From: "Jones, T. R." <tjones2@entergy.com>
To: "'James Noggle'" <JDN@nrc.gov>
Date: 1/25/06 3:10PM
Subject: FW: Unit 1 Tritium Mass Balance Report

From: English, Christopher
Sent: Wednesday, January 25, 2006 3:09 PM
To: Croulet, Donald
Cc: Jones, T. R.; Mayer, Don
Subject: Unit 1 Tritium Mass Balance Report

Don,
Attached is the tritium mass balance report prepared by Dennis Quinn. Please forward to NRC, the team and other interested stakeholders.

<<TritMassBal2002-05-Jan23.doc>>
Thanks,
Chris English
914 734 6753
cengli2@entergy.com

A137

From: "Croulet, Donald" <dcroule@entergy.com>
To: "'Timothy Rice'" <tbrice@gw.dec.state.ny.us>, <JDN@nrc.gov>
Date: 1/25/06 3:32PM
Subject: FW: Unit 1 Tritium Mass Balance Report

Tim, As requested.

From: English, Christopher
Sent: Wednesday, January 25, 2006 3:09 PM
To: Croulet, Donald
Cc: Jones, T. R.; Mayer, Don
Subject: Unit 1 Tritium Mass Balance Report

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Tritium Mass Balance for Unit 1 Spent Fuel Complex

The purpose of the tritium mass balance is to determine if the amount of water estimated to be leaking from the Unit 1 Spent Fuel Complex (U1 SFP) can account for the amount of tritium being collected in groundwater and surface water drainoff nearby. Specifically, the tritium balance compares the nominal leakage rate from U1 SFP (25 gallons per day, gpd) at the measured tritium concentration in the West Pool to the total activity collected in the Sphere Foundation Drain Sump (SFDS) and the North Curtain Drain (NCD).

Calculations were performed using the best available data, including the following parameters:

- Unit 1 West Pool tritium activity: Samples were collected and counted for tritium on a regular basis starting in 2003. The primary error associated with this sample type is the sampling error. Specifically, the sample collected may not be representative of the location from which the pool is leaking.
- North Curtain Drain Volume: Volume was determined by FRAC Tank volumes from discharges (through 2003) and from flow totalizer readings in 2004 and 2005. The use of the FRAC tanks smooths out the flow so that it was not possible to obtain an time dependent accurate measurement of the total volume passing through the NCD system.
- North Curtain Drain tritium activity: These composite samples were generally above the minimum detectable concentrations, and they did not have large counting errors.
- Sphere Foundation Drain Sump Volume: Volume was determined from totalizer readings starting in 2004. Prior to 2004, an average flow rate of 20 gallons per minute was used.
- Sphere Foundation Drain Sump tritium activity: These composite samples were often near or below minimum detectable concentrations, and there was a relatively large counting error.

The methodology involved performing calculation of monthly data as follows:
(NCD H-3 x NCD Volume) + (SFDS H-3 x SFDS Volume) = total H-3 collected
U1 SFP H-3 x 25 gallons per day = total H-3 released
Note that the 25 gallons per day leakage from the U1 SFP is based on reviews of operational data including pool levels, water additions, and water removals. For the last 3 months of 2005, a rate of 65 gallons per day was used, based on actual level measurements.

The amount of tritium released was compared to the amount of tritium collected. The curtain drain and the SFDS systems are expected to collect the vast majority of the water from the U1 SFP, based on the depression in the groundwater created by the SFDS. Ongoing and planned hydrogeological studies are being performed to validate this assumption. Using this tritium balance method, one can determine if the Unit 1 Spent Fuel Pool Complex is the sole contributor to the tritium contamination in the groundwater at Unit 1. It can also provide information that will help to determine if the U1 SFP leakage is being captured in the NCD and SFDS systems.

Based on the results of the tritium balance for 2002 - 2005, there is not a matching balance of activity released from the U1 SFP and the activity collected in the NCD and SFDS Systems. Table 1 shows the total tritium activity collected in the NCD and the SFDS systems over the years 2002 – 2005, compared to the amount of tritium released from the U1 SFP, assuming 25 gallons per day (and 65 gallons/day for last 3 months of 2005). The table also lists the percent of tritium collected that can be attributed to the U1 SFP. Figure 1 is a bar graph that shows, on a monthly basis, the percent of tritium activity that is represented by the SFP source term. For example, in July 2005, about 20% of the tritium activity collected in the NCD and SFDS systems can be attributed to releases from the U1 SFP.

