

**From:** Dykhuizen, Ronald C  
**Sent:** Friday, August 06, 2010 10:13 AM  
**To:** Morrow, Charles W  
**Subject:** RE: Flow Rate Calculation

**From:** Ratzel, Arthur C  
**Sent:** Thursday, August 05, 2010 9:51 PM  
**To:** 'Tom Hunter'  
**Cc:** Ratzel, Arthur C; Wayne Miller; 'mcnutt@usgs.gov'; Dykhuizen, Ronald C  
**Subject:** FW: Flow Rate Calculation

Tom

I asked Wayne Miller to respond to Bill Lehr's questions passed on to us earlier today by Marcia McNutt. I had also copied you but the email bounced – used Comcast.com instead of Comcast.net (oops!)

Below I've attached his response. I'll visit with Ron Dykhuizen and the rest of the Tri-Lab Flow Analysis Team and confirm that we responded to the questions related to compressibility appropriately; I also recall hearing the same numbers being mentioned in discussions with Paul Hsieh last week when we were trying to establish conditions for the reservoir that could help us with computing flow rates for times other than the shut-in period.

Art

**From:** Miller, Wayne O. [mailto:miller99@ltnl.gov]  
**Sent:** Thursday, August 05, 2010 5:07 PM  
**To:** Ratzel, Arthur C; Bill.Lehr@noaa.gov  
**Cc:** 'Tom Hunter'; mcnutt@usgs.gov; Dykhuizen, Ronald C  
**Subject:** RE: Flow Rate Calculation

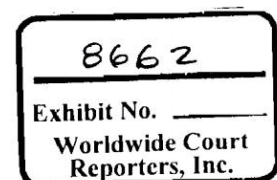
Bill,

The estimate of flow rate change before and after the riser was cut was from an analysis by Ron Dykhuizen of Sandia. He considered what we knew and didn't know about the well and BOP, and the whole system response (reservoir to exit). His analysis is attached. His conclusion: "Thus, taking into account the various scenarios for the flow, and the various uncertainties, one can then estimate that the flow increase due to the removal of the riser is about 5%. This estimate consistently used parameters that maximize the increase."

As I recall the reservoir rock compressibility of  $6 \times 10^{-6}$ /psi was the original estimate from BP. Paul Hsieh of USGS used this value, and also 12, 18 in his reservoir studies. Higher values resulted in higher flow rates all else equal. It was a modeling parameter used to try and fit limited observed data. I recall Paul liked 12 the best, but any could be made to work with different reservoir assumptions such as size and aquifer drive. He discussed this in the July 30 round-table and the results are in the compiled presentation (also attached).

Regards,  
Wayne Miller

~~~~~  
Wayne O. Miller  
Thermal Fluids Group Leader  
Associate Program Leader for Renewable Energy  
Lawrence Livermore National Laboratory  
7000 East Ave., L-140  
Livermore, CA 94551



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(925) 424-4472  
~~~~~

**From:** Ratzel, Arthur C [mailto:acratze@sandia.gov]  
**Sent:** Thursday, August 05, 2010 1:46 PM  
**To:** Miller, Wayne O.; Ratzel, Arthur C  
**Cc:** Tom Hunter  
**Subject:** Fw: Flow Rate Calculation

Wayne

See if you can craft a response on this please

Art

**From:** Marcia K McNutt [mailto:mcnutt@usgs.gov]  
**Sent:** Thursday, August 05, 2010 12:34 PM  
**To:** Tom Hunter <>; Ratzel, Arthur C  
**Subject:** FW: Flow Rate Calculation

Art, Tom -

Can either of you provide details for Bill's questions below? The 4% isn't based on the base-BOP pressure gauge that we decided to trash, is it? I remember Tom saying something about being able to calibrate the effect of the riser from data taken during the Top Kill, but I don't remember the details. I do recall that an offset in that gauge was determined then....

And I don't recall at all the discussion on what compressibility to use, so am at a loss on that.

Thanks.

