UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF:

TMI-2 LEAKAGE RATE MEETING

LOCATION: BETHESDA, MD PAGES: 1-182

DATE: 20 SEPTEMBER 1984

RECEIVED BY: X DATE: X TIME: X

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NUCLEAR REGULATORY COMMISSION

TMI-2 LEAKAGE RATE MEETING

NUCLEAR REGULATORY COMMISSION

ROOM P-114
7920 NORFOLK AVENUE
BETHESDA, MD

The Panel met, pursuant to Notice at 10:00 am.

NRC STAFF MEMBERS PRESENT:

JIM VAN VLIET, NRC
BOB CAPRA, NRC
DON KIRKPATRICK, I & E
LOIS FINKELSTEIN, ELD
BILL RUSSELL, NRC
JIN CHUNG, I & E
PETE CONNOLLY, NRC

UTILITY REPRESENTATIVES:

NOMAN COLE, MPR
PAUL DAMERELL, MPR
ROBERT WINTER, KF&C
EDWIN STIER, ESQ., KF&C
DWIGHT HARRISON, MPR
JACK WETMORE, GPU NUCLEAR
DAVID TAYLOR, TAYLOR & ASSOC.
FRED DEVESA, KF&C

OTHER INTERESTED PARTIES:

JOANNE DOROSHOW, TMI ALERT
JON SEVRANSTY, UCS

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Present at the meeting:

For the Commission:

Jim Van Vliet,
NRC
Bill Russell,
NRR
Bob Capra,
NRR
Jin Chung,
IEE
Don Kirkpatrick,
I and E
Pete Connolly,
NRC
Lois Finkelstein,
ELD

Utility Representatives:

Noman Cole,
MPR
Dwight H. Harrison,
MPR
Paul Damerell,
MPR
Jack Wetmore,
GPU Nuclear

David E. Taylor,
Taylor Associates
Robert Winter,
KF and C
Fred DeVesa,
KF and C
Edwin Stier, Esquire,
KF and C

Other Interested Parties:

Joanne Doroshow,
TMI Alert

Jon Sevransty, UCS

P-R-O-C-E-E-D-I-N-G-S

MR. VAN VLIET: Good morning. My name is Jim Van Vliet. I'm the NRC project manager for TMI 1. The purpose of this morning's meeting is to provide GPU Nuclear an opportunity to present certain of the technical aspects of their review of the TMI 2 leak rate pattern.

We have with us this morning people from the region who are familiar with the current status of the leak rate proceedings and much of the past activity. We don't anticipate providing you with specific comments today and certainly before we provide any comments at all on what you present to us we'll want to encompass.

I think that's all I have to say. With that, I'll turn it over to the licensee.

MR. STIER: Let me speak, since --

Pardon?

MR. VAN VLIET: You're going to have to move to the microphone.

MR. STIER: Okay.

Let me respond. As I've previously stated, my name is Edwin Stier. I'm an attorney with the firm of Kirsten, Friedman and Cherin. I'm the one who's responsible for the meeting, although it was arranged through the licensee. The licensee acted as an intermediary to arrange for the meeting which was at my request and the licensee, GPU Nuclear, is not going to participate in this discussion.

Jack Wetmore of GPU Nuclear is present here, but his role is strictly that of an observer.

I have been retained to conduct an independent investigation of leak rate testing at TMI Unit 2. I was retained by GPU Nuclear.

We began our preliminary work in March of 1984 to collect whatever data was available in preparation for an active investigation. During the course of reviewing what had been collected up to that point, we learned that MPR, a Washington engineering firm, had done a considerable amount of work. They had been retained by a New York law firm which was -- which had been representing GPU Nuclear in connection with a criminal litigation in the middle district of Pennsylvania concerning the leak rate testing at TMI 2.

We did some independent checking of our own on MPR. We looked at the work product that had been produced by them up to that point and we made our own judgment that MPR was an independent, reputable, responsible engineering firm and decided to retain them to continue their work since they were no longer working for the firm that had been representing GPU, continue the work that they had started so that we could review it and use it to the extent that we found it appropriate in connection with our investigation.

Since that time MPR has performed a number of additional efforts at our request at refining the work that they had been doing before we began our investigation. They have received data from Unit 2, from GPU Nuclear, from the Department of Justice, the NRC and we've supplied them with additional material for them to review and analyze.

MPR has conducted no interviews and the findings that they've reached up to this point, we consider to be preliminary in nature.

At this stage, we have not made our own judgment. That is my staff and I have not made our own judgment about the extent to which their work will be incorporated into our final report. Our report will be based not only on technical analysis done by MPR, but analysis done by other sources that we determined appropriate in interviews, record reviews, that we will do ourselves.

We have found that MPR's work has appeared to us to have been complete and thorough and we felt that it was appropriate for reasons that I will indicate in just a moment. We felt that it was appropriate to request or suggest to the NRC that this meeting should take place so that MPR could present its information, the results of its analysis for your consideration.

The reason that I have made the request is because the NRC OI presently with -- in conjunction with NRR is continuing its investigation of leak rate testing at TMI 2. As an important element in that investigation, it is going to be necessary for NRC representatives to consider plant data.

I think it would be beneficial to the NRC to hear the results of an analysis of that data performed by MPR. I think that in making your final judgments, the more information you get, the more points of view you receive, the better the product is going to be and ultimately I think we're all interested in the NRC coming up with a report that is as thorough, complete and enlightened as possible.

I would hope that as we progress and as we come up with additional information that we think is relevant to this investigation, we can forward it to the NRC for your consideration.

The areas that MPR is going to be discussing this morning have to do with their analysis of leakage at TMI 2 based on their review of certain information such as sump starts and strip chart analysis and their review of data relating to allegations that they're aware of, of hydrogen or water additions to the makeup tank which may have had an effect on the results of leak rate testing.

If anybody has any questions for me at this point, I'll be happy to respond. Otherwise, I'd like to turn the meeting over to representatives of MPR so that they can make their presentation.

MR. VAN VLIET: I would like to just say one thing and that is that we appreciate meeting with people like this so that we can understand as much about a topic as possible. But everyone must always keep in mind the board notification responsibilities in this case in particular and I don't think that a meeting like this absolves anybody from the requirement to keep the boards and the commission advised.

In this particular case, I will take the transcript and the attendance list and any handouts and I will make a board notification to the commission at this meeting. But, in the future, each party has certain responsibilities that they have to live up to.

MR. STIER: Norman?

MR. COLE: My name is Norman Cole. I am with MPR Associates and what I think I'd like first to do is run down through the agenda that we plan to cover today and I will then pass that out so that you know where we're coming from and the topics we will be covering.

I don't know if you can all see that because it's so close, if we could maybe move this out of the way because the people in the back of the room will not be able to see that.

MR. VAN VLIET: Let's see. Do you have handouts?

MR. COLE: I only have handouts for the outline. The rest of the things are on view graphs you will not be able to see.

In all honesty, if I could sit that right back and scoot it back, I think it would be better.

MR. VAN VLIET: Why don't you just take it off the stand.

MR. COLE: Right. That's what I'm talking about here.

MR. VAN VLIET: Off the record.

(Off the record.)

MR. COLE: On the record.

The topics that we plan to cover today in our discussion and presentation, in our dealings with going over and trying to determine what were the actual leak rates, we ended up finding it very important to define what are the terms and terminology used under the various leakages or determine for the reg guides, a review of the history of the leakage requirements, in particular, the temperature for the unidentified leakage.

The next area on specific issues that we will cover are the RCIB tests. Then we would like to discuss the actual TMI 2 leakage and we'll do it by several different methods. Basically, one method is by the sump collection method. There are alternate methods and we use the term, "the slope and water addition method."

Then we would like to review the time periods from this analysis that show that there were potential time periods of high and normal unidentified leakage.

The other -- some other related issues concerning this will be the makeup tank level instrumentation that we will discuss. And finally, we will discuss the allegations of water and hydrogen additions and then we will try to wrap up and have any questions or other things we could be of help to you on in understanding how we did this analysis.

I would like to make a comment in regard to our work. We did not base any of our work on interviews or any of that type or hearsay by what operators thought they did or may have thought. It's solely on what we could dig out from the hard factual records at the plant and so that is where we're coming from.

So, what people have said or interviews, we took no account of that. We only went back, what we could find on the record, and traced back to technical data and various documents.

Here's an outline of what we will be covering today. One of the first things when we got into this analysis of what the leak rates were -- one of the first things obviously you do, is say, what are the requirements and we went first to do the TMI tech spec and I will leave you all a version of this because we have not found a nice easy way to present it, but it was trying to get some of the working level information out. We thought, hey, we'll take this with us and read at least a summary portion of it because this was critical to our understanding and our analysis of the terms we ended up using.

When we went to the TMI tech spec, one of the first things in the basis under the leak rate requirements was that it referred us back to the reg guides, 1.45. In the text of the TMI tech spec, it did have limiting conditions for operation and it did set a limit for identified leakage of 10 gpm. It did not set a surveillance requirement for that.

The one gpm leakage rate unidentified, we assume based on the meeting the reg guide which was referred to, we could monitor the sump. For the term "intersystem leakage," there was no definition in the TMI tech spec which, in there, concerning that, however, it did require -- the surveillance required an inventory balance test every 72 hours.

After reading this, we said we better go back and read what the regulatory guidance that was provided by the NRC. The way this chart -- and you all have other times to digest this thing -- is set up where the first top line concerns comments regarding identified leakage. The second column or line across refers to matters dealing with unidentified and the third line across regards intersystem leakage and the bottom is basically a series of notes.

I know you will have -- may have some trouble. Your eyes aren't this good. I wish we all were. But, I will try to encap -- try to -- so when you get this and have a chance to read it in more detail, you will at least understand where we are coming from on the thing. You'll have a chance to read this in more leisure.

Identified leakage, basically, as set up by the reg guide, is that which is hard piped to tanks and to sumps where you can actually measure and quantify. Basically, this is for various pumps, valve seals, and things of that nature and the reg guide indicates that septical methods are usually -- pipes -- it's leakage that is piped to tanks or pools where -- and therefore you can call it the identified leakage. That's the nominal definition.

Unidentified leakage they talk about is the moisture removed from the atmosphere of the containment. Any other leaks to containment are to be known as unidentified leaks and should be collected in tanks.

They indicate that the preferred way of monitoring unidentified leaks is by the sump. The punch line of both of these is that by -- there are discussions on how you prescribe to monitoring. The pool implies that you're measuring this type of leakage at room temperature. By necessity, if you're measuring in a sump, it has to be at room temperature. That's the only way you can measure that type of thing.

In -- for a thing called intersystem leakage which is between passive barriers and other valves such as cross steam generator or JD renewal system, for example, the title of that type of leakage, intersystem and the prescribed way to measure that is an inventory balance test.

One of the things which we obviously noted right of the bat when we started making this comparison, there was no requirement for intersystem leakage at TMI. We went through the reactive -- the next thing, we said hey, listen, began to follow this thing up and try to understand where the rates are headed.

We then left it in the standard review plan. The standard review plan was very consistent and for all three of these terminologies going on across as far as what identified leakage was, unidentified, and what intersystem leakage. And the prescribed methods clearly prescribed was, as far as the identified, was still fight to tanks. As far as the unidentified leakage, it's still leakage for the containment atmosphere, and it is one of the required methods. It had to be the sump level and it had to be modern.

As far as the intersystem leakage, the prescribed manner by the NRC was that we use a inventory balance test. We still tried to follow on down through the path and look at the standards and the specs, and the 10 standard text specs, which obviously was where the TMI -- must have been where the TMI text specs were provided.

It originated from, it didn't exactly follow what the rate guys and the basis for which the basis station told us to follow through on. For example, the identified leakage, there was no surveilance requirements. There was no intersystem leakage requirements.

Yet, in a way there was, because we looked over here and we can find an inventory balance test. And the only thing we can see that was prescribed for an inventory balance test was intersystem leakage. We could see that the words, as far as unidentified leakage, pretty much tracked what the regulatory history had been up until this time.

However, the definitions in the words, some of the definitions in the standard text spec didn't quite jibe with the various other guidance the NRC had put out in the past. We then said hey, let's look what has happened forward to that time.

We then looked at the standard review plan of 1981, and basically, it was still consistent with the guidance that had been back passed, you know, from the 1975, 1983 time period. It was still consistent. It still, unidentified leakage was to be monitored by the sub. Intersystem leakage was to be monitored by the inventory balance test.

Then we went to the Instrument Society of American standard, which was published in 1982. And the NRC was eminently involved, and this document and this document, I think, is obviously with express. It's better written. But as far as we can tell, it is clearly very consistent with what the standard review plans and the reg guide, 1.45 put out some years ago.

And in this case, they clearly spell out that all leakages have to be at room temperature. Here again, they still define the three types of leakages; unidentified, which is collected by a piping system to tanks, unidentified, which is principally monitored by to the sump of the containment welding. Intersystem leakage is still prescribed by an inventory balance test.

So this was the basis of we said hey, knowing this is the regulatory history, we will make our analysis on that brsis. This does not mean, I don't mean to prescribe the TMI -- followed exactly like this. But I'm trying to make sure we all understand how we did our analysis, and make sure you'll understand what our terms meant.

On the reg guide, we concluded there were for the total reactor coolant system leakage, it was made up of three parts; the identified reactor coolant system leakage, unidentified reactor coolant system leakage, and intersystem leakage.

The first thing was what is the reactor coolant system. We went to -- sorry this doesn't -- we went to 10 CFR 50, section 50.2B for a definition of the reactor coolant system. And basically, that defines the reactor coolant system as we have laid out here basically as to the first isolation valve.

Some people, when you talk about reactor coolant systems, tend to include a lot of other areas. But we were trying to play it right by the book and go right by the definitions. And in all honesty, when we played the definitions against what you've done in the new regs and the standard review plans, both before and after TMI and the Instrument Society of America, they all seem to hang together.

As for where you measure these things, if I were to take the new regs -- I mean the reg guides -- the unidentified leakage is to be basically measured in the sump. The identified leakage is to be hard piped. And in TMI it was known as the reactor coolant drain tank.

For intersystem leakage, it would be across such things as from the steam -- through the steam generator tubes, through some isolation valves in the decay heat system, another one down through the letdown cooler heat exchanger. Another area would be water that leaks out via the makeup tank.

So in running any analysis of what the inventory balance test, we used the following assessment. We said the total leakage would be determined by an inventory balance test. The identified leakage we obtained from measurements that fed from the reactor collant drain tank. So that is an input number to this inventory balance test.

Unidentified leakage, if you measured it from the reactor building sump, plus what you had measured of identified, you only had this number of the test run on the inventory balance test and that would leave you with one unknown, and that would give you intersystem leakage.

The one thing I would like to insure, that there's one little number, obviously a number subtleties in a lot of this things. But the reg guides basically prescribe that a couple ways you can reclassify some of this work, the basic requirement is to change leakage classifications from unidentified to identified is if you know the specific location and you can quantify the rate of that leak, and you know that the source is not a flaw within the reactor coolant system boundary; then --

MS. DOROSHOW: What is that from?

MR. COLE: I beg your pardon?

MS. DOROSHOW: What is that from, that little block?

MR. COLE: Oh, this is from the reg guides.

Allows you, say if the guy has a small instrumently of sample life, and he's began to collect water in the sump, you can go in and find it and you can say that is no longer unidentified, that is and now can be classified as identifiedly.

Another thing, with the unidentified leakage as collected in the sump, if there are other systems such as various cooling water systems that go into the containment building, that may be a source of leak. It would appear that it's from the reactor coolant system. But if you can show that that is not part of the reactor coolant system at all, say like a building cooler or chiller, water, then you do not have to classify, you can just take that out of the calculations all together, since it's clearly not, while it's identified, it's not from the reactor coolant system.

I don't know if you all followed all of that, but that is the way you can go and change some of the classifications, because that will become important later on when we discuss.

MR. VAN VLIET: Let me check my algebra. You have an inventory balance test on the right and the left?

MR. COLE: Right. No, I have an inventory balance test. That gives me, feeds in the data and I get a number.

MR. VAN VLIET: Say if --

MR. COLE: That's a total -- that gives me a total leakage.

MR. VAN VLIET: All right.

You subtract from that your drain tank measurement and your sump measurement and that leaves you with intersystem?

MR. COLE: Right, you got it.

The next thing, as far as the thing that we would like to mention to you again, is after reviewing the history, the regulatory history, there was an unidentified leakage, and our view is pure -- by necessity from the way it says you're supposed to measure it, it's supposed to be measured cold.

And it is finally confirmed, you know, clearly unambiguously stated in the document which the NRC has been eminently involved with of the Instrument Society of America totally states leakage rates expressed and volumetric units per unit of time at 20 degrees C and at atmospheric pressure, or STP.

So from a regulatory point of view, it was our conclusion that the right way to handle the inventory unidentified leakage was on the basis of cold.

Another thing that some people have indicated as well, TMI was uniquely different or something, that it had to be hot. That argument dealt with a critical crack size. And in the FSAR, they go through the analysis of the critical crack size for the cold leg pipe and a reactor vessel.

A critical crack size is eight and a half inches long. With the pipe and the vessel, it's almost 11. You run through the analysis of one gpm hot, which at the FSAR, it was done at 557 degrees.

The critical crack size was one and a half inch and 1. -- about one and five eighths.

And you can see that this crack size that would give you a one gpm leak hot, was 17 percent of a critical crack, or 15 percent of a critical crack in the reactor vessel. And the reason you go through this type of analysis is to insure that the leak rates, you can continue to use the argument of leak before break.

In other words, you've got plenty of margin between the time you began to have a leak, it is your limit, and when you would really be in some kind of more serious trouble.

When you run through the numbers on a cold basis, these numbers change something, and this one changes about 190 mils. and this one's slightly over 200 mils. And the percent differences are between the crack of a one gpm cold, and the critical crack size still show a very large margin, the numbers change very little.

So irrespective of which, you take one gpm hot or cold, the overall conclusion regarding a one gpm minute for unidentified leak with respect to the crack size, critical crack size, remains uneffected. So from the critical crack size and are we have an adequate margin, it's sort of a no, never mind.

And we were interested to find that basically that NRC had also come to that same conclusion. There's an NRC letter report DeYoung to Dircks of November 7th, 1983. It covers the NRC review of the reactor coolant system leak rate test procedures at Davis-Besse and a number of other plants.

The NRC report indicated that the NRC concludes that Davis-Besse reactor coolant leak rate test procedure and calculational method used in 1978 were sufficiently comprehensive and accurate to determine the leak rates to within the applicable limits.

One thing you should note is that Davis-Besse used room temperature. It is a companion pipe plan of TMI 2. They used for 8.25 balance per gallon for the reactor and inventory balance. The Davis-Besse FR has the exact same crack analysis that was run on a hot basis, but as we ran through the numbers, it's sort of a no, never mind where that critical crack analysis comparisons run hot or cold.

The Davis-Besse reactor basically reported to be okay, and I guess our analysis would confer with that.

MR. COLE: And looking the next general subject the inventory balance test that was run at TMI. At TMI your inventory balance test basically measured the total reactor coolant system leakage. They measured identified reactor coolant system leakage from the drain tanks. That was a no number. I have two no numbers.

And in essence what they did is they literally lumped unidentified and inner system leakage into one term, and this, in essence, was the output of the computer program at TMI. And while it was called unidentified leakage at TMI, in reality if you go back and look at what the new regs and everything said it should -- what we should be calling it, that really, in fact, was unidentified leakage plus inner system leakage.

With regard to the test that was actually run at TMI, we found that there were a number of technical errors. The majority of those errors were small and in most cases under most situations.

However, there was one major error. They did not correct temperatures that was measured in various place to a common temperature. What the effect was on this when there was no more additions were made to the makeup tank, and when the collection rate in the reactor coolant drain tank was low, the error, this error, has little effect.

However, when the reactor coolant drain tank collection rate was high compared to the amount of water going -- amount of water being added to the makeup tank, then there was a significant effect. In other words, it would clearly overstate the leak -- the unidentified leakage rate.

Likewise, when the reactor coolant drain tank collection was low compared to the water that was injected into the makeup tank, then there was also a significant effect but to the opposite direction. It would understate the leakage rate.

When both the reactor coolant drain tanks and the amount of makeup tank of water were comparable, say high, then the effect, again, was small.

The consequence of this was that the temperature effect was quite different from test to test. There is a large variability in the test results, and from this we can sense this would be a great source of frustration to an operator trying to run a test, particularly if he didn't know all the intermechanics of the guts of that calculation and what was making it go up or down.

So I could see how an operator would be very frustrated in various tests that would be run using this technique.

There was another major problem which added to the -- contributed to the concern on the makeup of the RCIB test, and that is the makeup tank level instrumentation. There was a problem with that and we would like to discuss that as a separate issue.

The other thing here again is the unidentified leakage limit of 1 GPM that TMI would use the hot basis rather than cold. And I would like to say in that regard all of our analysis further on today will be based on the basis that unidentified leakage is cold based on our review of what the regulatory history of that -- what identified leakage. How it's suppose to be measured, the terms, and also seeing the own internal NRC documents also indicate that also come to that same conclusion.

The -- by the way, if anybody wants to interrupt, I don't have any -- I have -- if I've said something you don't quite fully understand or that type of thing, do not hesitate to interrupt.

The next thing I would like begin to get into is the actual leakages. And the first method that we ended up going into was the sump because when you read the reg guides, automatically you see -- if you want to check what the unidentified leakage is, you're automatically directed to the sump.

And to give you an example, we've looked at it several different ways. A couple of things you have to know about the TMI sump is that they are two small pumps, A and B pump, that pump out, and there are limit switches that start and stop. And there has been a calibration number of that, and from the data we had picked up, and in all honestly we had one of the NRC people found the latest calibration curve, and that was set at the pump out was arranged at 14 inches.

And 14 inches is equivalent when you go to the prescribed -- to physically what's built there is 244 gallons per pump out. The -- this curve is applied for the month of March of 1979. What we have plotted here, and this is time and this is the number of pump starts, stops and starts.

Each little vertical step, all right, is equivalent to 244 gallons per each pump out. And we have plotted the pump outs for the entire month of that period. We've done it for many more months but this will give you the example of what we've done.

Once we've obtained this type of

information, then we plotted the slope of what -- how this increased. This gives us the rate. Also by doing it this way we can see when there's some unusual change rather than smearing it over a long period of time.

By knowing the slope that represents a certain leak rate. When you plot it in a -- probably an easier form which you could take a look at is the 1 GPM unidentified leakage rate. This is the apparent leakage -- unidentified leakage rate in the sump for the period of March, and toward the end of the accidents it's getting up close to the limit.

Also on subsequent charts, because I'll be showing you other ones that go, remember when you get a reactor coolant sump leak rate, it is not automatically the reactor coolant unidentified leakage rate because you could have a high number here, for example, and it would still be satisfactory.

MR. RUSSELL: May I ask a question?

MR. COLE: Yes.

MR. RUSSELL: Did you have any period of 72-hours in which you had more than 18 actuations of the pump?

MR. COLE: Yes, we did.

MR. RUSSELL: That would indicate that you had a complete degrade over that 72-hour period granted one gallon per minute

MR. COLE: Right, and I've got that.

The -- when you take this analysis and play out for a longer period of time, I'm talking about from -- we took the period of October through March; here's March, March time period. And I'm sorry that this thing is -- we found that there were a total of ten time periods over that period of October through March that the sump would indicate that the apparent unidentified leakage rate was in excess of 1 GPM.

When I say ten, this is actually -- we took any ones that were close. And we examined those in detail to see if they were, in fact, truly like -- I'll give you an example. This one that was up sky high turned out to be they were flushing some reactor coolant mechanisms and it had nothing to do with the reactor system leak, but it shows up in the sump.

So you have to examine these ten times, but this is a good screening process to begin to go through and say here are the periods of interest that we want to go back and examine in detail.

After we have gone and examined -- altered the methds which we like to put them all together and tell you our conclusions from this plus alternate methods.

MR. KIRKPATRICK: Yes. These are based on 72-hour periods?

MR. COLE: No. This is, as I prescribed, is on a sump period which is even -- the way we've done it is even much more sensitive than a 72-hour period because it will -- that's what I was telling you why we did the slope method was to pick up any really sudden change.

So this is more sensitive than a 72-hour period.

MR. CAPRA: What was the source of your pump starts?

MR. COLE: We -- that's a good question because one of the reason -- we got lead off on a number of blind alleys a number of times.

We originally went to the logs; then we found that the logs. There were transcribing errors so all of our data is based on the alarm collectors.

MR. CAPRA: Could you give me a technical reason as to why you feel that is more sensitive than the 72-hour period, the shorter period?

MR. COLE: Because you can see sudden changes. This is --

MR. CAPRA: But you can see break points?

MR. COLE: Right.

MR. CAPRA: How do you smooth the curve also?

MR. COLE: Well, I'll show you how the --

MR. HARRISON: Maybe you ought to explain that in some more detail. I think there's a misunderstanding about what's plotted there.

MR. VAN VLIET: Let me say one thing.

MR. COLE: Yes.

MR. VAN VLIET: Procedurally. When you're speaking from back here, could you just identify yourself for the transcriber so that we can pick it up.

MR. HARRISON: I'm Dwight Harrison.

Let me explain why we finally got to this kind of method. We tried a number of different techniques, like taking each pump time and trying to plot those, timing between each start. We found that wandered around a lot; it didn't seem to be physically like what we wanted on --

This is like an intregal curve of how much water -- if you would have had a big enough bucket, it would have told you how you collected water in the bucket for sump. And so the rate of rising -- it's like infinite long something like a level rising in a sump.

What we found is that you can look at it this way and if the characteristic of the leak, in any case, suggests to you such that there's need to be a curve. Apparently a lot of the leakage tends to behave that way.

And what we did in places where they were built higher, we had to go down in finer and finer plots until we could get a pretty close correlation as to where did the water start to appear in the sump irrespective as to what kind of time period one tried to use.

This is the nice thing about the sump. It's kind of small, it's pretty sensitive, and the whole sump collection it doesn't miss anything. You can't be looking the other way when the water going into the sump is sitting down there catching it. On some of the inventory balance tests, for example, you only know it when you ran the tests.

The sump collection, you -- it records it basically for you.

MR. COLE: And the other thing that was important to us about this was that the sump is, in essence, is like it's a very rudimentary thing of filling up a bucket. And we can measure the time it takes to fill up a bucket to get a leak rate.

The second thing that's important to us was the fact that we could go to a source of data that didn't seem to have as much human error type thing could be put into. Namely, we could go to the alarm printer and get the recordings of when the pumps stopped and started. And there was no one, you know, you weren't depending on transcribing or people's memory to incorporate that.

MR. CAPRA: Is there any significant period of time in which the alarm printer was not available during that period?

MR. COLE: We found some small number of periods of times, and we tried to compensate for that. We put in what was the rate before, and after that -- there were very small periods of time.

MR. CAPRA: Your sensitivity argument -- what is it that physically causes the leak rate to decrease? Twice there your slope shows decreasing leak rates?

MR. COLE: People fix something.

MR. HARRISON: Something changed.

MR. COLE: Something changed.

The other -- there are other ways you can go at this time, and this -- another way we had seen the

NRC had -- and we'd seen an analysis the NRC had done of the sump. And it looked like rather than a 72-hour basis, but it looked like a -- NRC apparently in analysis we had that was dated 1/5/84. It appeared to do close to a 24-hour of what the sump leak rate was. We also went and said, "hey, let us take a look at that and go that method." And we did one thing that was slightly different. Rather than -- we took rather than an exactly 24-hour period we took the closest 24-hour period where there were full pump-downs. In other words, like on this particular day, and this is for the latter part of March, there were a total of three pump-downs and they occurred over a total of a 26-hour period. And so all we did by knowing that we had three pump-downs multiplied by the 3 times 244 and divide by the number of minutes and you will get our column E.

That period showed that the leak rate was rising. And when we got down we noticed that the NRC had had a number -- I believe it was around the 20th of March and this analysis was above a 1 GPM by 200. And we think we know what -- where the difference was.

When we went back, it appeared to us, we do not know this for a fact, but it appeared that they must have used the, on this analysis, must have used the logs. And there was a logging error that appears in -- when you put the correct number of pump starts and starts from the alarm printer you will find this number -- both numbers come in pretty close agreement. It may have been they split in the days or split them differently time wise or something.

But when we go back to the log -- and this is a very -- I think most people can follow it and see the exact times coming off of the alarm printer and you can pick the -- get them in round units so you get full pump-downs and it's easy to see where that number came from.

MS. DOROSHOW: Which logs are you talking about that were --

MR. COLE: The -- I beg your pardon.

MR. VAN VLIET: Doroshow -- just if you would identify yourself.

MS. DOROSHOW: Joanne Doroshow. I am asking which logs --

MR. COLE: Let me finish and I'll show you what the problem is.

If you've ever said, gee, how could somebody miss something in transposing. Here is the alarm data printer. And this just represents two hours so this sheet is massive. So it's -- to me it's very easy for a person to go and miss one of the logs. It turns out -- here's one and here's when it s opped. But when you have a long data sheet yahoo long, it's easy to see how an operator miscounted such a -- and missed one of these things.

MS. DOROSHOW: Could you -- all right, I'm just curious as to which logs you were --

MR. COLE: The CRO log was the one or was it the --

MR. HARRISON: Dwight Harrison with the answer to that. This -- the alarm printers -- say it's its own -- the log that he's talking about is the shift in daily surveillance log which is the series of records that the CROs use when shipped to the basis. And that included a -- they entered in that log the sump levels and the number of starts since the last month which put -- which leads to a mechanism to count an extra start because you don't put a start and stop very close to the shift change.

