EXTREME COLD WEATHER SPILL RESPONSE EQUIPMENT: THE MONTANA REFINING COMPANY EXAMPLE, 2004

BY

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April 2004

ABSTRACT

The Oil Pollution Act of 1990, which amended the Clean Water Act, requires oil spill response plans to address adverse weather conditions. In Montana, response teams should expect adverse weather conditions to mean extreme cold weather with sub zero wind chills and ice conditions on streams and lakes to reach 36" in thickness.

This requires additional clothing (PPE) and equipment procurement. Supplementary PPE purchases include insulated boots, insulated bibs, insulated over coats, ice cleats, hardhat liners, inner glove liners and outer waterproof gloves. In addition, chain saws, hand-held ice saws, gas powered ice augers, plywood, T-bars, and ice gauges need to be purchased or fabricated.

The traditional strategy for dealing with oil under the ice in a river or lake is to cut a slot. However, this technique requires an enormous amount of human resources and equipment. MRC with DOWCAR has pioneered a better and faster way to accomplish this task. We have developed the use of the Janicke Slotting Guide (JSG) with the Diversionary Plywood Sheet Barrier technique to respond rapidly in ice conditions. This technique can be accomplished using minimal responders and equipment therefore, decreasing the initial need for vast human and equipment resources.

INTRODUCTION:

In Montana, response teams should expect adverse weather conditions to mean extreme cold weather with sub zero wind chills and ice conditions on streams and lakes to reach 36" in thickness. MRC responders have experienced wind chills of -55^{o} F (Figure 1). This requires additional Personnel Protection Equipment (PPE) and equipment.

Figure 1. Rogers Pass, Montana (-55^{o}F Wind Chill)

The traditional strategy for dealing with oil under the ice in a river or lake is to cut a slot. Ice slots can be cut using chain saws, handsaws, ice augers or some form of trencher.

Montana Refining Company (MRC) uses two traditional strategies, ice slotting or ice slotting with the Diversionary Plywood Barrier Method.

MRC with DOWCAR has pioneered a better and faster way to accomplish this task. We have built and developed the use of the Janicke Slotting Guide, the JSG. The following paper discusses PPE, Equipment, Strategy, and the JSG.

PERSONNEL PROTECTION EQUIPMENT:

A responder should anticipate sub zero wind chills in Montana. This requires additional clothing or Personnel Protection Equipment (PPE) not normally found in a spill responder's inventory. Supplementary PPE purchases include insulated bibs, insulated boots, insulated over coats, ice cleats, hardhat liners, eye protection, chain saw chaps, safety harnesses, inner glove liners and waterproof gloves. The cost to supply each responder with cold weather PPE is approximately $ 455.00 (Table 1).

MRC is very aware of slips, trips and falls on the ice. To prevent a slip or fall ice cleats have been purchased for every responder. A very aggressive cleat has been chosen with long spikes attached to a metal frame that attaches to a responder's boot. A second cleat has recently been purchased that has sheet metal screws driven into a hard rubber material that straps onto the bottom of a responder's boot. The cost for a pair of cleats is approximately $40.00 a pair (Table 1).

TABLE 1 COST ESTIMATE FOR PPE

ITEM	ESTIMATED COST
Bibs (Insulated)	$ 85.00
Boots (Felt Lined)	$ 50.00
Chain Saw Safety Chaps	$ 90.00
Cleats	$ 40.00
Duffel Bag	$ 30.00
Eye Protection Clear	$ 5.00
Eye Protection (Sun Protection)	$ 5.00
Glove Inner Liner (Polyester)	$ 5.00
Gloves Outer, Insulated, Water Proof	$ 8.00
Hard Hat Liner (Light)	$ 4.00
Hard Hat Liner (Extreme)	$ 8.00
Over Coat (Insulated)	$ 75.00
Safety Harness	$ 50.00
TOTAL COST	**$455.00**

Extremities are points on the responder that require extra attention to prevent injury. MRC has selected a glove combination to prevent cold weather injury to hands during a response. First, an inner polyester glove is used. Polyester was selected due to availability and its ability to wick perspiration away from the hands. A lined, water proof, outer glove is worn over the polyester glove. The inner glove cost approximately $5.00 a pair and the outer glove approximately $8.00 a pair (Table 1).

MRC has issued two styles of hardhat liners for responses. A lightweight liner is issued for cool temperatures and light winds. A heavier liner is issued for extreme cold and strong winds. The heavy liner can be tucked into the responder's coat to form a seal in heavy winds. Costs range from $4.00 for a lightweight liner to $8.00 for a heavy weight liner (Table 1).

