Summary Preliminary Report from the Flow Rate Technical Group

Prepared by Team Leader Marcia McNutt, U.S. Geological Survey

The Flow Rate Technical Group (FRTG) has determined that the flow from the Deepwater Horizon well is likely to lie between G and H barrels of oil per day. In arriving at this preliminary range of values, the FRTG pursued two entirely independent strategies, each of which yielded it own range of values. The values from the independent methods were combined to find the area of overlap for the mostly likely flow rate for the well. Team 1, 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 image analysis to estimate fluid velocity and flow volume. Team 2, the Mass Balance Team, used remote sensing data from deployment of the Airborne Visible InfraRed Imaging Spectrometer (AVIRIS) 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.

Plume Modeling: X to Y barrels per day

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. 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 ROVs 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.

[need some words about the methodology here]

Mass Balance: 8000 to 12,000 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 observed 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. Further uncertainty is introduced in making corrections for the amount of oil that was evaporated, skimmed, burned, and dispersed either subsea or on the sea surface. As all of these effects cause oil to disappear from the surface, the mass balance calculation is more likely to under-represent the average flux from the Deepwater Horizon oil well than over-estimate it.

[anything more you want to say about the corrections here, Vic?]

Reality Check: at least 9000 to 10,000 barrels per day

To these independent estimates, an approximate 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. 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 10% of the original flow, then the lower bound on the flow rate rises to about 8800 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. For that reason, a lower threshold on the flow from observing changes in flow after insertion of the RITT is between 9000-10,000 barrels per day of oil. Note that this lower bound alone is about twice the earlier flux estimate of 5000 barrels per day and is independent of any calculations or model assumptions made by either team above.

Team Membership:

Plume Team
Bill Lehr (NOAA) – lead
Alberto Aliseda (U-Washington)
Paul Bommer (UT-Austin)
Peter Cornillon (U-Rhode Island)
Pedro Espina (NIST)
Juan C. Lasheras (UC-San Diego)
Ira Leifer (UC-Santa Barbara)
James Riley (U-Washington)
Omer Savas (UC-Berkeley)

Franklin Shaffer (DOE National Energy Technology Laboratory)
Steve Wereley (Purdue University)
Poojitha Yapa (Clarkson University)

Mass Balance Team
Vic Labson (USGS) – lead
[Vic – add team members]