

ICE DRILLING DESIGN AND OPERATIONS - TECHNICAL ADVISORY BOARD

Monday, September 14, 2015

Union South - Agriculture Room, 3rd Floor
University of Wisconsin – Madison
Madison, WI 53706

Attendees: Dale Pomraning, George Cooper, Jeff Cherwinka, Keith Makinson, Mark Twickler, Steff Bo Hansen, Alex Pyne, Frank Wilhelms, Kris Zacny, Pavel Talalay, Marshall Pardey, Mark Mulligan, Kristina Slawny, Tanner Kuhl, Mary Albert, Blaise Stephanus, Bill Eustes, Grant Boeckmann, Rory Holland, Joe Souney, Jay Johnson, Chris Gibson, Josh Goetz, Zack Meulemans (AM), Don Lebar, Terry Benson, Ross Powell, Jim Koehler, Trevor Popp

8:30 AM Welcome **Mulligan**

8:35 AM Meeting Logistics **Slawny**

8:40 AM Chairman Opening Comments **Wilhelms**

8:40 AM Update on the IDPO Science Advisory Board **Albert**
• Albert summarized the board's makeup, objective, and planning.

8:50 AM SAB Issues **Powell**
• *Estisol 140*: Presents problems with temperature logging, clouds optics, and is hard to remove from core. It can be a skin irritant, induce headaches, and create a burning sensation in the eyes for some people. It's difficult to find compatible plastics. A further discussion of Estisol 140 was deferred until later in the meeting.
• *Zacny*: Inquired about the IceDiver. *Albert* summarized what she heard during her recent trip to France.
– *Wilhelms*: The IceDiver is part of a high risk / high reward program in Europe. There is an article about in the recent Annals of Glaciology. (*Twickler* passed out copies he provided to the TAB.)
• *Cooper*: How old is the oldest ice? *Powell*: 1-1.5 Million Years. RAID is going to try to find it.

Opened the phone line.

9:05 AM Update on the Long Range Drilling Technology Plan **Slawny**
• Summarized the Long Range Drilling Technology Plan.

EXISTING SYSTEMS

9:15 AM 2014-15 Field Season & 2015-16 Field Season **Holland**
• *Cooper*: How much of the DISC Drill remains at WAIS?
– The majority of equipment is still down there. It will be removed this year and returned to UW or left at McMurdo. Jim Koehler will be going down for IDDO.
• A discussion on the depth capability of the Blue Ice Drill was deferred until later in the meeting.

- *Talalay*: Why use the thermal drill recently in Greenland?
 - *Slawny*: Due to the aquifer. It is better suited to get through the known aquifer layer in the firn.
- *Wilhelms*: Inquired about the brittle zone on the SPICE Core project.
 - *Kuhl*: We were just entering it as the season ended. There will be a further discussion of this during the IDD talk later.
- *Pomranning*: What drill fluid is being used for SPICE Core?
 - *Holland*: Estisol 140.
- *Twickler*: We will be out of WAIS Divide after this season. We need to extend the casing this year. This is two years later than originally planned due to the government shutdown two years ago and logistics issues last year.
- *Twickler / Pyne*: Alan Hills is looking for old ice.
- *Pomranning*: Are the SIPRE drills used for dirty ice?
 - *Holland*: Yes
- *Cooper*: What are the plans for the DISC Drill?
 - *Albert*: The next planned use is at Hercules Dome, but no science proposals have been submitted yet. IDPO has been tasked with trying to streamline it to reduce the logistical burden.
- *Talalay*: Why is the SHWD being used for shallow seismic holes vs. the RAM Drill?
 - *Slawny*: While they have overlapping capability, the SHWD is a logistically more friendly (portable by Twin Otter).

9:36 AM Hand Augers

Goetz

- *Stephanus*: Asks about the old PICO augers vs. the IDDO augers.
 - *Goetz*: Scientists have not shown a specific preference between the systems, but users have been happy with the IDDO systems. PICO augers have 2 cutters while IDDO/SIPRE have 3 cutters.
- *Stephanus*: Does IDDO plan to make more Sidewinders?
 - *Goetz*: We can easily make more if needed.
- *Pyne*: Any plans to revisit the design of the sidewinders?
 - *Goetz*: No.
- *Cooper*: What do the Sidewinders weigh?
 - *Goetz*: They weigh about 125 pounds.
- *Zacny*: How deep can the Sidewinders drill? Have there been requests to go deeper than the limit?
 - *Goetz*: Theoretically they can get to 40 meters. To go much deeper would make the system too heavy/less transportable. We are torque limited. To go much deeper, you likely need to a 4-inch drill system, which has a larger logistics burden.
 - *Pavel* reports that they have drilled to 54 meters with a Sidewinder.
- *Hansen*: Have any drills been lost?
 - *Goetz*: No, but the flights came off of one drill and had to be reattached.
- *Zacny*: What is the setup time?

