ALASKA REGIONAL RESPONSE TEAM IN-SITU BURN GUIDELINES and PRE-APPROVALS

John Whitney; NOAA; 510 L St., #100; Anchorage, AK 99501
Carl Lautenberger; USEPA; 411 W. 4th Ave; Anchorage, AK 99501
Larry Dietrick; ADEC; 410 Willoughby Rd.; Juneau, AK 99801

Abstract

Use of burning as an available oil spill response method is an important issue in both the coastal and inland zones of Alaska. The capability to adequately respond to an oil spill in Alaska can be hampered by a number of critical factors, which combined with the potential to experience large spills, require ttools," other than mechanical response such as in-situ burning (ISB), be preplanned and immediately available to responders and government officials to ensure an adequate response to spill events. Because of this, the Alaska Regional Response Team (ARRT) has been working over the past 2 to 3 years to develop procedures and guidelines, scientifically based, to facilitate the decision process regarding ISB. The first major hurdle was developing a consensus that, outside the immediate region of the fire, the potentially most damaging effects of the smoke plume were those on the health and safety of the general population. The natural resource agencies were unable to document any adverse effects of the smoke plume on biological populations and/or habitats. The second hurdle occurred with the determination that particulates in the smoke plume less than 10 microns in diameter were the major culprit causing potential adverse effects to the general population. As a result, the Alaska Hazardous Substances Spill Technology Review Council funded the National Institute of Standards and Technology (NIST) to model downwind particulate concentrations for the burning of North Slope and Cook Inlet crude oils under typical winter and summer conditions in southern and northern Alaska. Based on a very conservative interpretation of the National Ambient Air Quality Standards (NAAQS), a particulate level of 150 micrograms per cubic meter ($\mu g/m^3$) - real time, one hour average - was selected as the acceptable exposure level to the general population. Using these parameters, the Alaska ISB guidelines now allow the Unified Command (FOSC and SOSC) to authorize ISB without RRT consultation. Provisions have been developed to conduct a trial burn, conduct controlled and uncontrolled burns, extinguish a burn, monitor a burn, and notify the public of a burn.

Brief History of In-Situ Burning in Alaska

As a tool for mitigating oil spills in Alaska, ISB of spilled oil has a long tradition and history of use. With the discovery of North America's largest oil field in a harsh snow and ice environment, new techniques were needed to deal with oil spilled in this setting. In the late '70s, ABSORB, the first North Slope oil spill coop in Alaska, conducted numerous experiments and demonstrations burning oil mixed in snow. This was followed in the early '80s with several tests of burning oil on, in, and under ice. In the middle '80s, the oil industry desired to extend its offshore drilling season into periods of broken ice on the Beaufort Sea. The State of Alaska responded with a program called "Tier 2", which required the oil companies to develop and

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refine techniques of dealing with oil in broken ice. Their answer was largely one of burning oil trapped in an ice matrix. Several tests were conducted burning oil in large pits filled with seawater and ice in contained and uncontained state (Allen, pers. comm., 1994). It was out of this effort that the Helitorch was adopted from use in fighting forest fires to become an important ignition tool for oil spill responders (Spiltec, 1987).

Coincidentally, the Canadians were moving ahead with oil exploration on the MacKenzie River delta, off their northwestern coast, and they faced similar problems of wanting to conduct oil related activities during the lengthy broken ice seasons that occurred during freeze up and thaw. In an effort parallel to the Tier 2 program for the American Beaufort Sea, the Canadian government required the oil companies to develop and demonstrate the capability of handling spilled oil in broken ice. Burning was embraced here, too, and the effort resulted in the first fireproof boom, the Dome stainless steel boom. Shell followed with the first fireproof fabric boom, and that was followed by the lighter and more durable 3M Fire Boom, which has seen a number of refinements since its introduction.

The first fully operational test of the 3M Fire Boom occurred off the coast of Spitsbergen, Norway during the summer of 1988. It involved the deployment of 300 feet of Fire Boom, which was towed by two vessels. A total of 500 gallons of crude oil were spilled inside the "U"-shaped deployment and ignited using a Helitorch slung beneath a helicopter. This test demonstrated the feasibility of ISB using Fire Boom; a removal efficiency of 95 percent was reported (Allen, pers. comm.,1994).

In the early months of 1989, only 500 feet of this new 3M Fire Boom existed in the state of Alaska and in the entire United States. The Cook Inlet Response Organization had agreed to make this initial investment. It was this boom that was summoned on March 24, 1989, to Valdez where Allen conducted the first actual oil spill remediation by the ISB of 15,000 to 30,000 gallons in North Slope crude in an open water setting (Allen, 1990).

Alaska RRT ISB Guidelines

Realizing the important potential of ISB, one of the first priorities of the Alaska RRT, after the *Exxon Valdez*, was to develop a set of ISB guidelines and pre-approvals. For the *Exxon Valdez* ISB, the ARRT had granted approval to conduct the burn even though no formal procedures were in place. This task was given to the Response Technology Working Group of the ARRT and their first effort was to produce an ISB Oil Spill Response Checklist on which the responsible party could submit the kinds of information that the RRT needed to evaluate a request for ISB. A longer term goal, however, was to develop a complete set of ISB guidelines with pre-approvals so the decision process, in a time-critical oil spill, could be speeded up dramatically. Having just completed the dispersant pre-approval zones for Prince William Sound, the first tendency was to define similar zones where burning was permissible, conditional, and not recommended. It was soon realized, however, that these nice boundaries for ISB didn't really apply (the movement of the smoke plume was unconfined) and that a whole different scheme was going to have to be developed. This quest just came officially to fruition last April, after several years that included literature searches, laboratory measurements, computer runs, and hundreds of hours of deliberations. Acknowledgment is extended and credit is due the many individuals representing resource and regulatory agencies, oil companies, citizen groups, and others for their contributions and perseverance in seeing these guidelines through to formal adoption.*

To the credit of the oil industry in Alaska, Alaska Clean Seas, the oil spill response cooperative for the North Slope, realized the need for a fast oil spill reaction using ISB in their dominantly ice and snow environment. As a result, in 1991, they signed an agreement with the ARRT in which the ARRT granted its pre-approval to conduct an ISB response. However, a statutory permit from the State of Alaska, which had a different checklist than the RRT checklist, was still necessary. One of the objectives of pursuing ISB guidelines and pre-approvals was to unify the previously fragmented approval process and to streamline the entire procedure.

