Flow Rate Technical Group Preliminary Report

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Attached is a copy of the Flow Rate Technical Group (FRTG) Summary Preliminary Report and a transcript of her press call last week. This information will also be posted to DOI's website and the Deepwater Horizon Response (JIC) website.

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FRTG Summary_Preliminary_Report.pdf 5.27.10 Press Call w. Marcia.doc

Summary Preliminary Report from the Flow Rate Technical Group
Prepared by Team Leader Marcia McNutt, U.S. Geological Survey

Three independent methods considered by the FRTG place the minimum oil flow rate at greater than 12,000 barrels per day. Two of the methods determine that the flow rate could be as high as 20,000 barrels per day. The team using video to analyze the plume believes that the flow rate could be at least 12,000 to 25,000 barrels per day. Therefore, the area of overlap of all three methods ranges between **12,000 to 19,000 barrels per day**. These are all preliminary estimates.

In arriving at this preliminary range of values, the FRTG pursued entirely independent strategies, each of which yielded it own range of values. The values from the independent methods were combined to find the mostly likely flow rate for the well from the intersection of different methods. The Plume Team pursued the approach of observing video of the oil/gas mixture escaping from the kinks in the riser and the end of the riser pipe, using particle image velocimetry analysis to estimate fluid velocity and flow volume. The Mass Balance Team used remote sensing data from deployment of the Airborne Visible InfraRed Imaging Spectrometer (AVIRIS) and satellite to calculate the amount of oil on the ocean surface on a certain day. The team then corrected the value for oil evaporated, skimmed, burned, and dispersed up to that day and divided by time to produce an average rate. Each method has its own limitations and biases as described below.

Mass Balance: 12,000 to 19,000 barrels per day

The mass balance team used data from the AVIRIS airborne sensor flown over the Gulf of Mexico on May 17, 2010. The sensor can map both the aerial extent and thickness of oil by observing changes in reflectance that occur in the near infrared because oil absorption is less in that waveband. AVIRIS can only observe a portion of the total spill area in one day, and there is some uncertainty in estimating what proportion of the total spill area is represented in the scene that is imaged. On May 17, the mass balance team calculates that they observed 15% of the total spill, and assumes that the portion they observed is representative of the total spill. An adjustment is made for additional dull oil and sheen that coat the surface in fairly uniform layers too thin to be sensed by AVIRIS but from other sensors have been shown to persist in known ratios to the area of the thick oil (88:10:2 for sheen to dull oil to thick oil). On May 17, the amount of thick oil was 70,000 to 150,000 barrels. Bounds on the contribution of sheen and dull oil that need to be added to those totals are 60,000 to 120,000 barrels depending on reasonable thicknesses chosen for sheen and dull oil. Therefore, lower and upper bounds on the oil spill on May 17 are between 130,000 and 270,000 barrels of oil. This is the amount of oil that poses the largest threat to the coastal environment, and a large proportion of the oil released after this date was either disperser subsea or collected with the riser insertion tube tool (RITT).

Corrections are then made for the amount of oil that was evaporated, skimmed, burned, and dispersed either subsea or on the sea surface. These corrections nearly double the total amount of oil as of May 17th. The total oil is then divided by the number of days to get an average rate. This method is not without its biases that might not be captured by formal uncertainty bounds as well. For example, all of the corrections made to the surface oil were to add in losses of oil to the system. To the extent that there are other unknown processes that remove oil naturally from the system that are unaccounted for, there may be "unknown unknowns" in this analysis as well. Therefore, further scientific investigation could push these estimates higher. For example, a correction was made for anthropogenic dispersion of oil subsea (assuming that none of it arrived at the surface), but current expeditions underway may determine that there is more oil in the subsurface than can be accounted for from surface and subsea dispersion. Note that while the plume team's analysis yields an "instantaneous" rate for flow of the well at that time that the video was taken, the calculation based on mass balance is an average rate for the first 27 days of the spill, assuming that the 5 days that sea-bottom dispersants were being applied did not contribute to the observable spill.

Plume Modeling: at least 12,000 to 25,000 barrels per day (range of lower bounds)

The plume modeling team observed video from both the end of the riser where the majority of the flow is escaping and from the kink in the riser where a smaller amount exits through small slits in the top of the riser. The main method employed to make their estimates was through a common fluid dynamic technique called particle image velocimetry (PIV). While difficult in practice, it is simple in principle. In this method a flow event, e.g. an eddy or other identifiable item, is observed at two consecutive video frames. Distance moved per time between frames gives a velocity, after adjustment for viewing angle and other factors. Repeated measurement over time and space give an estimated mean flow. Flow multiplied by cross-section area of the plume gives a volume flux.