- *Goetz*: Less than an hour. A driller can get 20-30 meters in a day.
- *Wilhelm*: How is the motor attached?
 - *Goetz*: It's a direct drive with a Variac for speed control. (Cooper is very glad to hear variacs are still in use.)
- *Pyne*: Do we use Kovacs Systems?
 - *Goetz*: We don't, but the Berg Field Center (BFC) in McMurdo does.
- *Cooper*: What is the flight material?
 - *Goetz*: Polyurethane.
- *Pomranning*: Are the extensions the same between the 3 and 4-inch systems?
 - *Goetz*: Yes.
- *Zacny*: Are the cutters made of carbide? If so, what type of carbide? Do you sharpen them? Have you considered steel?
 - *Goetz*: Yes, carbide, but unsure of the type. Normally, we only use the cutters once. We have not been sharpening. We have found the steel and carbide cutters wear about the same as long as we don't hit a rock (carbide better?)
- *Zacny*: Do we drill sediment?
 - *Goetz*: No, but we can handle a bit of sand and an occasional rock but not sediment.
- *Talalay*: Does the drill provide any feedback on inclination?
 - *Goetz*: There is no feedback or measuring of inclination. I have seen the bottom of the hole in a 4-inch hole drilled to 20 m.
- *Pardey*: Have we looked at reducing the weight of the rods for reduced torque?
- *Goetz*: We are currently using aluminum and have not considered further weight reduction. Balance between cost and functionality.

9:52 AM Logging Winches

Goetz

- *Pomranning*: What is the weight of the new winch? What was its original use? Is it a steel cable with 6 conductors?
 - *Goetz*: It's 4,200 pounds for shipping. We are unsure of its original use. It is a steel cable but only 4 conductors.
- *Cooper*: Cable length?
 - *Goetz*: 4,500 meters
- *Wilhelms*: Is the 58" height correct for the tower?
 - *Goetz*: That is a shipping dimension. The tower is erected in the field. Total assembled height is ~5-6 meters.
- *Cooper*: Are there guide wires?
 - *Goetz*: Yes.
- *Cherwinka*: How is inventory?
 - *Goetz*: Seems to fluctuate up and down.
- *Slawny*: IDDO is relatively new to borehole logging. Have one 1,500 meter winch and two 4,000 meter winches. There are some plans in the future.
- *Cherwinka*: What about the IceCube Winch?
 - *WISSARD* is using it.

- *Slawny*: It is slated to come to IDDO when WISSARD is done with it.
- *Slawny*: We have 1500m and 4500m cables.
- *Cooper*: Shipping weights do not include gensets to drive the systems?
 - *Goetz*: No.

10:00 AM Eclipse Drill

Johnson / Meulemans

- *Cooper*: What was the floor?
 - *Johnson*: Just snow.
- *Wilhelms*: Was the same voltmeter used for the drill and the winch?
 - *Johnson*: We were drilling by monitoring current more than the voltage meter.
- *Pyne*: What was the system voltage?
 - *Johnson*: 110-volt. The Variac has a step coil in it to 240V. The input power is 110 volts and the Variac steps it up for the drill motor, which is 180V.
- *Wilhelms*: What is the step coil?
 - *Johnson*: A transformer.
- *Hansen*: Do you do depth monitoring?
 - *Johnson*: It's done on a separate box. We kept it that way.
- *Talalay*: Have two different drill heads based on conditions?
 - *Johnson*: Yes.
- *Cooper*: Surprised by the use of Variacs? Have been around a long time. That is great – keep it simple.
- *Wilhems/Zacny*: Inquired about the export control review.

10:15 AM Blue Ice Drill

Goetz

- *Wilhelms*: Weight of winch and cable?
 - *Goetz*: Unsure.
- *Pyne*: Does it have an anti-torque?
 - *Goetz*: Yes, 5 anti-torque blades.
 - *Goetz*: Used a Danish step cutter design. Increased depth capability from 140 – 155 m before poor quality occurred, short of our 200 m goal.
 - *Goetz*: The torque is not balanced if we use the rake and scoop cutters.
 - *Zacny*: Has not observed this.
- *Zacny*: How was the chip transport?
 - *Goetz*: Improved. Powdery before going to step cutters.
- *Payne*: What is the firn depth in Greenland?
 - *Goetz*: It is 80 meters. At Taylor Glacier its blue ice right to the surface.
- *Stephanus*: What do we list as the depth capability of this in the future?
 - *Goetz*: Unsure what our approach should be. It's a good topic for the SAB.
- *Albert*: Equalizing the torque?
 - *Zacny*: Went away from this due to shudder in the cutter. Staggered cutters: small differences in cutter volume. Used in percussive coring system. Feels vibration and powder building up gets cores to break. Keep powder out and reduce vibration.