There is a possibility that the guy before has counted the start and the guy after has counts the start, the only way the guy would have to check that would be to go back to the whole alarm entered from the time before. So it's possible that he will miss this and add some starts in this logging process.

That's why we didn't --

MR. COLE: Disuse it. We were not interested in trying -- we were trying to avoid transcribing errors and so we went back to the alarm printer.

When you take all of the NRC data or the reactor building sump, that's the 1/5/84 data and compare it with our analysis here's how it compares. I'm sorry that we got such a -- the solid line is the NRC data and the dotted line was our technique of measuring. And you can see that sometimes on a 24-hour basis, like this one, it was high but you didn't pick up -- the slope method did pick up a higher temp period.

I think in most cases we were pretty much together. Our numbers may have varied of what the actual number -- particularly during the short leak periods. The only one I see that it didn't pick up if you looked at it would have been this period. But what I would -- as I indicated to you earlier we would like to go back and go over the temp periods.

So I get -- the punch line of this, our technique verses what we had seen of this earlier NRC looks like our technique picks up all of the same things that the NRC and maybe one more. The next analysis of leak rates are by alternate techniques and Dwight, will you take that.

MR. HARRISON: Let me say what I'm going to emphasize in this. One of the objectives here is to, you know, is to share methods with you. So I am going to emphasize pretty heavily some of the methods that we used because I think that would be perhaps to the most utility to you.

Let me say what we mean by alternate methods. What we're trying to do is say is there some other way that you can look at this to see what might the actual leakage have been. Now, in one of the NRC reports that we have available to us May of '83 the NRC did look at it by two, you know, quite sensible methods to look at what the actual leakage might be. One of these methods was -- both of these methods were really related to the reactor coolant inventory balance test. One of them looked at how the makeup tank level changed with time.

You remember in the reactor coolant system there are two free surfaces basically. One is the pressurizer and the other is the makeup tank. Now, the reactor coolant system when you put the makeup system into it as he necessarily has to do in this case, the pressurizer level is controlled to a certain

-- it's a actively controlled level. So if you're losing fluid from this combined reactor coolant system and makeup system, what you see is a loss in the level of the makeup tank.

Now, we're going to -- you're going to get probably very tired of looking at makeup tank level charts but let me put one up here and we can -- I think you can -- you're going to have to get used to them. This is a typical makeup tank level chart. This particular one is in March. And what you see in that case is that these particular -- this is the makeup tank level going down. Here water was added. Drops, water was added, drops, water was added, drops.

So this gives you one clue to how fast you're losing water from the system. One of the things is that slope of that makeup tank level. And I think you'll find there is some indication that that's presented to the operator. This is from a recorder that sits up on a console right in front of the operator and he sees this chart. And this is the record of it. So that -- and that's a very sensible way to do it as to how -- to some degree the operator may be doing this in his head; we don't know.

Another method that you can look at is kind of like looking at how much money your wife is spending by how much money you're putting into the bank account. If you can take a period of time and look at how much water has been added in this period of time and see that you're about the same place when you started and ended, then you can get some idea of how much water you have lost from the system by how much water you added.

So conceptionaly of two schemes, one is to look at the slope of the makeup tank and the other one to look at how much water you have added over a period of time. Now that doesn't give you unidentified leakage though. What that gives you is a total leakage from the reactor coolant system. But as Norman explained to you that's not the whole story. You need to subtract from that at least what's collected in the reactor coolant drain tank. So you need to find out how much is going into the reactor coolant drain tank. And I'll explain to you how we did that.

We did it the same as the NRC did it. There really is only source of information you can use and that's what's printed out in your reactor coolant inventory balance test print out. You can take those numbers and you can see that they are printed out by the computer. They give you reactor coolant drain tank level and they give you from that an indication of what the identified leakage to the drain tank is.

Let me launch into detail here a little now into the slope method. Let me describe how we applied the slope method and then I'll contrast it to what we know about the method that was used by the NRC. We did come up with -- we did end up with some first trials as usual. We had some pit falls that we -- here's this method we eventually -- and words that we eventually came to.

The first thing we did, we went to the makeup tank charts and for -- we took it on a daily basis for simplicity. We selected regular slopes. Well, what do I mean by a regular slope? What's a regular slope? Let's go back to this one. What I mean by a regular slope is more by exception than by -- these are relevantly regular. That's not a regular slope; that's not a regular slope. We felt very -- that we shouldn't use those slopes because there was something else going on.

You've go to remember that the makeup tank level does respond to things like changes in the pressurizer level, changes in reactor system conditions of various kinds, and it will be reflected in the makeup tank. So there is lots of things to make the makeup tank level move around. You've got to be careful that you haven't ground those into your method and you're finding out something about the pressurized level change. So you try to only do the ones that are regular enough. And that's the only words I can think of that I could use.

MS. DOROSHOW: Can I ask this -- I am Joanne Doroshow. When you say you did not use these regular slopes because other conditions may have been occurring, did you seek to determine in your analysis whether the things may have been going on?

MR. HARRISON: Not for the selecting of this but in some other cases we have looked at. It turns out to be quite complicated to get all the information, to find out exactly what has happened for one of those -- in the chart. Many, many, many things could do it. And I suppose if one wanted to spend enough time and effort any one could be pretty well run down but it would be a monumental undertaking it truly would.

MS. DOROSHOW: So you're basically left with having to guess what --

MR. HARRISON: What we're basically left with doing is getting -- is picking some individual slopes that appear to be regular on a day and say that characterizes the day pretty well.

Now, what you see is, you know, the thing I said on the slope thing when we were talking about it, that that inherently you may miss peaks in this method. You may miss something going on because it's made the slope irregular. So that these alternate methods they both have that problem in them, in that they may miss what the sump sees. That's why we believe the sump is really the best. Our first discriminator for what time periods there could have been a reactor coolant system leakage that was from a pressure -- and it doesn't miss anything.

MR. RUSSELL: Bill Russell. Is your objective to identify what the actual unidentified leakage was from the plant and that's your basis for selecting only those which are regular and discriminating out from the other slopes?

MR. HARRISON: Yes, because -- another reason is, Bill, is I can't use the irregular slope. I don't know how to draw a curve.

MR. RUSSELL: For the purposes of identifying actual leak rate could the irregular slope curves indicate some activity which went on intentionally during the test --

MR. HARRISON: Of course.

MR. RUSSELL: -- that would cause the change in that? So if your objective is to discover instances of irregular behavior that maybe your operator induced, then it certainly would not be prudent to throw out all of those tests which are not regular?

MR. HARRISON: Oh, I'm not throwing out any tests at all, Bill. No, this has nothing to do within the balance test whatsoever.

MR. RUSSELL: Well, then I'm not sure I understand what your objective is. Your objective is to calculate as best you can what the real leak rate was from he facility during that period of time.

MR. COLE: Correct.

MR HARRISON: Right, that's, you know, what we think it really is. Now, let's go back to my -- one of the things we did was to try to take -- we did take all of the regular at any day that we could find. No sense throwing out any data that you don't have to but we didn't use ones that were -- that you couldn't get a good slope from.

Now we get -- the next thing, I would -- we were talking about discussing it later but I believe that we'd better talk about the makeup tank while we're still at the problem of this because -- at this juncture because it won't make -- this won't really make good sense.

Norman had said about the -- had talked about the makeup tank instrumentation. And this is the -- sometimes is referred to as the loop seal problem or what have you but let's step through. How do you measure the level in the makeup tank? You measure the level in the makeup tank as you do with so many tanks in this world. What you really do is you measure the pressure difference between two legs.

Now ideally this shows the condition which may have occurred at sometime in the plant. This is -- and this is -- I think discussed at a number of different places. This is not our invention by any means.

This line is suppose to be dry. That the intent of -- this line is dry. This line is filled with water. And what the pressure transmitter sees is the difference in the height of the water. And it -- if you add more water it gets a different pressure signal and it reads out. This is a normal pressure type level indicator.

Now what appears to be -- the configuration of this line is quite complicated. And there are some more valves and things that are simply not shown in this because it gets too complicated to explain. But what may have been the case at some times is that this line got some water in it, the so called loop seal.

Now what this does is depending on where this water is and what -- whether it has an elevation difference between one and the other, it acts as if it changes the pressure that the transmitter sees. So you get the wrong level out of this thing. Now take in this case what you would see is you'd think that your level was lower than it actually was in this case. And what this does -- you say why is this important at all? So we're just worried about changes in makeup tank level.

It appears that this thing will also screw you up when the level changes. Notice what happens to this thing, if I change the pressure in this tank what happens is it will try to compress the amount to trap part of this thing and will move this slug of water around. Now it will move it in some fashion and it will tend to give you the wrong answer out of the changes in level.

MR. HARRISON: I've sufficiently confused everyone. And the questions on this. It's been explained, Faegre Benson report explained it, United States reports have explained it. It's not a mystery.

There are some things I'd like to point out about it, though. We were aware of this problem with instrumentation. So we said well, we'd like at the sloping method. The slope, you know, this has got to have some effect on the slope measurement. And there was also some other evidence that the operators consistently -- they get the amount that they put in to the make up tank from a batch controller. A totally different instrument.

They write a number down in their log. They put it 300 gallons. And sometimes you go to the make up tank chart and you look at it and you find, gee, it's not 300 gallons in the make up tank it's 390 gallons in the make up tank or 400 gallons. Is that consistent with this kind of a mechanism and you say yes, it is.

If I increased the level in this tank, I increase the pressure in the tank. If I increase the pressure in the tank, this goes down, delta P increases so I get a larger level increased than I thought I had. So I -- there is the evidence from the batched addition that this kind of thing was occurring. So we said, gee, that's pretty reasonable. Let's go see if we can figure out how we take this out. So we said, well, let's try to take it out analytically. Let's try to figure out what happens. And you soon come to the conclusion that you simply don't have enough information. You don't know how long the slug was, you don't where it was. You also come to the conclusion that it depends on how much gas you've trapped in here because that's the springiness behind this thing. And that in turn depends on the past history, what was the lowest pressure at which you developed the log, what was the past history.

It seems to us that your chances of ever unsnarling this were, you know, to say the least not good. It would even be very difficult to run a test with this thing to be sure that you knew where everything was. So we concluded that the only way we had -- we knew it appeared to be occurring and so we took -- we said, well, pragmacically let's go back to this batch controller, the water additions and let's see if we can find when this effect occurred, find out how much magnitude it is and go correct our slope strip on that basis rather than just saying -- I might mention that what this does, of course, is it tends to accentuate the drop. It's going to get too high a slope. You tend to believe you've lost more water than you had because in the other direction as you down in level it tends to lower the pressure in the tank.

So what we did in conjunction with the slope method is that we went back through --

MR. RUSSELL: Could I ask a question of the previous graph please, of the previous slide for just a moment?

While you may not know the gas volume and the amount of trapped gas in the detector, you have some indication the size of the gas volume in the tank which is acting as a spring on the other end albeit being buried by the heighth of the water column differential is causing it, non-linear indication.

Did you evaluate that from the standpoint of the effective gas expansion as treated as a ideal gas on the top of ' e tank and see what kind of a change in pressure you would have?

MR. HARRISON: We looked at some of those changes in pressure. They appear to be a sufficient magnitude to get you some significant changes.

MR. RUSSELL: Do you give any feel for what kind of magnitude change you would see just do to the pressure change of the gas from pumping down the tank assuming that you did not have that loop sealed? I'm trying to determine whether this pressure change you're talking about is that significant to assume the extent --

MR. HARRISON: Well, I think Paul has an answer.

MR. RUSSELL: Just due to the expansion -- compared to the overpressure on top of the tank.

MR. DAMERELL: This is Paul Damerell from MPR Associates. If there were no loop sealed, the density of the hydrogen gas is very, very low compared to the water. And the change of pressure in the tank would only cause a very, very small change of the density in that dry leg. So if you take away the loop seal out of that figure and then you go change the pressure in the tank and you're looking at your metal transmitter and say what's the -- to the output of that device? It's extremely small and probably smaller than the resolution to that device.

MR. RUSSELL: I don't think you understood my question. How much change would you get in the pressure of the tank for just pumping down level in the tank as compared to how much pressure you would get in the tank associated with a hydrogen addition?

MR. DAMERELL: Okay.

MR. RUSSELL: Just try and understand the effects on change and slope independent of the water sluggish. Is there a small change in the pressure of the tank? In other words, simply pumping down the tank, if that causes a small change then the spring force on the other end is going to have a relatively small change. So then it becomes critical as to the size of the volume. If that's not the case, then I don't understand the argument that's being made.

MR. DAMERELL: I'll say something about that. The changes in pressure you can get as to the level of changes are significant enough to effect that level.

MR. RUSSELL: What kind of change is that, five pounds, ten pounds?

MR. DAMERELL: Well, it's --

MR. HARRISON: This is around 18 pounds of normal --

MR. DAMERELL: The tank slides 100 --

MR. RUSSELL: Who will change 300 gallons?

MR. HARRISON: That's about 10 percent of the volume of tank --

MR. DAMERELL: That's about 10 inches which is about 10 percent. Say if the tank --

MR. HARRISON: If the tank is 80 inches, 75 to 80 inches, that leaves about 20 percent of -- It may --

MR. DAMERELL: Changing the dry volume may be like a third to a fourth. So you're changing the absolute pressure by a third to a fourth. And the absolute pressure in the tank is like 40 ESI. So you'd be changing pipe 10 to 12, ESI.

MR. HARRISON: That's a lot of feet of water.

MR. KIRKPATRICK: This is Kirkpatrick from NRC. Also I'd like to point out that the head you get from that slug is very small compared to this pressure change we're talking about. You're talking about maybe 10 times the pressure change. But it only takes a half of a pound to lose water a foot. In this case we're talking about maybe an inch. It makes a lot of difference.

So you're talking about one percent, say, of that pressure out there in that tank will represent a -- what I'm saying is about one percent of the pressure in the tank is all it takes to move that slug a significant amount.

MR. HARRISON: Of course, that depends entirely on what -- what it's pushing it against. It also depends on what the configuration of a piping system happens to be in. If this were down here and this were on another level leg, it could move it and not make any change at all. This is simplified from what the real situation is as you're are well aware of I'm sure. It's critically dependent on how much you've got trapped but the configuration of the piping is how much water you have, where it is. As I said we kind of concluded we weren't going to ever get an answer that way.

MR. KIRKPATRICK: But probably what really happened in most cases was that the pressure change overwhelms the amount of water available and after you get a certain amount shipped and level to the slug effect, the rest of the gas is bubbled by. And so what you have is a chopped --

MR. HARRISON: We haven't been able to establish the bubble by business. We have not been able to -- If you did that then it would appear to us that you wouldn't -- you'd have a constant offset and not a relatively constant ratio. You'd get a different answer. What it would seem like for 100 rather than for a 300 gallon addition.

We seem to get irrespective of the size. There are oddball ones, obviously. But we seem to fairly constant ratio and that's why I have a little trouble with it being something that goes and adds a thing. And I can see if you had a very tiny amount of water that you get in those kind of things where it would blow through and and flow by. But I don't see how to get a relatively constant ratio out of that.

MR. HARRISON: My trouble is how we finally ended up trying to get a correction --

MR. RUSSELL: One other question. You've indicated -- or analytically why it's difficult to determine the fact.

Did you look at the empirical approach from the standpoint of known hydrogen additions and what the effect was on change in level for various levels in the tank when the tank may have been at the bottom of the normal operating band and at the top of the normal operating band to see if there's an empirical estimation that could be developed?

MR. HARRISON: I don't know enough data to do that. The hydrogen and the distance generally are logged if they added hydrogen. I think there's more than one that I remember that where they told us how much pressure they added. That's one of the problems on the whole hydrogen addition business is the guy will write down added hydrogen. Well, you don't know what pressure he ran the tank to, maybe he does. Maybe he remembers or maybe he had some practice but we don't know that. All we know is that hydrogen was added at sometimes.

You could, I suppose, in some kind of a pretty carefully controlled test. But in any test what you know is the water slug that's there when you ran the test. That doesn't necessarily mean that's the water slug that was there at the time that the plant was operated. So a little bit -- let me show you what we finally concluded. We needed to do something to see what we could get.

So what we did, as I said, was to go through and to take the logged addition, take the indicated tank wherever we could -- I got to caution you that as we found later on that sometimes the operator said he had an addition and what he really had was bleeding feed. So you had to not use those because you could get bad answers.

What we tended to find was that there was some consistency within a time period. We get some scattered -- it's not too well -- you can't see through them. One of the problems with this -- frankly, I'll tell you all the problems because that's one of the things we're here to do is that in this time period of 2 January of '79, they didn't add very much water to the plant. There wasn't a lot of water addition so the data is kind of sparse. But it also appears to indicate that there wasn't much effect.

This effect wasn't very strong. This is one -- sometimes there was maybe -- it looks like 10 percent off then 20, a few out -- sometimes it was even below.

However, back here, there is also some indication here that there was a very strong number. After February to March, here we got another fairly consistent but it's not consistent around one. It's consistent up here like around 30 percent meaning that -- and that's when you look at the data just to compare the logs to the numbers, that's what they tend to come out. The guy says I put in 300 gallons of -- 380 gallon will show up as rise in the makeup tank. So that's what we base -- when we went to the slope method what we did was to go and find out on the day we were taking a slope, what this air amounted to and correct the slope by that amount.

There's a pragmatic way to take -- to not just ignore the fact there was some possibility there but to do it as best we could because what we were after was to try to get as good an answer as we thought we could get as to what the actual leakage was. That's why we made that correction.

We can come back to the makeup tank level instrumentation anytime anybody wants to because it keeps reappearing in this whole thing. I guess I've determined the ratios average during the day and then you correct the average slope to obtain a leak break.

Let me show you what we get out of this. This is February and March of 1979. Each of these is the average of a day's worth of slopes. In some cases in March this may be 10 or 15, you take all you can get. This is total leakage remember. This is -- it's relatively consistent but there's a data spread in this thing which is about inevitable. This is what it looks like for the period of October through January. There -- I've got a couple of points on here that we'll come back to later on because in one place in going through the charts you say how did we get a slope method for an hour and 40 minutes.

The reason I put that on is because of going through the charts you can see the makeup tank level chart came up to some point and then took off down. The operator had written on the chart NUB 17 packing blew, you've gone along and you find it blew and at the end of that time they had isolated it and fixed it. But if you would have -- so there are times when if you look at the slope of the makeup tank it really is much greater and it shows up.

This we'll come back to. This is a period of time which turns up as low on the sump collection and is one of those cases where apparently the sump is showing you leakage from the reactor pump system. We'll discuss that a little bit later on.

Let me just comment on our understanding of the NRC slope method. I think I've already -- as I understand it one regular slope per day was used which probably isn't too bad. It's just too bad to leave out data that's there and not use it. It is as you saw from this other curve, it is not precise science drawing in the slope. Two guys could draw in the slope and get slightly different answers. There wasn't any correction for the makeup tank instrumentation problem. It was just -- the slope was whatever the maker would assume that the makeup tank level instrumentation was correct.

Let me now press onto the water addition method if you're still with me. Now the water addition method, we knew a number of things that -- what we did was that we selected a period that was relatively steady. We selected a period of time that we felt was not -- the plant wasn't maneuvering because this is subject to some of the same limitations as on an inventory balance test.

You've got to use -- you got to get the plants steady to make it work very well because you have to -- this is a case for example. This is a typical water addition period. In this case we used a five hour period. I'm sure you're -- why we used the evening periods.

The first thing you got to do is find out how many additions you have in the period. You really got -- you have a CRO log which says I added so much water but you find that the operators don't necessarily log all the water additions. And this is -- the end NRC has done a considerable study of this as to how many unlog additions were put in and that sort of thing.

Like for example in this case, when you go to the CRO log in this period of time you find that you can't account for these two additions. These all work out nicely but there's just anything in the log for those two additions. I think I have enough confidence in the makeup tank chart to believe that that really is a batched water addition. The batched water addition of around 300 gallons is something that you can pretty well believe that it's not some strange thing in the plant except when the plant trips and the makeup tank charts just goes berserk. It goes all over the map.

In this case what we would have to do in those cases where we tried to take periods of time that didn't have unlogged additions so you didn't have to mess with them. We also tried to pick these where they didn't have feed and bleed operations. Because feed and bleed operation was really -- feed and bleed operations tend to be -- let me explain what a feed and bleed operation is.

They add water to the system and they also take and remove water from the system. Primary reason being the change in borate concentration in the system. Well, this type of an operation sometimes they do it exactly right and get back where they were, sometimes they don't. And the operator -- we try to not have those kind of things.

But it's possible that that was a feed and bleed operation. I don't know for sure. But they tend to -- some of them look like that, some of them look the other way around, some of them you can't find at all depending on how the operator did it. So we try to -- what if we did have a feed and bleed operation, we try to not do addition through that in the addition method because it would just confuse it.

We also did -- okay, that tells you how much water but you do have to make some correction for the beginning and end conditions just like the inventory balance. You have to determine the changes in the temperature and the pressurizer level and that sort of thing.

But the beauty of the water addition method is is that if you can get the time long enough and the plant is in about the same condition, the water additions tend to be much more important than the changes in the inventory and there's difficulties in knowing the right coefficients to use when the temperature changes go away.

Basically what we use there is available to plant computer printout of a 24 hour summary which gives you plant conditions you need on the hour. That's why in this picture it runs from hour to hour because we have enough information in the file records to get the average temperature, makeup tank level and the pressurizer level at those times. And we also use compression --

MR. CAPRA: Can I ask you a question?

Most of us we've been using the makeup tank strip charts for both the protective corrections that's done through timing through the makeup tank strip charts --

MR. HARRISON: A lot. Not so readily --

MR. CAPRA: I guess I should have mentioned that when we first started because there are significant differences in --

MR. HARRISON: Yes, I'm glad you brought it up because -- errors in the strip charts are the -- anybody trying to use them which end up having to do when you go into one of these things, the first thing you do as we talk about looking at allegations of additions and what have you.

First thing you've got to find out is whether the strip chart time is right and it often wasn't. What you have to do is take things like the additions and you see whether they're reasonably close, take they're spacing. In this case they're probably pretty close. The guys tend to log it a little bit accurate -- occurred in lots of cases I think I saw an NRC -- some work on that too as to how late that they tended to log.

But we got some other clues to. Sometimes they write on the chart, the timing. Sometimes they -- and usually it's pretty consistent over a period of time once you get a portion of the chart timed then you can usually find when a man runs out of ink or the paper runs out and they may get themselves off again or they may have something wrong with the chart.

But you have to very careful of the chart time -- you time it and as we will see later on that's a principle way to get a -- to think something is wrong when nothing is wrong. Because you're at the wrong place on the chart, you've placed inventory analysis doesn't always come out at the right place on the chart. So we have to -- analysis.

MR. CAPRA: There's no theory to conclude an analysis of part-time versus makeup tank time, correct?

MR. HARRISON: Yes, as all of these are corrected. We correct the gallons, you make sure that you got to the right place on the chart so you don't get an addition in or leave it out. It's very tedious, I'll be quite frank about it. It can cause you --

MR. RUSSELL: While we're talking -- Bill Russell of the staff, we've talked a few minutes ago about the accuracy of the makeup tank level from batch editions for a certain quantity using the 300 gallons of the -- that would indicate 380 gallons, I believe is the number you mentioned.

We've talked about the difficulties with respect to getting timings. How about the accuracy of the batch editions actually made? I mean those 300 gallons went in indicate 390 wasn't 320 gallons that went in -- you indicate 390. You said what was the source of the data --

MR. HARRISON: That data.

MR. RUSSELL: -- quantity of the batch edition.

MR. HARRISON: The data, the source of the data is -- control room operator writes in the log and he gets it from his batch controller and we have no knowledge that that is significantly logged.

MR. RUSSELL: But it's the duty of the operator to write in the number based on what he --

MR. HARRISON: That's right.

MR. RUSSELL: -- saw from the batch control or he may have seen 275 gallons and just wrote in 300.

MR. HARRISON: He may have. But when you go to many many additions because these ratios are based on in many cases they'll be 10 or 15 additions a day. And the consistency of those -- for him to do that consistently, write the wrong number, I believe that he rounded them off on many occasions because we have found that sometimes an addition that he puts in a log is, say, 300 gallons if you go to the end of the -- balance test that that addition was in is recorded in the test -- it may be recorded as 304 gallons, for example.

But we're faced with the -- which one are going to believe a makeup tank system that you're pretty sure has got a significant potential for a problem or are you going to believe the batch controller. So we had to use -- we had to go to either one or the other.

MR. RUSSELL: But you did verify that you're using the batch controller as recorded by the operator in log which you've indicated that there's a potential for round off or --

MR. HARRISON: Certainly --

MR. RUSSELL: -- writes things down. What I'm curious about is to what extent did you attempt to verify the accuracy of the log data versus what was printed out on the inventory test where you may have had that corroborated. In other words, was it simply a round off of a few gallons so it's done in -- error or is it up in the range where it can be ten or more percent error.

MR. HARRISON: I don't believe there's any as much as ten. There were a number -- 2, 4, along something on that order that you would find.

MR. RUSSELL: But from that end concluded -- associated with makeup tank --

MR. HARRISON: That's our conclusion, yes.

MR. CAPRA: On that same line did you compare periods during when that was, when the additions were made during the -- test as compared where additions were made during the periods of -- rate tests.

In other words if an operator added 300 gallons of water and the makeup tank level indication indicated 380 and that happened to be during a leak rate test. If you go and look, maybe, a few hours before the leak rate test or the operator added the same amount of water does the makeup tank also indicate 380?

MR. HARRISON: That's a good thought, we have not done that. That was not, of course, fervent to this -- as far as the -- balance test. It's a separate issue. But that's a very good -- do you understand me saying that?

MR. STIER: Why don't you explain it -- Ed Stier, why don't you -- because I'm not sure --

MR. HARRISON: What he's saying is is there a difference in or out of an inventory balance test period of what the ratio of logged and unlogged appears? And I'm sure what you're getting is did he systematically when he did the inventory balance test put in 80 gallons less than he -- put in. I think that --

MR. CAPRA: No, 80 gallons more in --

MR. COLE: But the inventory balance test would always come up --

MR. HARRISON: But his calculation uses the number that he puts into it.

MR. CAPRA: You have to physically input into the computer any additions that you have made.

MR. STIER: Ed Stier, as I understand his question he asked whether you compared the ratio of batch water edition to the -- what the strip chart show both during and before and after inventory balance tests. And the answer to that question is?

MR. HARRISON: No, I have not considered that. These are just -- without reference to inventory balance tests. It's just --

MR. RUSSELL: You don't know whether there's any operator bias present?

MR. HARRISON: We didn't detect any operator bias.

MR. STIER: But you didn't just look at them during inventory balance or outside of an independent inventory balance, that was random.

MR. CAPRA: It was random across-the-board trying to get to, you know, what is the error factor in the --

MR. HARRISON: Basically everyone that appeared not to have some peculiarity we tried to use. Some of them -- sometimes you have suspicions of them that there's something -- like this -- would not use that because it's very hard to define what is the top and the bottom line.

You know, that throws out some and you may have something but -- number one on methodology here is to try to get the best answer we think we can get. And to try to not get distorted by some of the things that just -- you can look at the chart and see some of the chart -- gets distorted by a number of things. You try to not get those cranked into this, trying to figure out what's going -- really going on.

MR. RUSSELL: Could you give me some feel for why knowing the actual unidentified -- five years after the event is perceived to be significant as compared to what the team indicated to the operators and how that may have biased their activities?

MR. CAPRA: We can't answer that question. Let Ed Stier answer that.

MR. STIER: I had asked them to do it because it was important to me to reconstruct what was going on in order to try to reconstruct what their perceptions were. I think we're concerned about both, what they believe was happening and what was actually happening. Because we can draw some inferences from what were actually happening. And that is going to be part of the basis in the interview process.

MS. DOROSHOW: Why were operator -- Joanne Doroshow, why were operator and nuclear -- relevant to what was actually happening?

MR. STIER: Well, they aren't, they're not. They're high irrelevant. Of course, what you're seeing here is an analysis of Nevada that is necessary as a basis for conducting interviews.

MS. DOROSHOW: But I'm just -- just in terms of some uncertainties which you've explained, would operator interviews have helped him in determining in more certain terms what actually was happening so that your data could be more accurate?

MR. STIER: They may because it is one step in the -- investigation. This was the first step. All of your analysis of what actually going on at the plant and what they perceived is going to be based not only on technical analysis but on interviews. And we'll probably going to have to go back and do further technical analysis depending on what we hear --

MS. DOROSHOW: And then -- will undertake an additional technical analysis after -- leave to incorporate those interviews into the findings.

MR. CAPRA: It depends on what you find in the interviews, it may or may not.

MR. STIER: I'll have to make that decision with the report. But by the end of my investigation I want to know as accurately as possible what was happening, what they perceive was happening.

MR. HARRISON: Let me show you the results of this. This, for example, is the -- this is February and March. You probably forgotten what the slope looks like but I'll put them both together here in a minute so you won't have to do that mentally. But it's -- it, again, shows a scatter but also shows a relatively consistent trend.

This, for example, is the results that one gets back in October through January. In this period of time, let me emphasize again, the amount of water added was small and the number of times you have an opportunity to do this very well is pretty limited so that's why there's -- the points are pretty sparse in this case.