The challenges this team faced in getting reliable results were many. First, they only had a limited window of data in time to choose from. They had to select data from before the RITT was inserted into the riser as that tool captured a variable amount of flow. They needed a time window when application of subsea dispersant was not perturbing the flow. They required footage from after the period when a trench was excavated at the end of the riser to better expose the end of the plume. Most challenging was getting good lighting and unobstructed views of the plumes from work-class ROV's not intended to capture research-quality footage and occupied doing other tasks at the time.

Second, perfecting the methodology for calculating multiphase flow (oil, water, gas, hydrate in poorly known ratios) under very high pressure is worthy of a research effort. This is not a turn-key project, and yet the team did not have the luxury of time to explore many alternative approaches or calibrate methods with deep-sea tests using known fluxes of fluids in prescribed ratios. A key parameter was the average ratio of gas to liquid. This term seemed to vary over the time period of the spill. Increasing gas increased the velocity of the plume but decreased the mass flow. Lacking independent estimates, the group took the average values provided by BP at face value. Analysis of the available short movies of the raiser flow shows the existence periods when the flow oscillates from pure gas to seemingly pure oil. This appears to be an indication of Slug Flow Regime. These periods of gas-oil flow fluctuation are in the range of minutes but could also be in the range of hours or even as long as days. In order to properly determine the effect of the intermittency of the gas/oil composition in the total estimate of the oil discharged from the riser leak, the analysis should be extended to long video records spanning several days.

Not all of the experts engaged in PIV analysis. Some simply reviewed the work of those that did, while still others provided additional verification by checking the PIV answers with their calculations using other techniques. Given the challenges in applying the methods in to this particular problem, team members concluded that formal statistical error bounds on upper and lower limits on flow volume derived from a rigorous estimation of the uncertainty in model parameters would fail to capture all possible sources of error in this approach to recovering the true flow rate. It would only account for the known unknowns, but not the unknown unknowns that might be revealed if one could actually calibrate these methods against a known flow rate given the complex multiphase and flow behaviors at high pressure. The experts concluded that the effect of the unknown unknowns made it more difficult to produce a reliable upper bound on the flow rate. Therefore, they chose to simply produce a range of lower bounds from their independent analyses, all of which they thought were defendable. A formal error analysis by one member of the plume team estimated that the uncertainty in any one estimate (e.g., from the "known unknowns") would be $\pm$40%.

Reality Check: at least 11,000 barrels per day

To these independent estimates, a lower bound on the flow rate can be provided as a reality check by observing the behavior of the plume as a function of how much oil can be pulled up the RITT (Riser Insertion Tube Tool) from the leaking riser. On May 25, 2010, at approximately 1630 CDT, the RITT was yielding oil at the rate of 8000 barrels per day. The flow meter on the *Enterprise* vessel has been independently calibrated by a third party and thus this value is deemed reliable. We can revise that lower bound upwards by noting that a trickle of oil was still escaping out the end of the riser. If we assume that flow represents 15% of the original flow, then the lower bound on the flow rate rises to about 9000 barrels per day. At the same time, flow was moving through holes near the kink in the riser. It is difficult to estimate the proportion of oil versus gas escaping from the slits in the riser at this position. If the slits in the kink represent $1/6^{th}$ of the flow, a lower threshold on the flow from observing changes in flow after insertion of the RITT is about 11,000 barrels per day of oil. Note that this lower bound alone is more than twice the earlier flux estimate of 5000 barrels per day. We consider this lower bound close enough to the 12,000 barrels per day determined from the other two methods to be consistent with those lowest low bounds.

FRTG Members from the Federal Government appointed to date include:
Marcia McNutt, Director, USGS; William Rees, Jr., Los Alamos National Lab, Department of Energy; Darren Mollot, Department of Energy; Franklin Shaffer, Department of Energy; Victor Labson, USGS; Bill Lehr, National Oceanic and Atmospheric Administration; Austin Gould, US Coast Guard; Richard Brannon, US Coast Guard; Don Maclay, Minerals Management Service (MMS); Gerald Crawford, MMS; David Absher, MMS; and Bill Courtwright, MMS.