- *Cooper*: Vibration is not exactly a bad thing. Unbalance the force head against the wall to reduce the vibration.
- *Kuhl*: That may compromise the straightness of the hole.
- *Hansen*: The goal is to get away from powder. He does not see an issue with vibration.
- *Zacny*: Can you do stepping in a vertical direction instead of circular? Tried a side rake that helps to sweep cuttings to the side. **Goetz to follow up with Zacny on possible ways to improve BID-Deep core quality.**
 - *Wilhelms*: Single cutter inclination?
 - *Goetz*: Used it to bring down inclination.
 - Pomraning sketches a cutter and discusses it.
 - *Pardey*: Used a cutter like Pomraning's in mineralogy? Keeps a low energy point at the cutter point and higher energy away from the core.
- *Wilhelms*: What were the cracks like in the ice?
 - *Goetz*: They are fully through.
 - *Cooper*: Can you tell if the cracks are generated by torsion or tension? Diagnosis seems to be the release of internal pressure based on the appearance of the cracks.
- *Talalay*: Is fluid an option?
 - *Goetz*: Not for the current use and it is not designed to be wet.
- *Cooper*: Does the core look different at the cracking depth?
 - *Goetz*: No. Seems to be internal cracking. Would need fluid drilling to combat this.
- *Talalay*: Is fluid drilling an option?
 - *Goetz*: Not in the current configuration. Motors are not sealed and chip transport is not set up for wet drilling.
- *Twickler*: Drill was designed to go to 25-meters and after first season, the science team requested to 200-meters.

10:37 AM MORNING BREAK

10:58 AM DISC Drill

Johnson/Shturmakov

- *Johnson*: The blue gantry is used for initial setup and for a cable swap. Could come up with a new operational means to remove it.
- *Johnson*: Reduce wall thickness of screen barrel, which provides more volume for chips. Longer screen barrel does not translate directly to longer core – less volume.
- *Johnson*. Currently collecting 3.3 m cores. Could save 20 days with a 4-m core all other things equal.
- *Johnson*: We have considered modification/replacing the winch. It's unclear if it's a good pay off.
- *Cherwinka*: Are there goals for weight, size, or volume?
 - *Johnson*: No specific goals have been provided.
- *Hansen*: If you reduce the cable size, you could reduce the winch, perhaps remove the fiber?

- *Johnson*: It has been considered.
- *Twickler*: Tent vs. Steel Frame?
 - *Hansen*: Feels a tent would be too weak to last 3 seasons. Some locations have been too warm for a tent.
- *Zacny*: LabVIEW vs. C++?
 - *Johnson*: Unsure what was originally considered.
 - *Goetz*: We may have outgrown LabVIEW's capabilities.
- *Talalay*: Different drilling fluid? Silicone?
 - *Johnson*: It can be considered. Would need to look at the pump.
- *Pomranning*: New seals with silicone?
 - *Johnson*: Probably okay.

11:18 AM Intermediate Depth Drill

Kuhl / Johnson

- *Wilhelms*: Why the kink in the road from the station to the SPICE Core site?
 - *Cherwinka*: To avoid cables from IceCube.
- *Talalay*: What was the temperature in the tent?
 - *Kuhl*: -20°C.
 - *Twickler*: The storage tent was -30°C.
- *Pyne*: Were chips being left in the hole?
 - *Kuhl*: Yes. No doubt about it.
- *Pyne*: Did the altitude compound the effects of the Estisol?
 - *Kuhl*: Unknown.
- *Wilhelms*: Do the scientists want to go deeper?
 - *Kuhl*: Yes.
- *Wilhelms*: What material was used for the cutters?
 - *Wilhelms* and *Hansen* have had good luck with Viking Steel.
 - *Johnson*: Shturmakov researched hardening processes.
 - *Hansen*: Danes typically use A2 Tool Steel but they did not fully harden it. They have kept it a little softer. This was to reduce the brittleness. Have been very happy with it. Hansen used Viking Steel with good success at Dome C (-52C).
 - *Zacny*: Vascomax maraging steel works well (trade name).
 - *Pardey*: Typically use hardness of 56-58 Rockwell.
 - *Cherwinka*: The ice is harder.
 - *Hansen*: Yes, but they have had good luck in similarly cold ice. Ice will warm a few degrees this year.
- Estisol Discussion:
 - *Cooper*: Additional air in the control room, means sucking in outside air, so more heat load.
 - *Kuhl*: Correct. We did and used a heat recovery system, which grabbed 75% of the escaping heat.
 - *Wilhelm*: Could you use carbon filter to help with the Estisol?
 - *Cooper*: Would need to understand how many filters to use.

- *Kuhl*: Changing room was intense. Aprons were easily removed before going into the control room. The cuffs were an issue.
- *Wilhelm*: Can it be absorbed through the skin?
- *Kuhl*: It irritated skin. Unclear if its absorbed.
- *Pomranning*: What were the use levels vs. recommended? What was the atmospheric pressure? Does the use level account for lower atmospheric pressure?
- *Cooper*: They were at lower pressure.
- *Albert*: Suit changing really seems to be the issue.
- *Kuhl*: The control room may have been the primary problem. Felt that in the colder room, the drill floor, the Estisol was not that bad.
- *Pardey*: Have you considered integrated gloves and apron?
- *Kuhl*: Problematic due to needed dexterity.
- *Popp*: Danes experience was to change gloves every day or at least every other day. The Renland tent was warm, +3°C. It had a chip melter. Didn't notice the smell after a day. Renland was at 2300 m. It has also been used at Aura Basin (2500 m) and NEEM (2700 m).
- *Hansen*: This is the best drill fluid that he has worked with.
- *Pyne*: New cable, Teflon shield?
 - *Kuhl*: Both have Teflon wire jackets.
- *Souney*: Does the schedule account for bailing?
 - *Kuhl*: Hoping to maintain 21-meters/day. Did 22-meters/day last year.
- *Hansen*: Have you considered adding weight to make the trip down faster?
 - *Kuhl*: Maybe.
- *Hansen*: Seems like a lot of bailing.
 - *Kuhl*: We have added a pump on top of the drill. Jay will discuss this offline. Feel we may have better luck this year.
- *Hansen*: How were core breaks?
 - *Kuhl*: They were okay, within specs: 6-8 kN range, a few 10 kN.