Let me comment just a minute on what we know about the water addition method on the May 23rd report that we have. And there, again, we -- this is as we understand it. We may have the wrong slant at some point but we think that in some of these totals some of the water additions that some feed and bleed operations were not excluded -- basically the next point.

In the NRC's method they try to do it on a 24 hour basis, take a whole 24 hours and try to get the beginning and ending additions and take all of the additions in that day which meant they had to get both the -- take everything from the log, get all the unlogged ones they could find, evaluate those, get them all together and then use the 24 hour summary.

But one of the problems was that -- it seems to me and apparently is a problem, is that the feed and bleed operators got included and they weren't in that -- let me show you why we think there's some -- that things -- that that may be ending, is that particular -- this is a table, water additions by the operators. But this, as we understand it, is from the log and we checked a number of these and this seems to be -- these are additions, unlogged additions based on searching the makeup tank records. It's Table 4.

MR. HARRISON: And these amounts are added together to get a total amount of water added during the day. And what we feel is not very reasonable, is that you get great differences between the daily amount of water added, very inconsistent. And it's hard to believe that that's really the case in the plant. Look at what the -- that you would have variations of that amount.

So this doesn't look as bad but quantity-wise, for example here in March, there also is a substantial difference. These are pretty good but there still is a significant difference step to step. That's one of the reasons that we concluded we couldn't take a 24-hour period. Because we couldn't figure out a way to really figure out what a clean feed operation was and we didn't get enough, very -- the operators didn't log them consistently. They would log them but they may or may not be actually additions.

Again, we then recorded additions, the amount of makeup tank level change was assumed to be correct. We've already talked about that.

And the third thing is a little more subtle and it may be that we have misinterpreted what went on in this. But let me go through it very briefly and you can take it back and do with it as you please. One of the things that it looks to us like -- here is this other table which has been put together in a report where the estimates were made of the unrecorded water additions and their amounts.

In this case on March 26, and these are apparently cold gallons, these are as indicated by the makeup tank chart. It appears that when that number gets transcribed, A-26, over to another table, because in that case it was a 1,017 it went to 1,365. Which meant to us that it had been converted to hot gallons. But the log amount was cold gallons so hot gallons and cold gallons were getting added together. Then tracking this number on down, it appears that that number in turn at the end gets converted to a hot value and so the unlogged addition gets converted twice. Where there weren't any unlogged additions, obviously that isn't important. But I guess it's something that you ought to be careful of.

Let's get off of that and let's go --

MR. RUSSELL: This was in May 1983 report?

MR. HARRISON: Right.

MR. RUSSELL: This is not the one that was in January of '84?

MR. HARRISON: January '84, which we received in February of '84, there wasn't anything comparable to that. It consisted entirely of information on specific allocations of water and hydrogen additions and on a very elaborate sump analysis. And those were in the form of -- they were very helpful but they were -- some of them were computer output where things were put on the table and you have to do a little guessing as to what's really met and back calculating in trying to figure out exactly what happened in the course of getting to the final numbers.

MR. COLE: The only thing of comparable analysis was the --

MR. HARRISON: Let's look at a combined combination of those slope and water additions. And it's comforting to those of us that calculate numbers that they come out to be roughly the same numbers. That would be very disquieting.

This is February and March, these are the slope, those are the water addition methods, those are some least squares fits lines I've put into pieces to give us some way to easily go to other uses further. This similarly is the conditions October, November, December, January. Now, this is total, remember. This is not what we're trying to get to, this is not unidentified.

We've got to get the identified leakage. I won't belabor the identified leakage. What we basically did was essentially the same thing that the NRC did, was to take what came out of the -- the electrical input balance forms prints out the drain tank levels at the beginning and the end of the test. So on over an hour period you get a period and it does it very precisely and you get a good number to what the drain tank is doing.

For example, this is -- the only change we made is that we got concerned about the -- in the inventory balance test itself there was a technical error in how they put in the drain tank level a table that they used to figure out the level of the volume relation in the drain tank.

The drain tank is not a cylindrical tank, it lays on it side. Consequently, the level of volume relationship is not a simple relationship. And we finally ended up going back and recalculating it from scratch. We couldn't make to many people's numbers agree within -- and we finally concluded that we would just do it from scratch. So these are based on our own dimensions of the tank.

This is the identified leakage. Now, in these curves there is -- sometimes they had other -- particularly in this time period, the operators identified some leakage, that's the little flags on these. There was some leakage that they were quantifying and were identifying and putting into the inventory balance test. And there are daily sheets on those as to what they were in most cases.

Now, I've got all the numbers here now to get down to the answer, which is unidentified leakage, or what could be unidentified leakage. Remember the relationship that we put up. What we're going to want to do is we're going to take the total leakage, going to subtract the identified leakage and we're going to get the unidentified leakage by doing that, actually it's unidentified plus intersystem leakage just like you would put balance --

This one -- let me not give you -- that one is -- only when you've gotten through this one will I let you go to that one. All this is is -- this is February and March total leakage going up, identified leakage going up as well because of the collection you have to -- drain tank. The difference turns out to go along here and it does take a jump around the 16th of March as we'll see there with the sump and we'll compare it to the sump in a minute.

This is this curve minus this curve. I'll show you what it looks like. Here in these curves the identified leakage was low and it's considerably more complex in some places where you have some known leakage. Total leakage, identified leakage is small, unidentified leakage is here. Again, you see this thing creeping up on record over one gpm.

This is known sump curve, the curve of sump collection rate. As well as those two curves you just saw, they're plotted against each other. So you can see where they're similar and where they're not similar. One of the -- you see this is somewhat similar but these things you don't see at all.

You see this area in here, you see a place in there, you have some piece in here. But you don't have any -- we say that -- we make sure I make -- there than here. You don't have it in the sump then we don't believe that you can have unidentified leakage from the after truant pressure valve. Irrespective of what this shows, all it means is that whatever this was, like in this case, of whatever this was, it probably wasn't from the reactor coolant system because it would -- it was intersystem leakage, out in the makeup system in some fashion. That's one thing we've used this actual leakage for.

Now, let's go back and take the -- remember this curve, this was a sump curve that we had which had ten periods. Now, what we have done is to go into each one of these periods of time, and I guess you would call them "mini-slope and water addition methods" if you want to look it that way, gone to the makeup tank charts that go with particular periods of time in the sump -- that it was collecting water at these rates, to see whether the makeup tank level was affected by these things. Because we felt we could use this as a discriminator against those things that were being collected in a sump, the one from the reactor coolant system.

You see, you can look at it that if you can't see changes in the reactor coolant system inventory, say when the makeup tank level changes and that sort of thing, even though you're getting liquid in the sump, it shouldn't be out of the reactor coolant system. There's got to be someplace else for it. And in some cases you can, in fact, confirm that. Some other cases you can't. But you can confirm that it wasn't from the reactor coolant system.

You make sure everybody understands what I'm saying in that case. I've got a peak in the summer, water collecting in the summer. And I go look at the makeup tank level and I go look at the makeup tank like slope and water. And I don't see any change in what's going on in the makeup tank. I don't see anything that indicates I'm actually losing fluid from the reactor coolant system. Yet I'm getting coolant in the summer but I've now discriminated that that stuff that's flowing to the sump can't be from the reactor coolant system. Therefore, it can't be unidentified leakage from the reactor coolant system.

And when you apply this test in gross as we did in with this generalized thing and in detail going to each individual time, what you find is a lot of these peaks evaporate. They just aren't -- they just have nothing happening in the reactor coolant system, no loss of --. These peaks, nothing in them. This one, nothing happens in the makeup system, but there's also other information that indicates that that was an immediate close --.

This is the CRDM flush, it, of course, doesn't -- didn't appear. These don't appear in the reactor coolant system. This one doesn't appear in the -- and it almost does. It appeared just before the MUV 17, and MUV 17 wouldn't have hot water in the sump anyway, it's not there. This is -- and this one also doesn't appear in the sump.

So, we went back to this thing, all we were left with with out of our 10 periods, we had three of them that appeared to be times when you really did have something. It was coming out of the reactor coolant system, it wasn't identified.

Now, this one, he didn't quite make it over one. But, it looks like in this time period, whatever this -- in this sump wasn't the reactor coolant system. We don't know what that was, we have no -- we didn't find no information that will tell us what that was. This and definitely both of them were doing it. There's quite a bit of information in this time period in the logs concerning leakage of some small -- on the pressurizer level control. And also, I believe, on the loop flow meter, which, at this point in this shutdown, the records indicate that none of those valves were replaced and repaired.

And there is other things in the logs in this time period. We made no attempt to say, "Did they do it within 72 hours?" And that sort of thing. That's against -- -- --. But, there is a great body of information that there were some small leaks and in considerable evaluation of their safety significance and things in this time. We felt a little bit that -- I felt good about that, because it's good that you knew that those leaks were there and tried not to let the method show that they -- and they match up.

This one turns out to be a time period,

which had some considerable investigation in the past. And is a, I think it's CAV 6, appears to be the major contributor in that particular timeframe. And sure enough, in that timeframe, the water collection in the slump goes out that way. Makeup tank, level -- slow changes and it seemed to be improved reasonable time order on two things. Which, again, is company because it should happen that way. If your -- have any validity, it ought to happen that way.

So, basically, what we ended up was with these three time periods. And that, I guess, is a punch line of our actual leakage thing. And I guess that's -- the next step is up to -- --.

MR. CAPRA: Was your elimination of those other peaks strictly due to your makeup tank level -- and -- indication or did you, in fact, check the maintenance of --

MR. HARRISON: We checked --

MR. CAPRA: -- that time period, or maybe --

MR. HARRISON: Some of these other ones we -- a few of them, I can't remember those two, whether we could or couldn't. Just off the top of my head, I didn't bring all that many notes.

That one, for example, yes, there are plenty of records. And also, to corroborate what that system's shows us. In most cases, the makeup tank runs across a very sharp peak in the sump. You should get a pretty definite sharp changes in the makeup tank, this one is.

MR. CAPRA: Uh-huh.

MR. HARRISON: This one is classically nice, it that it does what you would expect. I felt fairly comfortable since these don't do that. I don't see any sign that they do that. That they -- whatever they were, even if we can't -- even if we have somewhat ambiguous information that it might be. It wasn't from the reactor coolant system, it was a leak from something else.

MR. RUSSELL: Would you go back to the curve that you had, the least squares fit of the total leakage in the March timeframe?

MR. HARRISON: This one.

MR. RUSSELL: That one's the one that you used for the -- in preparing to subtract out with some leakage to calculate the unidentified leakage?

MR. HARRISON: This one.

MR. RUSSELL: You would look at that for 72 hour increments when evaluating the quality of the --. That is, if I were to take different periods of time, I might be able to draw different curves in, maybe, some portions of the time period of using least squares fit to, you have a few data points when you're deriving the fit of the curve.

So, if you actually look at it from a standpoint of, say, plotting with mine and seeing what is the error band around that curve that would identify apparent other areas that could, in fact, have leakage approaching the one gallon per minute limit.

For example, if you take to about the 10th of March through -- about the 20th of March where you have that discontinuity of the leak rate. It would appear that if you eliminate the portion prior to the 10th of March, you may get a different slope to that curve.

And then, I brought to the fact that you've taken it from the 1st of March through the 10th of March, and you're taking a fit over 10 days that's compared to taking it to a fit over 72 hours, it will be interesting to see what the changes in the slope are from the curve pits over the technical specification time period, which was, in fact, 72 hours.

Even doing -- drawing a curve with a straight edge on the --. And see, I mean, it's just -- least square of strip just turns to be a statistical way of getting as many points above and below and assuring that you've got statistic --

MR. HARRISON: Even in this curve if there is not this discontinuity --

MR. RUSSELL: No.

I'm concerned --

MR. HARRISON: -- --

MR. RUSSELL: -- I'm concerned that their -- that this continuity appeared to be one of the points you said was validated.

MR. HARRISON: Yes.

MR. RUSSELL: Did you get -- you took comfort from. What I'm concerned about is periods of time just prior to that. And what kinds of --

MR. HARRISON: -- this curve -- if I -- because it's not the slope in this curve, it's how high it is.

MR. RUSSELL: Oh. Also, toward the end, it looked like you were creeping up with your identified leakage toward one, depending upon how you draw your total leakage curve, your least squares fit.

MR. HARRISON: Oh.

MR. RUSSELL: That's what you're subtracting out.

MR. HARRISON: That's right.

MR. CAPRA: I think what both -- I think what Bill's saying here, is that he takes the slope only from 10th through the 16th, you get a significantly higher slope than taking it from the -- of the margin.

MR. COLE: It isn't the slope, unless you have -- do it -- --.

MR. HARRISON: That's --, I understand.

MR. CHUNG But both of them look to us -- the slope and the sump are fairly well --.

MR. HARRISON: There's a -- now, you can draw the -- I'm not sure that you can draw the curve, so that you change the magnitude of all that -- . I have to raise the whole curve up to make the unidentified go up.

MR. RUSSELL: But in your calculation, you used a calculated curve, which is based upon a least squares fit of the data and change the timeframe that you're considering data --

MR. HARRISON: You'll get it -- it will move.

MR. RUSSELL: It will move.

Okay.

My question is, how much does that move, for instance, over a 72 hour period? And it would appear to me that that curve could be higher in absolute value toward the end of the timeframe where the -- it doesn't appear that there is more data slightly higher.

MR. HARRISON: The only thing is, Bill, that that particular form, if you go back and look at what we -- this doesn't have the points on it, this just has the --.

If you identify leakages pushing up pretty fast in that period of time then you can change this pair of -- just before the 16th a lot. And not bring this up.

MR. RUSSELL: But if you look at what you're characterizing as unidentified leakage, the concern I have is that you're showing that for some reason the plant's getting tighter in -- as a result of the way you handled that. If you look at it from the period of the 1st of March to the 16th of March, the unidentified leakage is going down.

MR. HARRISON: Physically --

MR. RUSSELL: I have a hard time understanding how a plant gets better with time if you don't do something. So I question whether with some activity going on which could account for that, or whether it's some --

MR. HARRISON: I wouldn't --

MR. RUSSELL: -- not in statistics.

MR. HARRISON: I would not put any great store in this slope. I agree with what --

MR. RUSSELL: That slope is directly a function of using the least squares.

MR. HARRISON: Yes, that's right.

And you could draw a line --

MR. RUSSELL: Draw a line by --

MR. HARRISON: -- by I and you would get a smoother curve. But it will still have the jump in it.

MR. RUSSELL: Must be testing the advantage of account of the leakage.

MR. HARRISON: Yes, I mean -- and we can smooth the curves out. I chose to do it this way because I handle the data in some fashion. I trusted the -- one way to do it would be, obviously, to take these and then, draw a smooth curve using these as a base as you would make someplace -- mark off a little smoother, it doesn't have a saw tooth.

MR. RUSSELL: In order to put the error bands on that are impossible to identify from the least squares fit, what kind of a leakage would you have if you included those error bands?

MR. HARRISON: Well, the --

MR. RUSSELL: -- errors that you have more cases above one.

MR. HARRISON: Well, it --

MR. RUSSELL: 85 percent confidence limit, for instance. If you wanted to include all that, plus, say one or one and a half standard deviations in your fit.

MR. HARRISON: If you had to put statistics on this and say that then you're obviously are going to make these things quite a bit larger. I don't see how that -- what that does --. You're trying to -- that's if you're trying to do a limiting case. What we were trying to do is by what was our best estimate for this, and sometimes, maybe approaching it from a different step. We're trying to do -- to us, that means you need the mean. You don't do error bands.

I've done all the stuff for some error bands on these things. And frankly, it's -- as you get up in here, as you would expect, you've got a substantial fraction of the gpm error just on standard deviation, because you're dealing with quatities which are really not much better than those used on the inventory balance test. In fact, they're probably worse.

MR. RUSSELL: The only reason why I asked those questions is that it appears to me that the identifying leakage increases, that is, leakage through the pressure of the valve. The ability to calculate the unidentified leakage is a much more difficult standpoint that the accuracy of measurement of identifying leakage and the amount of stuff that you put in, you have a small change in those numbers and the accuracy of that becomes very difficult. That's what derives the greater number of leak rate tests --

MR. HARRISON: Let me ask you -- you're absolutely correct. If -- as you get bigger and bigger numbers to subtract to get the small number, it'd be many of your -- take in this case where you're up to 5 gpm for total leakage, a 10 percent error in that is a half of gpm. That's -- that can wash you -- down here completely. This is a difficulty in these things which are related to the inventory balance. They get hard to get a good number as you start to subtract two big numbers from each other. Engineers spend a lot of time trying not to subtract two big numbers.

MR. COLE: I guess that's why we came back trying to get the -- -- leakage.

MR. HARRISON: This is primarily for corroboration, we are off in the left field. There's not something going that's not understandable.

MR. STIER: I'd like to add something at this point to clarify what our purpose was in asking for this, and what we intend to use it for. With -- analysis has given us a bit more focus than we had before we started. I, am by no means locked into excluding any particular time periods because of the fact that a preliminary review of plant records might suggest that there is some source for some of these results other than the -- unidentified leakage. Or that, calculation deficient, I'm sure, will -- these -- just below one gpm.

Our investigation is going to be focusing on time periods that have been excluded by reason of this analysis, just for the very reasons that you've raised. This is guidance, as far as we're concerned.

MR. KIRKPATRICK: Well, I -- this is Kirkpatrick again. I just wanted to comment that I must imply that there was some -- you're trying to find the unidentified leakage, that there should be some differences between your results and our -- report results. And I think the accuracy of that method of taking the difference between the -- what you call total leakage and identify that. I think, in that accuracy, you're going to find is on the order of half a gpm anyway. The difference in the results is that half a gpm is not surprising at all.

MR. CHUNG: I guess we realize the differences of -- -- where we are different on these other -- corrections in the same --.

MR. HARRISON: And if you don't make any corrections on the makeup tank level instrument, I think you do make -- you do -- by it with slope results. And in the direction to get higher numbers, at least in some time periods.

MR. KIRKPATRICK: Well, it's also part what assumption you make regarding that direction. Now, sometimes I think for portion -- apparently, you made a proportional correction.

In other words, you said that if you had 300 gallons unit of slope -- this is a slug effect, you have maybe, actually 250, and you use a linear counter-direction. I think that may have been appropriate in some cases. But I think in other cases it would be more appropriate to use a constant shift, depending on the height of that slug. Sometimes it wasn't even there at all.

So other times it was large. When it was large, a proportional correction might have been correct. If it was intermediate, it would probably be more like a constant shift. And if it was abstinent, you wouldn't have any corrections. So that's a hard thing to really get a handle on. A lot of times the spikey nature of that curve, I think was really due to the fact that you were having the slug effect tipping back and forth depending on if the pressure is going up or the pressure is going down.

MR. COLE: You didn't use it quite commonly. Capra had constantly kept changing what the correction factor is for that time period --

MR. HARRISON: We changed it from day to day.

MS. DOROSHOW: When was this analysis done, since February or was it prior to that?

MR. HARRISON: Since when? This was done primarily after February, primarily. We had done pieces of it. In an analysis like this you do it once and then you go back and you do it again. So I would say that some parts of it may have been done -- this analysis, meaning this -- it would be the whole thing --

MS. DOROSHOW: Well, how does this analysis compare to what was in front of the United States Attorney in February?

MR. COLE: I don't think he --

MR. HARRISON: I don't know of any difference.

MR. DAMERELL: You didn't start with that until October?

MR. HARRISON: No, I hadn't done that, that part. As I say, parts were done and pieces were done and things were redone. But I guess I'm not -- that's not a very answerable question.

MR. COLE: Is there any information that you got here that is different than what the U.S. Attorney did in fact change by --

MR. RUSSELL: I'm still struggling with how you're proposing to use the fact that actual leak ray, with a few exceptions of being less than the one gallon permitted leakage. Those exceptions can be explained by phenomena that occurred in the plant, corroborating that there was some leakage from the primary system.

The issue that we're concerned with is whether there was, in fact, manipulation of the particular leak ray tests. And in that instance, hydrogen additions would clearly change the slope on the make-up tank strip charts.

There were other aberrations that you did not look at. And while you may have a reasonable handle on what the actual leak ray was, based upon several months of calculation, that may not have been available at the time.

And so those periods of time where you have unexplained activity on make-up tank strip chart level during leak ray testing, I haven't heard any technical analysis of that yet.

MR. HARRISON: That's what -- that's a great introduction to that.

MR. VANVLIET: There are two more sections to your briefing; is that correct?

MR. HARRISON: Yes.

MR. VANVLIET: How long will they run?

MR. HARRISON: This can run a good -- we are prepared to discuss a large number of these allegations, not every one of them because there's 50 some of them, I suppose. But we'd like to give you a sample of how we've looked at them in some detail. Because -- I think it would be -- we really want to compare notes. We'd like to do it so that you really know what we looked at.

MR. VANVLIET: Well, at this point then it might be appropriate to take a 40 minute lunch break and reconvene at 1:00.

MR. RUSSELL: I'd like the staff to cut theirs down somewhat because I want to talk to the staff.

MR. VANVLIET: Shorter for the staff then.

MR. RUSSELL: Shorter for the staff.

MR. VANVLIET: Do you want us to stay here now?

MR. RUSSELL: Yes, just stay here now.

I'm also interested in what are the logistics with respect to being provided copies of the technical analysis and materials that are being presented today.

MR. COLE: When you get through we'll give you one set of all the new graphs and a copy of the chart.

MS. DOROSHOW: I would certainly request that since this is now being made a part of public record in the NICP that --

MR. RUSSELL: We'll also attach it to the staff's meeting summary of this meeting when we get the transcript back. So the transcript plus any handouts at the meeting that were discussed will be a part of this meeting summary and essentially noticed on the meetings of parties. We will provide that to the parties also.

MR. CAPRA: They can be bound into the transcript also.

MR. RUSSELL: Yes, that might even be a better way, to bind it into the transcript such as there's not a question of documents being lost.

MS. DOROSHOW: Would there also be included the professional qualifications?

MR. RUSSELL: I'm sure that would be in their report when it comes in. The actual report when they submit it when it's completed would identify -- if not, it can be obtained when we get into that phase of discovery material.

MS. DOROSHOW: Well, I mean, just --

MR. STIER: We'll be happy to provide it. We'll provide it now.

MR. VANVLIET: We'll adjourn until 1:00.

(Whereupon, at 12:25 p.m., the hearing was recessed to reconvene at 1:00 p.m., this same day, Thursday, September 20, 1984.)

A F T E R N O O N   S E S S I O N

MR. RUSSELL: Why don't you go ahead and we'll just continue with your presentation and maybe get a break here. Hopefully by this time after everybody gets back here we'd like to --

MR. VAN VLIET: Let's continue with the briefing with section three.

MR. HARRISON: What I'd -- we'd like to talk about now is to discuss the questions of water additions and allegations of water additions being made during our SV tests.

I'd like to give you some feeling for what methodology we've used to look at these things and what we see in the allegations and how they stack up.

First, however, I would like to -- let's talk about water additions first. First, let's review briefly what water additions do to the reactor during inventory balance tests. Let's be sure that we -- that we're all together if we're going to talk about this.

First is the simplest thing. If you take in -- if you add water during an inventory balance test. You don't -- do not include it in the calculation -- that is you don't input it through the computer to run the calculations. You are obviously going to have a significant effect on the result of the test.

This will be directly -- change the amount of unidentified leakage changes the -- totally changes the unidentified leakage. There also is in the inventory balance test -- if you -- even when you make an addition because the thing is -- even when you include the addition in the calculation as Oman discussed very early in this thing an inventory test itself because of the errors in the way the thing was set up it would tend to change the results of the test being one of the things that caused the -- building.

I'm not going to talk about additions that the guy properly included in the calculations and he did it, but he in that process changed the result. But there is no indication that he did that for any particular reason. I'm not -- those are not in the allegations and we're not going to talk about that.

But you've got to remember there is an effect as well of adding water just because -- even though you do everything just like the book.

What I'd like to go into now is -- there's -- we have been given over for a couple of times a number of different specific allegations that this test looks like somebody added water during the test. That's what I want to talk about.

Basically what -- the various allegations we've looked at are some that originally appeared in the Faegre Benson report back sometime ago. They have a number of things indicated where they test -- and again where they think something was where water was added.

We have a -- the report that I keep referring to in May of '83 that identifies a number of water additions, like 11 identifies it now. And in the material that we were given in February of '84 identifies a lot more something in the order of 50 some by now. By the time you got question marks and other things here in that particular facts.

Obviously we can't go through each and every one of those today and I don't think you want to do that, but I hope to be able to tell you some -- and also tell you what we get out of it as far as ones that we think all the things add up and we can confirm as being all additions.

Let's look at an allegation and let me -- let's look at --

MR. CAPRA: Let me ask you something here on what you just said because apparently you're not going to talk about it now. You said you did -- you were not going to concern with water addition which were properly made and properly accounted for.

The example being where the operator added 300 gallons and accounted for 300 gallons in the -- in the computer program or imputed it into the computer, yet the makeup tank level indication they have gone up to 380 gallons. So it appeared that there were not 80 gallons unaccounted for.

It is something that an operator could in fact see that with the makeup tank level was not indicating the same amount that he had input had he looked at makeup tank level at the time. Correct?

MR. HARRISON: That's correct if he had done that. But I -- from our investigation of the air in the makeup tank level that was the rule apparently. Now if we have not done one for one comparison as we talked about earlier, but by and large, the test -- they logged them out and the -- in those time periods where -- we found it was effective.

We haven't done the tests that you've talked about. I can't --

MR. STIER: Ed Stier. It wasn't clear to me whether you were talking about the effect of the loop seal or the calculation error -- what before --

MR. HARRISON: The calculation error.

MR. STIER: You were talking about the

calculation error? Okay. I wasn't sure if you were taking about the loop seal or maybe it wasn't the loop seal and it was the --

MR. CAPRA: We have two mistaked errors we're talking about. One is the calculational error if in fact what was put in at the computer was reflected in the makeup tank. They both registered 380 gallons there still would have in fact be an error.

MR. STIER: That's right. You're right. That's all I wanted to as is that were two effects -- two errors as a result of the conditions.

MR. HARRISON: Let me use as an example -- let's look at -- see if this is at all readable. I've got one slightly larger scale.

This is October 18, 1978, which is a period when those of you that are familiar with this thing are aware it was a period when there were a number of tests run that were not signed, but available.

This is a period I'm sure you're all familiar with. But I think it provides a good way to get a -- into makeup tank charts and what happens.

In this time period there are allegations for example that in this test there was a 60 gallon addition at this time on the chart apparently being that movement of the chart. Here is an allegation of

100 gallon jogged addition at this portion on the chart.

Here are -- here is another allegation to the 100 gallons that was added at this point on the chart. Here is an allegation of two additions were made and those were 100 gallons total. Now I think you can see that -- a couple of things come out in general to what the trace does a lot of movement.

Some things are very clear. This addition -- that's probably an addition. These don't seem to have quite the same shape. You are concerned that those -- that those may or may not be just typical of the rest of this time period.

Now if you look here you can see -- here the inventory balance test results in this time. And in here you can see that if there was an addition in this thing of 60 gallons you should have had a -- roughly one gpm effect in this result over this one. You don't see any such thing.

Here you have to take 100 gallons, that should be a substantial effect. That doesn't seem to show up in the inventory balance test results. You see a real -- you see also this -- it's a very interesting one, you also see a real change in the leakage in the plant if you look hard, you're talking about the slope, you'll see a real change in leakage in the plant about this time.

This might be considered a typical kind of allegation that one might have to fight through. Let me leave this for a minute. Let's go down -- let me tell you what specific things that we tried to look for when you have a specific allegation and I can try to explain what those are.

The first problem is you've got to find the test on the makeup chart and you've got to -- as we talked about earlier you need to time the chart, find where it is. And there are several ways that you can do that.

One of them is to compare the time of logged additions because they have a certain spacing in the log and you can match them up. And once you get a period of time going you can get a pretty good timing of the chart.

Sometimes they mark the chart. Sometimes they mark the chart, sometimes they have a day to mark the chart at a certain time. And you can use that to get the thing timed.

Sometimes there are other logged events. Sometimes that you can -- like a reactor trip or something of that nature.

And the last thing you can do is compare the values of the makeup tank level trays. Let me use a more colored thing here -- to see whether you're really getting the right -- this is a little bigger scale in the same time period.

But you feel pretty sure that you've got this one timed reasonably well because the makeup tank levels in these tests match up with the trace and that generally is fairly unique. I don't think you could find another time period that those would match up.

So that's your first thing that you've got to do. Then we always -- then we tried to see whether the trace fluctuations were typical of that particular day. As we saw on that other chart, traces tend to fluctuate and for example here's a period in March and all sorts of fluctuations in this time period as to what's happening.

And one of the tests that we thought was necessary was whether the kind of fluctuation that we were looking at was unique or whether it was spread out over the whole period. Whether it occurred earlier or later in the day as well on the basis that it's unlikely that the same kind of manipulation would be done exactly the same way.

Basically what kind of trace fluctuations are occurring, then compare the rate of the makeup tank level change during the test and the slope of the tracer to what was happening before and after.

And I think here and back to this maybe it has to say that the apparent slope that these are getting you out of this is pretty reasonable. It's hard to believe that whatever -- that if anything was done that it could end up that it matched this slope with these points.