The first question faced in developing the ISB guidelines was: <u>What potential effects can ISB have on the environment?</u> Generally, wildlife avoid the smoke produced by a fire and move away from it; smoke is an excellent hazing tool. Only fledglings and flightless chicks seemed anexception. Being uncertain of the effect of a smoke plume on these animals, it was judged as far better to eliminate the oiling by burning it rather than have sensitive habitats oiled and possibly causing long-term effects. Even though ISB might create some heating of the uppermost water layer, this phenomena would be very localized. Fish and marine mammals would probably not be affected, and any mortality to floating larvae and plankton species would be an acceptable trade-off if the oil could be kept off the shoreline. The hundreds of miles of oiled shoreline that occurred during the *Exxon Valdez* had convinced Alaskans that this was something that they never wanted to see happen again. The resource agencies decided that, at this time, they could document no unacceptable adverse effects of ISB to biological resources, and they were willing to accept it as a trade-off against other more adverse effects that spilled oil might cause.

Instead of coming from the natural resource arena, the answer to this question of the greatest possible effects of ISB became one of the potential unhealthful effects of the smoke plume on the general population. In particular, concern was expressed for the elderly, the very young, and those already compromised with respiratory problems. The by-products other than the airborne components, unburned oil and the solid-burn residues, were considered less of a potential impact than the smoke.

The second question the group had to answer was: <u>What aspect of the smoke plume produces the greatest potential health effects on the general population?</u> Direct studies of the human health impacts of oil smoke exposure were lacking. As a result, toxicological assessments are necessarily indirect and based in large part upon health studies for individual known constituents of oil-fire smoke. Many human health experts feel the most significant human health risk resulting from ISB would be inhalation of the fine particulate material that is a major constituent of the smoke produced. An early assessment of health concerns attributable to the Kuwait oil fires (ATSDR, 1991) identified the less than 10 microns particulate matter (PM-10) as representing the greatest health hazard. It has been well documented from long-term studies in exposed human populations that PM-10 presents a significant health problem (Schwartz, 1991; Archer, 1990; Schwartz and Dockery, 1991; Dockery et.al., 1993; Etzel, CDC, pers. comm.,1992); the extent to which these particles would present a health risk during ISB would be dependent on the nature of the exposure, i.e., the concentration and duration that an exposed population experiences.

Epidemiologic experts appear to agree that the greatest health risk posed by the smoke from oil fires stems from the particulates in the smoke. This includes both the soot (elemental carbon) and the hydrocarbon particulates (unburned oil). Other air pollutants considered as PM-10 include dust, dirt, soot, smoke from cars, natural windblown dust, fires, factories, power plants, construction activity and volcanic ash. Particulate size plays the most important role in determining the risk to humans. Particles larger than 10 micrometers (µm) in diameter tend to settle in the environment and generally are not inhaled. Particulates 5 to 10 µm in diameter may be inhaled, but most are deposited in the upper respiratory tract. Only particles smaller than 5 µm in diameter reach the sensitive alveolar portion of the lungs; of these, the median size is 0.5 µm. Fewer than 0.2 percent of the particulates deposited would be larger than 5 µm in diameter (Wright, 1978). Particles ranging in size from 5 to 10 µm will be deposited along the respiratory tract, and be cleared by mucociliary action, which is efficient and relatively rapid. Clearance of particulates reaching the deeper portions of the lungs is much slower and less efficient.

Overwhelming the respiratory tract with respirable particulates will cause breathing difficulties, especially to sensitive individuals, and can be associated with respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to lung tissue, and premature mortality. Significantly, the median size of the particulates in the smoke from oil fires is 0.5 µm, which is respirable, and these may reach and settle in the deeper portions of the lungs. The major subgroups of the population that appear likely to be most sensitive to the effects of particulate matter include individuals with chronic obstructive pulmonary or cardiovascular disease, individuals with influenza, asthmatics, the elderly, and children.

Concentrations of toxic gases (CO,NO_x, SO_2, etc.) and of polyaromatic hydrocarbons (PAH) produce harmful health effects of a lesser magnitude when compared to that of PM-10 (Shigenaka et. al., 1993).

The third question that we had to deal with was: <u>If the effects of PM-10 are the greatest concern in an ISB, what is the downwind concentration distribution of the PM-10 in a smoke plume as a function of atmospheric conditions?</u> At the time, virtually no actual data existed to help answer this question and all that seemed available were atmospheric dispersion models. The NOAA ALOHA dispersion model for toxic gas clouds was considered and rejected; it doesn't deal with by-products of a burning source nor the buoyancy effects of a high-temperature source. The EPA SCREEN model, which was developed as a screening tool for general emissions, was actually run. Its assumptions, however, just didn't seem to fit the conditions of an ISB (Evans et. al., 1992). About this time (1992) we became aware of the Minerals Management Service (MMS) funded NIST efforts to develop a computer model (Large Eddy Simulation-LES) to determine the actual trajectory of an ISB smoke plume and to calculate the particulate deposition at ground level. This effort was being conducted in conjunction with the mesoscale test burns being carried out at the United States Coast Guard Fire Safety and Test Detachment in Mobile, Alabama, sponsored by MMS, Environment Canada and the USCG. As suspected, predictions of smoke plume trajectory and particulate deposition at ground level from the LES model were found to be different from those predicted by the EPA-approved SCREEN model.