12:15 PM LUNCH (provided): Continue Discussions

1:30 PM Rapid Air Movement Drill

Johnson

- *Cherwinka*: Are you trying to fit the reel into the Herc?
 - *Johnson*: Yes.
 - *Cherwinka*: On ARA, reel split in two and fit into a Herc. It was the same diameter hose.
- *Cooper*: Could you use polyacrylamide resins that swell in water to seal the firm? They could it be blown into the hole as a dry powder, fill in firm holes, and swell shut.
- *Pyne*: What depth do you need to get to? Just first 10-20 m?
 - *Johnson*: Thinks we need to get to the transition.
- *Eustes*: What is the pressure drop over the depth?
 - *Benson*: The total drop is 100-175 psi. 100 psi of that is through the hose, so may be 60-75 psi.

- *Albert*: The bottom of the hole seems to be the key.
 - *Zacny*: Have you considered a casing for the bottom couple of meters?
 - *Johnson*: Have tried to use a parachute type material, but it did not work.
 - *Pomraning*: What if you used a material that has a seam that closes as you go down the hole?
- *Wilhelm*: If you can move the hose to the side, the resistance will drop dramatically.
- *Johnson*: We have considered using one larger compressor vs. two smaller compressors.
 - *Pyne*: Perhaps consider other options for the compressor (e.g. like a jet engine).
 - *Cooper*: Can you use the warm exhaust from the compressor?
 - *Cherwinka*: Not a good idea. Gummy chips, hard on cutters.

1:45 PM Small Hot Water Drill

Gibson / Benson

- Looking for input from BAS on their pumping configuration. Electric system with a submersible pump running the system.
- *Sediment Laden Lake Ice Drill*
 - *Gibson*: We did a couple of mods per Doran conversations last year to upgrade his system. Implemented some changes from Cherwinka.
 - *Cherwinka*: Maintenance of the Hotsy systems at McMurdo, is it still the MEC's responsibility.
 - *Gibson*: Yes. The one returned did not work, which is consistent with Doran's experience with it.
- *Albert*: Peter appreciated the Heat Exchanger advice. Is there any information/data we want Peter to collect while he is drilling this year?
 - *Gibson*: I will follow up with him on what to test this year.
- *Ross*: The WISSARD has two different deployment configurations. One is more mobile.
- *Makinson*: What is the water temperature in the tank?
 - *Benson*: We try to get to 70-80°C. The heaters are in parallel but the operator can choose to split the water how they see fit to go down hole or as a tank warmer.
 - *Makinson*: On the UK system, they get the tank to a minimum temp and then run the rest down hole. They add snow between holes to replenish the water supply.
 - *Benson*: We potentially could melt snow during drilling.
- *Makinson*: Nozzles options?
 - *Benson*: Have the option of full flow or 1/3. Jet spray or 15° spray.
- *Makinson*: Have you used a cone around the spray to direct the flow down?
 - *Benson*: Did use that on ARA. Drillers gave up on it.
 - *Makinson*: Unsure how well it worked on UK system.
- *Wilhelms*: Melt head vs. hot point?
 - *Benson*: 3m/hr at top speed.

- Summary Table of HWD Systems
 - *Pyne*: **ANDRILL system should be on table.**
 - *Powell*: What about University systems?
 - *Pomranning*: Alaska has a system.