You see it doesn't look like this is -- this has effected those particular -- for this -- by that test. We also needed to look whether the plant was in steady state because obviously the reactical inventory balance test is going to do -- give you unreliable answers in -- if in fact the plant isn't in steady state.

One of the things you can do is you go to the log. If their start up was in progress and in the process of pulling rods and if you see the makeup tank trace is wandering around, you're pretty sure that they weren't really in a period of steady state.

And you can also look at the reactical inventory balance test form gives you the beginning and ending parameters -- I think I pressurize a lot of old makeup tanks -- temperatures and you can look at those and if you see large changes in those parameters -- say you see a six or eight degree in average temperature between the beginning and end of the test, the plant isn't in steady state and the prospect of the makeup tank trace showing you very much under those conditions is pretty slim.

That's basically our methodology if you want to call it a methodology -- is just looking at -- and look at the reasonable most of the results.

Let me give you some feeling for parameter fluctuations too because we've talked about them before, but typically a swing in average -- typical parameter variations in this plant would be -- for average temperature over three to six-tenths of a degree.

Now that in itself is the order of an inch or two -- one of those fine graduations -- an inch or two in makeup tank level. Pressure 20 to 40 pounds about a half to one makeup tank level. Pressurizer level typically moved around by about one to three inches not PSI, I'm sorry.

And there again is about another inch. So it's -- with these things moving through typical kinds of variations the makeup tank level is also going to move through kinds of variations. So you are getting down to where when you start to try to discriminate an inch or two which is like 60 or even 60 to 90 gallons of something happening in a makeup tank you're stretching the ability of the system to discriminate this kind of an event.

It just is very difficult to pick it out unless it extends over a long enough time with some other characteristic that you can hang your hat on.

Let's go to specifics if you will permit me. Particularly with respect to this reasonableness. This -- this for example is a cable which appeared in the May NRC report which lists 11 specific allegations of weeks of manipulation.

And one of the things that strikes you immediately when you look at this is the last column. In the last column if you say, "all right, let's assume -- let's assume it really happened. Let's assume that they actually did what they said they did -- what the allegation says they're doing."
Six hundred and some gallons added.

It said a corrected leak rate was 11 gpm -- that's, you know, not a reasonable result. You don't really believe that there was that kind of a leak. Similiarly this one -- the subject read this one. Now let's take a look at what happened on those, why that

-- what might have been the problem with that allegation on running clear to that which incidentally does not appear in the later one.

I'm going to show you this so we can bring in -- if you take it for the chart time you put on here where the test occurred and you plot the makeup tank level. It said it was there and there and here was an addition. If you really had that that wouldn't -- you'd have a makeup tank levels would be like this and this.

You don't have that. You find by timing the chart that actually you're over here and this addition didn't occur during that time period.

Now in that chart that I showed you -- that list of ten things.

MR. CAPRA: One other comment here to -- you have made reference to this May '83 report on several occasions. You do realize that the NRC knows that there are significant errors in that particular report and does not report that to be the truth.

MR. HARRISON: Okay.

MR. COLE: Can I -- caused by anything. In the last Hayes report, Hayes?

MR. STIER: Hayes.

MR. HARRISON: -- on page 14 they talk about

10 allegations and the only part allege water additions and the only parts we could correlate with anything -- we said, "Geez, they must be going back to this report."

And so we thought you were -- you all had gone back and were -- had gone back and were going back --

MR. RUSSELL: Let me take a break for a minute so that you understand what the difference is. The recent Office of Investigation report addressed matters in evidence that was gathered by the staff as compared to evidence and information which was gathered in the Grand Jury and evaluated by members of the staff who were on detail to the Justice Department.

So when you talk about NRC reports what you have been talking about is reports that were generated by members of the NRC staff for the Justice Department as a part of that proceeding.

The information that was addressed in the August 16th, 1984 report was information that was gathered prior to turning the case over to the Justice Department, plus some work that was gathered as a result of the commission redirecting the staff to reopen the case along with a history of what happened during that period of time.

The analysis that you've mentioned earlier, the January 1984 analysis, is an analysis that was performed for the U.S. Attorney by a member of the staff who was not able to address that or discuss that with any other member of the staff because of the limitations imposed as a result of the Grand Jury secrecy and as a result of letters which he received and directions he received as to what he could discuss technically.

We today, the staff at NRC, do not have a complete copy of the January 5, 1984 report. We have portions of it, we have portions that have been blanked out because release of that information could result in a compromise of Grand Jury secrecy by way of identifying documents which were subpoenaed by the Grand Jury.

Now that report was provided as a part of pre-trial discovery under order from the court. It is that same court that has not agreed to give us the Grand Jury materials. That is why we've made the request to chief GPU to identify all documents obtained in the part of discovery. And to have those documents placed on the record so that all parties have access to the same information because we do not have that today.

We have only recently, within this week, obtained a partial markup of that report.

MR. COLE: Of which one, sir?

MR. RUSSELL: The January 1984.

MR. CAPRA: And that was based on materials which we had received from GPU --

MR. RUSSELL: The --

MR. CAPRA: -- the documents, I believe, that we have gotten that -- outside of the Grand -- outside of documents that were subpoenaed by the Grand Jury.

MR. RUSSELL: It was furthered complicated in the documents which were provided toward the end of the plea agreement were not analogue from the standpoint there had already been an agreement to a guilty plea by that time.

And they were no longer maintaining accurate records of what documents were turned over. So the first confirmation that we had that you had, in fact, obtained the complete January 5, 1984 report was today.

We didn't know that you had even received that report even though we know portions of it were discussed, and there were other pieces of the analogues that were discussed earlier. And that you had made a presentation to the U.S. Attorney in the February 1984 timeframe.

MR. COLE: And it was given to us, I mean, with no restraints.

MR. RUSSELL: No --

MR. CAPRA: We understand that.

MR. RUSSELL: And rightly it should have been as a result of the pre-trial discovery. There was no question that it should have been turned over, we just didn't know for sure whether it had.

And the staff at NRC was not involved in that except if they were on detail to the Justice Department, and they were sworn to secrecy. So that the staff did not have this -- this information. And you're saying in the earlier transcript today, the NRC evaluation, you're talking about individuals at the NRC who are on detail to the Justice Department who performed these analyses.

The work that we've done has been based upon the materials provided by OI, which is back in the 1980 timeframe, Arkin's Report, and the things that are documented August 16, 1984, OI Investigation Report. Plus the Faegre Benson Report, and basically that information that which is documented in new regs

680 supplement file.

Which gets to the point of why we're discussing this stuff now because we have, separate from the restart proceeding, activities going on with respect to individual operators under the terms and conditions of their license, under part 55 of the NRC's regulations.

The staff position on TMI-2 leak rate and TMI-1 leak rate is as it's stated in new regs 16, supplement five.

So that there was a question as to additional investigation of being done, or additional review that's being done, are review and evaluation is for the purposes of part 55, licensing concerns. We are not performing in a further review as it alleged to part 50 in the TMI 1 restart procedures.

MR. COLE: So you understand where we were coming from on the water additions when we read the August 15 -- paper. We're back to where we were arguing about the additions of the -- in the May '83 report, and maybe we misread it when we saw the ten.

But does that look like analogous with a ten?

MR. RUSSELL: Because that's exactly what you were reading. You were reading information that you may have seen before as a result of your support to the company in trial and discovery.

But we did not have access to the new information that was being generated.

MR. COLE: Bill, let's get to the bottom line.

We can go down through these ten and tell you -- if it's of interest to you, we can go down the chart, you know, blow by blow and tell you what we think of each of the ten.

We can go down through the other allegations, and the other things, that we received at the -- what we call the January 5th report. We can go down through those four allegations --

MR. RUSSELL: Through sump?

MR. COLE: And then we can go through the hydrogen additions, the same type of thing, if that would be of a benefit to you.

If it's not going to be of benefit to you, I'm sure you and we have other better things to do.

MR. RUSSELL: What would be of benefit is your review, if it was strictly focused on addressing allegations as to fair to looking at the data yourself for you to make a determination as to whether water additions had been made, or hydrogen additions had been made.

I'm interested in your analysis of what activities were going on at that time, rather than your comments on analysis which we admit contains errors, we know that, there has been subsequent work done on that. We now have access to some of that subsequent work.

And so what I'd be interested in, and what I think you should be interested in for the purposes of conducting your own investigation, is what do you believe to by factual with respect to potential manipulation during tests through either the vehicle of water addition, or hydrogen addition. Which ones were you able to confirm, or not, if I go back to the words that were used in your TMI Unit 1 leak rate categories.

So rather than an approach that would say, this is what you said, we think that's wrong, I'm not interested in it. Tell me what you think is right about when these events may have occurred.

Or if you conclude that none of it ever occurred.

MR. CAPRA: I'd be interested in that also.

MR. COLE: We can give you -- we can take all the allegations that we have found, all right. We can try and go through them one by one --

MR. HARRISON: Let me suggest that I go through -- certainly there's a minimum. The ones that we think are concurrently confirmed. Let's do that, and then -- because I think that's -- well, if that's what you want.

MR. RUSSELL: The other thing that we want to come back to is the question that Bob Capra asked earlier, and that is a water addition that was made during a test that was logged could have the same effect on leak rate.

If we use your 300 gallon water addition example, it would cause an 80 gallon change in makeup tank level.

If you properly log 300 gallons on the leak ray test, but the makeup tank went up 380 gallons, you have an 80 gallon discrepancy over one hour. That's greater than a one gallon per minute leak rate difference.

And if that individual was aware of the effect of adding to the makeup tank, and seeing a greater increase than was actually recorded that information could be used to, in effect, manipulate the leak rate test results by virtue of taking action. And while it wasn't explicitly prohibited, he was taking advantage of circumstances he'd seen.

And so the fact that you have excluded those because he simply logged it, if he had logged 380 which is what the makeup tank did, he probably wouldn't be as concerned.

But if he had, in fact, logged 300, which was the input, I would be more concerned about that particular case. And I understand that you didn't look at those.

MR. DAMERELL: Paul Damerell from MPR speaking.

Just to try to clarify what you're pointing out there. The effect that that difference would have would be only related to the amount of water addition which was in excess of the normal loss in level during the one-hour test.

In other words, if he had a total leak rate five gpm over a one-hour test he would have lost 300 gallons. And that would have been over stated by the makeup tank level.

If he would have added 300 gallons and wrote it down as 300 gallons, it would have brought that error on it exactly back to zero.

MR. RUSSELL: I agree.

MR. DAMERELL: So the addition is only the amount of water addition in excess of the normal decline in the makeup tank.

MR. RUSSELL: It would be less significant when the leak rate, toward the end of March, was near five gallons a minute --

MR. DAMERELL: That's right.

MR. RUSSELL: -- than it would have been back in the October timeframe --

MR. DAMERELL: That's right.

MR. RUSSELL: -- on the order of one gallon per minute.

I used an example for illustrative purposes of assuming no leak rate, and I agree that there would be a change.

But in any event you're maximum change for that 80 gallons would be like 1.2 gallons difference, 80 gallons over 60 minutes.

And if you had an actual leak rate of five gallons per minute instead of, say, 1.2 you'd see about one-fifth of that. Something on the order of .2 to .3 gallon per minute change as the result of the 80 gallon recorded --

MR. DAMERELL: I believe if the actual leak rate was five gpm it would come up to zero because the makeup tank would have been brought back to exactly the level it was when the test started and taken care of it -- you don't divide by five, you get rid of it. If you add the amount of water that's equal to the decline in level during the test, then the error goes away completely.

In fact, if you don't add enough water to bring it back to the level he started at at the test you still have the same error working, you know, against you to give you a larger total leak rate your adding water helped to reduce that.

MR. RUSSELL: That would be the case from --

MR. HARRISON: Yeah --

MR. RUSSELL: I have to think about that for a minute.

MR. HARRISON: Yeah, think about that.

MR. KIRKPATRICK: It's a little unfair when you're beginning to make your own calculations, and corrections.

Or are they correct as the drain tank leaking because they did not correct it.

MR. HARRISON: Yeah, that's correct.

MR. KIRKPATRICK: They had to add water.

MR. HARRISON: Do you want to look at a confirmed addition from the -- 11th of February 1978, CRO log says at 1825 he logged that he added 300 gallons.

If you put this -- get this timed on the chart -- I'm sorry, but this particular one is very bad.

MR. KIRKPATRICK: That's no problem.

MR. HARRISON: If you do a chart time, that's over here that obviously isn't right.

You put it in here and you find his addition occurs in here, and you have to conclude that they really did add water in the middle of the test.

MR. COLE: Was that logged or unlogged?

MR. HARRISON: That was logged.

MR. COLE: So you logged it in.

MR. HARRISON: And in your -- just by the different times on the RCIB test, you would say, that particular one has been around a long time. That's a little bit easier to verify that one.

MR. SEVRANSTY: I'm sorry, could you go over that?

MR. HARRISON: Well, in this case you have a situation where the CRO has logged an addition, which by the timing of the inventory balance test should have been in the inventory balance test. He's written down that at 18:25, he put in 300 gallons.

You go to the chart, you find where the test was conducted, find what the makeup tank levels were and it matches and it fits the chart and it appears to be a -- this is not very clear, but it appears to be a relativity sharp addition. There's not a lot of confusion.

MR. SEVRANSTY: So it's just the magnitude of the graph?

MR. HARRISON: Yes.

In fact, that these match up are the facts that you have an independent -- that he says, he did it and he wrote it down -- and he just didn't put it in the calculation.

MR. SEVRANSTY: He didn't put it in the calculation?

MR. CONNOLLY: If he had not made that calculation that the -- when the --

MR. HARRISON: Gee, I think in that case that -- I would -- I tended not do that, let me tell you why in that particular test. That particular test had some other particularities.

In that particular test, the level in the reactor collant drain tank went down. And levels and reactor collant drain tanks should not go down unless somebody made them go down. And for that reason, I think it's probably to go recalculate that test. That's probably not a valid test, for some other reason that we aren't too sure about.

MR. KIRKPATRICK: I think when you see the drain tank going down at the same time you see the makeup tank going up, that probably went directly from the drain tank to the makeup tank.

MR. HARRISON: Can they do that on TMI 2?

MR. KIRKPATRICK: They can on 1, I'm not sure on 2.

MR. HARRISON: I know that's come up before, and I think that TMI 1 there were some instances of that. Now, I'm kind of skeptical of that because it's -- the guy doesn't have much control over the quality and what's in the drain tank. And pumping it back into the system.

If I was an operator, I wouldn't do it. But -- and I don't know how the valve lineup would have to be in order to accomplish that.

MR. COLE: I'm not certain about 2 and how he did that, but I didn't think you could on 2. I'm not positive.

MR. HARRISON: So the wrapup on this one is, yes, it works like he -- he logged it and did it, but the test has some particularities, which I think you have to keep in mind.

MR. RUSSELL: In what count?

MR. HARRISON: On January 13th.

MR. COLE: In the subsequent report that you would rest the issue on whether that is physically possible based upon boundary arrangement, whether it is or is not covered by procedure, except that we do have evidence that there was another heater on.

MR. STIER: We will -- I think that's nothing -- worry about it, I'll look into it.

MR. HARRISON: January 13th, now, if you can remember, January 13th -- from back on what we did on the actual leakage, January 13th, should be a period where it was probably -- the -- inventory balance test should have been giving numbers like 1.

So I'll point that out because it is -- in this test, the control and operators log says that at 10 o'clock that he had 117 gallons. And the test time is 9:37 and 10:37. If you go to the makeup tank level chart, you can place the thing on the chart reasonably well. And that's a -- conceive a small jump, which appears to be the 117 gallons.

I have no reason to disbelieve the operators logging of the event. He just didn't put it into the calculation. So in that case --

MR. COLE: He logged it, but he didn't

include it in the calculation.

MR. HARRISON: So we had to conclude that that was a confirmed addition. That appears to be pretty much as is. I didn't have these in this order.

MR. COLE: This is the 23rd of February, where the operator says, in his log again, he logs -- at 11:35, he logged that he put in 150 gallons. When you get this thing around it fixed in time, it appears to be here, was his actual probable test period.

And you can find, what appears to be addition. My suspicion is, based on this, that this may well have been a feed and bleed operation, where he logged in his addition. But it clearly appears that he did do something in the middle of his test, just the way he logged it.

MR. HARRISON: Just a minute, I've got to find one, they're not in your order. I'm sorry, I do not believe that I have with me the other one that I've been able to confirm, which is February 12th. I thought I did, but I don't seem to have it.

It hours different from the others in that it doesn't appear -- there's nothing appears on the log, it appears so clearly. I'm sorry, I just didn't bring everything that I possibly had. I don't have that particular view graph with me.

But there is another one that we've been able to confirm. Basically, we've been able to confirm these four. The other ones, we've had a variety of problems with, in that basically along the lines of the fluctuations are -- appears to be other places on that trace a fluctuation that appears to be alledged as a variation appears other places.

There's one where there was some confusion as to whether it was on daylight saving time or standard time. There's a number where the plant didn't seem to be in steady state at all.

There's a number -- there is also another period of time in December where there is kind of an unusual situation, December, January. Let me show you, for example. Here is a -- here is a test which appears as an allegation as, gee, there's something wrong because the makeup tank went up instead of down on the course of this test.

And this is because of a particularity in the sytem in that -- in that there's two level transducers. And over this period of time, one of the transducers was not behaving properly. In that one of the transducers goes to the inventory balance test and one of the transducers goes to this makeup chart.

So what you see here is when the operator switched from one instrument to the other. So at this time, his chart was on the good instrument. You can see what the quote "bad instrument" was doing. And you can easily see that being off of this line in that period of time is a -- .

So you can't tell very much about -- this doesn't appear to be -- this appears to be a natural result on being -- being with these inventory balance test on the -- on the other transducer.

Surely you have problems with allegations like this, which are, in this case, the operator did switch his transducer, so that he had it on the good transducer to run the test.

But this trace is now so confused that you can't tell much of anything from the makeup tank chart as to what happened. So you have to -- this is one of the allegation that -- you know, a 100 gallons sometime in this -- I don't know how to deal with that one. I don't believe that could be confirmed from that kind of a chart.

MR. CAPRA: You should also still have the beginning and an ending printouts of what makeup tank level actually was on the computer printout sheet itself.

MR. HARRISON: That's right. That's what --

MR. CAPRA: And then you attempt to try to correlate that --

MR. HARRISON: That's what the dots -- if you look at the dots, in this case, you would say in this terrace here's the good instrument. And those dots match up reasonably well with the slope. It doesn't look like those are out of line with what you would have gotten if you'd have the rest of the thing on here.

So it's pretty hard to conclude anything -- happening in that one. Plus this slope is essentially continuance through this thing, which means that it's unlikely to add any water to it.

That's just a summary of some of the problems in trying to set up -- take any one test and say, did anything add up. Sometimes you can find something and sometimes you can't.

MR. CAPRA: You said, one of the things that you discounted was when strange oscillations or whatever, happened to the makeup tank level during periods which leak ray test was known to have occurred when he looked back a few years ahead of that makeup tank trace or behind that makeup tank trace, ahead or behind in time, similar traces were also evident, you tended to discount those.

At some period, many of these test were run back to back. So it would not seem to me to be strange that you would have similar hooks, bumps and jiggles on that makeup tank level.

If, in fact, the leak ray tests were also being done and water or hydrogen additions were made during this period of time. Just because it doesn't have a hard computer printout that says there was a leak ray test being done during that period of time, I would not discount the leak ray record that you have.

MR. HARRISON: Except the following Bob.

Consider it this way.

These the methods some of the suppose I were to jog in a 100 gallons, into my test. Not put it in the calculation but put it into the makeup tank. I've got a hundred gallons and it's gonna show higher in my makeup tank, and I'm gonna convert it to hot and I'm gonna make you know two GPM change in my unidentified leakage.

But I get in it or not. Now if my unidentifiable actual unidentified leakage is of the order of half a GPM or three-tenths of a GPM , and that's what the average of my variability is coming out with it would seem like I wouldn't need to do that, I wouldn't be running back to back tests that I did this in without getting good tests, which I would have saved.

That's the other side of the argument. I mean these things are so effective. If you start talking putting a hundred gallons in and not recording it, or sixty gallon in, it changes the thing directly by -- more than that amount, why he would do that back to back. Now look at it this way, now here this is right on your question.

Here's an allogation that this is where the tests come in once you time it. Here is an allogation that there is a jogged edition. You do see a little rise in this thing. You go over here and you see a little rise in this one and you also see a little rise in this one. And if you're depending on what you might -- you may include this one you see a little rise in this one.

That's what I see and you can't rule out the fact that the guy was running a test here and here and there, but if he really were putting in that kind of water it would seem to me that he would have gotten a good test, and put it in.

MR. COLE: But Dwight, before the allogation there is a period where there is a good test so why would he run it again. Why would he inject water again?

MR. HARRISON: I can't speculate on why the operator would be --

MR. CAPRA: Well just because the operator got a good test does not mean he waited to start another one. You have many periods where there is back to back tests that have been saved. So why didn't he run another one right away if he just had a good one?

MR. STIER: Good point.

MR. VAN VLIET: On the scope of your review, is your review to look at every allogation? Or is your review to look at every calculation?

MR. HARRISON: We have looked at every calculation in March, and we have looked at all the allogation before that time at this point. If Mr. Stier may ask us to do something else. Or more on that as to date that is what we have done. Because after all a whole lot of people have all gone through and looked at these traces, a number of times.

Faegre and Benson looked at every trace. Your staff members have looked at every trace. Other people and we also have it sometimes we can go back and look at the other ones. But I would hope that most of the questionable ones are out on the table at this juncture.

MR. RUSSELL: Let me ask the question a little bit differently. Mr. Hartman indicated that he was involved and admitted performing some manipulations of leak ray test. And when you looked at the records for those tests which were performed by Mr. Hartman to see if you could corroborate with these policies, his statements which he made concerning his own activities?

MR. HARRISON: We have not investigated any tests on the basis of any particular person being involved in that. Mr. Stier may ask that.

MR. STIER: That's a phase that we are just beginning. We have gone through records and sorted them out and by individual and by shift, and we are going to be requesting further analysis --

MR. RUSSELL: Well it would seem to me that the valid test of your analytical work and some of the explanations that you have made if, in fact, you were to look at these specific cases when Mr. Hartman was on watch for periods when he signed the leak ray test base upon his statements concerning what was being done to get good leak rays.

If your analysis shows that there are no valid tests, or none that you can confirm and yet he has admitted doing these things then that would raise questions about the ability to rule these out based upon the analysis method that you use.

MR. CAPRA: In addition, there are, of course, other individuals who have also claimed the same thing. And let me point out Billy just -- Billy said --

MR. HARRISON: He's going at it from one direction and we are coming at it from the other direction in that this -- but let me say first about job additions before we get to much farther. If there is, I in my opinion no way to tell from the make up tank level chart whether or not somebody jogged water in. If he put it in in increments of the order 20 or 20 gallons is like a half of one of these that a third of one of these. There's no way in my opinion to tell from this one way or the other.

MR. STIER: Let me indicate why it is like this.

MR. HARRISON: There's misconceptions as to why we claiming --

MR. COLE: We weren't looking at the claim we look at that tape here. And you say that is jogged addition.

MR. HARRISON: We can't confirm that it is a jogged addition.

MR. COLE: Just the raw facts --

MR. HARRISON: I am saying that it can't be a jogged addition.

MR. COLE: -- it's 0800 of the morning that I put in X amount of gallons. Hey, we have no way to repute that.

MR. STIER: Let me ask you, let me tell you why I asked them to do this. I asked them to go through this analysis to find out how many they could confirm so that I would know which ones on the basis of their examination I could be sure, more sure than on the basis of any other evidence that I know of.

Those were water additions, I didn't do that for the purpose of excluding any possible water additions. Just because they say they can't confirm doesn't mean that I don't believe it happened during that time or we won't find some evidence that it did in fact happen during a time when they simply can't confirm it on the basis of what they have done.

This process has been one of trying to identify lead information rather than excluding the possibility that something happened during those times.

MR. VAN VLIET: Let me get back to the fundamentals a minute. He mentioned a number of times I think that adding a 100 gallons or 150 gallons would have a major change on your unidentified leakage, but doesn't that really effect total leakage, identified or unidentified? And if a guy has very high identified leakage at that point may not have such a large effect; is that true?

MR. HARRISON: But if he has a high identified leakage he will since the identified leakage is coming from his system he must have a total leakage which is just as high. Right?

So then he pyramids that on top of that he gets more total leakage if he reduces his total leakage by adding water is what he does. He produces total leakage. His identified leakage stays the same because he can't -- the drain tank is still collecting it at the same rate. So we've reduced -- the difference that we took between the -- because the inventory balance test works just like the things we looked at.

The identified leakage is staying the same, you are reducing the total leakage and your unidentified leakage rose down.

MR. VAN VLIET: But doesn't that have

something to do that I guess it is the way you look at it, but doesn't it have something to do with the temperature involved and the temperature correction? Or your tanks? I think where we let off this morning you had no idea of knowing what is going to happen because of the temperature -- is up.

All I am saying is --

MR. COLE: There are two temperature corrections whether they are hot or cold, but it isn't uniformally handle the temperatures of the drain tank, the make up tank, and so depending on exactly which will be or whether you were --

MR. VAN VLIET: What I am saying is I don't think you can give too much weight to the argument that he may not have added it because if he had it would have had a significant effect.

MR. DAMERELL: Paul Damerell, from MPRP, and I think we can make the following statement: If an operator did sneak in on the order of 90 to 100 gallons during the test and did not enter in the calculation he'll get an answer and it's about 2 GPM's lower then if he did not sneak in 90 to 100 gallons during the test. Regardless of how much identified leakage or other things that occurred during the test that has -- of those other things that occurred during the test.

If he successfully -- if he did that or if he did not do that, that causes a difference in 2 GPM's regardless of identified leakage that we can make that statement.

MR. RUSSELL: How much variability did you see in the calculated result in all the tests that were run? What was the normal distribution of test results?

MR. STIER: Of the ones that were recorded?

MR. RUSSELL: The ones that were reported plus any others. They were throwing alot away. Two various individuals have testified to various numbers but a swing of one to two GPM, at least in my recollection that was not very unusual during this period of time. And such that somebody wants to hedge his bet putting in 60 gallons might give him one, 120 gallons might give him two, depending upon what the last one was that he ran, if it was a relatively large number and he wanted to throw this out.

Your behavior is very much subject of what you saw and what you perceived as compared to this more precise calculation of what was happening.

And that is why I said I didn't want to

focus so much on what the actual leak rate was doing in the plant but what were the operators seeing and what may have been their motivations based upon what they saw?

MR. COLE: But don't you believe the fact that an operator knowing this there must be something wrong with this test the way it is raised up and down. I look and we don't have any leakage in the sump if he did that.

And I have no leakage in the other plant. My credibility on the test, mentally I would, you know, I don't know what I would believe about the test. So it swings me all over the place because of some of these other facts and the temperature corrections are not, -- so you can't get major swings without having major leaks. That's the thing that is very frustrating.

MR. RUSSELL: I don't disagree with that but that's not the principle issue of concern.

MR. COLE: I understand that.

MR. DAMERELL: Just answer.

MR. COLE: However he got there the accuracy of what he tells us of what went on is much more significant than how he got there.

MR. DAMERELL: Just answer your point, Bill, as if -- speaking. I think you are right in the sense that maybe there could be some tests in that distribution where a guy snuck in 90 gallons or a 100 gallons and we could not disprove that on the basis of the analysis. We can just confirm specific allogations. We can't disprove that somebody would stand up and say that on some of these cases.

But I think the point was the statement was somehow made to try to key this to identify leakage and to somehow say that no, this thing isn't very effective at times. And I think we all need the statement that this is a very effective way if a guy would have done this to perfect the test. And indeed he would have expect the leak ray to come way down if a person could have done this.

But you know I think we wanted to link that statement.

MR. KIRKPATRICK: Well also to get back to this variation. You -- fluctuations here show where temperatures 30 to 60 pressures 18 to 36 and pressurize the level 20 to 40. You ought to be expected a variation of over a gallon a minute, wouldn't you?

MR. HARRISON: I'm not sure on this basis you would have expected that much. These are -- that would assume that the that these were not properly compensated for in the test and the test does compensate for the movement.

MR. DAMERELL: The purpose of the procedure is to account for changes in his inventory due to changes in pressurizer level, due to changes in temperature and things like that. But I think it wasn't perfect but the purpose of running the RCIB test and the way it was run in having those equations -- there, that measured temperature and measured pressurizer level was to account for those changes that occurred during the test.

MR. HARRISON: Yeah, we have looked at what the TMI 2 inventory balanced test accuracy would be. We've done considerable work in that area. We think it was pertinent to this discussion. But, Paul, you might tell them to what sort of -- we would have expected this one hour test on about a two signal basis, we thought. It would be like seven tenths of a GPM, plus --.

MR. KIRKPATRICK: Before we get away from this I would like to comment on one thing. You mentioned that the it sounds like right here assuming that the data was taken simaltaneously because you say that you know you doubt that a fluctuation. You are aware that the data was taken over a time period that is small -- a time period large compared to a fluctuation or of the order of magnitude of the fluctuation.

In other words, the data wasn't taken simaltaneously?

MR. DAMERELL: Yeah, we looked at that and also we have been able to come up with some estimates of the inaccuracy of the results of procedure due to that particular effect. And their -- they add -- they look at -- you can slice it in several different ways.