A grant from the Alaska Hazardous Substance Spill Response Technology Council (formed in 1990 to promote new and innovative spill response technologies in Alaska) allowed us to conduct actual burn tests of Alaskan oils and to model the downwind dispersion of PM-10. In the spring of 1993, two drums each of North Slope crude and Cook Inlet crude were shipped to the NIST laboratory in Gaithersburg, Maryland. There the oils were burned in 1.2-meter pans and the parameters of smoke yield, burning rate, and particle size distribution were determined (McGrattan et.al., 1993) and found to be similar to previous work with different crude oils.

All this information was fed into the LES model. In order to provide real-life ISB conditions, modeling was done with two different burn areas (2,500 and 5,000 feet^2), temperature profiles corresponding to typical summer and winter conditions of the Cook Inlet and North Slope region were used, and wind speeds in the range from 5 to 25 knots were considered. In order to provide worst-case scenarios, the temperatures profiles for North Slope winter and summer and for Cook Inlet winter all included temperature inversions, while the Cook Inlet summer profile was the only "normal" decreasing temperature with height profile. The LES model is based on flat terrain and focused on determining ground level PM-10 concentrations as seen in the example output of Figure 1. The PM-10 concentrations should be considered as one-hour averages.

Having these LES model runs of the theoretical downwind concentrations of PM-10 was very helpful, and led to the fourth question to be dealt with: What threshold level of exposure of PM-10 is allowable to protect the public health? The NAAQS for PM-10 exposure is a 24-hour average of 150 $\mu g/m^3$. The U.S. Occupation Safety and Health Administration 8-hour Permission Exposure Limit (PEL) for total particulates is 15 mg/m^3, and 5 mg/m^3 for respirable particulates or PM-10. Yet none of these seemed to be fully appropriate. An ISB will generally produce only a few hours of smoke exposure and the general public, as opposed to the more healthy working population, might be exposed to the smoke. No short-term exposure limit of PM-10 to the general public has been established. Yet recent studies of long term exposure of the general public to PM-10 may indicate more sensitivity than the NAAQS implies (Schwartz, 1991 & 1991/92; Archer, 1990; Schwartz and Dockery, 1991; Dockery, et. al., 1993).

In an effort to get some semi-quantitative sense of the short-term exposure of the general public to various PM-10 levels, three short-term acute air pollution events in Alaska were analyzed. On August 18, 1992, Anchorage was greeted with volcanic ash from erupting Mt. Spurr, approximately 60 miles to the west. For two days, until it rained, the city's citizens faced elevated levels of atmospheric pollution, and it became quite a common site to observe folks wearing simple dust masks or covering their faces with handkerchiefs, coats, etc. while outdoors. Fortunately, the municipality of Anchorage had an in-place PM-10 monitoring

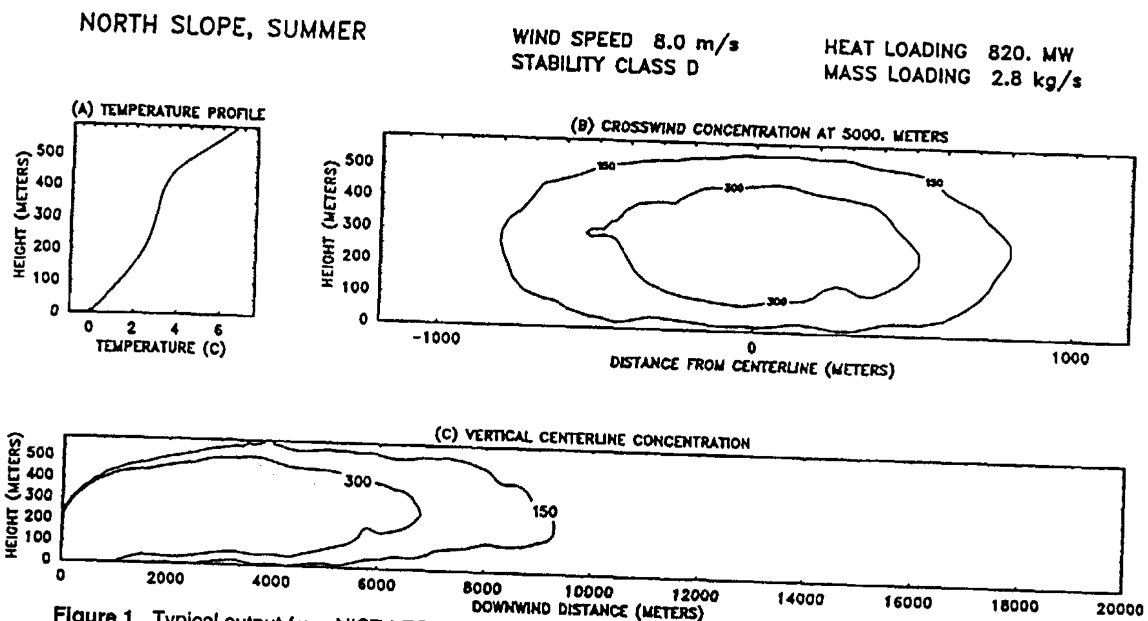

Figure 1. Typical output from NIST LES smoke plume trajectory model run, (A) temperature profile for the North Slope region in the summer, (B) crosswind extent of hour-averaged plume particulate concentrations of 150 and 300 $\mu g/m^3$ 5 kilometers downwind of the burn site, (C) downwind extent of these concen- tration levels in the plume.