DEVELOPMENT SYSTEMS

2:20 PM Foro Drill

Johnson

- *Wilhelms*: What is the drive?
 - *Johnson*: Cycloidal.
- *Hansen*: What is the weight?
 - *Johnson*: 563 lbs.
- *Cooper*: No level wind?
 - *Johnson*: Thinks we will be okay based on current experience. Can have up to 200 m of cable.
- *Pomranning*: DC/AC motor?
 - *Johnson*: AC
- *Wilhelms*: Pull strength?
 - *Johnson*: 8-10.5 kN
- *Pomranning*: Standard or custom cable?
 - *Johnson*: Standard cable, but they do have a minimum order. They only make when it's ordered.
 - *Wilhelms*: Ordered the same diameter cable but with #22 AWG conductors. Normally, #24 AWG conductors are used.
- *Wilhelms*: What brand motor controller? Elmo?
 - *Johnson*: No.
- *Pomranning*: Can you run the controller on a gas generator?
 - *Johnson*: No.
- *Wilhelms*: Can you keep the cable spooled for transport (weight issue)?
 - *Johnson*: The drum is 100 pounds and the cable is 56 pounds. It can stay on.
 - *Johnson*: Taking a phased approach to converting from a 4-inch system to the new Foro.
- *Zacny*: Did you look at Pelican cases for control box?
 - *Johnson*: Did consider a variety of cases. Could not find the right form factor and had issues accommodating the brake resistor. Wanted to be able to close it and still have cables connected.
- *Hansen*: No hammer? Why not?
 - *Johnson*: We have not found that we have needed one in the past. Have the pulling capacities we need.
- *Pomranning*: One or two-stage gearbox.
 - *Johnson*: It's two-stage with the cycloidal plates.

2:44 PM Winkie Drill

Boeckmann

- *Albert*: What ambient temperature do you need to be able to use air to remove ice chips?

- *Boeckmann*: Unsure. Could use after coolers. **Need to compute the temperature.**
- *Pyne*: Suggests a text to review for this. Could successfully drill ice/sediment frozen cores if the air circulation going into the hole was between -7 to -10C. Air coming out of the hole was about -3C.
- *Zacny*: What is the sediment temperature?
 - *Boeckmann*: Unsure. It is in the Ohio Range.
 - *Pomranning*: Hard rock is going to take a lot of energy.
 - *Zacny*: Send down LN2?
- *Powell*: What is the rock core length?
 - *Boeckmann*: 15-20 cm.
- *Hansen*: What is the weight-on-bit?
 - *Boeckmann*: Unsure.
 - *Pomranning*: May be a bit light.
- *Cherwinka*: Don't need to cool during ice drilling?
- *Pomranning*: Can you use a hot water drill for access?
 - *Kuhl*: Creates a problem at the interface. Need a clean rock surface.
- *Pyne*: Standard bits are not convenient for cooling fluid passage.
- *Talalay*: What type of rock?
 - *Boeckmann*: Granite. Plan to get samples this year. Will purchase bits based on the sample.
- *Wilhelms*: Could put water down right away to seal the rock/ice interface. Wait. Re-drill.
- *Wilhelms*: Could test blue ice with air.
- *Twickler*: Did the team request a hand auger?
 - *Boeckmann*: Don't think they asked. They plan to take surface samples where the rock is exposed. If they had a hand auger, they could drill and examine the quality of the blue ice.
- *Cooper*: Does not seem to be a moving glacier.
 - *Twickler*: No, it may be moving but very, very slowly.
- *Pardey*: Have you considered a thin kerf cutting system. Less heat.
 - *Pyne*: We have used to thin kerf cutting system.
- *Talalay*: Have a good set of theoretical use of air curves for how to not melt frozen ice.
 - *Pyne*: There is an English version of this document. They suggest better performance than Boeckmann assumed. **Boeckmann to follow up with Talalay.**
- *Talalay*: Analyzed special case of drilling ice and rock. Standard drill bits have trouble with such a mix.

3:15 PM AFTERNOON BREAK

3:30 PM Modified Agile Ice Coring Drill

Slawny

- *Slawny*: Can go deeper than the 4-inch system, but not as deep as the IDD and will not be as big as the IDD either.

- *Albert*: Plan is to adapt an existing system. Coastal Domes are a target, some sites in Greenland. Amundsen Sea area is a bad weather area. A more agile system may be better suited to bad weather areas.
- *Hansen*: Could not reduce fluid column below 260 m. Pressure difference becomes too low below that.
- *Popp*: Used 38 drums of drilling fluid for about 600 meters of drilling. Pretty much a full column.
- *Hansen*: Will present the Renland setup during his talk on day 2. The drill is very capable of getting to 800-900 meters. It would be a good model for it. They use a much simpler setup.
 - *Popp*: Took away a shelter. No centrifuge. No casing. No core removal system.
- *Wilhelms*: Try to look for a location where you can go in and get your core in one season. You do not want to design for two seasons. **Has an Excel sheet for computing core depth vs. core diameter vs. 2-3 shifts vs. other design criteria.**
 - *Slawny*: What type of structure?
 - *Wilhelms*: More than likely a trench.
 - *Wilhelms*: 1 or 2 seasons to get to depth is a strong design driver.
- *Hansen*: Did get to 600 m depth and hit bedrock. Did it in 2 months while being limited to 12 hours of drilling each day because it was too warm at certain times. Admits it was not a hostile environment.