There are numerous types of outerwear for a responder. MRC decided to pick outerwear based on durability and ease of cleaning. In addition, we choose to purchase bibs and over coats instead of a single piece. There are two reasons for this. First, if the bibs or coats are saturated with water, product or damaged, then only half of the outerwear will need to be replaced. Second, not all-cold weather response occurs at extreme low temperature. By having a separate coat, a responder can remove the coat in warmer conditions. A lined, heavy cotton fabric over coat cost approximately $75.00 and the matching bibs about $85.00 each (Table 1).

Any time the ice needs to be cut or drilled eye protection is required. MRC has issued two pairs of safety glasses to each responder. Clear pair of safety glasses are used for snowy days and a shaded pair for sunny days. Safety glasses are generally less than $5.00 a pair (Table 1).

Finally, safety harnesses and chain saw cutting chaps are issued to the response team. Anyone using a chain saw is required to wear cutting chaps. If responders work near an open hole or slot they are required to wear a safety harness and have a safety rope attached with a responder anchoring the rope. Chain saw chaps cost approximately $90 a set and a moderately priced safety harness costs approximately $50.00 (Table 1).

EQUIPMENT:

In Montana, ice on rivers and lakes can reach a depth of up to 36". This will require the purchase or fabrication of equipment dedicated to extreme cold weather response. Items such as chain saws, hand-held ice saws, gas-powered augers, plywood, T-bars, and ice gauges need to be added to the responders inventory (Tables 2 and 3).

Fabricated Equipment

MRC has fabricated two specialty pieces of equipment for cold weather response. When we first began cold weather response, we did not have a piece of equipment to measure the depth of the ice. To measure the ice thickness we used a 2"x2"x8' wood stick with a nail hammered into one end. We simply inserted the stick into the auger hole and marked the stick. The length from the mark to the nail was measure to determine the depth. We improved this by replacing the wood with steel conduit and the nail with a steel hook. To accurately measure, we etched a line around the conduit every inch. Now we insert the ice gauge into the auger hole and measure the depth from the markings on the conduit. The estimated cost to build two ice gauges includes $30 for conduit, two small pieces of scrap steel and 2-3 hours of a welder's time (Table 2).

TABLE 2 COST ESTIMATE FOR FABRICATED EQUIPMENT

ITEM	ESTIMATED LABOR	ESTIMATED SUPPLIES
Ice Gauges	2-3 Hours	$ 30 for conduit
T-Bars	1 Hour	$ 25 for steel and chain/cable

After a slot has been cut in the ice, the block must be removed. To accomplish this T-bars are necessary. The T-bar is inserted into an augured hole in the ice block and then a chain is attached to allow a force to pull the block out of the slot. T-bars were fabricated in our welding shop and required about 1-hour for fabrication of the first T-bar. The second, third, fourth were fabricated in less time than the first (Table 2).

Purchased Equipment

Cold weather response requires the addition of certain equipment not normally found in the typical responder's inventory. Chain saws are common inventory. However, the size needed for cold weather response maybe unique. MRC has two chain saws in its cold weather inventory with bars of 36" and 41" respectively. MRC uses a skip tooth chain with square cutters. We have found this chain to be durable with a good aggressive cut. When cutting through the ice, the chain kicks up water soaking the engine. Therefore, the cold weather response inventory will need a supply of dry air filters, spark plugs, chains, cutting bars and pull ropes (Table 3).

Ice augers are required to auger holes to determine ice thickness or to auger a series of holes when executing the Diversionary Plywood Barrier strategy. It has been MRC's experience that large inventories of chipper blades are necessary. River ice contains a lot of debris that dulls the chipper blades rapidly. We have experienced the frustration of only completing a single auger hole per chipper blade. We have found that having an

extra auger can reduce down time. In either case when using an ice auger where numerous auger holes need to be completed you may have to dedicate a responder solely to replacing the chipper blades. A typical cost for a gas-powered auger is approximately $300; extra-chipping blades, augers, shear pins, and spark plugs are costs to anticipate (Table 3).