You can look at contributions to the accuracy of the test due to instrument errors and look at contributions to inaccuracy of the test due to method errors in the test, like they didn't account for pressure, for example.

Then you can look at contributions due to uncertainly due to this effect of oscillations which came into play because the measurements were not taken precisely at the same time and on kind of a ballpark kind of field on the instrument errors you get an number on the order of, I think it's .7 GPMs on the two single basis. In terms of the method errors you get a number if you exclude the temperature compensations which were systamatic and not random.

If you get a number that's on the order of 1 GPM or so and on the oscillation effect I believe you got a number which is smaller than the instrument errors -- half GPM and .4 GPM's. So those get all combined together in some -- way to give you a total error which is in excess of one or two GPM's.

MR. HARRISON: You should be careful when we say error you mean, variability from the true value.

Is there anything more that we want to discuss about the water additions? Have I given you some feeling for our concerns with the allegations and what how we looked at them and told you what ones we think that we can confirm as having occurred as far as water additions?

Let's talk about hydrogen. Mr. Capra?

MR. CAPRA: I may be wrong in going back and looking through the data, but I certainly thought there were more than four logged water additions during periods of leak ray tests that were not included in the computer caculations.

MR. HARRISON: No, our review has to bear witness on this log. There was some things for the log's were incorrect and when you go to the charts you conclude that the guy put into his log that he added water 18:30 and he really added it at 17:30 because when you go place it on the chart it doesn't -- it doesn't play, it doesn't -- see if I can find that particular one.

MR. CAPRA: I think that gets back to one of my other questions that I asked orginally. Will, in fact, your report have your best estimate, best estimate of strip time chart versus real time, for the entire period evaluated?

MR. HARRISON: You would have had to have done that to begin with in order to evaluate these.

MR. CAPRA: In an effect, yes it will.

MR. DAMERELL: Damerell, from MPR speaking.

It may not be in a form where you can compare it against the table if you tabulated that. Because we have done that for each individual analysis but we haven't pulled that off as a separate issue on this day it was the chart time error and on this day it was a chart time error.

MR. RUSSELL: Could we have done something like that where you could compare each --

MR. DAMERELL: We have included it in our analyses.

MR. HARRISON: Could you clarify something for the record because I am getting the impression that there was some substantial variability on the chart, but it is not clear whether on a given chart where there is not an action taken such as putting ink in the pen or some other way of manipulating the chart. If that chart runs continuous for 8 or 9 days once you establish chart time that time should be consistent throughout that period unless something happens.

The computer also prints out in time. So unless there is something wrong with the charts speed mechanism or there is some other explainable failure, why are we going back and rebracketing around tests and re-validating bases on particular test rather than excepting the chart time once it is validate and going from there.

MR. HARRISON: Well let me, -- for some periods of time that works but they did apparently have trouble with the -- We can find some places where we can see chart runs where they turned the paper, we can also see where some places where it appears the paper drive was getting sick, so you can do that as a first guess but then you gotta go in and be pretty sure because they throw you one every now and then.

And every once in awhile they'll even -- they'll tell you that they did that and sometimes they won't tell you that they did that. Sometimes the pen will run out of ink and will start up again and you got to be careful when that happens.

By and large you are right. It is fairly consistent over some period of time. But we found that you don't want to bet on that. You want to look at each one and do as good a job that you can.

Because it does tend to change.

MR. CAPRA: But periods where your not talking about minutes and errors you are talking about hours and hours and errors.

MR. HARRISON: There was one time when they had a.m. and p.m. mixed up and they were 12 hours off, for some period of time. It is very confusing to try and work with that particular period.

Alot of there -- quite a bit of time they were 4 and 6 hours off. And you say why would the operators put up with that and the operator didn't -- he probably could hardly see this time down there on this thing, and he just wants to see what it is right now. So it is not too surprising you might take kind of a -- you might not even notice it for a period of time that it was off.

This is a particular example, one of the things that you mentioned, for example, a CRO log says that at 18:30 he added 200 gallons of water and 18:30 would be just before the end of this test. Well, you get this chart time, then you can find this addition and you look at this and say 18:30, he must have really been at 17:30, he must have been over here. He must have written it down an hour off.

Because otherwise it doesn't make any sense. And you look at the log and you find, sure enough, there isn't an entry before this before 17:30 and it looks like he just read the clock wrong and wrote it down wrong. So that basis even though the log says that he added water and it should have been in here, he looked at the strip chart and you say, if he had added 200 gallons in this thing just before the end, this thing would have been over here and this level would have had to have been up.

I couldn't confirm that addition for that reason. It looked like a logging error.

MR. HARRISON: Does that clarify? That's why the numbers match up. I think there's some other ones. I know that one in particular. But those who with -- we looked at the ones where the -- there's one of daylight saving time there.

Where -- where -- if I can find it here. Where the computer was still printing out -- all these were printing out times. Here, CRO log says very clearly that at 0211 I had 330 gallons. The test was run here from 0132 to 21 -- that would be ten minutes before the end of the test.

You would've added water. You go to the strip chart and you find that they change from daylight saving -- standard to daylight time. And that the computer was still running on old time.

And the guy was logging in new time. So, in fact, when the computer said he was on -- well, from the computer time's standpoint, the CRO put the water in evidently at 3:11 and not 2:11, it was outside the end of the test.

So, even though the log say he had water during the test, this peculiar clue -- and the guy moved his chart back too. And he wrote on it daylight saving to eastern standard time.

That's kind of fluky thing, but I think everyone's got to be -- you got to work at everyone and not just take what the log says That's why I think some of those other numbers came up.

Because of that -- for the reason. You got to not just take what the log says. You got to go look and see whether that really happened.

MR. RUSSELL: So, how many total tests did you review in detail to end up with your four that were confirmed?

MR. HARRISON: Well, we certainly reviewed 55. And we reviewed any of those in March that were not a subject of allegation. I would guess probably 75 to 80 tests had been -- we have made these -- made these particular kinds of comparisons.

And tried to place the thing on the chart and see what was -- see what was happening. That's probably 40 percent, I would guess, of the test, with around 160, 170 tests.

MR. CAPRA: Was the -- an appendix to the reporter included in your report?

MR. HARRISON: On the results of those would be.

MR. CAPRA: No.

I mean the actual strip charts that you used. The things that you've just shown today for each of those tests.

MR. COLE: You're saying you would like for each -- each one we looked at, put the strip charts of our analysis in. You're asking --

MR. CAPRA: No.

I'm asking you if we had not planned to put those --

MR. HARRISON: We had --

MR. COLE: We had --

MR. HARRISON: Because of the tremendous volume involved.

MR. COLE: We may make that an appendix or something.

MR. STIER: It's -- it's unclear to me, at this point, what I'm going to need for our report or at the beginning stages of the investigation.

As a matter of fact, there are going to be periods of time that I'm going to ask them to go back and look at strip charts again.

If they've looked at them before and if they haven't looked at them before, and I'm going to ask them specifically to look at certain -- certain test periods when -- from other evidence I believe that there's some reason to question whether there was any up at the manipulate tests during that period.

So, we suggest the first pass through by -- by MPR. And some difficult, from my perspective at this point, to tell you what I'm going to ask to be included in the forms would depend on -- on what we turn up in the investigation.

MR. RUSSELL: Let me identify a difficulty we had in reviewing the last report as related to the generic coating you would use for disregarding some test.

A strip chart with an engineer's notation on it in handwriting is to one, he rejected that. If you identify the test time under with the points before and after -- a picture being worth a 1,000 words is much better than saying, couldn't confirm through independent means and using that as a basis for disregarding a half of dozen tests.

MR. COLE: You have referred the -- somewhere. We may have the written words, saying we disregarded test C. Figured -- compressed to C --

MR. RUSSELL: If you use the technique as you have shown today --

MR. COLE: This technique that we have used --

MR. RUSSELL: That raw data being available when -- for each test that you say that you have looked at --

MR. COLE: Right.

MR. RUSSELL: -- and projected, you have this kind of a figure.

MR. COLE: Yes, we have.

MR. RUSSELL: That information, which would collaborate the strip time you use against the logs of the charts, et cetera. It's all in one place. That can be audited, we can agree or disagree on what the fact are, based upon that.

I would have some degree of difficulty reviewing the statements that say we could collaborate this by independent means. Therefore we don't think it happened.

MR. COLE: You've got to understand, we went to each one of these charts. And we put that section of the chart under the microscope as so as you speak.

MR. CAPRA: Well, that does what Bill was saying. That we believe if --

MR. COLE: It would be helpful that it would show more credence and more --

MR. RUSSELL: Because some of the predicted problems. For instance, I can understand the rationality if someone explains it, but the time was off or the addition was made afterward and this is the only place that this particular set of circumstances fit. And this is the rational way it happened. When you see that you see the picture that is much clearer than when you simply say the times were wrong.

And you know -- there's nothing to either agree or disagree on because words can be used to portray different pictures.

MR. COLE: Our words were really based on what we had pulled off those charts. I think Dwight Harrison and -- hadn't lost its hindsight.

MR. HARRISON: I have.

MR. CAPRA: I think we've been this enough. That we know without -- without the hard evidence, certain reasonable men disagree on these things.

MR. STIER: We'll keep that in mind when we prepare this.

MR. HARRISON: Let's a --

MR. RUSSELL: The other thing that I would suggest is some type of an effort to try and validate the analysis method with respect to statements which have been made by operators.

Our operators have publicly admitted their activities associated with manipulation. If you're unable to discover any cases of that with this methodology, then either the operators that were doing it understood the records that would be left behind and were smart enough to make small additions, jot things in, whatever. Or there's some flaw in the analysis methodology that we're using. And we're not able to reproduce it.

MR. COLE: Well, there's another possibility.

MR. RUSSELL: Or a combination of both --

MR. COLE: The guy who thought it like him, hydrogen addition would have an affect, but if the loop seal problem wasn't really accurate for that day -- the makeup tank, hydrogen wouldn't affect it.

So it can be a very random -- more random things. So you may thought he was cheating or doing something, where in fact he really wasn't. As we've looked at some of these things and we kept looking for that.

MR. KIRKPATRICK: But a 100 gallons -- you're the one that pointed out a 100 gallons is awful hard to stay on that chart. When you consider the fact that that things gone up to about five inches all the time, and a 100 gallon is maybe three inches.

MR. HARRISON: Particularly if you were to put it in. And a few steps -- there's enough of it just simply will not describe.

MR. COLE: And I assume you all will have oral discussions with the people to find out if they ever did such, but if they said he had put it in by the normal method. Now, putting in a 100 gallons all at one clip -- I think he would see that.

Maybe not at one time, but over a period of time if you don't work a lot of it, it should be showing.

MR. HARRISON: It should show up at slope offset, is what should really happen. You ought -- you ought to be able to see --

MR. KIRKPATRICK: If something else isn't going on as you've pointed out --

MR. HARRISON: Yeah.

But when something else is going on it can be very -

MR. KIRKPATRICK: You can't get out of that pressurizer level staying constant. You can't cast aside the fact that the temperature didn't change during that time. So they allowed a slope level change in that makeup tank that accounted for by other reasons other than this water leaked out.

MR. COLE: Well, I think you're also defining why you went back to the sump to find out what the actual leakage was.

MR. CAPRA: You also mentioned the switch in the level transmitter. And you happened to show a period where one of the level transmitters oscillated significantly.

For other periods in time, I believe, where one level transmitter read higher than the other transmitter, they didn't necessarily always read the same. Would you evaluate periods were the level transmitter made -- may have been fed to the -- transmitted input for the computer was base^d on the lower one at the beginning of the test and th_ middle of the test, shifted to the higher one during the latter half of the test?

MR. HARRISON: We have looked for it and something like that. We had not been able to find any places where there was an obvious shift in the test in these where there was a large oscillation.

In that case, the large oscillation is up at around a different level on -- than the other unit. And we did -- have very carefully gone over all the strip charts where that was a problem.

And we have been unable to find any place where the operator didn't took that action. Where he basically started out on the -- started out on the low one and ended up on a high on.

MR. VAN VLIET: Is -- the strip chart recorder is independent though of the computer, is it not?

MR. HARRISON: It's taking the other -- it's taking one level instrument and the computer is getting the other one. And the operator has a separate switch from one way to change a selector switch -- one that he had going to his strip chart record goes to the computer, and vice versa.

That's why you get this jump we saw on the thing. Those do, many cases, line up with a -- in the inventory balance test. I mean, they -- there are time when they don't, but they do line up with an inventory, the one hour ones many times do.

MR. CAPRA: In fact that there are -- they feed one piece of computer and one feeds the makeup tank, if you look makeup tank level you would actually see opposite effect, it looked like you went from a higher level to a lower level.

MR. HARRISON: I think the outstanding feature is the big oscillation on the bad transducer which makes -- chart reading very difficult, it probably makes the test result itself and certainly adds to variability of what the guy got out of the inventory balance test because of the number of tests where you can find that he didn't shift and these points would be strange locations.

MR. VANVLIET: Are we ready to move on to -- conditions?

MR. HARRISON: I think we've taken enough about hydrogen and the makeup and that we are aware of how -- I don't have to berate how somebody might affect the makeup level indication by changing pressure in the makeup tank, adds pressure to the makeup -- adds hydrogen to the makeup tank it appears that he could in fact even raise the indicated level.

Now in the case of -- there are -- Benson went through and searched the logs and came up with about 10 tests which they are logged hydrogen conditions and we have gone through those tests in some detail and of those tests we have found two which appear to have a very, you know, confirmable effect, not -- I assume that when a guy has added -- a log that he has added hydrogen, he really did, so there is no question of confirming if he had hydrogen or not, I can't.

But in this case for example, this is one of 15th of February which appears to have a -- you can't read it on this particular copy but someone has written on the chart "pressurized makeup tank" at this particular time and there is a definite offset and a slope between here, between this side and this side of the chart and he has evidently pressurized it enough to change the level. We have to say that our confirmed hydrogen addition and the interesting thing about that, is that if you remember in the TMI 1 there was one we mentioned one confirmed where again where the operator wrote "added hydrogen." He had a very similar offset in the slope changing the pressure in the tank so I felt pretty comfortable that that one, you know, occurred just as indicated, there was no reason to disbelieve that I should take another one.

MR. RUSSELL: Do you know from the log how much hydrogen was added to get that kind of an offset?

MR. HARRISON: There are a few times when they get a pressure that they want to, some places they say added some number of pounds but the problem is that some of those don't seem to give any -- don't seem to have any consistent effect on what happened. This is on the 17th of February. This one is not so -- not so obvious but does appear the test occurred here to here, it does appear that there is a reasonably offset in slope at that particular time and that is about two inches and that's getting down to about one's ability that they see anything, you get around to about two inches. Besides, I've completed the tests, that's a confirmed hydrogen condition addition in my lexicon of which there was some affect.

Now let's look at 2-14, in this case the AO log says, -- Benson says that the AO log says they added hydrogen at 2130 in this thing and to fix to move the time over 2130, the computer says this time was over 2136 so the -- this addition could well be in there. In this case I can't find it -- I can't -- I have very difficulty concluding that as a hydrogen addition compared to the rest of the trace was and I say that there probably isn't a hydrogen addition in there but it doesn't seem to be any effect on that hydrogen addition.

MR. RUSSELL: Unless you take and you draw the curve of, say, an hour after the test, deleted the the test and find that you do have an offset during the period the time you tested, it does appear to be a change in slope.

MR. HARRISON: There is a, consistently, in all these traces, there is a peculiarity which I suspect has something to do with the makeup tank -- these traces tend to do this a little bit and what offset would you put on this, Bill?

MR. RUSSELL: An inch, a inch and a half.

MR. HARRISON: That's the dilemma, at some point it becomes impossible in my estimation to discriminate what -- could be an affect.

MR. KIRKPATRICK: I think the peculiarity you're talking about is that the -- is resuming its original position when it -- above.

MR. HARRISON: Plus also you're fractional change in volume as you increase the volume in the tank becomes less per inch as you get the thing bigger. You would expect, theoretically at least, expect the trace not to be linear, that's one of the things wrong with the linear thing.

MR. KIRKPATRICK: -- you're saying that the area is not level, it's not constantly tight?

MR. HARRISON: No that the volume you are expanding -- as the tank gets more and more volume by changing the level an inch, it expands, it changes the pressure in the tank less so just a little bit of pre-volume in the tank and I change the level an inch and it makes a lot of difference in the pressure --

MR. KIRKPATRICK: I don't suppose you are a part of the --

MR. HARRISON: -- so you would expect some kind of nonlinearity in that. I guess if one did a doctoral thesis on this you might be well be able to figure that out.

MR. KIRKPATRICK: I'm not sure the NRC wants to -- it.

MR. CAPRA: I take it from what you just said, you would not put that in -- classify it as an confirmed hydrogen addition even though it was during the period of the pre-trial logged in the log.

MR. HARRISON: It's only my terminology. I would call it confirmed hydrogen addition. For one, it appeared it had not significant thing, it wasn't an effective hydrogen addition.

MR. COLE: That's what I was talking about when a guy says, yeah, I knew it was effective but when you go look and see it and affected it we can't find where it really affected the place there --

MR. HARRISON: Here's another --

MR. CAPRA: Operators were also well aware that the fact was not necessarily consistent with, well, I don't know.

MR. COLE: It's a --

MR. RUSSELL: There's quite a bit of testimony both ways and in sometimes it would help you and sometimes it wouldn't. The fact that the hydrogen was not consistent based upon --

MR. COLE: I guess the more we see the more we would say that the evidence would also indicate that.

MR. RUSSELL: -- testimony taken to by one case --

MR. HARRISON: Bill, here's another one where yeah that might be -- that might be very embryo of a hydrogen affect but you look at the rest of the trace around it and you see lots of motions which are the same -- are as the same order as this but -- and it makes it, I'd have to say I can't say it's not a hydrogen addition but on the other hand it certainly was particularly effective.

MR. KIRKPATRICK: Is that a lot of water addition?

MR. HARRISON: Right here?

MR. KIRKPATRICK: The first and second break.

MR. HARRISON: Yeah, okay, I see it right there and this was the hydrogen addition.

MR. STIER: The question is what that --

MR. KIRKPATRICK: That answer would be 200 gallons. Is that entered in your calculations?

MR. HARRISON: Yes. That one was apparently not too far off except this trace is distorted in here of whether there is -- sometimes these things get rounded off at the tops rather peculiarly and it makes it difficult to -- we try to consistently stem these things and use the vertical distance because it's trying to get --

MR. COLE: He actually made the line --

MR. HARRISON: -- it seemed two variable.

Sometimes each would bend over and try to get mostly what the offset was from the addition to try to -- because there seemed to be some things that were not --

MR. RUSSELL: Did you look at the instrument response characteristic to see if there was significant damping in the instrument based upon -- or some kind of delay that would be a smoother function for a big -- valve. Because that gives the characteristic of damp response right there --

MR. HARRISON: This one doesn't.

MR. RUSSELL: I don't know whether there is any characteristic in that particular instance..

MR. DAMERELL: Yes, you didn't particularly look at that but these times they look extremely sharp on this strip but it is really several minutes. And your typical instrument usually can respond in a fraction of a second and electronically they may be only damp to like on the order of a second -- something like that. So although we didn't look at it, you know, a typical instrument of the --

MR. RUSSELL: Unless you've got some mechanical binding in the instrument.

MR. DAMERELL: Yes, usually that doesn't affect the response time though, that they give you a sticktion type effect where it will stick some place where it shouldn't be.

MR. HARRISON: So far the ones that have been pointed out and are logged, I can get two that have a significant affect. They seem to affect -- out of the roughly ten that you confirmed -- of the ten that you confirmed from the logs probably happened.

Now, five of those occurred back in the time period -- of course, you will remember back to our curve of the ratio of indicated occurred back before February, back in the time period when there wasn't -- where the amount of the ratio was about one where there wasn't too much air, which is what you would expect.

I, in addition, wouldn't admit it particularly effective in doing anything when the effect on the makeup tank level was not high.

Do you remember the curve that we had of the ratios and how it tended to be around 1.3 or so in a period from about February to March but in the period before January along in October -- late October, November, December, January, it was wandering right around one and that would be apparently a time when they wouldn't be expected. As a matter of fact, I found no indication in those that I can attribute to hydrogen --

MR. COLE: But that's why there are only two of those; right?

MR. HARRISON: There are only two of those. Let me say as far as unlogged hydrogen additions, I quite frankly -- I don't think you can -- you might find some, like that four-inch one, that you'd be willing to say, "I really think that that could well be a hydrogen addition".

Short of that, trying to find a small hydrogen addition and discriminate it from, say, a water addition or just a change in pressurizer levels as far as that goes. I just don't think it is possible to do that.

MR. CAPRA: When you were doing these analyses did you try to look at other plant variables to see what their effect was on makeup tank levels? For example, ships being ICS'd from modern to manual, keeping pressurizers spray in auto versus manual to help you try to screen out some of the significant makeup tank characteristics from other --

MR. HARRISON: I have not tried the auto to manual tank. Dr. Chung has mentioned that to me previously. He thought that there tended to be some correlation with that. I have not done that.

We have, of course, looked at some of these from the standpoint of what kind of -- both of these in-water additions. One of the things that I have indicated in the methodology. We'll look at the end of the current balance test and you look at the beginning and ending conditions in that if you find, for example, a pressurizer's level changed a large amount in the course of the test you try to make at least some compensation that was in the same direction that the makeup tank level had to go, which is a reasonable thing.

It is conceivable that you could try to go -- we did not try to go to pressurizer level charts per se and try to match them up with the tension for the times not being -- getting chart times to match up. We felt that that was probably not practical. It could conceivably could be if it was important enough on any one test but to try to do very many that way is probably very, very difficult, to make sure that your pressurizer chart and your makeup tank chart are, in fact, on the same time. Because the pressurizer doesn't have any very good indicators. On the makeup time charts you can get it time pretty well because you've got the logged additions that you can work with.

In a pressurizer you've got to find some other things to work with on it. The pressurizer charts that I've seen are not very good scale and they run pretty much the same for long, long periods.

I've looked at a few of them and I'm not sure it's practical.

MR. CAPRA: Yes, the reason I had asked you is just to see if you would look at other things in order to help understand what some of the traces were on makeup tank levels so I can understand some of those strange things that go on.

MR. COLE: These traces, from the traces I've seen at other plants, traces like these makeup tank --

MR. CAPRA: To tell you the truth, I don't think I've ever studied another makeup tank level in another plant.

MR. COLE: I don't think anybody has studied makeup tank levels on other plants, do they excite you?

MR. HARRISON: These look a lot like TMI-1's, I know that.

MR. CAPRA: Yes, well, you know, outside of TMI-1s --

MR. COLE: I think all of them, they go through -- it is the bumps and grinds of those indications are not typical of that. I have not seen one that's nice and flat and straight but maybe there is one.

MR. HARRISON: Is there anything -- that's all I've really got to say on hydrogen additions. Is there anything else that we could add to our discussion that's --. We appreciate your suggestions on what's needed in the final report.

MR. CONNOLLY: Did your analysis determine if any unrecorded hydrogen additions were made during that test?

MR. HARRISON: We, as I said, I found no unrecorded hydrogen additions that things like confirmed or unconfirmed hydrogen just -- principally because the ones -- even the ones we know about are so tenuous and so small, it's probably indistinct, that I just don't think that it is possible to find an unlogged hydrogen addition without any ambiguity.

There is just too many flat spots -- the ones that we knew about have a fairly distinctive character in this case. There are lots of places on lots of traces that have that flattening and it is hard to believe that all of those are hydrogen additions or which ones are and which aren't.

MR. CONNOLLY: If we would not be able to differentiate the particular signature for a hydrogen addition then it's --

MR. HARRISON: I don't think -- in this case, that the ones that we know about seem to be a simple offset of the slope -- some kind of a -- something related to how -- presumably to how fast he added the hydrogen to the system.

In the addition of hydrogen, there are a number of things that we don't know. We don't know whether he always added the same amount, he always added it at the same rate, did he have some rules that he used? We don't know whether it was a consistent-type operation anyway, whether we're looking for that system -- trace of that substance.

I think it is very humble idea that people are going to get to it.

MR. COLE: We've looked at an awful lot of traces and we haven't been able to say, that's the hydrogen addition, that's the one.

MR. RUSSELL: Of the 75 or so traces you have looked at, have those traces all been laid out on the standpoint of correct chart find versus point identified at the makeup tank level from the computer sheets from the beginning of the test to the end of the test are a fraction of more than what we've seen today?

MR. HARRISON: Yes.

MR. RUSSELL: And that's 75 -- that's approximately half?

MR. COLE: That's in order of magnitude.

MR. RUSSELL: All of the tests were done during a time the plant was operated.

You say that in looking at those half and that half, particular in the later timeframe of February and March, you did not see any traces where there were distinct offsets in --

MR. COLE: You should say, you know, hey, we're merely putting in the time. We could stand up just off that.

That date alone we could not.

MR. CAPRA: That also excludes that fairly large body, though, that we talked about earlier of logged water additions in which a logged amount and the amount in the -- we can give you in the -- in the computer printout -- was not looked at in detail.

MR. DAMERELL: I think we've dutifully recorded that in another sequence. It is something else.

MR. STIER: That's a good point.

MR. RUSSELL: One other comment -- things were -- slow approach. We went through a lot of analysis this morning that identified what you felt was the best estimate, the actual leak rate in the facility during the period of time.

MR. COLE: By that method.

MR. RUSSELL: By that method.

By other methods you took a least squares strip and you said, "This is what we think has happened". Based upon all of the evidence that you can generate in your best answer.

If you plotted that leak rate that is associated with your best estimate of what we was really happening -- on the curves for the leak rate tests during the period of time in which you have data or have you just eyeballed it in each case to see if it was straight. Because if you plot your best estimate of what that slope is and you find out that the slope tails off and the slope is substantially different from that that may be an indication to you that something was being done during that test that maybe needs to be explored.

In other words, if yours sloped during the period of time that says you have an identified or a total leak rate of five gallons per minute, that happens to be during a period of time when you know that the actual -- or your best estimate leak rate was posted six gallons a minute, you would wonder what was going on. There may be a flattening of the curve. You're marked one eyeball drawing a straight line is not the line that you just characterized based upon all of this other analysis that was done.

How much deviation do you see between the slope and draw and what you've calculated to be the case to remember -- recognizing yours may be a five or seven day average to refer to the 72 hour average.

MR. HARRISON: We have not done that specific thing. One of the things that we have done, though, -- as I mentioned, is that we have always looked at the slopes before and after and during the test right at that time period to see whether the slope given in the inventory balance test, whether it was reasonable or unreasonable. If it appears that it was unreasonable why is there --

MR. RUSSELL: If we go back to the chart you put on earlier this morning, over a period of time of a few days, based upon how you've interpreted the data, you see quite a significant difference in your leak rate.

So did you use the technique of a least squares fit to try and identify what you thought was your best estimate of total leak rate leakage into the drain tank than what I thought identified leakage was.

MR. HARRISON: We had a --

MR. RUSSELL: During this particular test -- that would give you information as to what you think the makeup tank level should be doing, what kind of a slope should it have?

It's off that calculation, a rejection hypothesis --

MR. HARRISON: We can do that but I believe that it is better to take the slopes before and after and compare them because they are much closer to the time of what you are doing.

MR. RUSSELL: I think they are just as quick.

MR. HARRISON: We can certainly do the other but I believe that in comparison with the general timeframe that you are in, which is equivalent, as a matter of fact, it is an equivalent tank as far as the slope is concerned.

MR. STIER: I take it that you are talking about looking for an affect on -- within a period of the test itself.

MR. RUSSELL: Considering what the slope is during that period compared to what you felt the best estimate of what the actual leakage was at that time.

MR. COLE: I think he is gong back to the individual slopes --

MR. RUSSELL: You're right.

MR. COLE: What -- of the individual slopes. How is that compared to what the RCIB tests.

MR. RUSSELL: That's correct.

MR. STIER: What happened during that test period.

MR. RUSSELL: You've taken the time to calculate and then you smooth it all out by taking the least squares curve --. You calculated all of this data but then you smoothed it out and then you sort of didn't use it again.

All I am saying is, now that you've got all of that data calculated, if you compare those calculations from other methods to the slope that you then feel is appropriate, how does that compare to a numerical analysis, how does it benchmark against what you were seeing from drain rate into the -- the rate into the drain tank versus other indicators. Is all this data consistent when you look at it on a small segment of time as compared to when you were averaging it over four or five days.

MR. RUSSELL: Because NRC is the best I know of right now. We did not use a smoothing technique. We tended to concentrate on all the data that was available at that timeframe, the kinds of things the operator would have been seeing. What is the rate of stuff going into the drain tank which you now have calculated? What is the rate of water addition? All the other techniques we discussed, if it's on a much more compressed timeframe. Particularly, from the time of one ship or a day as he may recall what his experience was on his previous ship. And whether there aren't sufficient pertivations in the system over a two week period of time and yet in some cases you have data averaged over that two week period.

MR. STIER: Well, I've -- I had the same --

Excuse me, Norman.

I had the same question. The purpose of this analysis over the entire period of operation was to try to give us large chunks of time, period in which problems were likely to have occurred in administering leak ray tests. Among things that I have asked MPR to do during those specific period -- and I think we have identified ten of them -- is go back and not average out the results during those periods. I was concerned about the same thing.

And so we're going to be focusing in much greater depth on smaller periods of time and hopefully come up with the kind of thing we are asking about.