FRTG Members from academia and independent organizations appointed to date include:
Omer Savas, Professor of Mechanical Engineering, University of California Berkeley
James Riley, Professor of Mechanical Engineering, University of Washington
Juan Lasheras, Prof. of Engineering and Applied Sciences, University of California San Diego
Poojitha Yapa, Professor of Civil and Environmental Engineering, Clarkson University
Paul Boomer, Senior Lecturer, Petroleum and Geosystems, University of Texas at Austin
Steve Wereley, Associate Professor of Mechnical Engineering, Purdue University
Ira Leifer, Assoc. Researcher, Marine Science Institute, University of California Santa Barbara
Alberto Aliseda, Assistant Professor of Mechanical Engineering, University of Washington
Pedro Espina, National Institute of Standards and Technology.

NWX DEPT OF INTERIOR

Moderator: Julie Rodriguez
May 27, 2010
11:56 am CT

Coordinator: Welcome and thank you for standing by. At this time all participants are in a listen-only mode. After the presentation we will conduct a question and answer session.

To ask a question you may press star 1. Today's conference is being recorded. If you have any objections you may disconnect at this time. I would now like to turn the meeting over to your host for today's conference, Mr. Frank Quimby. You may begin sir.

Frank Quimby: Good morning. Welcome to the Department of the Interior's media teleconference on the BP oil spill flow rate. The principal speaker today is Dr. Marcia McNutt, Director of the U.S. Geological Survey and Chair of the Flow Rate Technical Group Under the Unified Command for the Federal Response.

Dr. McNutt will make a presentation. Following that there will be an opportunity for questions from the media. Please confine your questions to today's topic because of time limitations. We will begin the presentation with Dr. McNutt's statement.

Marcia McNutt: Good morning. I'm Dr. Marcia McNutt, Director of the U.S. Geological Survey and I serve as Science Advisor to Secretary of the Interior, Ken Salazar.

I just got back late last night from Houston where I was with the Federal Science Team that's overseeing BP's efforts to kill the well. We have been working non-stop to help get the well closed and the BP oil spill under control.

Over the last few days I have also been leading the Flow Rate Technical Group. Admiral Thad Allen convened this group under the Unified Command to develop updated, independent and scientifically grounded estimates of the amount of oil that is flowing into the Gulf from BP's well.

The Flow Rate Technical Group is comprised of federal scientists, independent experts and representatives from universities around the country. It includes representatives from the USGS, NOAA, DOE, the Coast Guard, MMS, the National Labs, the National Institute of Standards and Technology, UC Berkeley, University of Washington, the University of Texas, Purdue University and several other academic institutions.

BP is not involved in our efforts except to supply raw data for our scientists and experts to analyze. Before I talk about the preliminary estimates and the methodology used, I want to be perfectly clear about two points.

First, it's important to understand that since the beginning of this incident the administration's deployments of resources and tactics in response to the oil spill have been based on a worst-case catastrophic scenario.

We have not been constrained by flow rate estimates. The scale of the response would have been the same regardless if it were 1000 barrels a day or 100 times that.

We've made an all-out response, all hands on deck and all possible resources are being made available. Second, I want to emphasize that these numbers are still preliminary.

They're based on new methodologies being employed to understand a highly dynamic in a complex situation. We are still getting more data and we are improving our scientific modeling.

We will continue to refine and update these estimates. One of our teams is still working and will be reporting out in a few weeks. Having made these points, I want to talk now about how we've developed our preliminary estimates.

Within the Flow Rate Technical Group two teams are reporting out today using two entirely independent strategies for estimating the flow of oil into the Gulf.

To develop the preliminary range of values we've combined the range of values from each of the independent methods to find the area of overlap for the most likely flow rate for the well.

This is the most sound scientific approach because measurement of the flow is extremely challenging given the environment, unique nature of the flow, limited visibility and of course lack of direct human access.

The first team, the Mass Balance Team, analyzed how much oil is on the surface of the Gulf of Mexico. The Mass Balance Team developed a range of values using USGS and NOAA analysis of data that was collected from NASA's Airborne Visible/Infrared Imaging Spectrometer called AVIRIS.

The AVIRIS is an advanced imaging tool loaded on board a NASA airplane. USGS has previously used this AVIRIS tool to discover water on the moon, and this is the first time however that we've used it to measure the volume of an oil spill.

The imaging spectrometer essentially is able to measure the volume and mass of the oil on the surface of the water. Even if it is mixed with other materials such as (dispersent) and water, USGS is able to determine how much of that material is oil.

Based on observations on May 17 and accounting for thin oil not sensed by the AVIRIS sensor, we estimate that between 130,000 and 270,000 barrels of oil are on the surface of the Gulf of Mexico on that date.