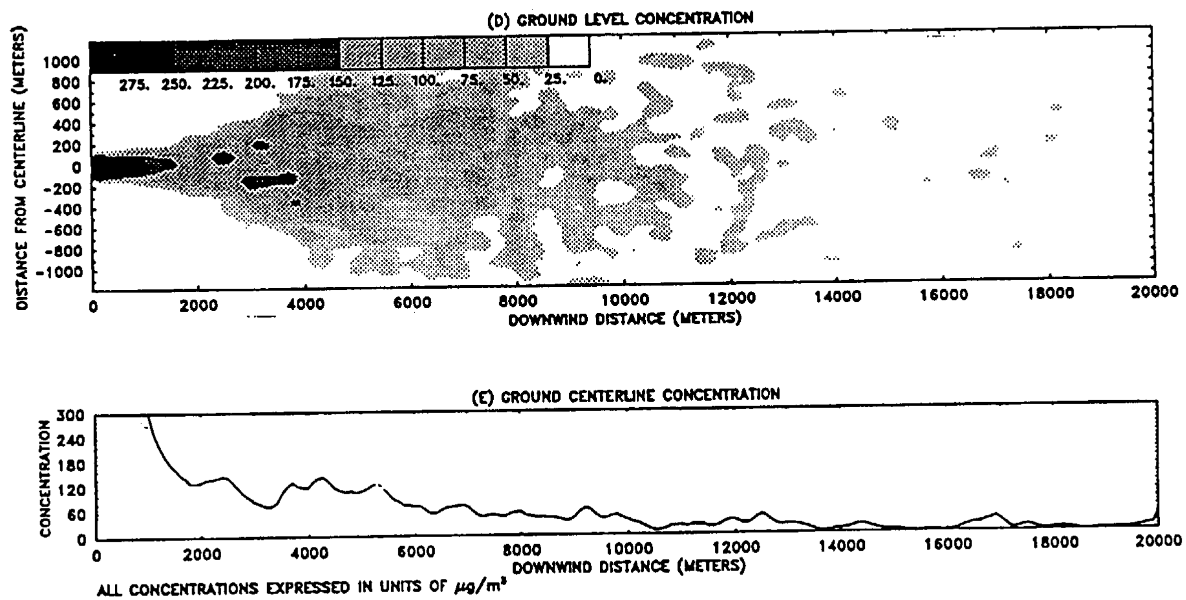

Figure 1 (continued). (D) particulate concentrations at the ground level, (E) decrease in plume concentrations along the plume centerline.

device and was able to record levels of PM-10 throughout this volcanic ash air pollution incident. Figure 2 shows the hourly averages of PM-10 during this two day plus period; while Figure 3 shows a 24-hour average per hour. The PM-10 meter was located next to a major traffic arterial, which may account for some of the heightened values, e.g., 7:00 am till 11:00 am on August 19. Nevertheless, it is obvious that the Anchorage general public received a short-term dose of PM-10 far in excess of the NAAQS of 150 $\mu g/m^3$ averaged over 24 hours. The maximum concentration was around 1000 $\mu g/m^3$, while the average exposure was 577 $\mu g/m^3$, both averaged over 24 hours, for this two day plus period. According to the Municipality of Anchorage Department of Health and Human Services, no increase in health problems directly attributable to the volcanic eruption were reported by hospital emergency units throughout the city. A fairly exhaustive consultation with national (Center for Disease Control and NOAA Hazardous Materials Assessment and Response Division) and local health experts and officials strongly suggests that comparing the health effects of petroleum-sourced PM-10 with volcanic-sourced PM-10 is valid. In other words, the dominant health effects of PM-10 are due to their size and not their chemical species or shape.

The second two events involved a phenomena common to the north country, that of prolonged wild fires in the northern forests lasting several weeks and covering hundreds of square miles. During the summers of 1990 and 1991, wild fires occurred in central Alaska each lasting several weeks, consisting of from 25 to 77 individual fires, and raging out of control from 25 to 200 miles away from the city of Fairbanks. Interviews with personnel at the State Forestry Department in Fairbanks and with the air quality supervisor of the North Star Borough (containing Fairbanks) recall persistent smoke and poor visibility. Smoke was so thick that firefighters were unable to fly out of Fairbanks due to restricted visibility. Early morning inversions would hold the smoke in the low areas, and it often wasn't until afternoon when the inversion broke sufficiently enough to increase visibility and allow flying. Only the tops of large hills and peaks showed above the smoke as the smoke covered all the low areas (where people lived) around Fairbanks. Air pollution monitoring devices located in downtown Fairbanks measured the PM-10 levels. The 24-hour averaged values of PM-10 for 1990 and 1991 are displayed in Figures 4 and 5, respectively. Note that in 1990 there were 3 to 4 days of continuous exposure of the general public at the NAAQS level of 150 $\mu g/m^3$ averaged over 24 hours.

The effects of these two air pollution events on the health of the general public were determined by interviewing three individuals, Pam Muth, the head of the Fairbanks Public Health Service in 1990 and 1991; Fran Gibbs, the head nurse of the respiratory specialist in Fairbanks; and Linda Jinks, head of the emergency room at Fairbanks Public Hospital. Their anecdotal recollections are summarized as follows; "During a period of a week or more, for each of the two summers, the smoke from the wild fires was extremely heavy throughout the Fairbanks bowl exposing nearly the entire area population. There was no noticeable increase in respirator complaints to the Public Health Service during these periods. However, field medical personnel, making home visits, noted increased complaints from the elderly and the very young folks, who had already been compromised with a chronic respiratory condition. There were increased discomforts to asmatics during the smoke periods, but probably no long-term effects from the smoke. Increased