TABLE 3 COST ESTIMATE FOR PURCHASED EQUIPMENT

ITEM	ESTIMATED COST
Chain Saw 36” Bar	$ 950.00
Chain Saw 42” Bar	$1350.00
Chain Saw Spare Parts	$ 400.00
Ice Auger Gas Engine	$ 300.00
Ice Auger Spare Parts	$ 400.00
Handsaw 42” Blade	$ 75.00
Handsaw 48” Blade	$ 85.00
Pry Bars	$ 24.00
Ascenders	$ 49.00
Pulleys	$ 40.00
11 mm Static Rope	$ 1.14 ft

There is always the chance that the responders ice augers and chain saws may fail to start or break down during a cold weather response. When the equipment fails a non-mechanized alternative for slotting the ice is necessary. MRC has purchased two handsaws with blades that are 42” and 48” respectively. The slot can be manually cut using them. The handsaws cost range from $75-$85 depending on the size of the blade (Table 3).

After a block of ice has been cut, it is necessary to remove it. MRC has concluded the safest way to remove ice blocks is with a rope and using the z rig. The cost for a z rig

includes pulleys, hand ascenders and 100 feet of static rope (Table 3). If ice blocks cannot be pulled out using the rope and z rig then an alternative technique is required. DOWCAR has developed a technique where one can literally remove the ice by pushing pry bars under the block of ice and lifting the ice out of the water by pushing down on the bars. Then all one has to do is pull the block of ice to the side away from the open slot. Pry bars cost approximately $24 a piece (Table 3).

STRATEGY:

The strategy begins with a well-rounded response team. MRC maintains a response team, which includes welders, mechanics, and electricians. This allows us to make rapid repairs in the field.

In Montana, a responder should anticipate ice depths of 36" during the winter. Some kind of mechanical equipment will be needed to cut through the ice and allow the hydrocarbons to rise up to the surface for collection. The traditional strategy for dealing with oil under the ice in a river or lake is to cut a slot. Ice slots can be cut using chain saws, handsaws, ice augers or some form of trencher. MRC uses chain saws, handsaws, and ice augers to cut a slot in the ice. Montana Refining Company uses two strategies, ice slotting or ice slotting with the Diversionary Plywood Barrier Method.

Ice slotting is a very basic technique used to gain access to oil trapped beneath the ice. In ice slotting, a J shaped outline is sketched into the ice at a 30^{o} angle to the current. The

slight J hook or curve is necessary at the upstream side to provide flow towards the recovery area. In general, the slot width should be 1.5 times the thickness of the ice. Remember, a block of ice is heavy and the width of the slot must be taken into consideration so it can be safely removed or pushed under if the water beneath the ice is sufficiently deep. The length of the slot will be determined by the width of the river and strategy (Figure 2).

Figure 2. Slot with Recovery Sump (Approximately 50 Feet long)

This technique is a successful strategy to implement. However, there are a few pit falls to be aware off. First, responders will fatigue rapidly if required to cut the slot or slots by hand using a chain saw or hand held saw. If you do not have sufficiently trained Hazmat technicians available immediately, this technique can become dangerous due to human

fatigue. A chain saw with a 41" bar gets heavy quickly. Second, when cutting with chain saws, large volumes of water are kicked up by the moving chain onto the responder. This is a safety problem when the responders get wet in extreme cold weather conditions. Wearing rain gear however can reduce this problem.

A second technique is to slot the ice and use plywood to help divert oil beneath the ice to a recovery area. This technique is called the Diversionary Plywood Barrier method. In this technique, a narrow slot is made through the ice and 4' x 8' sheets of plywood or equivalent are dropped into the slot to create a barrier and force the oil to follow along it to the collection area. This is the same principal employed when using floating boom.

The slot can be cut or drilled depending on the equipment available at the time of the response. If drilling is required, a gas powered ice auger can be used. In this scenario a series of 8"or 10" holes are drilled next to each other in the J pattern (Figure 3).

A chain saw can be used to connect the holes if an ice bridge exists between two auger holes. After the ice auguring is complete, plywood can be dropped into the augured slot.

Again, river ice is dirty and our experience has shown that the chipper blades on the augers may only last long enough to complete a single auger hole. This technique requires a large inventory of chipper blades. Extra auger flights can be used, which reduces down time to change blades. A real plus to slotting the ice with an ice auger is the limited exposure of responders to water. The water is generally restricted to the area around the responder's feet.

Figure 3. Diversionary Plywood Barrier Method

If an ice auger is not available, a chain saw can be used to cut a narrow slot. After the slot has been cut and ice removed, plywood can be inserted. MRC has traditionally used 1/2" to 3/8" plywood when employing this technique. However, we have found when using our saws that it will make a 3/8" cut and we are able to insert 1/8"-1/4" plywood or outdoor siding into the slot and effectively create the barrier. Again, the down side when using large chain saws is fatigue and splash from water being kicked up by the chain. However, this problem is not as bad as cutting large slots as described above. Since only a single slot is made, the number of responders can be reduced and extra PPE in the form of rain gear can be used to minimize the water splash.