Table 1

Unit 1 - Total Tritium Activity Collected and Released 2002 – 2005					
Year	**NCD Collected (mCi)**	**SFDS Collected (mCi)**	**Total Collected (mCi)**	**U1 SFP Release (mCi)**	**% of H3 collected attributable to U1 SFP**
2002	57	50	107	23	22%
2003	139	47	186	23	12%
2004	141	206	347	18	5%
2005	112	65	177	134	76%
Sum of all 4 years	449	368	817	198	24%

There are uncertainties in the data collection (activity in NCD, SFDS, and U1 SFP). Of these, the most significant activity uncertainty is the U1 SFP. The sample is generally taken from the West Pool, but the location of the sample may not be the location of the leakage (unknown location). On particular sample in October indicated 4E-2 uCi/ml in the West Pool, a value almost a factor of 100 higher than previous values. A later sample showed substantially lower (but still elevated) values. In addition, in the 2002-2004 time frame, the U1 SFP tritium activity was in the range of 5 E-4 uCi/cc. There were some errors in sample preparation which yielded substantially higher results, and those results were eliminated from the calculations.

To compound the uncertainties related to activity, the leakage rate may not have been equal throughout all years. The height of water in the pool complex, and the number of pools which were full may affect the amount of leakage. In October of 2005, there were substantial rains, and there was a need to fill pools other than the West Fuel Pool in the U1 SFP system. This is believed to have increased leakage rate. However, the water added was relatively low activity water from the north curtain drain. In addition, the level in the West Pool was raised to perform fuel assembly inspections. These activities

caused variations in both pool activity and pool leakage. Considering these uncertainties, precise agreement between the tritium released and the tritium collected in the NCD and SFDS is not expected. However, the total tritium released from the U1 SFP only accounts for less than 25% of the tritium collected in the NCD and SFDS.

Summary and Conclusions:

1. The historical average leak rate from the Unit 1 West Pool is about 25 gallons per day, based on physical measurements (water depth and makeup water logs)

2. The 25 gallon leakage value changed significantly in the fall of 2005. At this time, the water level was raised in the west pool to facilitate fuel assembly inspection. At the same time, a substantial rain necessitated the filling of other pools in the U1 SFP complex. The pool levels varied over the October to November time frame so that an accurate determination of leak rate was not possible. In December 2005 and January 2006, the leak rate has settled into a steady 80 gallons per day, with about 15 of those 80 gallons being evaporation losses. Therefore the net loss from the pool is about 65 gallons per day, and this is taken to be for the months of October 2005 and later.

3. Tritium released from the U1 SFP accounts for about 25% of the total tritium collected from the NCD and SFDS. The amount of leakage that would be necessary to account for all of the tritium in the NCD and SFDS can be back-calculated, and the values are not reasonable in that the amount of leakage would be readily detectable using conventional means such as makeup water tracking and depth measurements.

4. Potential sources of the tritium balance differences are as follows:

    a. Unit 2 fuel pool is an additional source of tritium
    b. Other sources in the Unit 1, 2, or 3 areas could be contributing. This is possible based on the current understanding of the groundwater depression in the vicinity of the sphere foundation drain sump.
    c. There is a reservoir of tritium from past releases that acts to continuously release tritium into the SFDS and NCD areas. Figures 2 and 3 show the concentration of tritium in the NCD (Fig 2) and the SFDS (Fig 3) as compared to gallons collected and precipitation. There is no indication of dilution of the source with heavy rains or high gallons pumped. This information, while not definitive, points toward a reservoir of activity or an additional source beyond the U1 SFP.

5. Based on the current understanding of the hydrology onsite, the NCD and SFDS are most, if not all of any leakage from the U1 SFP complex. This review of the data would support that understanding.

6. Additional monitoring wells are planned in the vicinity of Unit 1 to improve the current understanding of the extent of groundwater depression. The data collected will help to further understand and/or validate assumptions that essentially all of the activity from the U1 SFP is collected in the SFDS and NCD. It will also help to determine if there are additional sources of tritium contributing to the concentrations in the groundwater near Unit 1.

Figure 1.