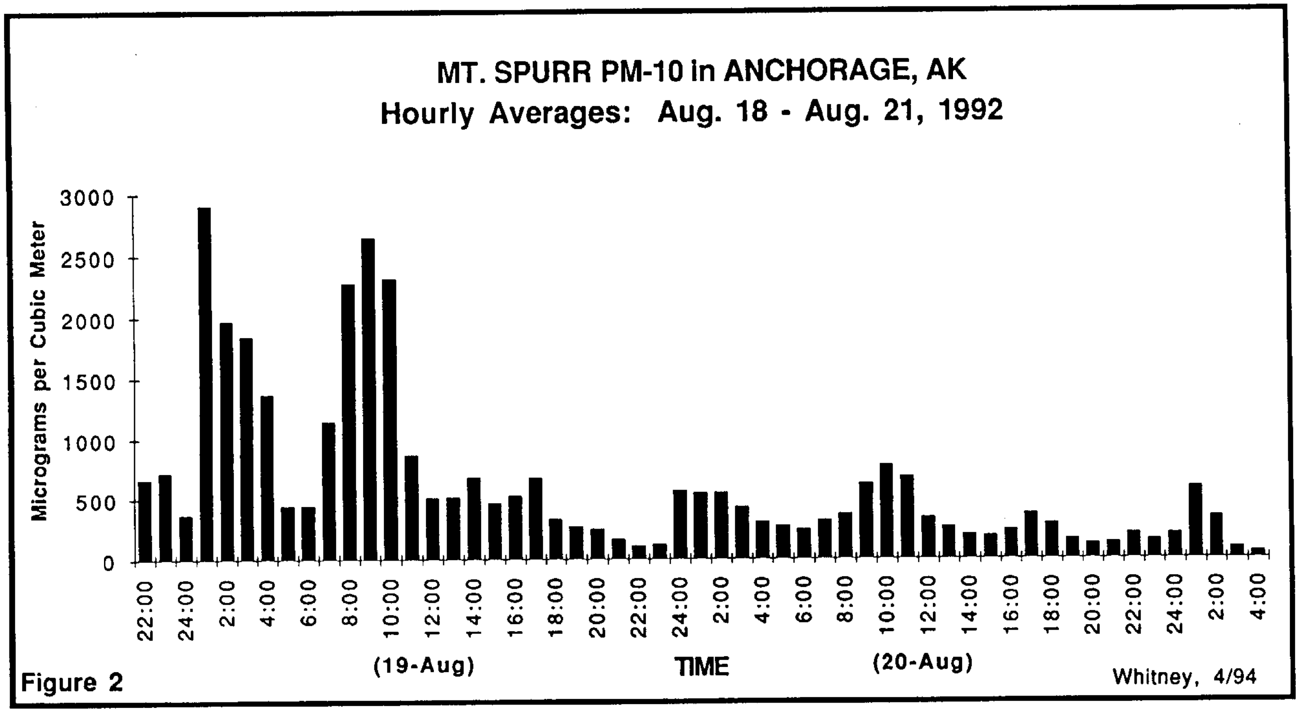

Figure 2

Figure 2 - Hourly averaged concentration levels of PM-10 from the Mt. Spurr eruption, August 18, 1992, as measured in Anchorage, 60 miles away.

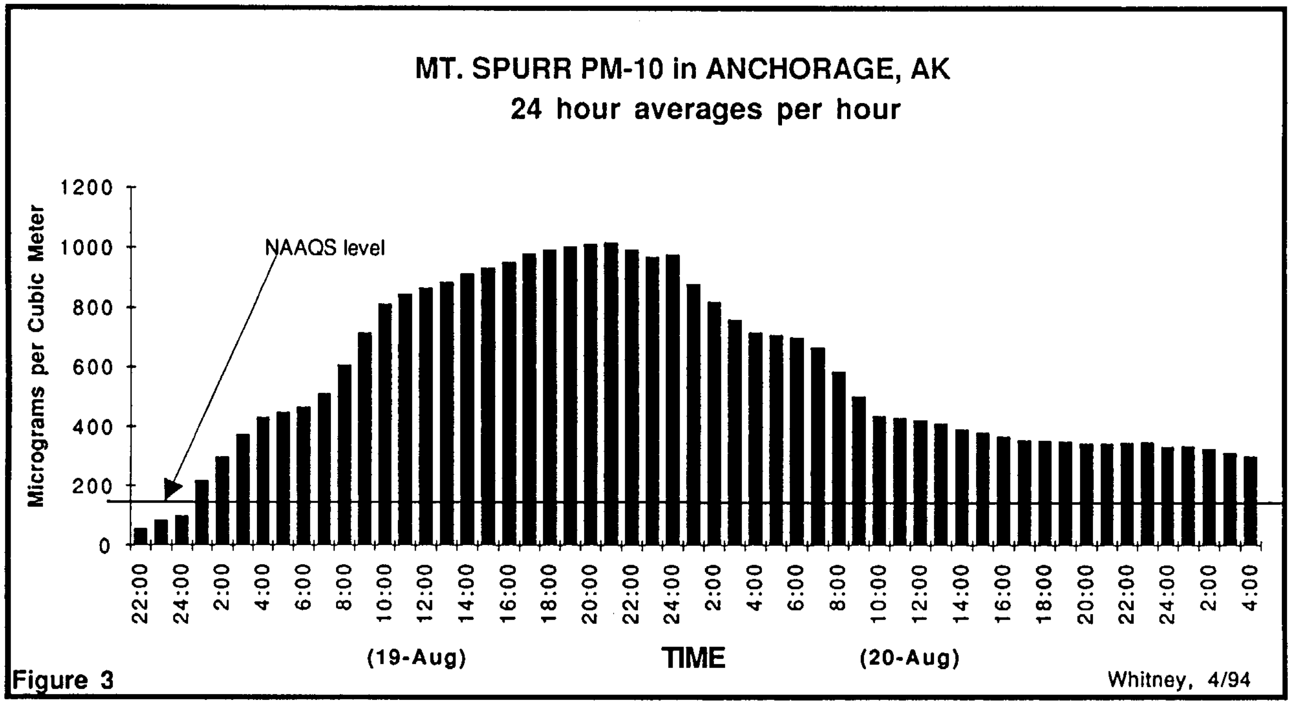

Figure 3 - 24 hour running averages per hour concentrations levels of PM-10 from the Mt. Spurr eruption, August 18, 1992, as measured in Anchorage, 60 miles away.