To be clear this is not the flow rate but the oil on the surface. This estimate could be of assistance to responders because it gives a sense of how much oil on the surface they are still battling and that could come ashore.

We estimate that in addition to what the AVIRIS measured on the surface as of May 17, a similar volume of oil has already been burned, skimmed, dispersed or evaporated.

Given the amount observed and the adjusted calculations for the amount of oil that was burned, skimmed, dispersed or evaporated the initial estimate from the Mass Balance Team is that the rate of release from the well was between 12,000 to 19,000 barrels of oil per day.

Now this methodology carried several challenges, including the fact that the AVIRIS plane can only fly a portion of the spill in a day, meaning that an assumption had to be made that the area image was representative of the entire spill region.

The second team within the Flow Rate Technical Group reporting out today is the Plume Modeling Team. They used a different methodology. They pursued the approach of observing video of the oil/gas mixture escaping from the kinks in the riser and the end of the riser pipe, using advanced imaging analysis to estimate fluid velocity and flow volume.

This team faced several methodological challenges including having a limited window of data in time to choose from, getting good lighting and unobstructed views of the end of the riser and estimating how much of that flow is oil, gas, hydrates and water.

Based on their analysis, the video observations that the Plume Modeling Team has provided an initial lower bound of the rate of flow between 12,000 to 25,000 barrels of oil per day.

As mentioned earlier the method of each of the teams has its own limitations and biases, and that is why we are quoting the range of values from both of these methods.

What is remarkable is that these two entirely independent methods yielded such similar results. We then reality checked the estimates from both teams with a basic calculation of the lower limit of possible oil that is spilling, which is the amount of oil collected by the riser insertion tube tool, or RITT, plus the estimate of how much oil is escaping the RITT and how much oil is leaking from the kink in the riser.

We know that on May 25, 2010 at approximately 1730 Central Daylight Time the RITT logged oil collection at a rate of 8000 barrels per day as measured by a meter whose calibration was verified by a third party.

Based on observation of the riser the team estimated that at least 10% of the flow was not being captured by the riser at that time. So the lower bound estimate of the flow rate then rises to about 9000 barrels per day.

Adding in the flow from the kink at the riser which is before capture by the RITT, a reasonable low amount on total oil flow is at least 11,000 barrels per day.

Note that this lower bound alone is more than twice the earlier flux estimate of 5000 barrels per day and is independent of any calculations or model assumptions made by either of the teams.

Therefore three methodologies that I have cited today suggest that a lower bound on the flow is 12,000 barrels per day, and two methodologies used by the Flow Rate Technical Group suggest that the flow rate could be as much as 19,000 barrels per day.

I want to emphasize that these numbers are preliminary, based on new methodologies being employed to understand a highly dynamic and complex situation.

As we get more data and improve our scientific modeling in the coming days and weeks ahead, we will continue to refine and update our estimates. Everyone is working diligently to ensure these numbers are peer reviewed.

In coming up with the estimates I'm reporting today, my scientific team pulled all-nighters to come up and be able to report on today and I want to thank them for their very, very hard work.

We are also creating a Web site to ensure this information is available to the public in a timely fashion. And thank you. I'd be happy to take questions.

Coordinator: Thank you. We will now begin the formal question and answer session. If you'd like to ask a question, please press star 1. You will be announced prior to asking your question.

To withdraw your question, please press star 2. Once again to ask a question, please press star 1. One moment please. Our first question comes from Seth Borenstein of the Associated Press. You may ask your question.

Seth Borenstein: Yes thank you Dr. McNutt. First, you mentioned the lower bound of the video team was 12,000 to 25,000 barrels but then later you said there were 19,000.

Can you tell us what the upper bound of the video observation team is? That's the first part of this question. The second part of the question is are you satisfied with the fact - with BP's cooperation in terms of video because some people on the science team have said they are not?

And the third part, the AP has been asking for the names of all the members of your team for a week now and no one has responded. Can you commit publicly to releasing the names of this federal team today? Thank you.

Marcia McNutt: Lots of questions there Seth.

Seth Borenstein: Well if someone answered them when I asked earlier it would be good.

Marcia McNutt: Seth all in good time here. Okay first of all the reason why the Flow Rate Team did not give an upper bound is that the flow goes between a gas phase and an oil phase.

And the - truly a true lower bound might be if it's all gas which would be zero oil, if it went to a completely oil phase which has not actually been observed but could be if they had video that showed it, then it could be higher.

They are looking at more video now which has been supplied by BP and could come up with a higher bound but stay tuned. It may come. But it may not be sustained over a long enough time to truly add up to much.

