dimas Technology and Development Center), confirms that overexposure to respiratory irritants is primarily due to elevated short duration smoke exposures.

The Federal Occupational Safety and Health Administration (OSHA) and state laws prohibit exposing employees to hazards exceeding applicable occupational exposure limits (OELs). These limits are applicable in routine and emergency settings. Because recent data confirms overexposures to respiratory irritants do occasionally occur in the dynamic fire environment, respective wildland fire agencies must implement mitigation measures to mitigate these exposures.

Recommended Exposure Level Ranges for Fireline Operations:

The current OSHA permissible exposure limit is 50 parts per million (ppm) for an 8 hour work day. However, wildland firefighter work shifts are typically much longer, often 12-13 hours. Based on the best available science to date, the Smoke Exposure Task Group (SETG) and their group of leading researchers from across the United States established an exposure recommendation for wildland fireline operations to be:

- Carbon monoxide of 8 ppm for a 24 hour period and
- 16 ppm for a 13 hour work shift

The multi-year (2009 – 2011) smoke study data indicates the average CO exposure is just under 3 ppm for wildfire operations and slightly above the 3ppm for prescribed fire and 95% of shift exposures were below 17 ppm. Based on the work by Reinhardt and Ottmar referenced above, CO can be used as a surrogate for respiratory particulate near the combustion source. At locations away from the combustion source the relationship between CO and respiratory particulates decreases. Data from 2011 to better define the decrease in relationship between CO and respiratory particulates away from the combustion source is still being analyzed.

Most Common Over Exposure Fireline Tasks:

Based upon the on-sight smoke field studies, there was approximately 5% of firefighters who had an overexposure during an average work shift. The following fireline tasks are identified as having the greatest potential for smoke/CO over exposure:

- Mop-up
- Fireline holding
- Saw operations (combined exposure from smoke and saw exhaust)

Recommended Exposure Level Ranges for Incident Base Camp Operations:

Incident base camp personnel are demographically similar (e.g., age, weight, gender, health status) to the general adult population and the recommended exposure range matches that of the Environmental Protection Agency (EPA) based upon particulate matter (PM) and stated below:

- 35.5-80.4 24-Hour BAM(ug/m^3)

At risk factors for smoke exposure within the general public also apply to incident base camp personnel, which include, but not limited to; cigarette smoking, cardio vascular disease, high blood pressure and obesity.

Signs and Symptoms Associated with Carbon Monoxide Exposure

Table 1 identifies signs and symptoms that typically occur with exposure to carbon monoxide. It should be noted that these symptoms can vary by individual and predisposition to smoke exposure. For example, cigarette smokers show fewer symptoms than a non smoker with similar CO exposure.

Mitigation Recommendations:

The SETG determined that several of the mitigation measures recommended in the 1997 report, *The Health Hazards of Smoke,* are not currently being implemented, or there is no documentation of implementation. In 2010, interagency fire management and operational personnel developed a revised list of recommendations to mitigate employee smoke overexposure. The smoke exposure task group ranked the measures according to their potential effectiveness and the practicality of their implementation. The top recommended mitigations are shown in table 2. These recommendations constitute the administrative controls that OSHA regulations and agencies' policies require before fire management can implement the use of PPE.

Respiratory Protection:

As stated above, OSHA regulations and agencies' policies preclude the use of personal protective equipment (in this case respirators) until alternative engineering and administrative controls are found to be ineffective or infeasible. Respirators may be useful in limited circumstances, but they impose a physiological burden on the wildland firefighter which could lead to unintended health illnesses. If implementation becomes necessary, agencies must establish a written respiratory protection program, and respirators must be approved by NIOSH and comply with *NFPA 1984 Standards on Respirators for Wildland Fire Fighting*. To date, there are no respirators for wildland firefighters that meet these requirements and when/if they become available, physiological burdens will still exist. It is also noted that if appropriate controls and mitigations are implemented (as in Table 2), then the use of respiratory protection should not be warranted. With that, the Risk Management Committee at this time does not recommend the use of respiratory protection for the wildland fire environment and fire managers should focus on mitigation implementation.

Table 1: Signs and Symptoms Associated with Carbon Monoxide Exposure

***CO in atmosphere (ppm)**	**COHb in blood (%)**	**Signs and symptoms**
10	2	Asymptomatic
70	10	No appreciable effect, except shortness of breath on vigorous exertion; possible tightness across the forehead; dilation of cutaneous blood vessels.
120	20	Shortness of breath on moderate exertion; occasional headache with throbbing in temples
220	30	Headache; irritable; easily fatigued; judgment disturbed; possible dizziness; dimness of vision.
350-520	40–50	Headache, confusion; collapse; fainting on exertion
800-1220	60–70	Unconsciousness; intermittent convulsion; respiratory failure, death if exposure is long continued
1950	80	Rapidly fatal

***** Symptoms may appear with less CO exposure due to other irritants in smoke

Source: (Winter and Miller, 1976; Ellenhorn and Barceloux, 1988) in Fierro et al, 2001.

Table 2: Recommended mitigations for reduction of smoke exposure

It is important to note that smoke is just one of the potential risks faced by wildland firefighters. When instituting these recommendations it is important to evaluate and balance all the risks associated with the operational objective. The following recommended mitigations are not intended to be used in sequential order, but individual or combined mitigations that can be applied based upon potential or actual onsite smoke hazards identified.