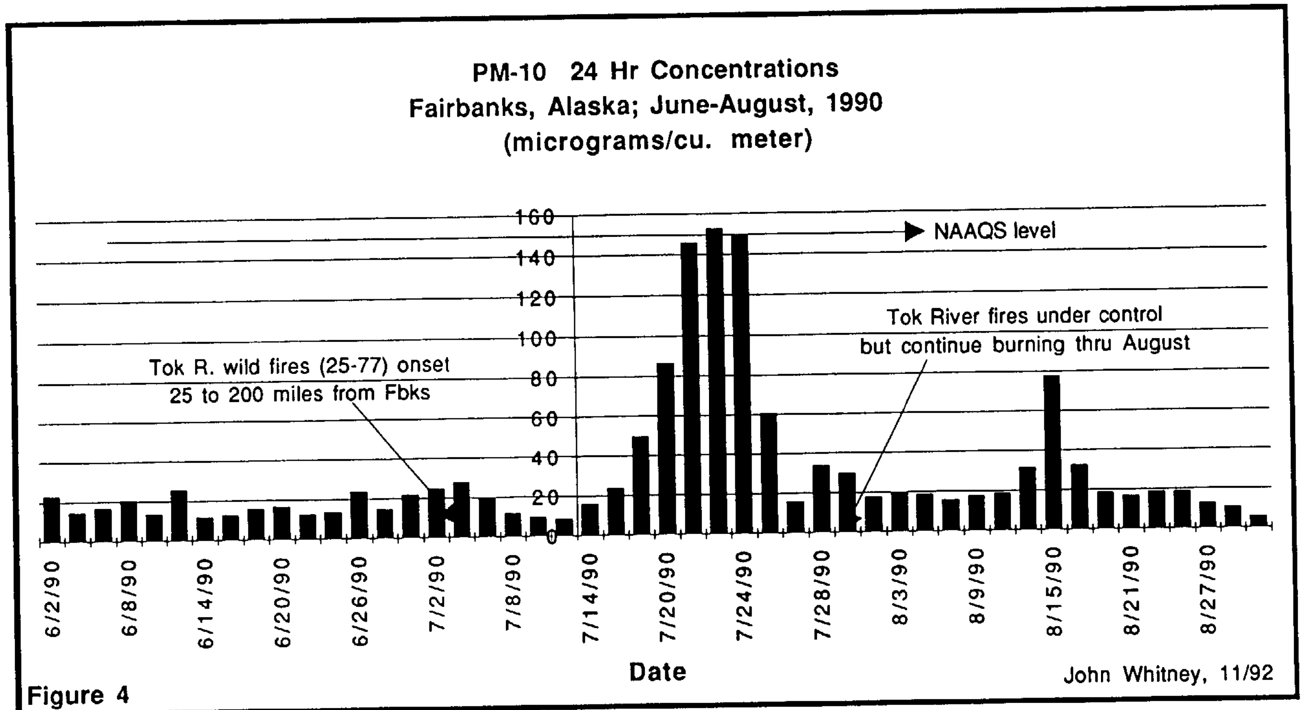

Figure 4 - 24 hour averaged PM-10 concentrations measured in Fairbanks, Alaska, during the 1990 wild fire season.

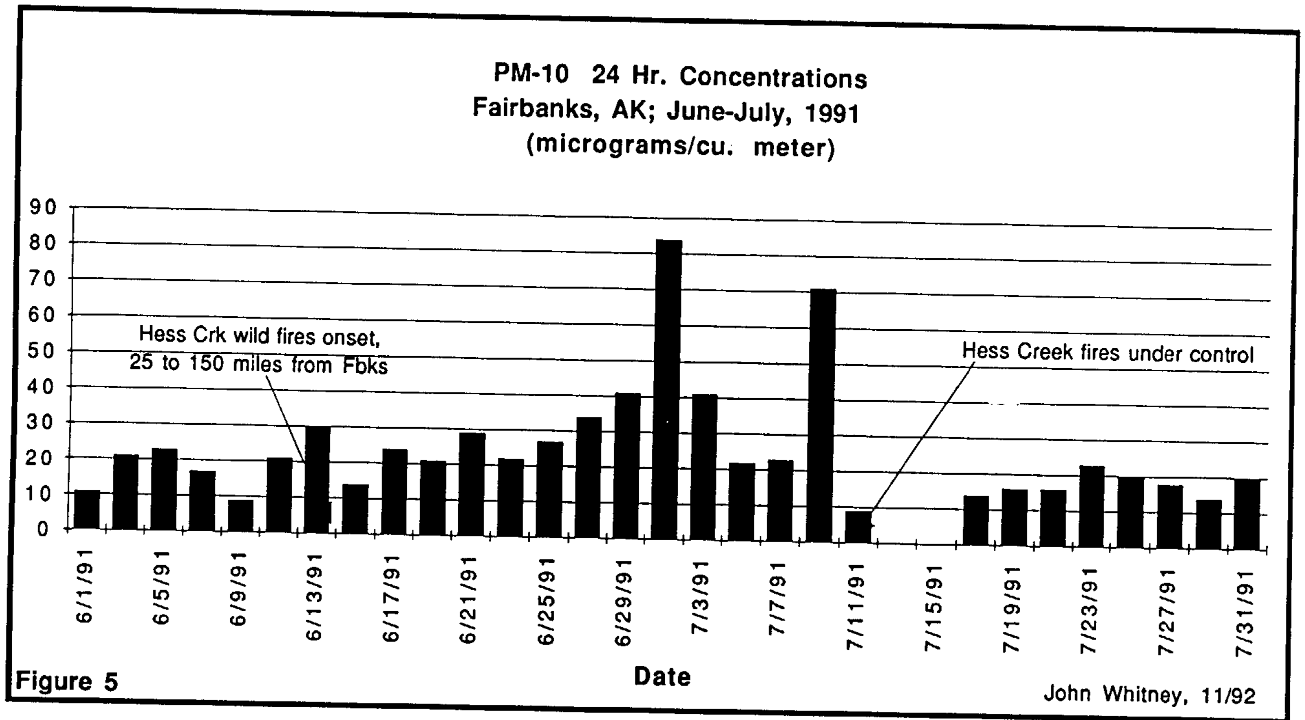

Figure 5 - 24 hour averaged PM-10 concentrations measured in Fairbanks, Alaska, during the 1991 wild fire season.

visitations from asmatics to the emergency room (ER) occurred, however the two summers were both very dry and there was a substantial increase of pollen in the air. It was uncertain whether the increased ER visits from asmatics were due to the pollen or the smoke or both. No long-term effects were noted, though, and nobody died during these intense smoke episodes."