I agree with you there's a danger in averaging too much because you're talking about what a guy was looking at at the time you had finished with the test not what the situation was over an extended period of time.

MR. COLE: What do you hope to get from that just to make sure I understand where you're headed on that. What are you trying to get out of it?

MR. RUSSELL: For example, if the slope that you see on the strip chart --

MR. COLE: Right.

MR. RUSSELL: -- appears to be different even though it is the best estimate of what you can draw.

Let's say the slo e is indicating a makeup rate of 3 gallons a minute, based upon other information, do you believe that that slope at that time for your total leakage should have been 4 gallons a minute based upon the rate of water going other places and other analysis over that period of time?

All it says is that the slope was possibly changed somehow during that period of time.

MR. COLE: Take a cut at and see what -- flush this out.

MR. RUSSELL: It may very well be that the other data is consistent with the slope that you're seeing and if the lines you've drawn are consistent.

But because those curves do have the appearance of some non-linearity because there is an awful lot of noise on them from the standpoint of oscillations about whatever the mien value of the slope is, then there's a construction technique on a piece of graph paper.

If you can bench mark the accuracy of that slope, with the other data which based upon this morning's presentation looks like you've already calculated it all, you calculated the slopes.

My question is how close does the calculated data compare to the lines that were drawn by the engineer on the --

MR. VAN VLIET: Are there any other questions?

MR. RUSSELL: Do you have a feel for what your estimated schedule is for completing --

MR. STIER: If I had one I'd be wrong.

I'm always wrong in making these estimates. We anticipate beginning our interviews within the next week. How long it takes depends on the degree of cooperation we get and other variables.

We expect to interview, perhaps, as many as 80 people. And I would think that the interview process including memorializing statements in sworn question and answer form would take a couple of months to complete. After that we'll have to prepare our report.

Now, of course, during the same period that we're conducting interviews, we're doing further document analysis. And the -- will be doing strip analysis for us. We may have other consultants doing other analytical work, depends on what we come up with during the interview process.

MR. RUSSELL: Do you have an estimation as to schedule completion date for this phase -- analysis from the standpoint of when the report can be available documenting information that's been presented today? Would that be held, for instance, until the end of your interviews to incorporating subsequent analysis or is there a report based on what's completed now and then a supplement addressing additional analysis later or you haven't decided?

MR. STIER: They'll be preparing a preliminary report up to --

MR. COLE: It will not have such things as we discussed today.

MR. STIER: Right, we didn't intend to include all the details that you --

MR. COLE: -- we have had today, we were hoping to begin something like this this month.

MR. STIER: Right.

MR. COLE: And what we've done --

MR. RUSSELL: Let me make sure that another ground rule is understood.

MR. COLE: Let me ask you if you've got a report before I get through. We haven't crossed the bridge of putting in everyone of those charts, those charts like you asked -- why you --

MR. RUSSELL: I understand that. But I'm not -- we haven't decided yet on the scope of the staff review, your technical analysis or even your investigation. There are different ways of approaching it.

If our independent conclusions are similar to yours, we may do it in a fashion similar to what was done on your evaluation of TMI 1 -- That is, you compare the end conclusions. If they appear to be consistent, then you don't have a need to go into some of the details.

So, some of the questions that I was asking were questions about the analysis technique you used. I don't intend those questions or any of the questions from the staff to be direction to you as to how you want to do your technical work. Because we have not yet decided upon how we would proceed in our own review.

It may very well be that we will decide to do our own work independent of yours. From that standpoint, I think today's meeting was useful to an understanding of what you've done and where your analysis results are similar to ours or in some cases are different from what's been done already.

So, I certainly would not treat this in a context of a typical meeting with the staff on a submittal that you're going to be making and say these are the things we're going to be modifying the report. This is your own technical --

MR. COLE: Right.

MR. RUSSELL: -- evaluation to support your investigation which is independent. And the purpose of the meeting as as a dialogue.

MR. COLE: We've been trying to tell you

what we have done. The report will reflect basically that. We're not trying to just answer your questions.

MR. STIER: Questions raised, I think, have been very helpful in assisting me in making my judgments about what I will want from MPR and what I ought to include in the report, have been very helpful.

MR. RUSSELL: I think the other perception is that it's more probable that there will be differences in the conclusions in this case than the outcome on the TMI 1 case where the conclusions were fairly consistent.

In this case we also have other evidence which we may not be able to develop by way of technical analysis from the part of statements by operators that they did, in fact, manipulate these tests so --

MR. COLE: Bill, there's one thing you weren't here when we went through. And it really would have been -- well, unfortunate, is how we got to where we are, terminology is and some of the inconsistencies that we run through.

It's in your TMI 1 -- except that it's not new there. That chart and how we -- the basis for the temperatures and we showed the terminology. Because, in fact, just as we've pointed out, that the inventory balance test came a -- well it called it unidentified leakage. It was, in fact, for your regs unidentified leakage plus intersystem leakage. There are some subtleties like that.

MR. CAPRA: But that's not new information.

MR. COLE: Read it somewhere.

MR. CAPRA: I don't think -- what I'm trying to say is, I don't think Bill missed anything by that because I think he is well aware of that rationale also.

MR. VAN VLIET: And you will be providing us with a set of your view graphs?

MR. HARRISON: Yes.

I do have one request but I guess I would like to address it to you, Jack, and maybe you can follow up with Ernie Blake to find out where it is. It is documentation which may have been prepared by NRC staff members in support of the Justice Department as a part of endictment subsequent preparation for trial, that that document which you've received as a result of discovery be identified and that arrangements have been made to place that on the docket by serving it on the parties so that their questions about what the staff can address or not address based upon the court orders with respect to release of grand jury materials are able to be separated.

That is, we've got an order from the court that says, participate, give out the stuff for discovery and we can use that as a basis for what subject matters can or cannot be discussed. That would make it probably the most straight forward mechanism and it would also provide the information to the parties that are not here at this time.

MR. STIER: Well, in all likelihood I have control over whatever material that is. I'll make sure that you get it, right away.

MR. RUSSELL: If there are no other questions I thank you for coming in.

MR. STIER: Thank you very much.

(Whereupon, at 3:03 p.m., the hearing was concluded.)

CERTIFICATE OF PROCEEDINGS:

This is to certify that the attached proceedings,

IN THE MATTER OF:

TMI-2 LEAKAGE RATE MEETING

DATE: 20 SEPTEMBER 1984

PLACE: 7920 NORFOLK AVENUE, BETHESDA, MD

were held as herein appears and that this is the original transcript for the file of the Commission.

REPORTER: JOHN E. CRASS

SIGNED: John Cross

TRANSCRIBER: Neal R. Gross

SIGNED: Neal R Gross

OUTLINE OF TMI-2 LEAKAGE RATE MEETING
SEPTEMBER 20, 1984

I. <u>INTRODUCTION</u>

A. DEFINITION OF TERMS, TERMINOLOGY

- o LEAKAGE TERMS
- o RCS SYSTEM

B. HOW VARIOUS LEAKAGE WAS TO BE DETERMINED PER REG. GUIDES

C. REVIEW OF HISTORY OF LEAKAGE REQUIREMENT

- o TEMPERATURE FOR UNIDENTIFIED LEAKAGE

II. SPECIFIC ISSUES

A. TMI-2 RCIB TEST

B. ACTUAL LEAKAGE AT TMI-2

1. RATE OF COLLECTION IN RB SUMP

   (A) MPR METHOD

   - o ALARM PRINTER
   - o SUMP PUMP DOWN AND VOLUME

   (B) ALTERNATE SUMP EVALUATIONS

2. ALTERNATE METHODS

   (A) SLOPE METHOD USED BY MPR

   - o COMPARISON TO NRC SLOPE METHOD

   (B) WATER ADDITION METHOD USED BY MPR

   - o COMPARISON TO NRC SLOPE METHOD

   (C) DETERMINATION OF IDENTIFIED LEAKAGE

   - o COMPARISON TO NRC METHOD

   (D) COMPARISON OF RESULTS OF ALTERNATE METHODS TO RB SUMP RESULTS

3. REVIEW OF PERIODS OF POTENTIALLY HIGHER THAN NORMAL UNIDENTIFIED LEAKAGE

C. OTHER RELATED ISSUES

1. MAKEUP TANK LEVEL INSTRUMENTATION PROBLEM

III. <u>ALLEGATIONS OF WATER AND HYDROGEN ADDITIONS</u>

- o SOURCES OF ALLEGATIONS
- o OCTOBER 18, 1978 (AS AN ILLUSTRATION OF SOME OF TECHNICAL CONSIDERATIONS IN EVALUATING ALLEGATIONS)

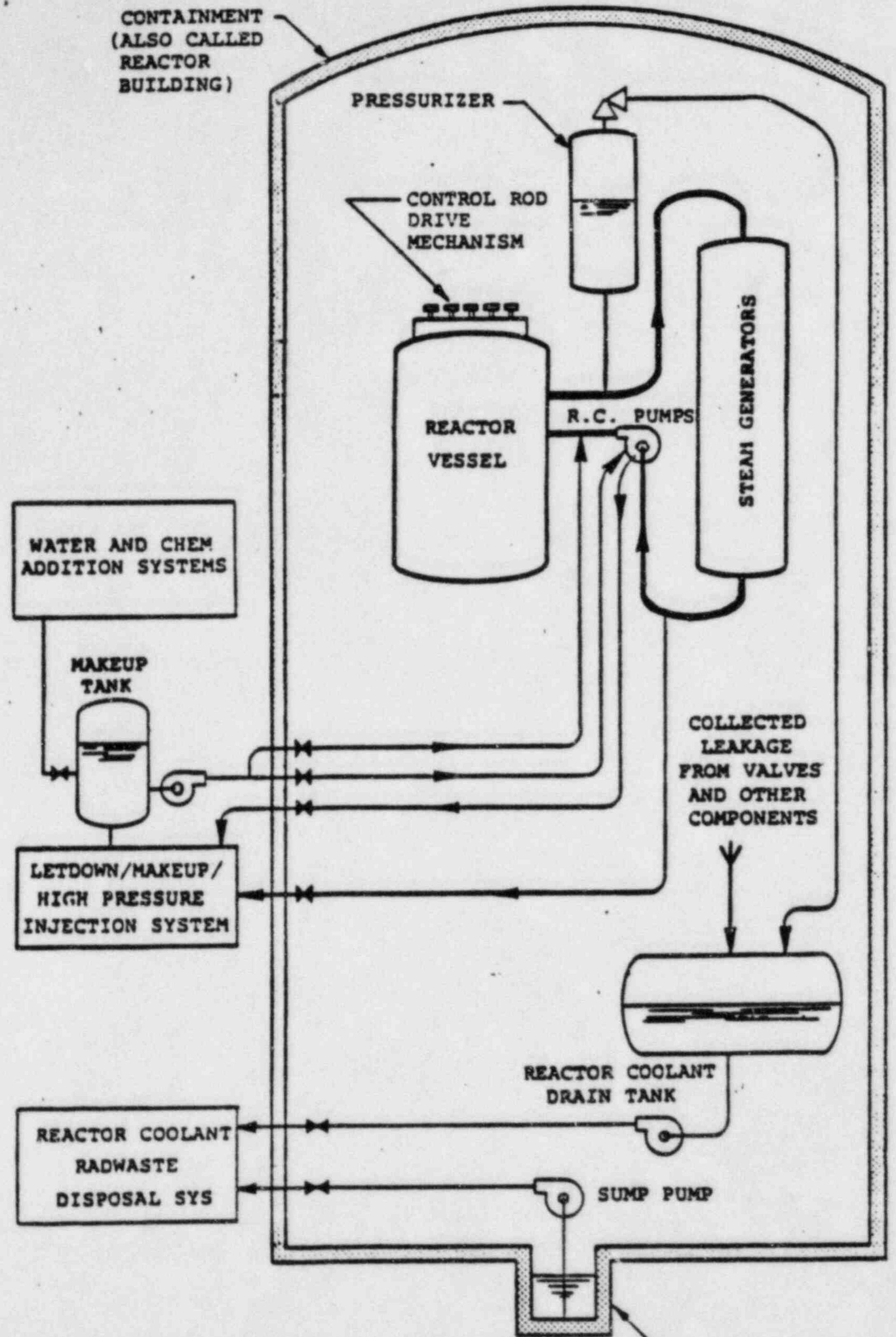
A. WATER ADDITIONS

B. HYDROGEN ADDITIONS

IV. <u>SUMMARY</u>

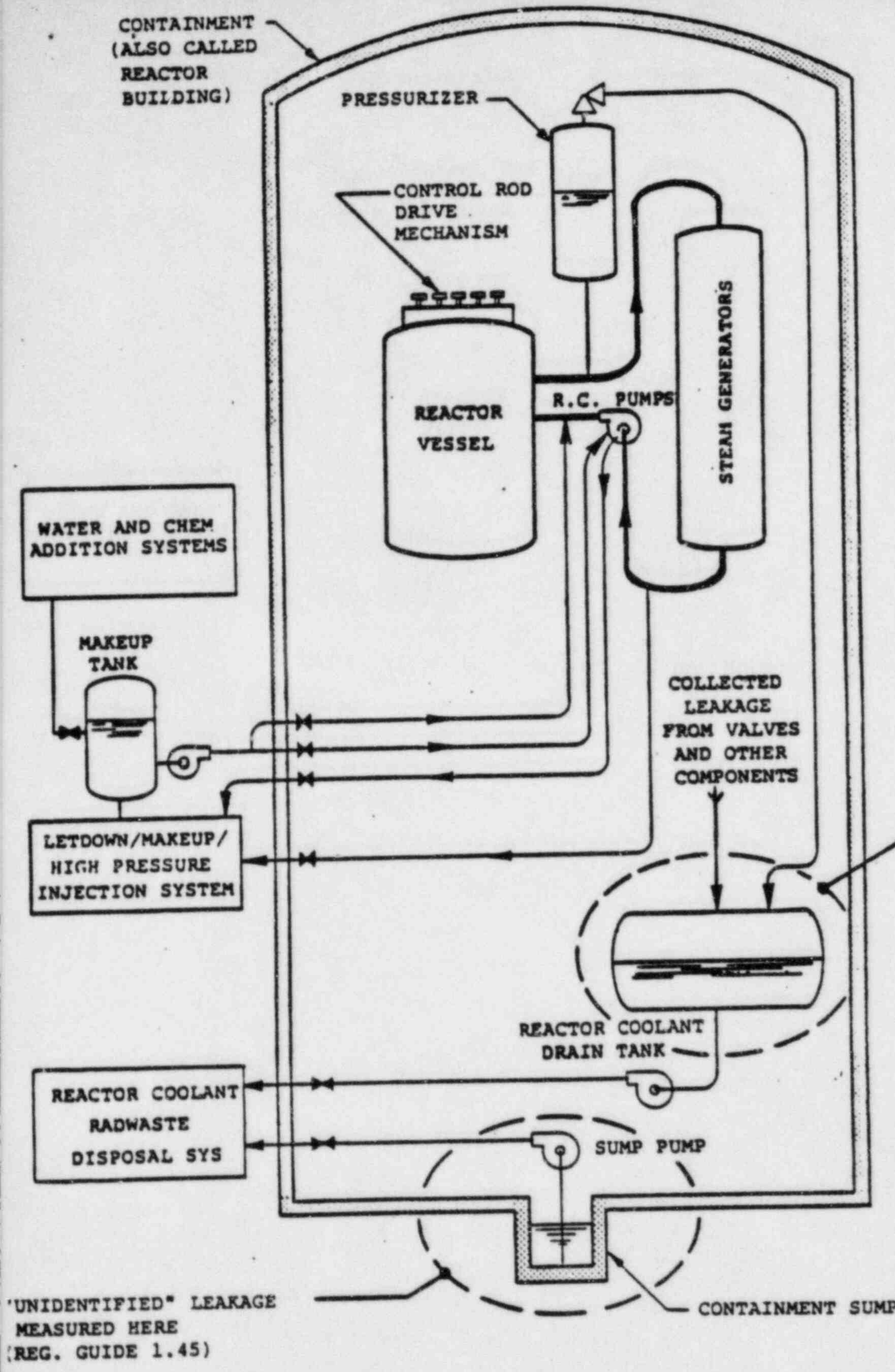
TOTAL LEAKAGE = IDENTIFIED RCS LEAKAGE + UNIDENTIFIED RCS LEAKAGE + INTERSYSTEM LEAKAGE FROM RCS

*RCS - REACTOR COOLANT SYSTEM



SIMPLIFIED REACTOR COOLANT SYSTEM

MPR ASSOCIATES
F-80-87-1
2-10-84



SIMPLIFIED REACTOR COOLANT SYSTEM WHERE VARIOUS TYPES OF LEAKAGE IS MEASURED

MPR ASSOCIATES
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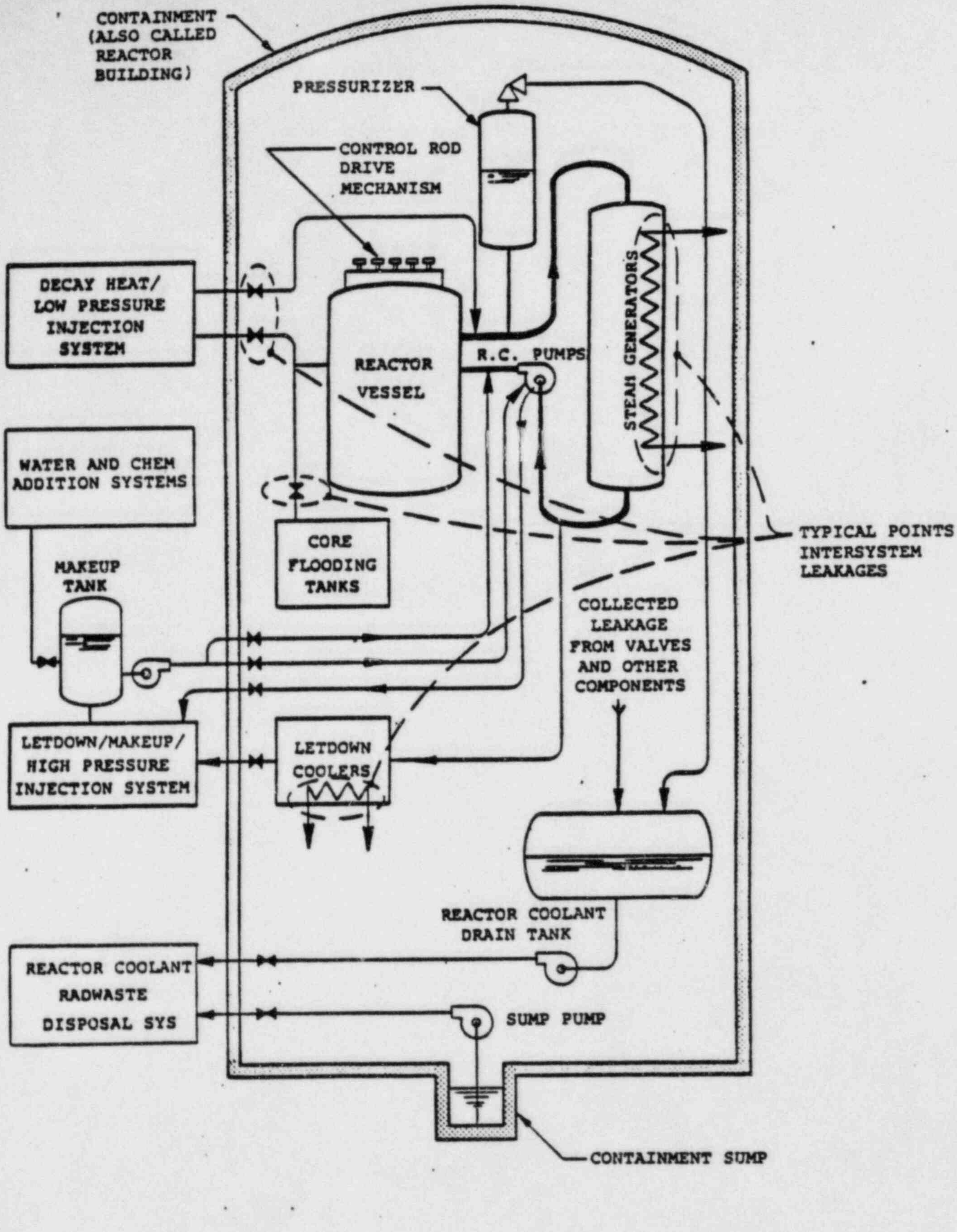
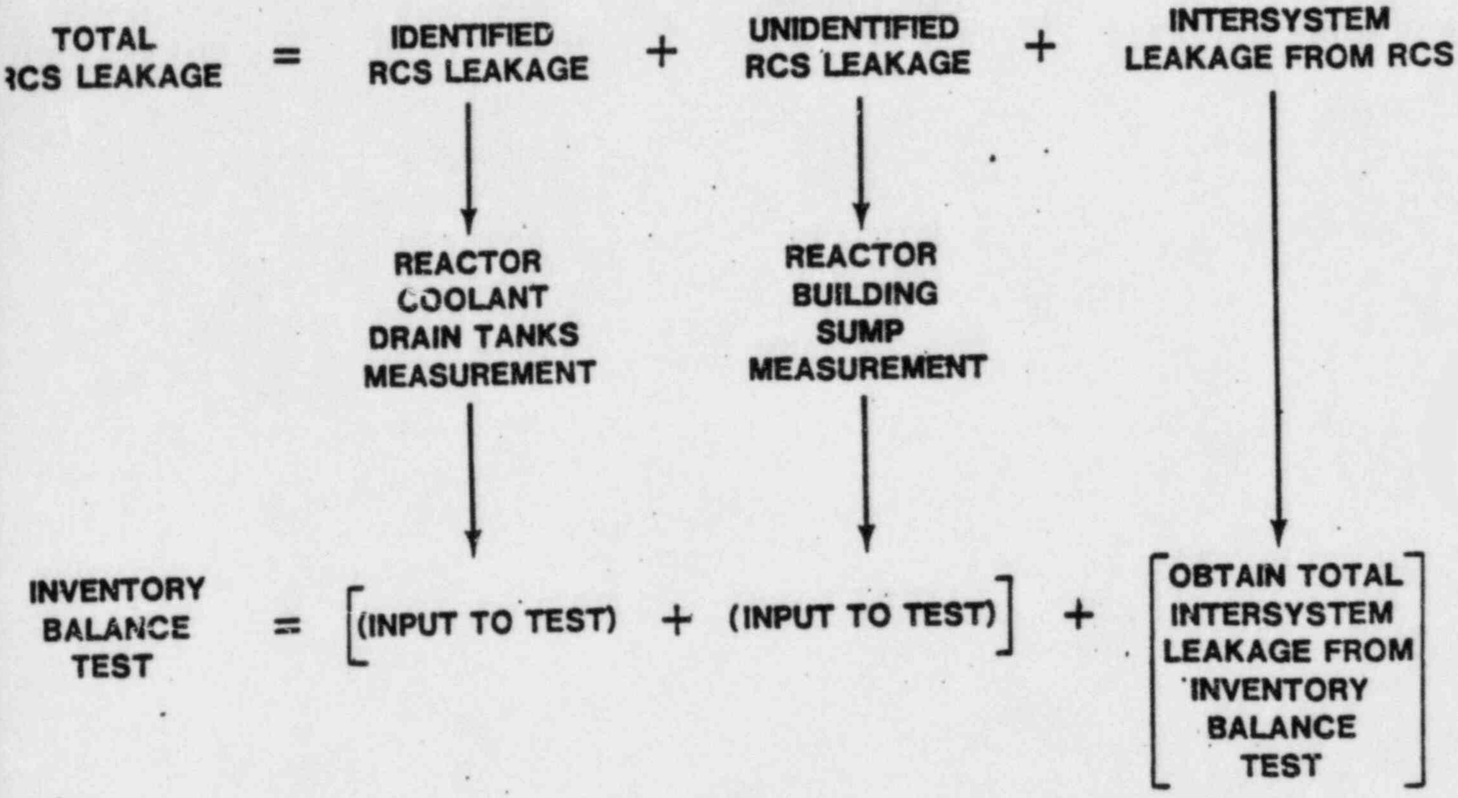
2-10-84



SIMPLIFIED REACTOR COOLANT SYSTEM SHOWING TYPICAL POINTS OF INTERSYSTEM LEAKAGE

MPR ASSOCIATES
F-80-87-3
2-10-84



TOTAL
RCS LEAKAGE
=
IDENTIFIED
RCS LEAKAGE
+
UNIDENTIFIED
RCS LEAKAGE
+
INTERSYSTEM
LEAKAGE FROM RCS
REACTOR
COOLANT
DRAIN TANKS
MEASUREMENT
REACTOR
BUILDING
SUMP
MEASUREMENT
INVENTORY
BALANCE
TEST
=
(INPUT TO TEST)
+
(INPUT TO TEST)
+
OBTAIN TOTAL
INTERSYSTEM
LEAKAGE FROM
INVENTORY
BALANCE
TEST

TOTAL RCS LEAKAGE = IDENTIFIED RCS LEAKAGE + UNIDENTIFIED RCS LEAKAGE + INTERSYSTEM LEAKAGE FROM RCS

IDENTIFIED RCS LEAKAGE → REACTOR COOLANT DRAIN TANKS MEASUREMENT → (INPUT TO TEST)

UNIDENTIFIED RCS LEAKAGE → REACTOR BUILDING SUMP MEASUREMENT → (INPUT TO TEST)

INTERSYSTEM LEAKAGE FROM RCS → OBTAIN TOTAL INTERSYSTEM LEAKAGE FROM INVENTORY BALANCE TEST

RC INVENTORY BALANCE TEST = [(INPUT TO TEST) + (INPUT TO TEST)] + [OBTAIN TOTAL INTERSYSTEM LEAKAGE FROM INVENTORY BALANCE TEST]

BASIC REQUIREMENTS TO CHANGE <u>LEAK CLASSIFICATION</u> FROM "UNIDENTIFIED" TO "IDENTIFIED":

- SOURCE SPECIFICALLY LOCATED AND THE RATE QUANTIFIED
- SOURCE KNOWN NOT TO BE FROM A FLAW IN RCPB

TEMPERATURE FOR EVALUATING UNIDENTIFIED LEAK RATE

BACKGROUND

- AS DESCRIBED REG GUIDE 1.45 AS WELL AS NRC STANDARD REVIEW PLAN (NUREG-75/087, 11/24/75), THE GPM LIMIT ON "UNIDENTIFIED" LEAKGAGE IS BASED REACTOR BUILDING SUMP COLLECTION

- REACTOR BUILDING SUMP COLLECTIONS ARE NECESSARILY AT NORMAL ATMOSPHERIC CONDITIONS

  Detector Sensitivity ... Therefore, an early warning signal is necessary to permit proper evaluation of all unidentified leakage.

  Industry practice has shown that water flow rate changes of from 0.5 to 1.0 gpm can readily be detected in containment sumps by monitoring changes in sump water level, in flow rate, or in the operating frequency of pumps. Sumps and tanks used to collect unidentified leakage and air cooler condensate should be instrumented to alarm for increases of from 0.5 to 1.0 gpm in the normal flow rates. This sensitivity would provide an acceptable performance for detecting increases in unidentified liquid leakage by this method.

- INTERESTING TO NOTE INSTRUMENT SOCIETY OF AMERICA, ISA-567.03 OF 1982, "STANDARD FOR LIGHT WATER REACTOR PRESSUE BOUNDARY LEAK DETECTION" WHICH NRC PARTICIPATED IN PREPARATION, STATES THAT LEAKAGE RATE IS "EXPRESSED IN VOLUMENTRIC UNITS PER UNIT OF TIME AT 20°C AND ONE ATMOSPHERIC PRESSURE" (I.E., ROOM TEMPERATURE CONDITIONS).

CONCLUSION

IN VIEW OF THE ABOVE, THESE EVALUATIONS OF "UNIDENTIFIED LEAK RATE" ARE BASED ON ROOM TEMPERATURE CONDITIONS.

CRITICAL CRACK SIZE AND 1 GPM UNIDENTIFIED LEAKAGE
FSAR SECTION 5.2.7.4

Crack ocation	Critical Crack Size	UNIDENTIFIED LEAKAGE			
		1 gpm - Hot (557°F) in FSAR		1 gpm - Cold per Nu Reg	
		Crack Size	% of Critical Crack Size	Crack Size	% of Critical Crack Size
old Leg Piping	8.7" long	1.5"	17%	1.69"	19%
eactor Vessel	10.9" long	1.625"	15%	1.83"	17%

NOTES

egardless of whether 1 gpm Unidentified Leak Rate is Hot or Cold, the overall onclusions regarding the 1 gpm limit for Unidentified Leakage with respect to the ritical Crack Size, remains unaffected (e.g., plenty of margin between 1 gpm crack ize and critical crack size).

age 5.2-16: In establishing a maximum unidentified leakage, the following criteria re considered:

. The magnitude of the leakage should be well below the leakage associated with a crack of critical size.

. The magnitude should be well within the capability of the normal makeup system.

. The magnitude should be sufficiently large to allow for ease of detection within a reasonable period of time.

. Offsite releases should be within 10 CFR 20 limits.

ccordingly, a 1 gpm leak was selected as the maximum allowable unidentified leakage ate. This value is well below the leakage associated with a crack of critical ize. It can be detected within a reasonable period of time as discussed reviously. It is believed that continued operation at this level for some period f time to allow for corrective action will not jeopardize plant safety nor will xternal releases exceed 10 CFR 20 limits. Details concerning continued operation t this level are discussed extensively in Technical Specification 3.1.6.