JSG (Janicke Slotting Guide):

The traditional strategy for dealing with oil under the ice in a river or lake is to cut a slot. However, this technique requires an enormous amount of human resources and

equipment. MRC with DOWCAR has pioneered a better and faster way to accomplish this task. We have built and developed the use of the Janicke Slotting Guide, the JSG (Figure 4).

Figure 4. The Original Janicke Slotting Guide (JSG)

This JSG with the Diversionary Plywood Sheet Barrier technique allows us to respond rapidly in ice conditions with a minimal number of responders. Fred Janicke designed and fabricated the JSG in the MRC maintenance shop. The purpose of the JSG is to reduce the hands on use of chain saws by responders. This greatly diminishes fatigue and eliminates the splash problem associate with cutting a slot by hand with a saw. Further, it

decreases response times to cut ice and reduces the number of responders needed to carry out the response.

The JSG was fabricated using 1 ½", 1" steel tubing, and flat iron. Fourteen-inch wheels were placed on the back to allow a responder to pull the device onto the ice with minimal effort. In addition, skids were added so the JSG could be pulled easily when in use. The device was designed to cut at an angle to either the right or left. Cutting at an angle is important because it allows the block of ice, when free, to pop up and not jam into the slot. It can also cut straight in the vertical position. A handle is used to pull the JSG by one or two responders. Finally, a safety shield was added (Figure 5).

Figure 5. Modified Janicke Slotting Guide (JSG)

A chain saw is secured to a lift that is lowered or raised by a simple crank. A throttle was added to ensure maximum speed of the chain saw to cut the ice. A guide pin was added

to the bottom of the device so the responder pulling the JSG could easily follow the etched outline of the block or slot to be cut.

Before we used the JSG, it took approximately 2-3 hours to cut a 50-foot long by 2-3 foot wide slot in the ice. With the JSG, it takes less than a 1.5 hours and the number of responders can be reduced to accomplish the same task. This year we cut a 50-foot slot in <60 minutes (Figure 6).

Figure 6. Cutting a slot with the JSG

If the Diversionary Plywood Sheet Barrier method is selected as the response strategy, a single straight line cut can be made. One responder would cut the slot and two additional responders would drop plywood into the slot just behind the JSG (Figure 7).

Figure 7. Slot cut with the JSG and ¼" plywood inserted in slot.

This reduces the number of responders initial needed to respond and greatly reduces fatigue associated with handling a large saw. The entire response becomes safer. Besides a great reduction in the number of responders, the JSG virtually eliminates the splash problem associated with chain saws. A splashguard was added to reduce water splashing on the saw and to reduce the splash to the responder. Now water only splashes around the responder's feet.

DRAWBACKS:

There are two major drawbacks when using the JSG and both relate to the chain saw. First, if you ground the chain saw on the river bottom the chain will dull immediately and you will not be able to cut ice unless the chain is changed. In addition, if the ice is dirty, meaning there is sand or gravel imbedded in the ice, the chain will dull rapidly when it

hits the material. Second is water. If you flood the saw and water gets into the carburetor, through the air intake, the saw will stall and most probably will not restart until completely dry out. This requires the inventory to contain a supply of saws and chains.

CONCLUSION:

Extreme cold weather oil spill response requires additional PPE and equipment not normally found in a responder's inventory. However, costs associated with this additional equipment need not be a big financial burden.

The traditional strategy for dealing with oil under the ice in a river or lake is to cut a slot. However, this technique requires an enormous amount of human resources and equipment. MRC with DOWCAR has pioneered a better and faster way to accomplish this task. We have built and developed the use of the Janicke Slotting Guide, the JSG.

Using the JSG with the Diversionary Plywood Sheet Barrier method, we are able to respond rapidly and with minimal responders and equipment. Thus decreasing the initial need for vast human and equipment resources needed during the initial phase of the response.

ACKNOWLEGEMENTS:

We could not have accomplished any of the tasks we set out to do without the support of Montana Refining Company and in particular, our group the Inland Waters Oil Spill

Response Team. We gratefully thank you. Most of all we would like to thank Bonnie, Cindy and Dee for letting us go play, in Montana, with the augers and saws on the frozen rivers and lakes.