3:50 PM Agile Sub-Ice Geological Drill

Gibson / Kuhl

- *Stephanus*: Is there schedule slack for next summer?
 - *Gibson*: The schedule shows an Aug 2016 ship date. We drill during the 2016-17 season.
- *Stephanus*: What is the drill speed in ice?
 - *Gibson*: 2 m/min.
 - *Pomranning*: Really, the system can run at whatever rates you want. It's normally not an issue for rock drillers.
- *Wilhelms*: Considered fiberglass footer for his shallow drill?
 - *Gibson*: We may want to consider it to reduce weight.
 - *Wilhelms*: Dead man anchors used in mountaineering. Consider those as well.
 - *Makinson*: Have used a piece of wood and a rope.
- *Wilhelms*: What is Crystal 200?
 - *Gibson*: Mineral Oil. Similar to Isopar.
 - *Kuhl*: EFC Crystal 200 is not yet in production.
 - *Wilhelms*: What is the difference?
 - *Gibson*: Higher flash point and no aromatics.
 - *Wilhelms*: Have a whole range of Isopars to choose from.
- *Talalay*: Why not consider D-60?
 - *Tanner*: Prefers Isopar-K to D-60.
 - *Talalay*: Disagrees.

- *Pyne*: Why low viscosity? To keep the pressure down?
 - *Gibson*: Yes.
- *Cooper*: Will the Filtration Module have liquid water in it?
 - *Gibson*: Yes. It will definitely have that. We rented and tested one. We are building one out of aluminum to reduce weight.
- *Hansen*: Trying to get down to 20%?
 - *Gibson*: You will find the fluid as 20% fluid on top of the water.
 - *Hansen*: Found it to be 10% with melting it.
 - *Wilhelms*: Depends on how long you spin it.
- *Pyne*: What was the one you rented used for?
 - *Gibson*: Vegetable juice. PICO used some conical screws, which generated great pressure.
 - *Kuhl*: It's a balance between getting as much fluid back, keeping it dynamic vs. batch and adding a massive system. Can always just melt it.
- *Wilhelms*: Twin otter to what distance?
 - *Gibson*: 200 nm.
- *Wilhelms*: If the packer was filled with fluid just above the hole fluid level, the packer would be over pressured.
 - *Gibson*: May not work for our test since we need to keep the fluid moving.
- *Wilhelms*: Is Hydro fracturing really a problem?
 - *Gibson*: According to Jeff Severinghaus it is a potential problem. Just want to confirm, as we don't believe it is.
 - *Pyne*: Can potentially be a problem.
- *Zacny*: Suggest checking army surplus as they use inflatable tents. Have used them at Resolute.
- *Pyne*: Three-bladed cutter head was shown. That would need to be pulled out during coring. Drill string must be pulled.
 - *Pardey*: This drill would run the RAID tooling. Could do a mini-RAID?
- *Pyne*: Is the design predicated on having a frozen bed.
 - *Gibson*: Yes, if not, it's more complicated.

4:45 PM Fusion Welding Update

Boeckmann

- *Wilhelms*: Was the bead tool recommended for a warm or cold pipe?
 - *Boeckmann*: The German company he talked to said it would not work for a cold pipe.
- *Pyne*: What is the trade between the pipe thread vs. this welding? Wonders if we used the wrong thread.
 - *Wilhelms*: What depth did the threads leak? 80-meters?
 - *Kuhl*: Unsure what level.
 - *Hansen*: How do we know that the leak is not at the firm / ice transition?
 - *Wilhelms*: Agrees. There are two O-rings that should not leak.
 - *Wilhelms*: Feels the reason to use the fusion is for lighter tubing vs. fiberglass and thinner walls.

- *Boeckmann*: Have observed leaking in two threaded sections that were tested. Water poured out. Did not use O-rings. Fit did not look supportive for it. Used caulk to fill it in.
- *Wilhelms*: Another indication: it improves over time. Ice is settling in around it over time.
- *Cooper*: What about pulling internal bead?
 - *Boeckmann*: Do have a plan with a tool on a pole with foam to keep the bead from falling in.
 - *Cooper*: Have used a warm wire that seals from the outside in.

4:25 PM End of Day Wrap Up

All

4:45 PM Adjourn

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Tuesday, September 15, 2015

Union South - Agriculture Room, 3rd Floor

University of Wisconsin – Madison

Madison, WI 53706

Attendees: Dale Pomraning, George Cooper, Jeff Cherwinka, Keith Makinson, Mark Twickler, Steff Bo Hansen, Alex Pyne, Frank Wilhelms, Pavel Talalay, Marshall Pardey, Mark Mulligan, Kristina Slawny, Tanner Kuhl, Mary Albert, Blaise Stephanus, Bill Eustes, Grant Boeckmann, Joe Souney, Jay Johnson, Chris Gibson, Josh Goetz, Terry Benson, Ross Powell, Trevor Popp, Jim Koehler, Rory Holland

8:30 AM Next TAB Meeting **Slawny**

- Planning to move the meeting to March/April timeframe.
- IPICS Conference in March
- Need to flesh out an agenda for the TAB/SAB

8:35 AM Travel Expense Reimbursement Information **Slawny**

8:40 AM TAB Terms of Reference Discussion **Slawny**

- *Slawny*: Raises the concern of training additional drillers on systems moving forward.
 - *Wilhelms*: Says the Germans are having the same issue. Considering sending drillers through IPICS. Curious if the NSF would support such a model.
 - *Eustes*: Suggests recruiting out of the mining and petroleum school.
 - *Wilhelms*: Concerned that it may be a ‘one and done’. Germans have tied it to a Master’s Thesis.
 - *Pardey*: C4 group has the same issue. Members of the group went in on hiring a large group of people that are willing to be on call to go out into the field. The drillers are paid a premium for days in field.
 - *Johnson*: DOSECC expressed that they struggle with the same issue.
 - *Cooper*: Suggests that we look for industries that have off seasons that are opposite ours. Can be costly to keep staff on site.
- *Eustes*: Has suggested several candidates to replace him on the TAB.