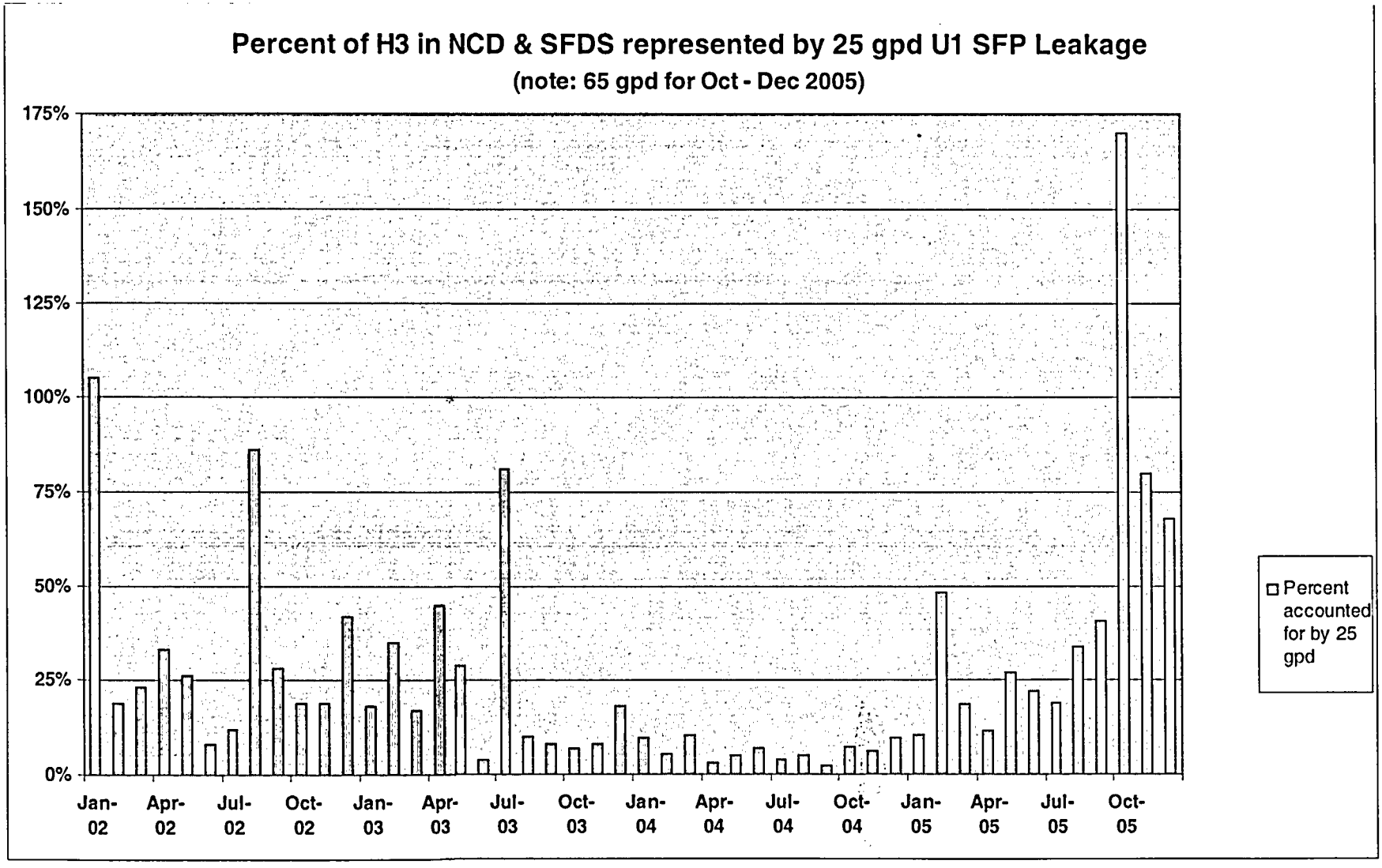

Percent of H3 in NCD & SFDS represented by 25 gpd U1 SFP Leakage
(note: 65 gpd for Oct - Dec 2005)
175%
150%
125%
100%
75%
50%
25%
0%
Jan-02
Apr-02
Jul-02
Oct-02
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05
Apr-05
Jul-05
Oct-05
Percent accounted for by 25 gpd