Even though these short-term exposure events of the general public to PM-10 concentration are definitely more PM-10 exposure than one might expect to occur in an actual use of ISB to mitigate an oil spill, no "official" short-term exposure level exists. Even so-called mathematical methods to transform a 24-hour standard into a one-hour value may not be valid in the real world (Barnea, 1994, pers. comm.). Yet the 24-hour PM-10 standard appears to be somewhat inappropriate and inadequate. In this dearth of appropriate information, the ARRT decided to use the value of 150 $\mu g/m^3$ averaged over one hour as a very conservative threshold value above which is an unacceptable exposure of PM-10 to the general public from an ISB. Conceivably, in a large spill employing multiple fire booms for a long period, the 24-hour NAAQS might be approached. This level served as our absolute upper limit, but it is clear that studies to more clearly enumerate the effect of PM-10, particularly in the short term, are needed.

Once an exposure threshold had been established, it was relatively simple to advance to the next step of answering the question: <u>What are safe distances of the general public from an actual ISB?</u> Since the NIST smoke plume trajectory models cover the two Alaskan oils which comprise a very high percent of the oil spill risk, the atmospheric parameters were selected to represent reasonable worst-case situations, and the two major areas of Alaska where oil is handled were considered, it was relatively easy to pick the downwind distance where the ground level value of PM-10 was reduced to 150 $\mu g/m^3$. Table 1 is a summary of the NIST smoke plume trajectory model runs and lists the distance to the 150 $\mu g/m^3$ particulate concentration level. The NIST model is still in the development state and the principal investigators have recommended a safety factor of X2 to account for uncertainties. As a result, based on the findings of the NIST smoke plume modeling report (McGrattan et.al., 1993), the ARRT has set a worse case, conservative downwind distance of 10 kilometers or approximately 6 miles as the primary value for "a safe distance" to conduct burning operations away from the general public. Additional work is being pursued to validate the model (using data from the recent Newfoundland burn), modify it to accommodate complex terrain, and install the model software code in Alaska.

This all leads to the final set of questions: <u>How do we make a decision regarding ISB of an oil spill, and who makes that decision?</u> The ISB guidelines developed by the ARRT consist of two parts. The first part provides background information and includes such things as the general authorization procedures for the pre-approved use of ISB in Alaska, an overview of ISB as an oil spill response tool, the by-products of ISB, human health and safety concerns related to ISB, potential ecological effects of ISB, potential tradeoffs relevant to ISB, and operational considerations for conducting ISB. Much of this first part draws heavily on existing reviews of this topic (Shigenaka and Barnea, 1993; Alyeska, 1992). The second part of the ARRT guidelines involve the decision-making protocols and establish a process whereby the decision to approve or disapprove an ISB request is in the hands

Table 9: Summary of NIST smoke plume trajectory model runs.
Distance to 150 µg/m3 particulate concentration level.

Location	Season	Stability Class	Wind Speed (knots)	150 µg/m3 (miles/km)
		Burning Area of 232 m2 (2500 ft2)		
Cook Inlet	Summer	C	8	<0.6 / <1
Cook Inlet	Summer	D	16	<0.6 / <1
Cook Inlet	Summer	D	23	0.9 / 1.5
Cook Inlet	Winter	C	8	<0.6 / <1
Cook Inlet	Winter	D	16	<0.6 / <1
Cook Inlet	Winter	D	23	1.2 / 2
North Slope	Summer	C	8	1.5 / 2.5
North Slope	Summer	D	16	1.8 / 3
North Slope	Summer	D	23	1.5 / 2.5
North Slope	Winter	C	8	1.8 / 3
North Slope	Winter	D	16	2.4 / 4
North Slope	Winter	D	23	1.5 / 2.5
		Burning Area of 465 m2 (5000 ft2)		
Cook Inlet	Summer	C	8	<0.6 / <1
Cook Inlet	Summer	D	16	<0.6 / <1
Cook Inlet	Summer	D	23	0.6 / 1
Cook Inlet	Winter	C	8	<0.6 / <1
Cook Inlet	Winter	D	16	<0.6 / <1
Cook Inlet	Winter	D	23	1.2 / 2
North Slope	Summer	C	8	0.6 / 1
North Slope	Summer	D	16	2.4 / 4
North Slope	Summer	D	23	2.4 / 4
North Slope	Winter	C	8	3.0 / 5.0
North Slope	Winter	D	16	3.0 / 5.0
North Slope	Winter	D	23	2.7 / 4.5

of the two key government officials on the Unified Command, the Federal On Scene Coordinator (FOSC) and the State On Scene Coordinator (SOSC).

In Alaska, the request and approval process must be initiated by the responsible party by submitting the Application for ISB (a checklist of information includes a brief evaluation of ISB including a terse explanation why mechanical recovery is not feasible and/or adequate, a proposed burn plan, and an evaluation of anticipated emissions). Upon receipt of an Application to ISB, the OSC staff, a combination of federal and state representatives assigned to the Unified Command, will immediately initiate a four-step review. OSC as used in the ARRT ISB guidelines includes both the federal and state On-Scene Coordinators. The four review steps are:

- Evaluation
- Feasibility
- Acceptability
- Authorization and Conditions

Step One: Evaluation

In the evaluation step, the OSC determines the need for ISB by evaluating the response measures being deployed or the potential options that may be viable under the spill circumstances. There must be a full evaluation of mechanical containment and recovery operations and the capability to determine if mechanical options are feasible, adequate, and available. This includes gathering information on the nature, size, and type of product spilled, weather and sea conditions, spill trajectory, and a general evaluation of response operations.