RCIB/TEMPERATURE

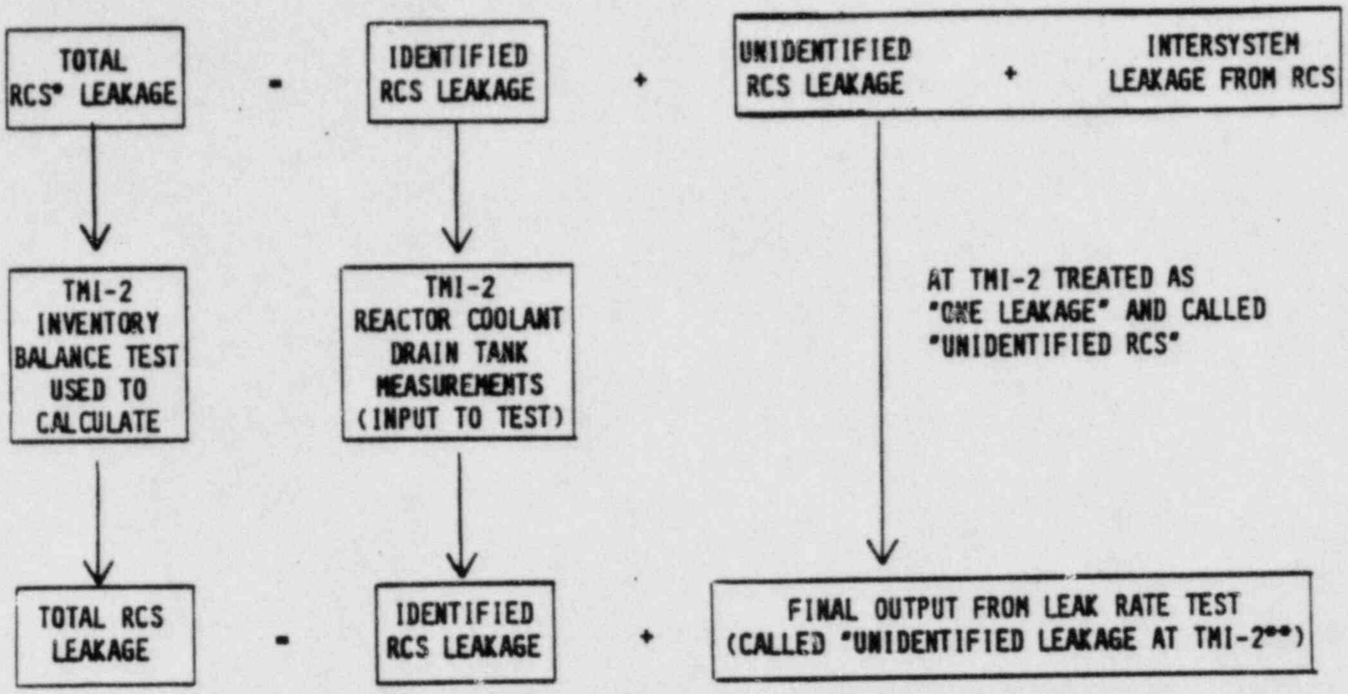
NRC LETTER REPORT (DeYOUNG TO DIRCKS) OF NOVEMBER 7, 1983 COVERS NRC'S REVIEW OF RCS LEAK RATE TEST PROCEDURES AT DAVIS-BESSE ET AL. THE NRC REPORTS INDICATE THAT THE NRC CONCLUDES THAT DAVIS-BESSE RCS LEAK RATE TEST PROCEDURES AND CALCULATIONAL METHOD USED IN 1978 WERE SUFFICIENTLY COMPREHENSIVE AND ACCURATE TO DETERMINE THE LEAK RATES TO WITHIN THE APPLICABLE LIMITS.

SPECIAL NOTES

1. DAVIS-BESSE USED ~ ROOM TEMPERATURE FOR THE 1 GPM UNIDENTIFIED LEAKAGE LIMIT (E.G., 8.25 LB/GAL) IN RCIB TEST.

2. DAVIS-BESSE FSAR HAS SAME CRITICAL CRACK SIZE ANALYSIS AS TMI-2.

3. DAVIS-BESSE'S RCIB TEST PROCEDURE BASICALLY OK'D BY NRC, IN SUBJECT REPORT.



* RCS - REACTOR COOLANT SYSTEM

** "UNIDENTIFIED LEAKAGE" USED BY TMI-2 WAS, IN FACT, UNIDENTIFIED LEAKAGE PLUS INTERSYSTEM LEAKAGE.

TMI-2 RCIB TEST

A. A NUMBER OF TECHNICAL ERRORS

- MAJORITY OF ERRORS - SMALL EFFECT ON RESULTS IN MOST ACTUAL CASES

B. ONE MAJOR ERROR - NOT CORRECTED TO COMMON TEMPERATURES

1. WHEN NO WATER ADDITIONS WERE MADE TO MAKEUP TANKS AND WHEN COLLECTION RATE IN RCDT WAS LOW - ERRORS HAD LITTLE EFFECT.

2. WHEN RCDT COLLECTION WAS HIGH COMPARED TO THE AMOUNT OF MAKEUP TANK WATER ADDITIONS, THEN THERE WAS A SIGNIFICANT EFFECT (I.E., IT WOULD OVERSTATE UNIDENTIFIED LEAKAGE).

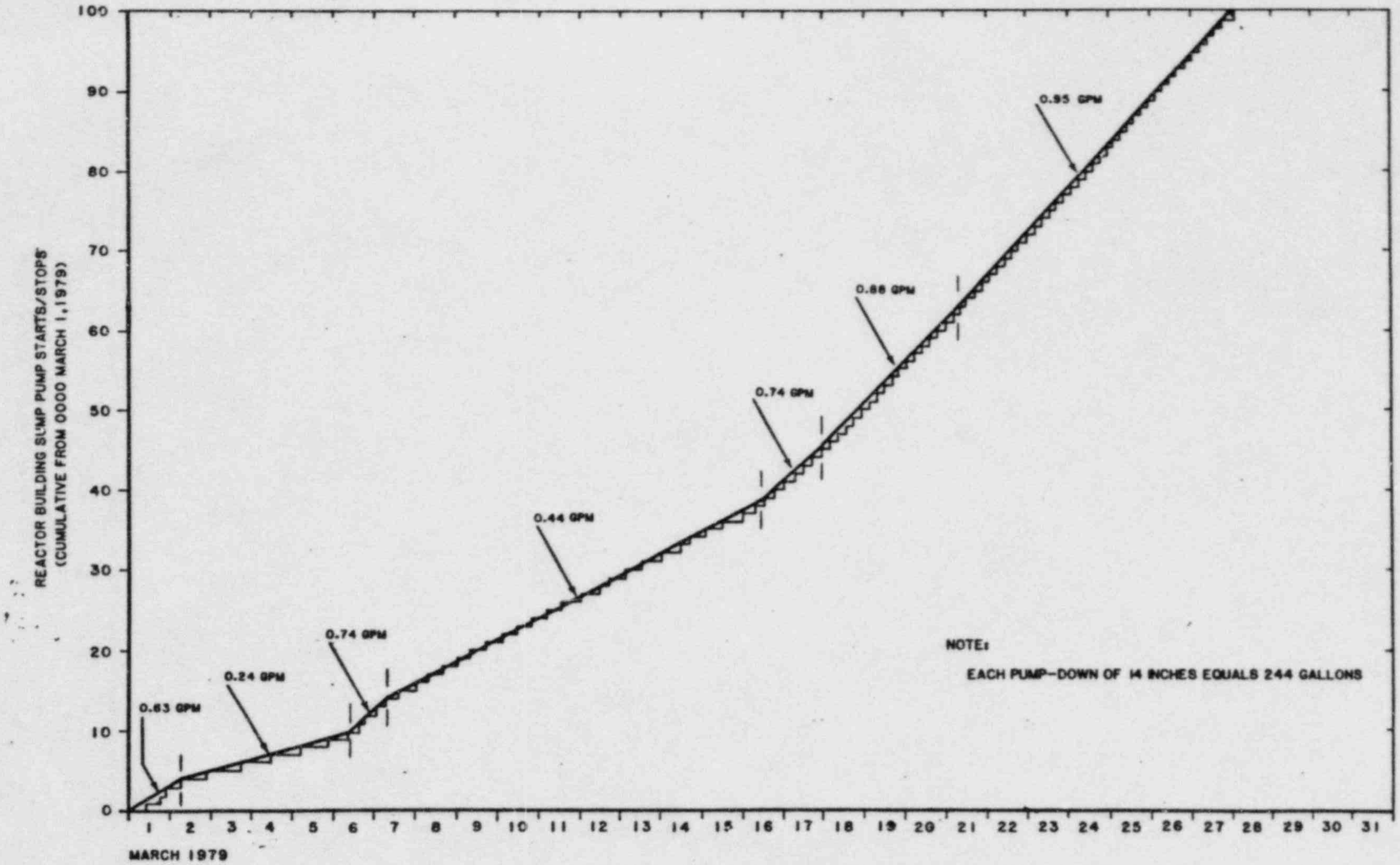
3. WHEN RCDT COLLECTION WAS LOW COMPARED TO THE AMOUNT OF MAKEUP TANK WATER ADDITIONS, THEN THERE WAS A SIGNIFICANT EFFECT (I.E., IT WOULD UNDER-STATE UNIDENTIFIED LEAKAGE).

4. WHEN BOTH RCDT COLLECTION AND THE AMOUNT OF MAKEUP TANK WATER ADDITIONS WERE COMPARABLE, THEN THE EFFECT WAS SMALL.

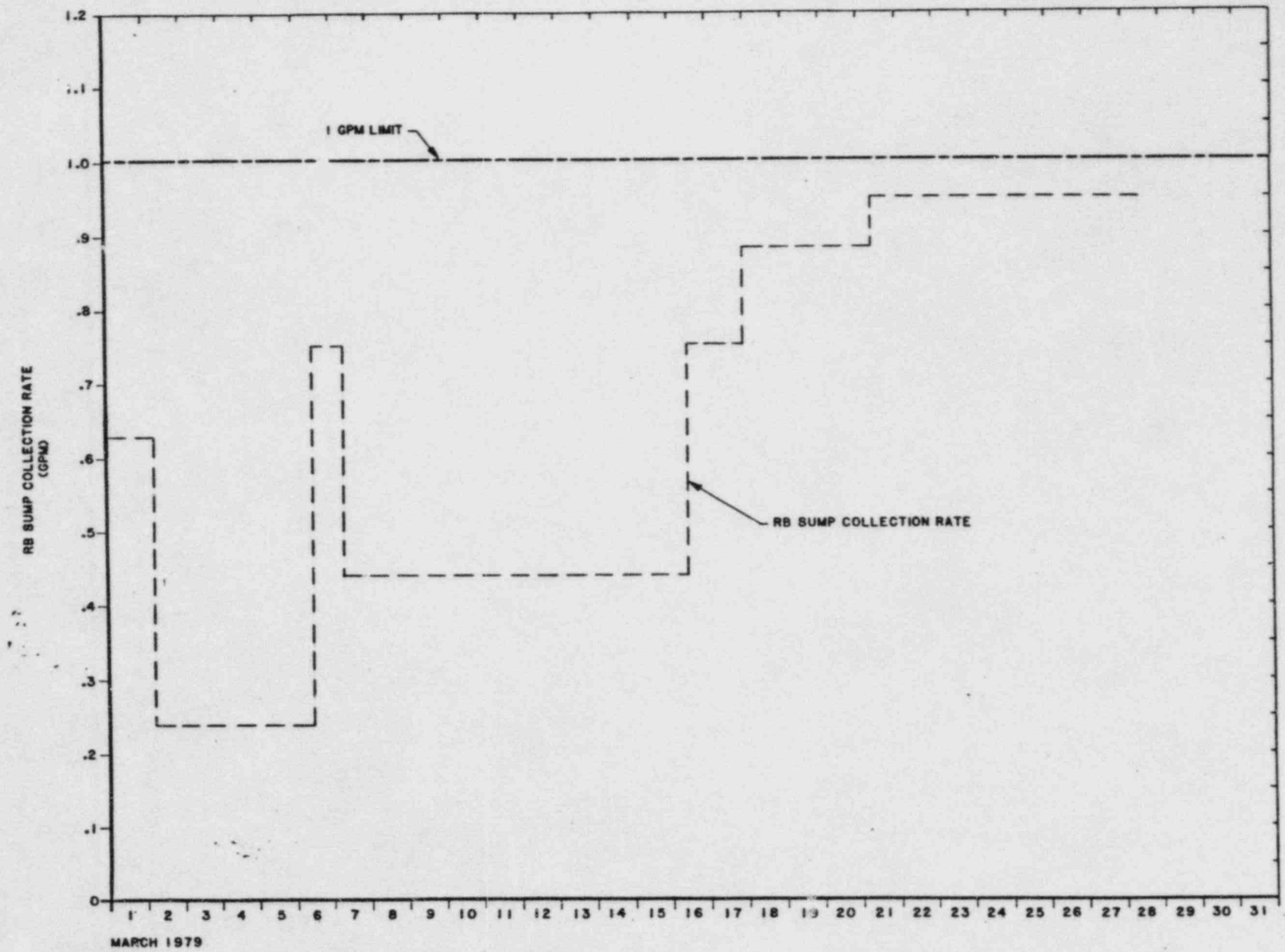
5. CONSEQUENTLY, THE TEMPERATURE EFFECT WAS QUITE DIFFERENT FROM TEST TO TEST - LARGE VARIABILITY IN TEST RESULTS.

C. MAJOR PROBLEM - MAKEUP TANK LEVEL INSTRUMENTATION

D. UNIDENTIFIED LEAKAGE LIMIT OF 1 GPM WAS BASED ON HOT RATHER THAN COLD CONDITIONS.

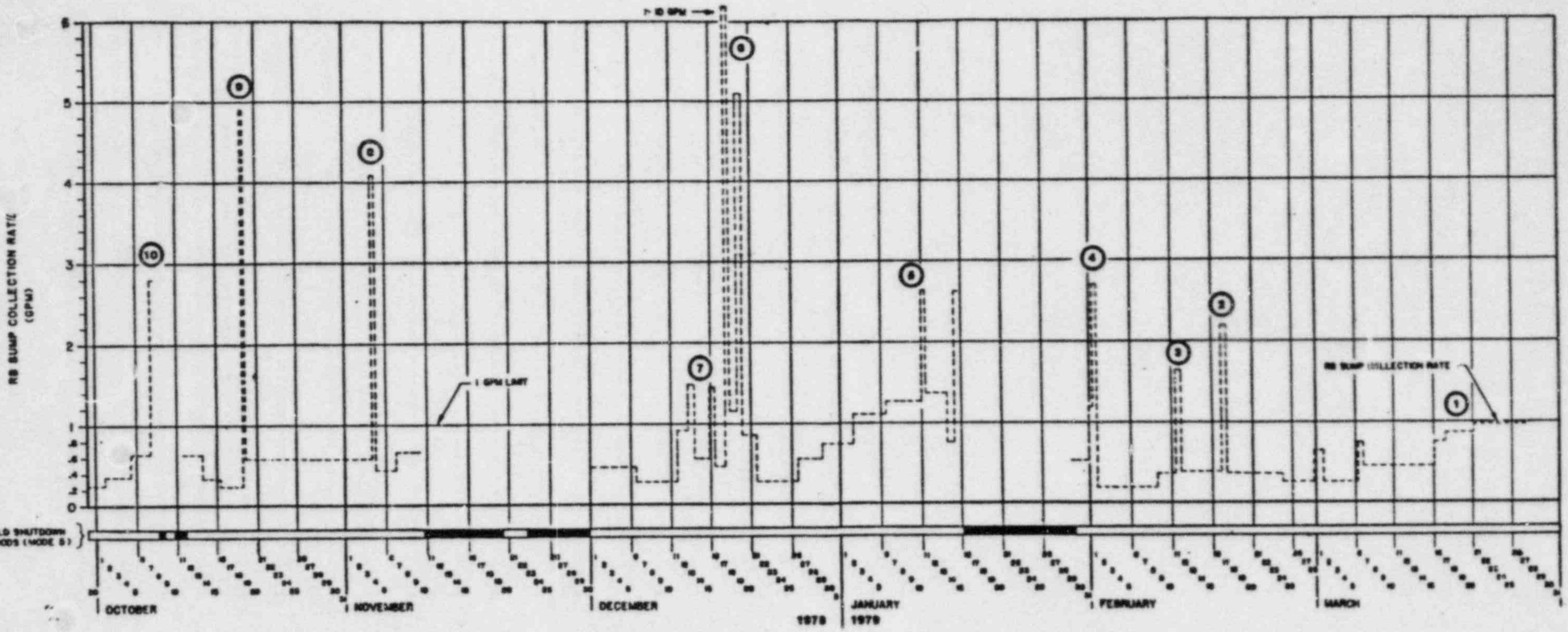


TMI-2
REACTOR BUILDING SUMP PUMP STARTS/STOPS
FROM ALARM PRINTOUT
(MARCH 1979)



TMI-2
RB SUMP COLLECTION RATE
BASED ON ALARM PRINTOUT

(MARCH 1979)



PERIODS REVIEWED

NOTE:

BASED ON 244 GALLONS PER PUMP-DOWN (14 INCHES)

TMI-2
RB SUMP COLLECTION RATE
BASED ON ALARM PRINTOUT
(OCTOBER 1978 THROUGH MARCH 1979)

Table 1

APPARENT UNIDENTIFIED LEAKAGE RATE AT THI-2 FOR LAST HALF OF MARCH 1979, BASED ON REACTOR BUILDING SUMP DATA

(Daily Average Leakage Data Based on the Full Sump Pump-Downs. Therefore used closest daily period to cover the full pump-downs of sump -- e.g. daily periods for full pump-downs of sump vary between approximately 21 hours to 27 hours - see Column C below.)

Both Our and NRC's Data Based on: (1) Standard atmospheric conditions (68° and 1 atmosphere)
(2) A Sump Pump-Down of 14" is equal to 244.347 gallons.

A	B	C	D	E = D x 244.347 ÷ C	F
Date	Time of RB Sump Pump Start for "Pump-Down" (Computer Printout)	Daily Hours in Time Period for Full Sump Pump-Down	Number Pump Starts In Time Period (Number of Pump-Downs) (244.347 gallon/ Pump-Down)	Apparent Unidentified Leakage From RB Sump gpm	NRC Daily Sump Data - 1/5/84 gpm
March 12, 1979	1:49 13:26 19:36	26 hr.-23 min. (1583 min.)	3	.463	.51
March 13, 1979	4:12 13:47	20 hr.-59 min. (1259 min.)	2	.3881	.39
March 14, 1979	1:11 13:00 19:17	27 hr.-0 min. (1620 min.)	3	.4524	.53
March 15, 1979	4:11 14:45	21 hr.-21 min. (1281 min.)	2	.3815	.33
March 16, 1979	1:32 9:30 15:44 21:10	25 hr.-0 min. (1500 min.)	4	.6516	.5[illegible]
March 17, 1979	2:32 8:15 14:19 19:58	22 hr.-32 min. (1352 min.)	4	.7229	.72
March 18, 1979	00:56 5:40 10:21 15:27 19:50	23 hr.-6 min. (1386 min.)	5	.8815	.87
March 19, 1979	00:02 4:21 8:45 13:26 18:03 22:19	26 hr.-41 min. (1601 min.)	6	.9157	.91
March 20, 1979	2:43 7:04 11:46 16:33 21:01	22 hr.-38 min. (1358 min.)	5	.8997	1.02 * (See Note)
March 21, 1979	1:21 5:38 9:55 14:40 19:14 23:23	22 hr.-2 min. (1322 min.)	5	.9242	.81
March 22, 1979	3:36 7:44 12:25 17:09 21:30	22 hr.-7 min. (1327 min.)	5	.9207	.93

Table 1
(Continued)

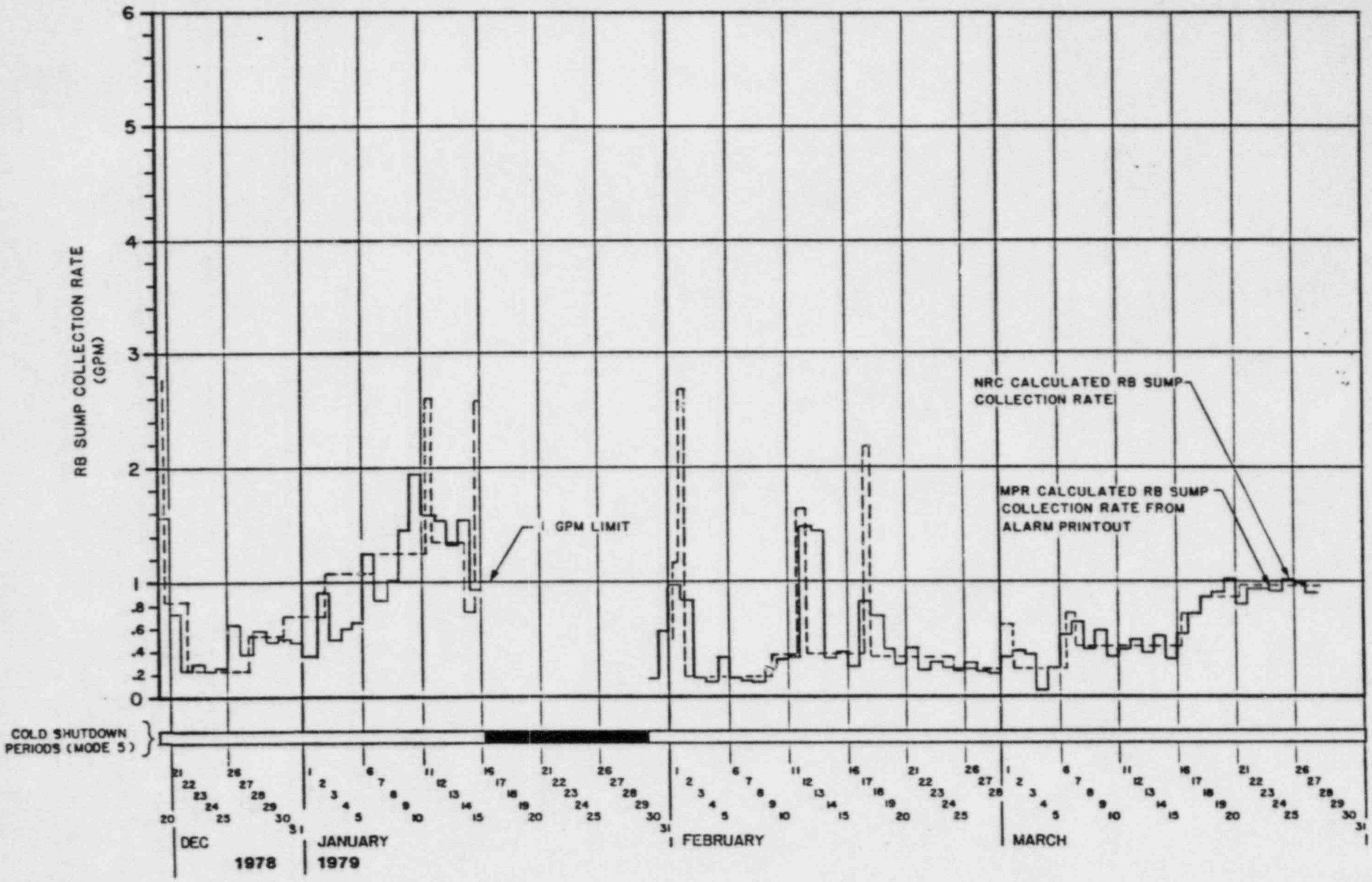
A	B	C	D	E = D x 244.347 ÷ C	F
Date	Time of RB Sump Pump Start for "Pump-Down" (Computer Printout)	Daily Hours in Time Period for Full Sump Pump-Down	Number Pump Starts In Time Period (Number of Pump-Downs) (244.347 gallon/ Pump-Down)	Apparent Unidentified Leakage From RB Sump gpm	NRC Daily Sump Data - 1/5/84 gpm
March 22, 1979	21:30				
March 23, 1979	1:57				
	6:06	25 hr.-52 min. (1552 min.)	6	.9446	.93
	10:17				
	14:58				
	19:04				
	23:22				
March 24, 1979	3:45				
	8:02	25 hr.-26 min. (1526 min.)	6	.9607	.92
	12:31				
	16:50				
	20:59				
March 25, 1979	00:48				
	4:39				
	8:41	24 hr.-34 min. (1474 min.)	6	.9946	1.03 * (See Note)
	12:49				
	17:01				
	21:13				
March 26, 1979	1:22				
	5:35				
	9:46	21 hr.-50 min. (1310 min.)	5	.9326	.97
	14:04				
	18:24				
	23:12				
March 27, 1979	3:28				
	7:40				
	11:59	26 hr.-4 min. (1564 min.)	6	.9373	.90
	16:53				
	21:17				
March 28, 1979	01:16				

Note

* We believe that the NRC unidentified leak rate from the sump data for these two days is in error due to overcounting the number of sump pump starts for these days. Specifically, the automatic recording of the sump pump starts on the computer shows 5 rather than the 6 starts used by the NRC in their calculations for March 20 and it shows 6 rather than the 7 starts the NRC used in their calculations for March 25, 1979. Accordingly, when these two corrections are made, the NRC sump data shows that the unidentified leakage was less than 1 gpm.