Exposure Mitigations for Fireline Operations: • Minimize mop-up whenever possible, utilizing alternative means with less exposure.
➢ Use time and patience to put the fire out: ▪ allow secured areas to burn out ▪ rely on burn-up instead of mop-up ▪ use dozers or other mechanical equipment to spread out burn piles
➢ Adjust operational periods on mop-up to avoid periods of inversion.
➢ Adjust prescriptions during prescribed fire where possible to reduce smoke by providing more complete combustion.
➢ Minimize snag falling as long as all other safety concerns are mitigated.
• In heavy smoke conditions, consider establishing control lines where conditions allow for less smoke exposure to firefighters, even if more acreages is burned.
• Rotate personnel out of heavy smoke areas
• Use equipment rather than people when possible in holding areas (sprinklers, retardant, foam, etc).
Exposure monitoring for Fireline Personnel: • NWCG is developing a surveillance plan and if an agency/IMT wants to perform monitoring in the meantime, utilize exposure ranges as previously stated and follow the current American Conference on Governmental Industrial Hygienist (ACGIH) monitoring guidelines. Monitoring equipment will need to be acquired through specific agency channels.
Exposure Mitigations for Incident Personnel at Base Camps: • Locate camps and Incident Command Posts in areas that are not prone to inversions or upwind of fire. Utilize spike camps as alternatives to impacted camps. • Utilize facilities with filtered air systems
Exposure Monitoring for Incident Base Camps:
• Fire camp Smoke Monitoring Kits are available in the national cache system, NFES 5840. These systems come with easy to follow directions. Currently the National/Great Basin cache stocks 15 Kits that can be order through Resource Ordering and Status System (ROSS) (see attached ordering process).
Additional Mitigations for Incident Base Camp and Fireline Operations:
• Include smoke hazards on the Incident Action Plan Safety Analysis, ICS-215A worksheet, at planning and briefing sessions, and adjust operations accordingly.
Address smoke impacts in job hazard analysis/risk assessments:
• Need to reinforce the inclusion of smoke exposure and mitigation methods

If you have any questions, please contact your respective agency RMC representative at: http://www.nwcg.gov/branches/pre/rmc/contactus.htm

INFORMATION AND ORDERING GUIDELINES FOR SMOKE MONITORING KIT #5840

If you are a Smoke Monitor Operator and have been instructed to order a #5840 Smoke Monitor Kit and **are not** familiar with the ICS (Incident Command System) or ROSS (Resource Ordering and Status System) your first step is to call the agency responsible for the project or incident. If that fails, call information and have them connect you to the local Federal, State or interagency dispatch center. Ask for a coordinator; brief with pertinent information about your project and ask which steps to take next. If this becomes time consuming and you feel that your project is suffering and you're getting nowhere, call Mark Barbo @ RAWS or Cell listed below and he will assist you.

ROSS ordering procedures for Smoke Monitoring kit (NFES #5840)

Ordering Smoke Monitoring kits will need the following information to be passed to local or incident dispatchers to complete ROSS ordering process.

*ROSS orders are broken up into numbered blocks 2-12 (refer to ROSS order attachment)

*There is no reference to block #1, this has been substituted with an initial date and time block, this information is when the dispatcher has initiated your order.

*Block #2 - Incident / Project name. This is the name of the incident or project that your equipment will be assigned to.

*Block #3 – Incident / Project Order Number. This set of Alpha Numeric's is unique to each geographic interagency dispatch area and is a referral to whose agency is responsible for project or incident.

Financial Codes – This block has no number assigned (top right hand corner) Prior to entering a charge code, each agency will have to make contact with their agencies Grants and Agreement (USFS) or Budget and Finance (All other Agencies) personnel to properly issue a current year reimbursable financial code, **THIS MUST BE COMPLETED PROPERLY OR YOUR ORDER WILL NOT PROCESS.** A dispatcher or coordinator will be assigned to help you with this process; you will need to have telephone numbers of proper finance personnel and contacts to speed process (**This is your responsibility prior to placing order!!!!)**

> For USDA Forest Service prescribed fire monitoring, a national agreement has been established. When ordering the equipment for a project prescribed burn, use all of the following codes in the Financial Codes block: **LLFA241000 / LF6900000.HT0000 / LRRFRX131200**, and the following job codes: **WFHF0211 and WFPR1311 (override for both is 1302).** For wildfires, use the "P" codes.

*Block #4 – Office Reference Number. This information is for dispatcher to fill; this is not your responsibility.

*Block #5 – Descriptive Location - Geographic area location (local area name, ask dispatcher for help)

*Block #6 – Mapping Information – Township, Range, section or Lat. / Long. (Ask dispatcher for help)

*There is no reference to block #7

*Block #8 - Incident Base / Phone Number - This block is a set of telephone numbers that are directly associated with this project or incident, this is the responsibility of the dispatch center that placed your order.

*Block #9 – Jurisdiction / Agency - This block indicates which agency is responsible for all actions related to your project or incident.

*Block #10 – Ordering Office - This indicates which interagency or geographic dispatch center placed the order.

*Block #11 – Aircraft Information – This information is for strictly for aircraft, pilots, air operations and aircraft dispatchers. This is not your responsibility.

*Block #12 - Request Number – This block indicates how many resources are requested, date and time needed, and which resource is assigned:

Each Smoke Monitor will be ordered with an **"S"** (Supply) number, **do not group multiple Smoke Monitors under one "S" number** - your order will not process.

When indicating Time and Date needed, consider the amount of time needed to completely process your order, taking into consideration dispatch processing time, time of day or night, day of the week and National Planning Level (PL). Work with your ordering dispatcher, they have the daily responsibility of keeping you informed on local and national priorities.

Also in this block is a special needs section and reporting instructions, use these areas to indicate any special instructions and directions.

If there are any damages to the station while deployed, you must acquire an additional "S" number from the ordering manager on the incident to cover damages incurred.

For questions on ordering, inventory levels or general assistance, call Mark Barbo (RAWS Operations Coordinator @ Office: 208/387-5726 or Cell @ 208/850-0640) prior to placing your order.