And that's why it's good to have the estimate from the Mass Balance Team as well because the Mass Balance Team shows that integrated over any length of time what does the average flow rate look like, which is a very meaningful number.

And then you asked about the names of the team members. We will be making that public and so we can post that for you. And that would probably be easier than me reading off the names right now.

Is the team happy with the data they've gotten? Yes, we did have some shakeups in terms of getting the data to the team simply because of the way the ROBs record their data.

The file sizes were too big to FTP but we did find a way that we were able to distribute it and they now have probably more data than they know what to do with.

So I think if you talk to the team members they're probably pretty happy and you can verify that yourself.

Coordinator: Bettina Boxall of L.A. Times, you may ask your question.

Bettina Boxall: The USGS and Coast Guard and the federal authorities have, you know, consistently of course pointed to 5000 barrels and rely heavily on surface observations until now.

Why were the video analyses not employed earlier and why was the federal government so reliant on the surface observations, which clearly could only catch a portion of the spill?

Marcia McNutt: Okay, very good question. Here is the problem with the video data. The video data we knew from the very beginning was going to be dominated by the gas phase.

And until the RITT tool was put into the riser at the bottom of the ocean there was no way to correct how much of that flow was gas. And that was not until the last week and a half that we had that piece of evidence so - and to know that about 75% of what was being seen was actually gas coming out of the bottom.

And so it really was mostly the surface that was telling us more about the release rate, and that's why we're now getting better estimates from the flow because we can correct for the gas phase.

Frank Quimby: Next question.

Coordinator: Melanie Trottman of Wall Street Journal, you may ask your question.

Melanie Trottman: Hello, I - the range, the lower bound rate - is it 12,000 to 19,000 or 12,000 to 25,000?

Marcia McNutt: The reason I quoted 12,000 to 19,000 is that's the overlap of both of those independent estimates. I think that the Plume Team of course came with the 12,000 to 25,000 for their range of estimates.

So of course these are different kinds of estimates. The - those are - the Plume Team is looking at instantaneous rates whereas the Mass Balance Team is looking at integrated data, so they are looking at averages over the first 27 days of the oil spill. So there's slightly different ways of looking at it.

Coordinator: David Mattingly of CNN, you may ask your question.

David Mattingly: Hi, thank you for taking my question. The - what I would like to know is who exactly got that original estimate so wrong and how did they get it wrong?

Marcia McNutt: The original estimate was of course based on very limited data. It was approved by the Unified Command and it was based on limited data that had come in from NOAA.

I - actually before the Flow Rate Technical Group started their work I interviewed many of the people who had been involved in producing that rate just to see what they had come up with.

And to tell you the truth they did have numbers that were kind of ranging from - anywhere from 1000 to 1300 - or 13,000 gallons per day - or 13,000 barrels per day, excuse me.

And they had such wildly different numbers, all based on surface observations that they decided to take a number somewhere in the middle that they thought was conservative but defensible.

And they reserved the right of course to revise it and felt that it was important to convince Thad Allen to stand up this Flow Rate Technical Group to look more closely at it once sufficient information was in hand to improve the number.

Frank Quimby: Next question.

Coordinator: Jordan Burke of Bloomberg News, you may ask your question.

Jordan Burke: Hi there. Thank you for your time. Can you comment on how much it's leaking now or how recent we should be believing this data for for the well?

Marcia McNutt: If you're asking about time dependent of facts, whether the well is flowing a lot less now than it was earlier, the advantage of using these different types of analyses is that the Plume Group believes they'll be able to look at video from different epics and actually look at some time variability.

And they fully intend to do that to see whether they can see whether the rate may have changed in time. Our initial thought from simply looking at the change in pressure at the base of the blowout preventer is that there probably have not been major changes in the flow rate as a function of time.

But that - the one major change that may happen would be now that the riser seems to be failing as a function of this top kill, if that is taken off then the flow rate would change.

Frank Quimby: Next question. We have time for one more because Dr. McNutt has to go to a hearing.

Coordinator: Chris Baltimore of Reuters, you may ask your question.

Chris Baltimore: Thank you very much. Is - can we say now definitively that this spill has eclipsed the Exxon Valdez in terms of its total - the total amount of oil released?

Marcia McNutt: Chris that's - this is obviously a very, very significant environmental disaster and I think with the numbers I've given you, you can vouch for that.

Chris Baltimore: It'd be better if you could.

Frank Quimby: Thank you very much. That concludes our teleconference for today. Appreciate your participation.

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