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TO: F. R. Bruce

FROM: W. D. Burch

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The high activity level, remotely operated sampler to be used in the HRT was designed for sampling one phase solutions. The high solids concentration in the chem plant underflow pot would undoubtedly plug the 30 mil openings in the present isolation chamber. However, the advantages to be gained by obtaining a representative sample at the underflow pot when desired are sufficient to warrant a certain amount of development effort to devise a slurry sampler.

For long range purposes, extensive efforts would probably be worthwhile, but for the HRT, a sampler is required in the immediate future. In an effort to utilize the great amount of design effort already expended on the present sampler facility, a brief look has been taken into the possibility of modifying the existing facility for sampling a slurry stream. This modification was sought on the premise that a representative sample could be obtained by recirculating the contents of the underflow pot through the sampler at a flow rate sufficient to keep the solids suspended uniformly. This recirculation would entail a rather simple change in the present flowsheet, but would require one more high pressure valve and two freeze plugs as shown in Fig. 1.

In order to use the sample flask loading and transfer mechanism in the existing design, it is necessary to retain the external dimensions of the present isolation chamber. Figure II shows one possible isolation chamber design which has minimum openings of 0.200 inches and still retains a sample of less than 5 cc. This is approximately the upper limit for the flow passage dimension with the 13/16 in. O.D. isolation chamber body. For our design it might be feasible to eliminate the coil surrounding the chamber, increase the size to about 1-1/16 in. and enlarge the flow passages to 300 mils. The coil was designed to maintain the sample solution above 70° during the 15 minute cooling period to prevent peroxide precipitation of uranium. This cooling is required because of the

short-lived fission products which are taken directly from the reactor in the reactor samples. However, in our case, the solution has already cooled in the order of a few hours to a few days, so no additional cooling is required. Furthermore, any precipitated uranium could still be handled in the proposed slurry sampler.

The minimum dimension in the sampler may be established by the needle through which the sample is drained from the isolation chamber to the sample flask. While the needle size can certainly be increased over the present 0.054 in. I.D., it may not be feasible to enlarge it to 0.200 in. because of damage to the rubber diaphragm when it is pierced by the needle. Some of the internals of the sample flask holder would have to be enlarged to accommodate the large needle, but no unusual problems should arise. Table I lists all sampler assembly parts with openings less than .200 inch.

It is estimated that a flow of 2 - 3 gpm can be maintained through the recirculation loop and sampler. At the moment it is problematical whether this flow is sufficient to maintain a uniform slurry in the underflow pot. Line velocity is great enough so that any size particle will be swept along with the flowing liquid. At 2 gpm, linear velocity in the underflow receiver is 1.3 ft/minute which places the flow just within the turbulent region. (Reynolds number about 2500). Figure III shows the calculated sample to underflow pot solids concentration ratio as a function of particle size, assuming Stokes law settling rates, but neglecting all turbulent effects. These results are probably quite pessimistic because of turbulence, which could be increased by means of special entrance nozzles and baffles.

One other apparent problem is that of draining the isolation chamber completely after first isolating a "representative" sample. With 0.1% ThO_2 slurries, Bruce Hannaford at Y-12 found that the present sampler retains 20 - 30% of the solids in the slurry on the walls. However, at that concentration, this was an extremely small quantity of solids. In more concentrated slurries this effect might not be as important. He reported no troubles with solids retention in the bellows corrugations.

Recommended Development Work

It is recommended that Unit Operations initiate an experimental program to demonstrate the reliability of a slurry sampler. This program might begin with simple experiments with slurries in glass or steel tubing, expand to a plexiglass mockup of the proposed modified isolation chamber and culminate with tests of our modifications in the full sampler assembly mockup to be completed within the next few weeks at Y-12. This program quite logically could be performed in conjunction with Unit Operations' test of the underflow pot drain and circulation system.

Specifically the following information is required:

1. Particle size which can be maintained in a uniform slurry in the underflow pot at flow rates of 2 - 4 gpm. The existing pot design with bottom outlet should be investigated and then the effects of induced turbulence through special entrance nozzles and baffles determined.
2. Maximum size needle which may be used in puncturing the sample flask diaphragms.
3. Uniformity of sample which may be expected. As many factors as possible should be isolated. Is a representative sample obtained in the isolation chamber? What fraction of the solids are retained in the sampler? Are there any difficulties with plugging?

Considering the extreme simplicity of sampling the underflow in comparison with removing the entire contents of the underflow pot weekly for analysis, the feasibility of a slurry sampler should be investigated as soon as possible.

W. D. Burch

W. D. Burch
Process Design Section
Chemical Technology Division

WDB/nh

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Table I

Flow Passages in Sampler with Dimensions Less Than 0.200 in.

<u>Location</u>	<u>Present Size</u>	<u>Remarks</u>
1. Block valve entrance and exit ports	3/16" = 0.1875	Easily enlarged
2. Block valve seating port	.076	See no reason why cannot be enlarged, but must be done in manufacturing
3. Isolation chamber nipples	.125	No problem
4. Isolation chamber	.030	Requires redesign of I.C. body, valve stem, valve stem stop - within present overall external dimensions.
5. Isolation chamber drain port	.076	Easily enlarged
6. Sample flask holder needle	.054	Can be made larger, but may create problem in damaging diaphragm, so as to prevent resealing
7. Needle guard	—	External dimensions probably increased slightly necessitating changes in body and compression ring, which, however, should not be difficult
8. Needle holder	—	
9. Body (sample flask holder)	—	
10. Teflon washer	.0625	May be drilled larger

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FIG. 1
FLOWSHEET REVISIONS REQUIRED FOR RECIRCULATING
SAMPLER

NOTE: UNDERFLOW COOLER AND SCREEN NOT REQUIRED
WITH NEW SAMPLING TECHNIQUE.

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VOLUME OF SAMPLE IS
ABOUT 5CC
MIN. CLEARANCE = 0.200

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FIGURE II
PROPOSED MODIFIED
ISOLATION CHAMBER
SCALE: 1"=2"

SECTION A-A

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SAMPLE CONCENTRATION/UNDERFLOW POT CONCENTRATION

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FIGURE III

RATIO OF SAMPLE TO UNDERFLOW CONCENTRATION
VS
PARTICLE SIZE ASSUMING STOKES LAW
SETTLING-NO TURBULENCE

ASSUMED: FLOW RATE - 2 GPM
TEMPERATURE - 80° C
DIAMETER - 6" SCHEDULE 160 PIPE

FLOW IN POT DOWN

FLOW IN POT UP

PARTICLE SIZE - MICRONS

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