Marcia

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Dr. Marcia K. McNutt  
Director, U.S. Geological Survey  
12201 Sunrise Valley Drive MS 100  
Reston, VA 20192  
(703) 648-7411 (office)  
(703) 648-4454 (fax)  
(bb)  
(cell)

www.usgs.gov

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**From:** Bill.Lehr@noaa.gov [mailto:Bill.Lehr@noaa.gov]  
**Sent:** Sunday, August 01, 2010 2:41 AM  
**To:** Marcia K McNutt <mcnutt@usgs.gov>  
**Subject:** Re: Flow Rate Calculation

Marcia.

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Considering the uncertainties we have in determining the other oil budget terms. I think that the DOE estimates for flow are satisfactory. The 53 K bbl/day at shut-down seem pretty solid. As you point out, if we use the WHOI liquid-gas ratios, then the Plume Team numbers are compatible with the new standard. I would like to see more details someday on the 4% reduction due to riser impedance (as compared to the BP guess of 20%) and justification for the use of a different compressibility than the reported value of 6.

Regards,

Bill Lehr

----- Original Message -----

From: Marcia K McNutt <mcnutt@usgs.gov>

Date: Saturday, July 31, 2010 12:32 pm

Subject: Re: Flow Rate Calculation

To: Steve Chu <[REDACTED]> "OConnor, Rod" <Rod.OConnor@hq.doe.gov>

Cc: [REDACTED], Tom Hunter <tohunte@sandia.gov>, Ken Salazar <[REDACTED]>

Bill.Lehr@noaa.gov

> I'm ok. I don't think you need to widen the uncertainty bounds for the  
> Plume team, but I will copy to Bill Lehr for input. Original PIV used  
> 0.29 for oil to gas and new WHOI in situ data raises that by 50  
> percent, raising the Plume Team flow rate estimates correspondingly.

>

> Over and out.

>

> Marcia

>

>

> ----- Original Message -----

> From: SCHU [REDACTED]

> Sent: 07/31/2010 03:19 PM AST

> To: "OConnor, Rod" <Rod.OConnor@hq.doe.gov>

> Cc: "[REDACTED]" <[REDACTED]>; "Hunter, Tom

> (Sandia)" <tohunte@sandia.gov>; Marcia McNutt; "Ken Salazar

> [REDACTED]" <[REDACTED]>

> Subject: RE: Flow Rate Calculation

>

>

>

> I am OK. Tom, Marcia and Ken should weigh in.

>

> Steven Chu

> Department of Energy

> From: OConnor, Rod

> Sent: Saturday, July 31, 2010 3:17 PM

> To: SCHU

> Subject: RE: Flow Rate Calculation

>

> Are you okay with this chart going public?

>

> From: SCHU

> Sent: Saturday, July 31, 2010 3:14 PM

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DEP445-000279

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> To: OConnor, Rod; Owens, Missy; [REDACTED]; Marcia K McNutt  
> Cc: Ken Salazar [REDACTED]  
> Subject: RE: Flow Rate Calculation  
>  
> Should have listened!  
>  
> We think the uncertainty of the flow just before the sealing cap was  
> used to stop the flow was 53,000 barrels, probably good to  $\pm 5\%$ .  
> However, there are uncertainties with change in pressure due to well  
> depletion. Also, since the plume team was on the low side and the  
> nodal teams had large uncertainties, we decided to expand the  
> uncertainty to  $\pm 10\%$  to be safe.  
>  
> [cid:image001.png@01CB30C3.C56AAE10]  
>  
> Steven Chu  
> Department of Energy  
> From: OConnor, Rod  
> Sent: Saturday, July 31, 2010 3:07 PM  
> To: SCHU; Owens, Missy; Tom Hunter [REDACTED]; Marcia K McNutt  
> Subject: RE: Flow Rate Calculation  
>  
> One more change in red-is this okay  
>  
>  
> Total flow ~4.9 million barrels with an estimated uncertainty of  $\pm$   
> 10%. That makes the daily range equivalent to 53,000-62,000 barrels  
> over 84 days (with the flow rate declining towards the lower bound  
> over that period). We will continue to refine this estimate and its uncertainty.  
>  
>  
> Missy Owens  
> Deputy Chief of Staff  
> Department of Energy  
> 202.586.4251 work  
> [REDACTED] cell

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DEP445-000280

TREX 008662.0004