Step Two: Feasibility

In the feasibility step, the OSC must determine whether the operational considerations and physical conditions associated with the spill are conducive to burning. This involves evaluating the weather, the equipment and personnel proposed by the responsible party to conduct the burn, and the general burn plan. Since in Alaska, only the three spill coops have the appropriate equipment and personnel necessary to conduct an open-water ISB, much of this step can be addressed in advance of an actual oil spill.

Step Three: Acceptability

In the acceptability step, the OSC must evaluate the proposed location, size, number, and anticipated duration of the burning activity and consider downwind and surrounding areas for human presence that could be affected by the burn emissions. Using this information and a downwind distance provided by air modeling, the OSC must determine if atmospheric conditions will disperse the particulate emissions to a concentration of below 150 $\mu g/m^3$ averaged over an hour before it impacts human population areas. For the time being, the air modeling referred to is the findings of the earlier referenced NIST report. This report establishes "a safe distance" of a 6 miles downwind sector within which members of the general public must be excluded. For large portions of empty, sparsely populated Alaska this should be no problem; however, special attention will be necessary for the small villages and towns along the coastline. If a small number of people are initially present within the "safe distance" and they can be evacuated/relocated/sheltered prior to burning, burning may proceed. This "safe distance" may be modified (decreased or increased) after evaluating spill specific data such as location of spill, type of oil, and stability class of current meteorological conditions. If the burn involves either Cook Inlet or North Slope crude and is located on the North Slope or in south-central Alaska (Cook Inlet or Prince William Sound), the specific distance values from the NIST report (Table 1) may be used with a safety factor of X2.

Fourth Step: Authorization and Conditions

In the fourth step, authorization and conditions, the OSC must evaluate the manner in which burning will be conducted and determine the conditions which are necessary. If the OSC's review of the first three steps support the need for, and the feasibility and acceptability of an ISB, a trial burn consisting of one fire-resistant boom full of oil shall be initially authorized to confirm anticipated plume drift direction and dispersion distances downwind. The resulting smoke plume shall be monitored by aerial observation performed by representatives from lead government agencies responsible for monitoring or directing the response. The purpose of this monitoring is to ensure the resulting smoke plume is visually comparable to the anticipated emission pattern in size, direction of drift, and dispersion. If the plume does not travel in a consistent downwind direction as anticipated, then the 6-mile downwind distance shall be expanded to the area of a circle centered at the burn with a radius of 6 miles extending in all directions. After evaluating the results of the initial trial burn, decisions to continue authorization or prohibit/limit future ISB shall be decided by the Federal and State OSCs.

Should a burn be authorized by the OSC, a method for terminating the burn and extinguishing the fire shall be available for use with sufficient means to communicate with response workers who will implement the procedures. For burns in broken ice, this control is not practicable; therefore, OSC's shall authorize ISB occurring in broken ice in locations located at least 6 miles away from human presence and under appropriate weather conditions that will ensure dispersion of harmful concentrations of particulates before reaching a populated area. An alternate value from the summary NIST table in Table 1 may be used if the size of the burn is comparable to the sizes listed in the table and a safety factor of X2 is used.

The ARRT ISB guidelines also provide for secondary operational controls: those conditions that would be imposed to assure a burn could be conducted safely in an area near or adjacent to existing human populations or human use areas. These controls range from mandatory public notification/warning that burning is occurring and the downwind area should be avoided to public notification/warning with in-place sheltering or temporary evacuation instructions. These operational controls are to be implemented upon the discretion of the OSC as appropriate.

Summary

In summary, the ARRT ISB guidelines totally remove the consultation process from the RRT and place the approval authority in the hands of two individuals, the FOSC and the SOSC. Hopefully, their presence on-scene and a scientifically based decision process should make ISB a real viable response alternative. Alaska is well suited to take advantage of this response technique. The capability exists—the three Alaskan oil spill cooperatives have close to 24,000 feet of fire boom and a dozen Helitorch ignitors in their inventories. The environmental conditions prevail—solid to broken ice conditions for 9-10 months of the year in the Beaufort Sea off the North Slope and broken, dynamic ice conditions for several months of the year in Cook Inlet.

Last March an international conference was held in Anchorage on Oil Spill Response in Dynamic Broken Ice and included experts from Canada, Norway, and the United States. The objective of the conference was to investigate response options in dynamic broken ice and attempt to reach a consensus. Through presentations and panel discussions the collective experience of those present gave a strong endorsement to the use of ISB in this kind of environment. Adding strength to this position, the Cook Inlet Regional Citizens Advisory Council, formed under OPA-90 as a group of local citizens to oversee and ensure environmentally safe operations of the oil industry in Cook Inlet, has unanimously endorsed the primary use of ISB during times of broken ice conditions in Upper Cook Inlet, and has asked the appropriate regulatory groups to make the necessary modifications in contingency plans and the ISB guidelines to accomplish this goal.

Looking ahead, the ARRT sees the ISB guidelines as a continuing issue on which revisions and refinements will be made as more information is available. Last August the highly touted Newfoundland Offshore Burn Experiment (NOBE) was conducted. Some of these measurements will be used to verify the NIST smoke plume trajectory model, so we in Alaska and others can begin to develop a level of comfort in using this model to predict the downwind concentration distribution of PM-10 emanating from an ISB under a variety of atmospheric conditions. The preliminary results of NOBE (Environment Canada, 1993) tend to verify that PM-10 is potentially the most unhealthful component of the smoke plume and that the ARRT ISB guidelines' "safe distances" may be too conservative. As other ISB test are conducted, the importance of obtaining ground-level information on the concentration of PM-10 cannot be overemphasized, thereby further validating the NIST smoke plume trajectory model and helping to answer ranges of concern of ISB for the general public.

***Members of the Alaska RRT Response Technology Working Group:** Co-chairs Carl Lautenberger, EPA, and Larry Dietrick, ADEC; Phil Means, USCG; Pamela Bergmann, DOI; Joe Banta, PWS RCAC; Sharon Hillman, Alyeska; Brad Smith, NMFS; Claudia Slater, ADFG; Gary Hufford, NWS; John Whitney, NOAA

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