NON-IDDO DRILLING AND SYSTEMS

9:05 AM Microturbines in Arctic Environments **Cherwinka**

- *Cherwinka*: No derating like typical generators.
- *Cooper*: What is the power level?
 - *Cherwinka*: 65 kW electric, 95 kW thermal.
- *Wilhelms*: What is the weight?
 - *Cherwinka*: Unsure for this model, but the 30kW unit was ~1200 lbs. and could be broke up into 400 lbs. assemblies.

- *Benson*: C65 is 2500 pounds. Battery pack is the bulk of the weight. There is a lighter version for if the unit is backed up with online power.
- *Cherwinka*: Chenega is interested in lithium batteries, which would lighten the load.
- *Wilhelms*: So it's a UPS?
 - *Cherwinka*: Yes.
- *Wilhelms*: Permanent magnet with an inverter?
 - *Cherwinka*: It creates AC power, converts to DC and then IGBTs (Insulated Gate Bi-polar Transistor) convert back to 480 3-phase. Capstone, another vendor, has not been interested in modifying anything.
- *Stephanus*: What is the efficiency?
 - *Cherwinka*: About 25% efficient for electricity. If you grab the heat, then it's more efficient than a diesel generator.
- *Cooper*: What is the weight comparison between a turbine vs. diesel?
 - *Cherwinka*: In general the diesel is heavier. Depends on packaging and heat recovery.
 - *Wilhelms*: Diesel is much heavier. Depending on whether it is running all the time or for short periods. Have seen 600 kg units, which run all the time.
- *Pomranning*: How many units do they have? 2 or many?
 - *Cherwinka*: They have many but only two that are running arctic outdoors. They run on oil but not sure grade.
- *Kuhl*: Have they been used on a mobile platform?
 - *Cherwinka*: Has not asked, but would not move it running.
 - *Benson*: 30kW units have been used on buses.
- *Pomranning*: Field maintenance?
 - *Cherwinka*: There is minimal maintenance, but there is also little you can do to repair them in the field.

9:22 AM Update on CIC Drilling Activities

Hansen

- *Wilhelms*: What was the tripping speed?
 - *Hansen*: 0.7 m/s, would prefer to be at 1 m/s.
- *Pyne*: Did they have problems with the packing of dry chips?
 - *Hansen*: Worked but not as well without fluid. Cores were running 1.5-1.7 meters.
- *Wilhelms*: Used only one 1 booster?
 - *Hansen*: Yes.
- *Pyne & Wilhelms*: What was the power on the drum heater?
 - *Hansen*: 1.5 kW heating blankets on the drum to melt chips.
- *Cherwinka*: Altitude?
 - *Hansen*: 2400 meters.
- *Pyne*: Did the fluid have an effect on CFA analysis?
 - *Hansen*: Unknown.
- *Pyne*: Would it have been better drilling into rock rather than the sand they encountered?

- *Pyne*: How do you maintain the pressure in the balloon drill structure?
 - *Hansen*: Compressors.

9:54 AM Recent BAS drilling activities and future field plans **Makinson**

- Any IDDO ideas for a better trigger mechanism to drop a weight for hammering sediment core?
- *Pyne*: When did the hose walk?
 - *Makinson*: When it was unpressurized coming out of the hole.
- *Albert*: Does RAID do isotope analysis on the way down?
 - *Makinson*: No, the chips are brought to the surface.
 - *Wilhelms*: Curious which name came first (BAS-RAID or US-RAID)?

10:20 AM MORNING BREAK

10:36 AM Instrumented Tethered Stake at Taku Glacier **Pomranning**

- *GC*: What is the expected movement of the glacier?
 - *Pomranning*: Felt the 35 m would have lasted a year. Unsure if the stake is securely into the ground.
- *Pyne*: Tension cable from the surface to the body?
 - *Pomranning*: Yes.
- *Powell*: Where was the drill site.
 - *Pomranning*: About a mile from the edge.

10:48 AM WISSARD **Powell**

- *Wilhelms*: Why such high heat flow?
 - *Powell*: Near mountain and geothermal fluxes can vary.
 - *Wilhelms*: Would be interesting to get data from multiple holes.
 - *Powell*: Agrees.
 - *Twickler*: Have observed high heat flux at other sites.
- *Talalay*: Future Plans?
 - *Powell*: Universities own the system. Maintenance and storage is an issue that SAB is working on. Four proposals have been submitted for different parts of the WISSARD system.