Figure 2

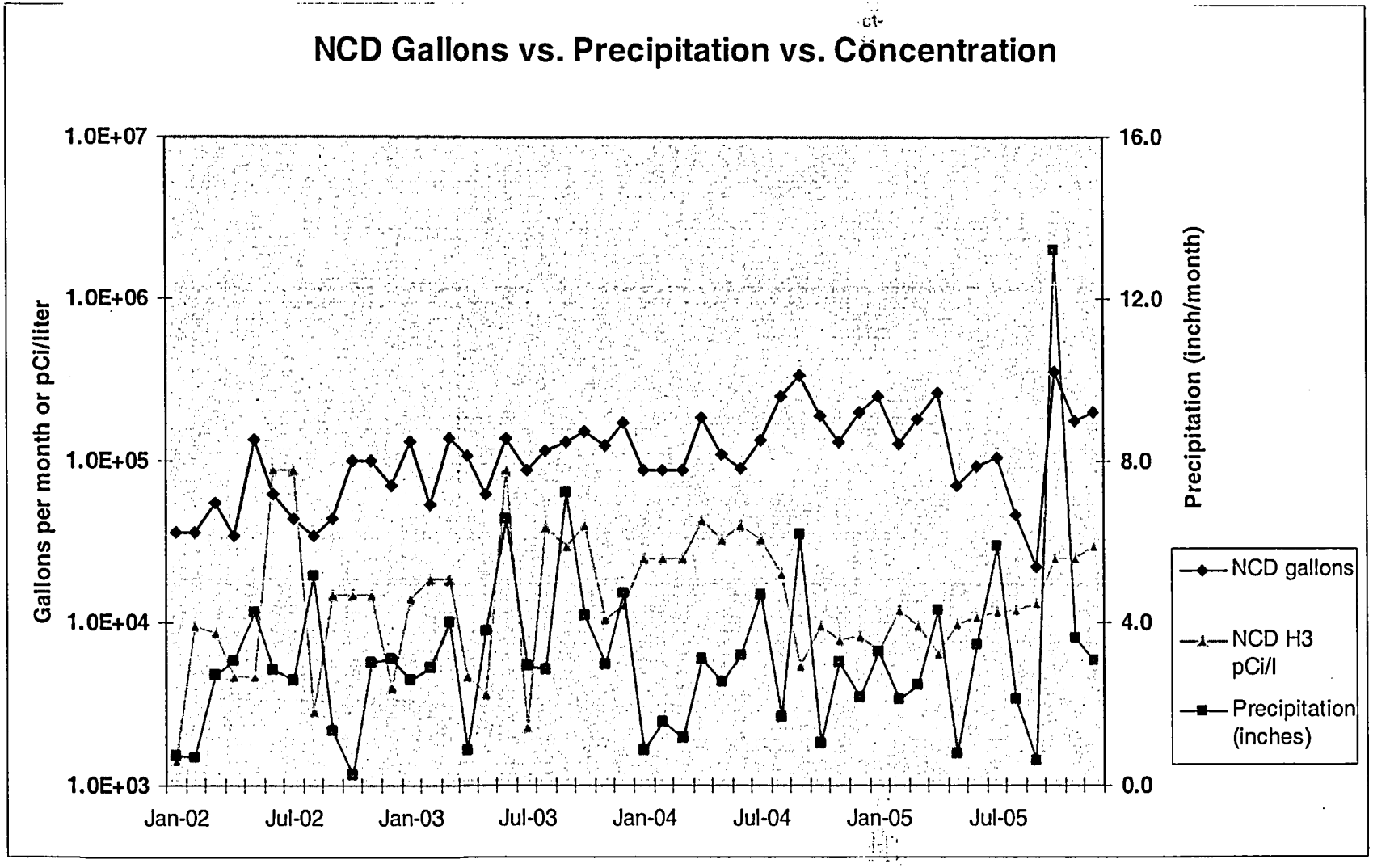
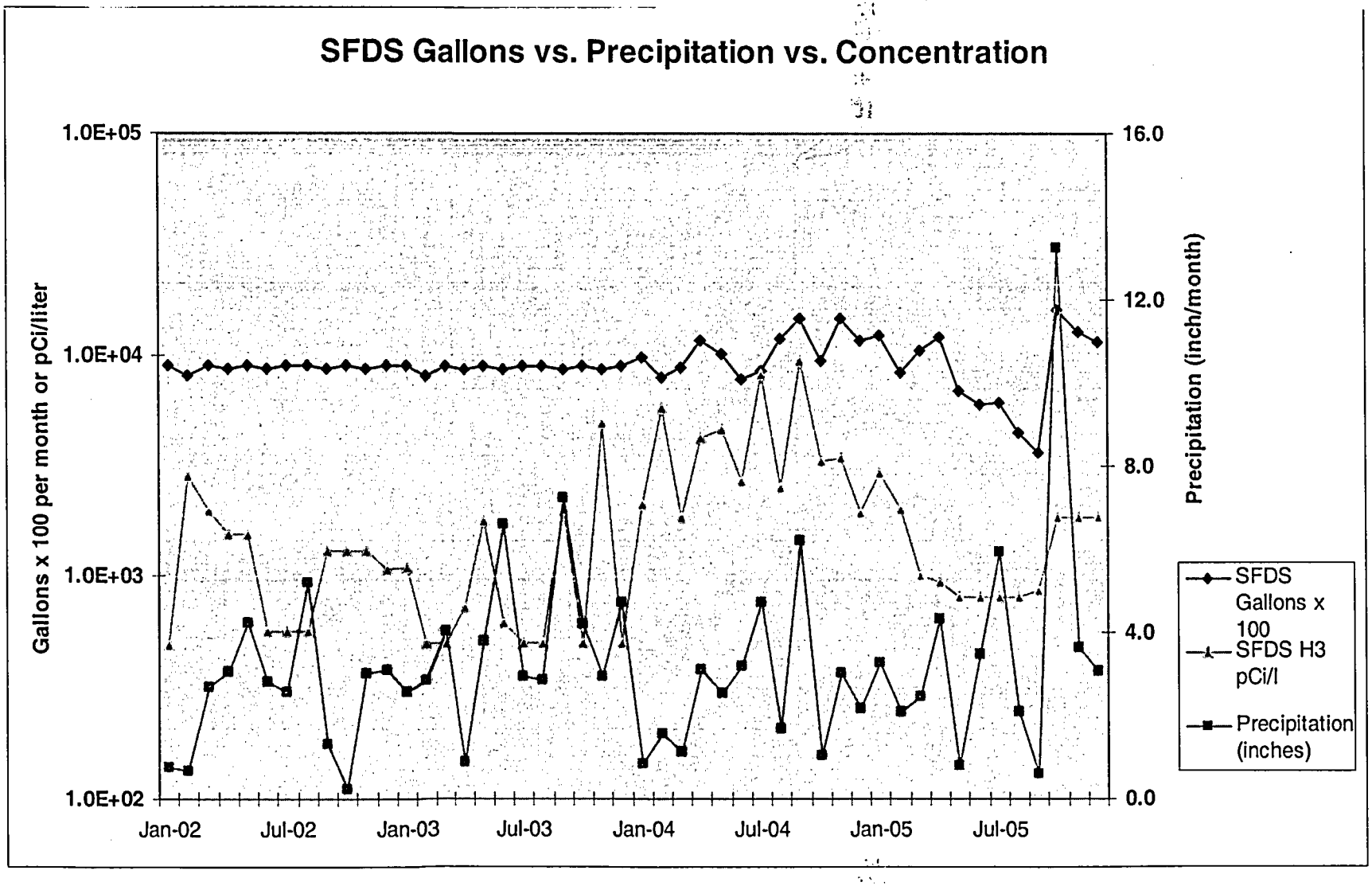

NCD Gallons vs. Precipitation vs. Concentration
Gallons per month or pCi/liter
1.0E+07
1.0E+06
1.0E+05
1.0E+04
1.0E+03
Precipitation (inch/month)
16.0
12.0
8.0
4.0
0.0
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
NCD gallons
NCD H3 pCi/l
Precipitation (inches)

Figure 3


SFDS Gallons vs. Precipitation vs. Concentration
1.0E+05
1.0E+04
1.0E+03
1.0E+02
Gallons x 100 per month or pCi/liter
16.0
12.0
8.0
4.0
0.0
Precipitation (inch/month)
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
SFDS Gallons x 100
SFDS H3 pCi/l
Precipitation (inches)