11:06 AM RAID **Stephanus**

- *Wilhelms*: Tube container – manual or self-feed?
 - *Stephanus*: Manual
- *Talalay*: What is the drill fluid?
 - *Stephanus*: Estisol 140. Selected prior to IDDO experience.
 - *Talalay*: The drill fluid affects the circulation system. Cannot change it without considering the effect.
- *Pomranning*: Was hose selection an issue with the Estisol 140?
 - *Stephanus*: Did not seem to be an issue with the selection, but they did see some goop/junk in the pump traps. Similar problems as IDDO with gloves, etc.
- *Pomranning*: What was the fluid circulation during drilling?
 - *Pardey*: Should be on the order of 10-20 gpm.

- *Stephanus*: Did not tax pumps.
- *Pardey*: Too much velocity will fracture the ice, so the rate was chosen carefully.

11:20 AM Chinese ice-drilling projects in Antarctica

Talalay

- *Wilhelms*: Run on one 1 generator or 2?
 - *Talalay*: One, have a spare.
- *Wilhelms*: Did you derate the power?
 - *Talalay*: Using two 80kW generators (1 primary/1 spare) derated to about 45kW at elevation.
- *Pyne*: What is the thickness of the ice at Amery Ice Shelf?
 - *Talalay*: 400-500 m shelf, 2000 m at the grounding zone.
- *Cherwinka*: Do you want a 2000 m system?
 - *Talalay*: Yes
- *Pardey*: What was the weight-on-bit and RPM?
 - *Talalay*: IBED Drill: Runs at 450 RPM and had a mass of 300 kg during testing. We added dead weight to it to increase the mass. The drill head is 150 kg.
- *Kuhl*: Do you know what the ice/bedrock transition is like at GSM?
 - *Talalay*: Have been talking to geologists to gain a better understanding of the transition zone. Likely a clean interface.

11:46 AM Victoria Univ of Wellington Antarctic Research Centre Activities & Plans 14-16 Pyne

- *Pyne*: ANDRILL was not funded. The system is returning to the University of Wellington.
- *Talalay*: Do you plan to cool and dry air?
 - *Pyne*: Yes. We are going to a larger compressor. Want to cool it below 0°C to get the water out. May have to go to active refrigeration. There are pros and cons to using air to drill through the permafrost. We are planning to drill 50 m.
- *Twickler*: What is the elevation of the marine sediment?
 - *Pyne*: 200-300 m. There has been a major uplift in the last million years.
- *Pomranning*: Drilling near Lake Ohau?
 - *Pyne*: Planning to find a sheltered area for drilling.

12:00 PM AWI for Polar & Marine Research

Wilhelms

- *Pardey*: What is the wall thickness?
 - *Wilhelms*: 108 mm ID, 130 mm OD, so 11 mm wall.
- *Pomranning*: What is the material?
 - *Wilhelms*: ASTM 316
- *Pomranning*: What was your broach tool?
 - *Wilhelms*: A custom broach tool was made for ~\$15k. We used wire erosion.

12:15 PM LUNCH (provided) Continue Discussions & Annual IDPO-IDDO Exec Meeting

1:45 PM Estisol 140 Discussion

All

- **Powell?**: At the SAB, it was brought up that it negatively affects temperature logging (convection cells) and has negative effects on tooling.

- That was Estisol 240. Do not believe Estisol 140 will negatively affect temperature logging.
- Gary Clow is feeling better about the 140.
- *Hansen*: We have not had to change seals on anything to accommodate Estisol 140.
- Butyl Acetate – PPE is expensive.
- *Pyne*: Can we get input from the science community, CFA analysis?
 - *Twickler*: COASOL increases the density of the 240 and creates the issue. No CFA analysis on the SPICE Core. On another project, there has been no effect on the isotopes. Data seems good.
 - *Pyne*: COASOL just does not evaporate. 240 evaporates well.
 - *Wilhems*: Clean the cores with another liquid like Isopar K.
 - *Popp*: Cannot do CFA on brittle ice.
- Optical Clarity
 - No data on this with 140 or 240.
 - Should be easy to measure by has not been measured.
- *Hansen*: Planning to use up our supply of Estisol 240 and will finish with 140.
- *Gibson*: Is Estisol 240 better for ventilation, but does not evaporate well?
 - Good for drilling but not for the scientists.
- *Stephanus*: Any recommended replacement?
 - *Talalay*: Will be publishing a paper soon, but no obvious choice. Will be using silicone oil on his next project. Comparably priced to new liquids, but its two times the cost of Estisol 140.
- *Pyne*: Is flammability an issue for RAID.
 - *Stephanus*: No.
- *Twickler*: Butyl Acetate is an ideal drill fluid but it has ill health effects and smells bad. If you can use it in a well-ventilated area, it's great.
- It seems that Estisol properties have changed as they developed it, at least that was what was observed with Estisol 240. The Danes, Colorado School of Mines and Pavel have different values for 140.
 - Actually Colorado School of Mines and Pavel's data agree.
- *Pyne*: How do you remove silicone oil?
 - *Talalay*: Don't know of a good method. It has not been investigated. It does evaporate - eventually.

2:30 PM Adjourn