06:47:42	BAD	0028	8STG HTRA [illegible]	NORM
06:47:47	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	-???.?
06:47:52	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
06:48:12	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	-???.?
06:48:17	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
06:48:47	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	-???.?
06:48:52	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
06:58:57	NORM	0096	COND HWL LVL (IN H2O)	-???.?
06:59:12	LOW	0096	COND HWL LVL (IN H2O)	22.92
07:00:12	NORM	0096	COND HWL LVL (IN H2O)	22.44
07:10:12	LOW	0096	COND HWL LVL (IN H2O)	23.10
07:10:27	NORM	0096	COND HWL LVL (IN H2O)	22.44
07:12:52	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	22.97
07:13:02	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
07:13:17	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	-???.?
07:13:27	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
07:18:38	CONT	2738	D-G ROOM AIR CPRSR DF-P-2A	-???.?
07:21:27	LOW	0096	COND HWL LVL (IN H2O)	NORM
07:22:20	CONT	2738	D-G ROOM AIR CPRSR DF-P-2A	22.42
07:24:47	CONT	2727	RB SUMP PUMP WDL-P-2B	TRIP
07:25:52	CONT	3137	500 KV MN XFMR BKR B2-02	ON
07:25:53	CONT	3137	500 KV MN XFMR BKR B2-02	TRIP
07:26:11	CONT	3137	500 KV MN XFMR BKR B2-02	NORM
07:26:13	CONT	3137	500 KV MN XFMR BKR B2-02	TRIP
07:26:19	CONT	2727	RB SUMP PUMP WDL-P-2B	NORM
07:36:17	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	OFF
07:36:22	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
07:49:51	CONT	2740	D-G ROOM AIR CPRSR DF-P-2C	-???.?
07:54:10	CONT	2740	D-G ROOM AIR CPRSR DF-P-2C	NORM
08:21:53	BAD	1643	FWP 1B OUTBD BRG(C)	TRIP
08:21:53	BAD	1644	FWP 1B THR BRG	-???.?
08:22:53	NORM	1643	FWP 1B OUTBD BRG(C)	-???.?
08:22:53	NORM	1644	FWP 1B THR BRG	2.2
08:37:52	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	3.2
08:37:20	CONT	2757	13STG FDW HTR A LVL LOW	.0
08:38:36	BAD	0572	RP INT RANGE NI4 LVL (LOG AMPS)	LOW
08:38:36	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	-??.??
08:39:06	NORM	0572	RP INT RANGE NI4 LVL (LOG AMPS)	-???.?
08:39:36	BAD	0572	RP INT RANGE NI4 LVL (LOG AMPS)	-11.03
08:40:06	NORM	0572	RP INT RANGE NI4 LVL (LOG AMPS)	-??.??
08:41:00	CONT	2757	13STG FDW HTR A LVL LOW	-11.03
08:41:06	BAD	0572	RP INT RANGE NI4 LVL (LOG AMPS)	NORM
08:41:51	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	-??.??
08:42:06	NORM	0572	RP INT RANGE NI4 LVL (LOG AMPS)	.0
08:42:14	CONT	2769	13STG FDW HTR A LVL HIGH	-11.03
08:42:35	CONT	2781	13STG FDW HTR A LVL TRIP	HIGH
08:42:38	BAD	0572	RP INT RANGE NI4 LVL (LOG AMPS)	TRIP
08:45:02	CONT	2782	HTR DRAIN TK LVL HIGH	-??.??
08:47:27	NORM	0096	COND HWL LVL (IN H2O)	NORM
08:47:42	LOW	0096	COND HWL LVL (IN H2O)	22.91
08:48:06	NORM	0572	RP INT RANGE NI4 LVL (LOG AMPS)	22.38
08:48:36	BAD	0572	RP INT RANGE NI4 LVL (LOG AMPS)	-11.00
08:49:36	NORM	0572	RP INT RANGE NI4 LVL (LOG AMPS)	-??.??
08:50:12	NORM	0096	COND HWL LVL (IN H2O)	-11.03
08:50:36	BAD	0572	RP INT RANGE NI4 LVL (LOG AMPS)	22.97
08:51:57	LOW	0096	COND HWL LVL (IN H2O)	-??.??
08:52:12	NORM	0096	COND HWL LVL (IN H2O)	22.36

06:47:42	BAD	0028	[illegible] LVL LOW	NORM
06:47:47	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	-???.?
06:47:52	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
06:48:12	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	-???.?
06:48:17	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
06:48:47	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	-???.?
06:48:52	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
06:58:57	NORM	0096	8STG HTRA TO HD TK FL(KLB/H)	-???.?
06:59:12	LOW	0096	COND H/L LVL (IN H2O)	22.92
07:00:12	NORM	0096	COND H/L LVL (IN H2O)	22.44
07:10:12	LOW	0096	COND H/L LVL (IN H2O)	23.10
07:10:27	NORM	0096	COND H/L LVL (IN H2O)	22.44
07:12:52	NORM	0028	COND H/L LVL (IN H2O)	22.97
07:13:02	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
07:13:17	NORM	0028	8STG HTRA TO HD TK FL(KLB/H)	-???.?
07:13:27	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
07:18:38	CONT	2738	8STG HTRA TO HD TK FL(KLB/H)	-???.?
07:21:27	LOW	0096	D-G ROOM AIR CPRSR DF-P-2A	NORM
07:22:20	CONT	2738	COND H/L LVL (IN H2O)	22.42
07:24:47	CONT	2727	D-G ROOM AIR CPRSR DF-P-2A	TRIP
07:25:52	CONT	3137	RB SUMP PUMP HDL-P-2B	ON
07:25:53	CONT	3137	500 KV MN XFMR BKR B2-02	TRIP
07:26:11	CONT	3137	500 KV MN XFMR BKR B2-02	NORM
07:26:13	CONT	3137	500 KV MN XFMR BKR B2-02	TRIP
07:26:19	CONT	2727	500 KV MN XFMR BKR B2-02	NORM
07:36:17	NORM	0028	RB SUMP PUMP HDL-P-2B	OFF
07:36:22	BAD	0028	8STG HTRA TO HD TK FL(KLB/H)	.0
07:49:51	CONT	2740	8STG HTRA TO HD TK FL(KLB/H)	-???.?
07:54:10	CONT	2740	D-G ROOM AIR CPRSR DF-P-2C	NORM
08:21:53	BAD	1643	D-G ROOM AIR CPRSR DF-P-2C	TRIP
08:21:53	BAD	1644	FWP 1B OUTBD BRG(C)	-???.?
08:22:53	NORM	1643	FWP 1B THR BRG	-???.?
08:22:53	NORM	1644	FWP 1B OUTBD BRG(C)	2.2
08:37:52	NORM	0028	FWP 1B THR BRG	3.2
08:37:20	CONT	2757	8STG HTRA TO HD TK FL(KLB/H)	.0
08:38:36	BAD	0572	13STG FDW HTR A LVL LOW	LOW
08:38:36	BAD	0028	RP INT RANGE NI4 LVL (LOG AMPS)	-??.??
08:39:06	NORM	0572	8STG HTRA TO HD TK FL(KLB/H)	-???.?
08:39:36	BAD	0572	RP INT RANGE NI4 LVL (LOG AMPS)	-11.03
08:40:06	NORM	0572	RP INT RANGE NI4 LVL (LOG AMPS)	-??.??
08:41:00	CONT	2757	RP INT RANGE NI4 LVL (LOG AMPS)	-11.03
08:41:06	BAD	0572	13STG FDW HTR A LVL LOW	NORM
08:41:51	NORM	0028	RP INT RANGE NI4 LVL (LOG AMPS)	-??.??
08:42:06	NORM	0572	8STG HTRA TO HD TK FL(KLB/H)	.0
08:42:14	CONT	2769	RP INT RANGE NI4 LVL (LOG AMPS)	-11.03
08:42:35	CONT	2781	13STG FDW HTR A LVL HIGH	HIGH
08:42:36	BAD	0572	13STG FDW HTR A LVL TRIP	TRIP
08:45:02	CONT	2782	RP INT RANGE NI4 LVL (LOG AMPS)	-??.??
08:47:27	NORM	0096	HTR DRAIN TK LVL HIGH	NORM
08:47:42	LOW	0096	COND H/L LVL (IN H2O)	22.91
08:48:06	NORM	0572	COND H/L LVL (IN H2O)	22.38
08:48:36	BAD	0572	RP INT RANGE NI4 LVL (LOG AMPS)	-11.00
08:49:36	NORM	0572	RP INT RANGE NI4 LVL (LOG AMPS)	-??.??
08:50:12	NORM	0096	RP INT RANGE NI4 LVL (LOG AMPS)	-11.03
08:50:36	BAD	0572	COND H/L LVL (IN H2O)	22.97
08:51:57	LOW	0096	RP INT RANGE NI4 LVL (LOG AMPS)	-??.??
08:52:12	NORM	0096	COND H/L LVL (IN H2O)	22.36
			COND H/L [illegible]	



TMI-2
COMPARISON OF NRC CALCULATED
RB SUMP COLLECTION RATE TO
MPR CALCULATED RATE
BASED ON ALARM PRINTOUT
(DECEMBER 1978 THROUGH MARCH 1979)

ALTERNATE METHODS OF ESTIMATING UNIDENTIFIED LEAKAGE

RELATED TO RCIB TEST

UNIDENTIFIED = TOTAL - IDENTIFIED

SLOPE METHOD TO GET TOTAL LEAKAGE

- SELECTED REGULAR PERIODS
- DETERMINED SLOPE
- CORRECTED FOR MAKEUP TANK INSTRUMENT ERROR

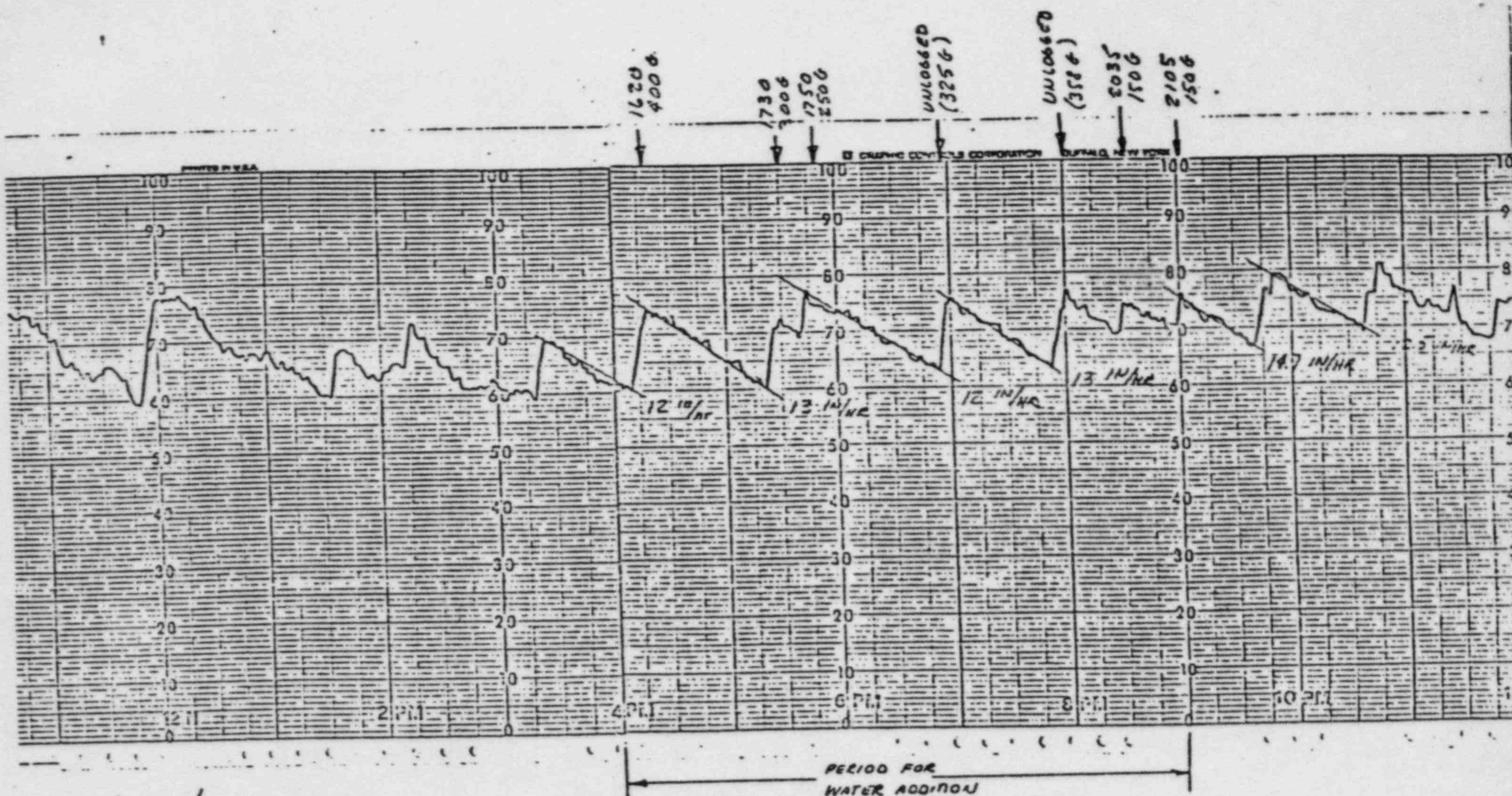
WATER ADDITION METHOD TO GET TOTAL LEAKAGE

- SELECT REGULAR PERIODS
- DETERMINED ADDITIONS AND CORRECTED FOR MAKEUP TANK INSTRUMENT ERROR
- USED HOURLY COMPUTER LOG TO CORRECT FOR CHANGES IN SYSTEM CONDITIONS

TOTAL LEAKAGE RATES COMBINED TO GET A COMPOSITE BEST ESTIMATE

IDENTIFIED LEAKAGE

- FROM RCIB PRINTOUTS OF RCDT LEVEL
- INDEPENDENT LEVEL/VOLUME RELATIONSHIP USED


1620
400 g
1730
300 g
1750
250 g
UNLOGGED
(325 g)
UNLOGGED
(358 g)
2035
150 g
2105
150 g
Graphic Controls Corporation Buffalo, New York
12 in/hr
13 in/hr
12 in/hr
13 in/hr
14.7 in/hr
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
PERIOD FOR
WATER ADDITION

3/19/79

"SLOPE" METHOD

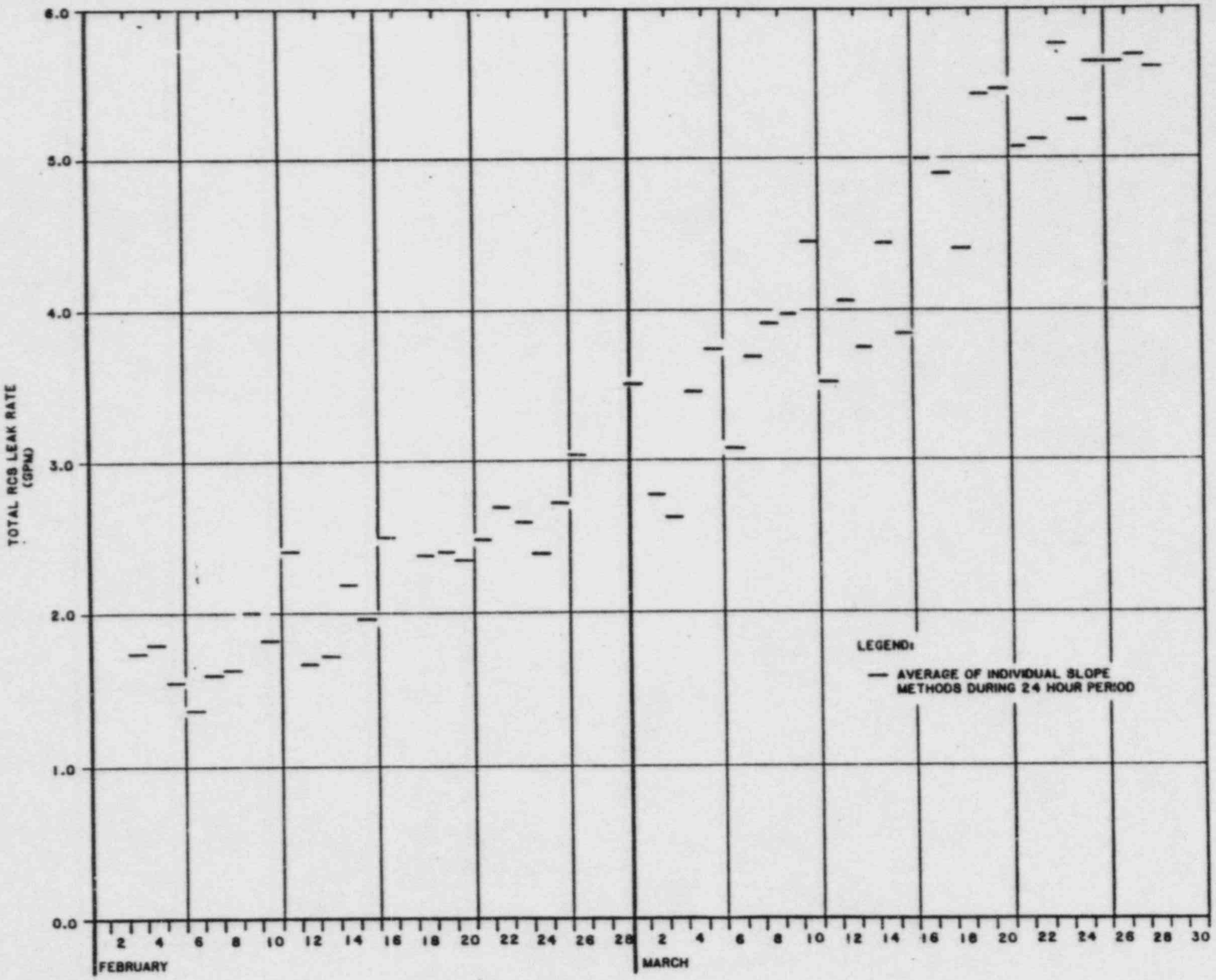
- SELECT "REGULAR" SLOPES

- AVERAGE ALL AVAILABLE

- DETERMINE RATIOS OF INDICATED TO LOGGED ADDITION

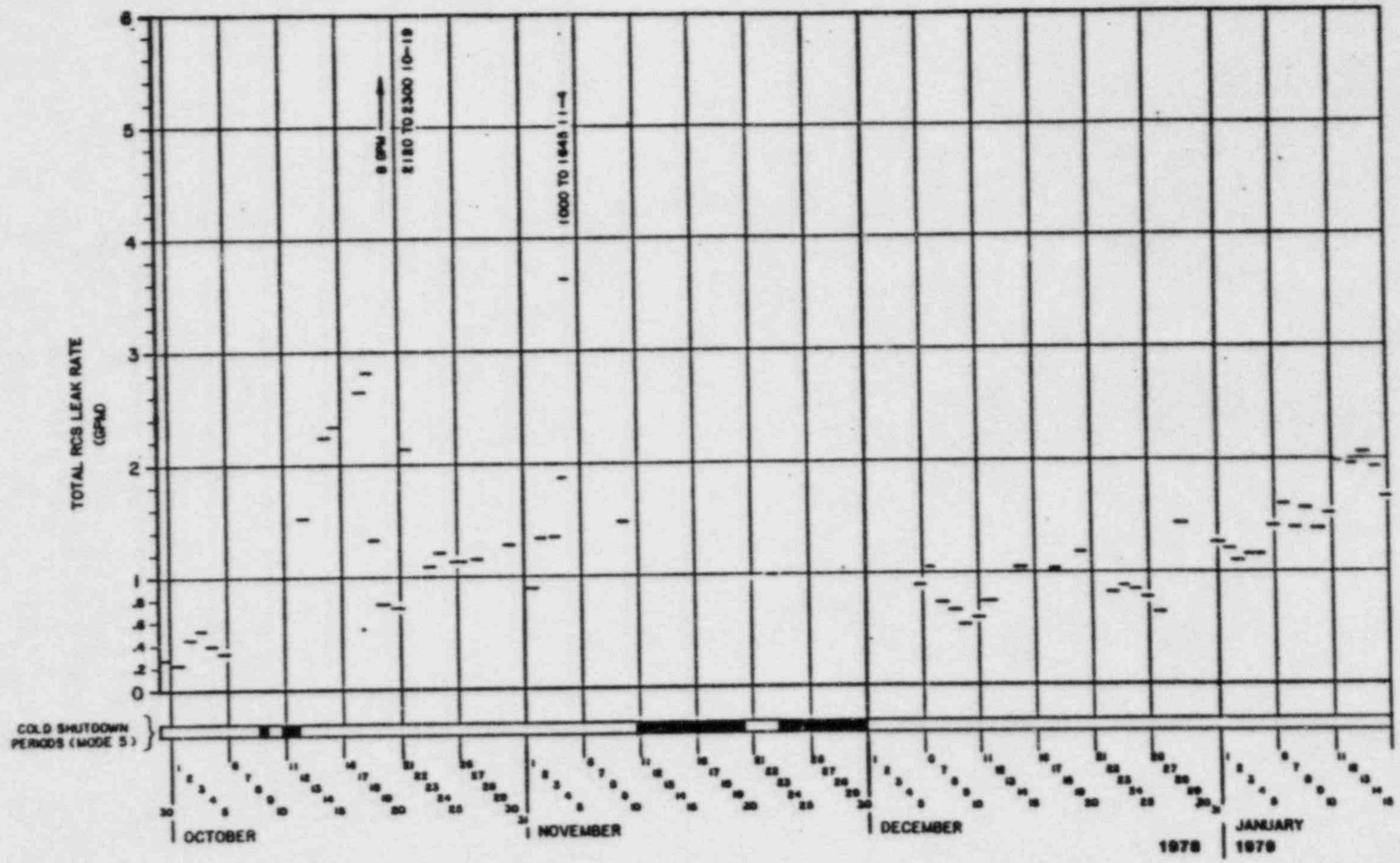
- AVERAGE ALL AVAILABLE

- CORRECT AVERAGE SLOPE BY AVERAGE RATIO TO OBTAIN LEAK RATE



TMI-2
ESTIMATE OF TOTAL RCS LEAK RATE BASED ON RATE OF MAKEUP TANK LEVEL CHANGE "SLOPE" METHOD

(FEBRUARY AND MARCH 1979)



LEGEND:

— AVERAGE OF INDIVIDUAL SLOPE METHODS DURING 24 HOURS PERIOD

TMI-2

ESTIMATE OF TOTAL RCS LEAK RATE
BASED ON RATE OF MAKEUP TANK
LEVEL CHANGE " SLOPE " METHOD

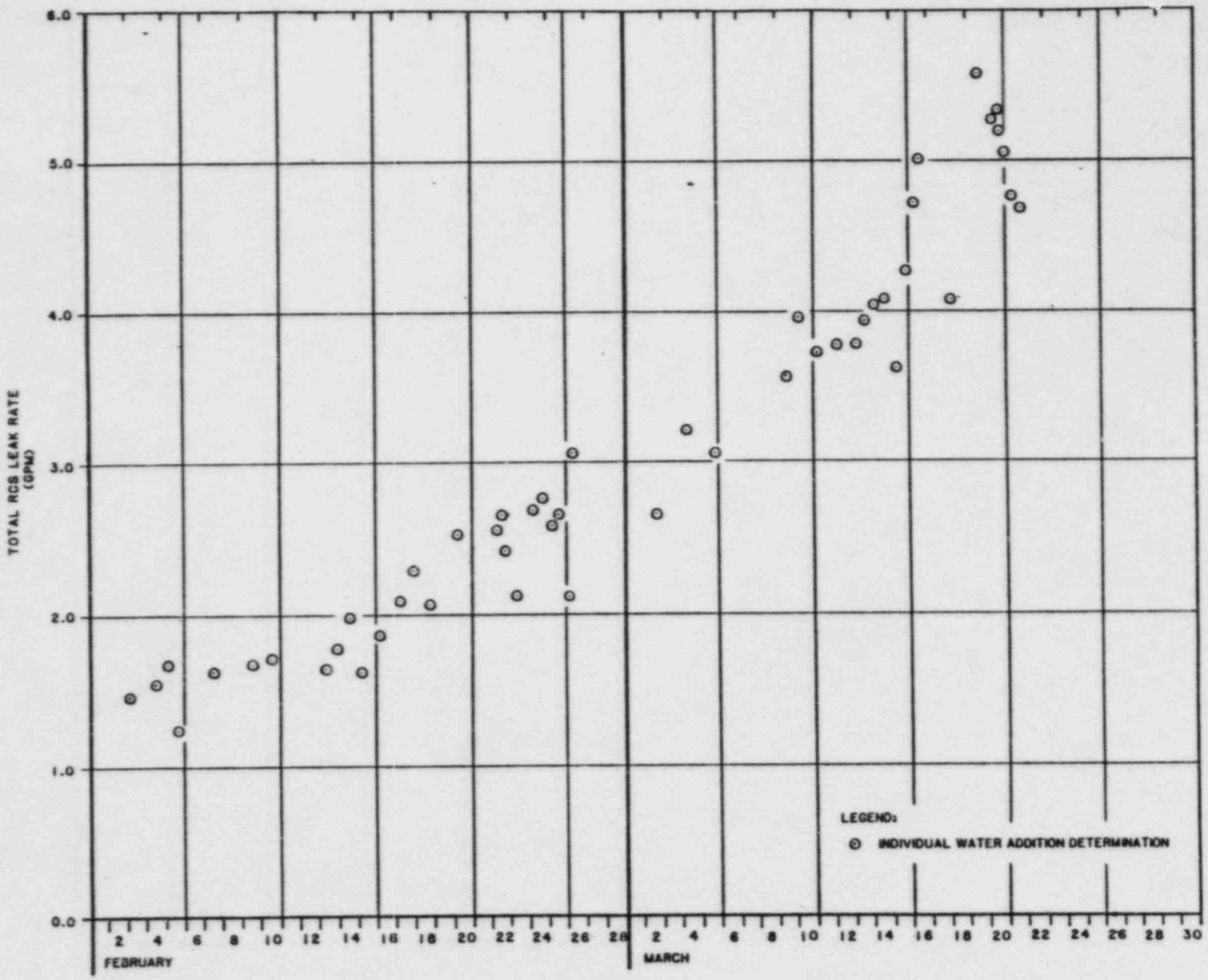
(OCTOBER 1978 THROUGH MID-JANUARY 1979)

NRC'S "SLOPE" METHOD
(MAY 23, 1983)

- ONE REGULAR SLOPE PER DAY
- NO CORRECTION FOR MAKEUP TANK INSTRUMENTATION PROBLEM

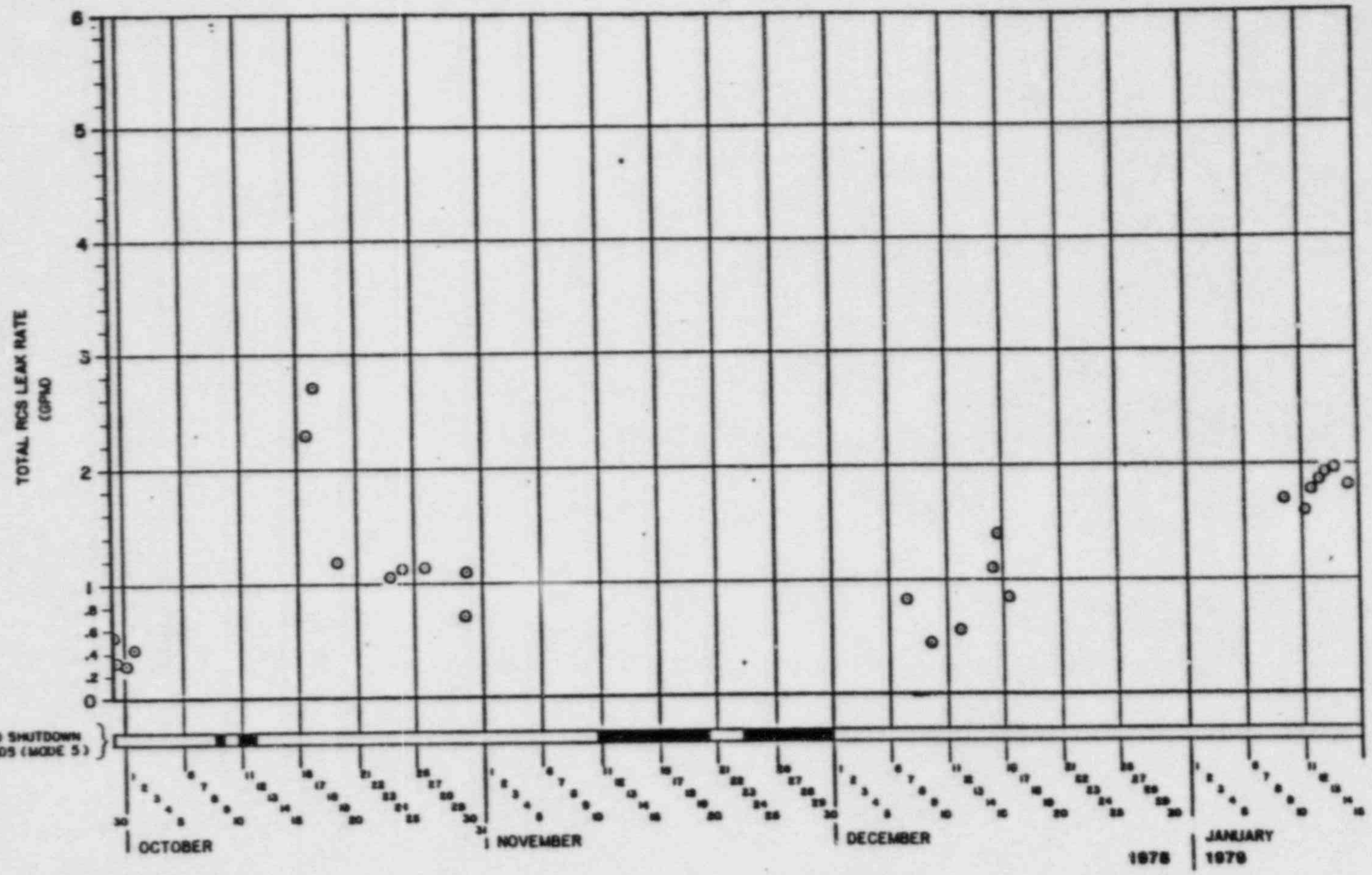
"WATER ADDITION"

- SELECT STEADY PERIOD
- IDENTIFY ADDITIONS
  - CRO LOG
  - UNLOGGED
- DETERMINE BEGINNING AND END CONDITIONS
- DETERMINE INVENTORY CHANGE
- LEAK RATE = ADDITIONS + INVENTORY CHANGE



TMI-2
ESTIMATE OF TOTAL RCS LEAK RATE BASED ON
SUMMATION OF WATER ADDED " WATER ADDITION " METHOD

(FEBRUARY AND MARCH 1979)



LEGEND:

⊙ INDIVIDUAL WATER ADDITION DETERMINATION

TMI-2
ESTIMATE OF TOTAL RCS LEAK RATE
BASED ON SUMMATION OF WATER ADDED
"WATER ADDITION" METHOD
(OCTOBER 1978 THROUGH MID-JANUARY 1979)

NRC'S "WATER ADDITION" METHOD
MAY 23, 1983)

- SOME FEED & BLEED OPERATIONS NOT EXCLUDED

- UNRECORDED ADDITIONS ASSUME NO ERROR IN MAKEUP TANK LEVEL INSTRUMENT

- UNRECORDED ADDITIONS CONVERTED TO RC TEMEPRATURE TWICE

Table 4

WATER ADDITIONS BY THE OPERATORS IN GALLONS

NO.	DATE	CRO LOG NO.	CRO LOG AMOUNT	MUT SEARCH NO.	MUT SEARCH AMOUNT	TOTAL AMOUNT
49	12/06/78	8	2400	0	0	2400
50	12/07/78	7	694	0	0	694
51	12/08/78	4	900	1	331	1231
52	12/09/78	1	400	0	0	400
53	12/10/78	3	300	0	0	300
54	12/11/78	2	400	1	455	855
55	12/12/78	13	3480	0	0	3480
56	12/13/78	8	344	0	0	344
57	12/14/78	3	1100	2	1449	2549
58	12/15/78	4	1300	0	0	1300
59	12/16/78	2	600	0	0	600
60	12/17/78	3	1561	0	0	1561
61	12/18/78	0	0	0	0	0
62	12/19/78	2	1400	0	0	1400
63	12/20/78	1	450	0	0	450
64	12/21/78	0	0	0	0	0
65	12/24/78	11	2605	1	331	2936
66	12/25/78	4	1400	0	0	1400
67	12/26/78	8	2024	0	0	2024
68	12/27/78	9	1600	0	0	1600
69	12/31/78	12	3595	0	0	3595
70	01/01/79	7	1850	0	0	1850
71	01/02/79	4	1650	0	0	1650
72	01/03/79	7	2186	0	0	2186

TABLE 4

WATER ADDITIONS BY THE OPERATORS IN GALLONS

NO.	DATE	CRO LOG NO.	CRO LOG AMOUNT	MUT SEARCH NO.	MUT SEARCH AMOUNT	TOTAL AMOUNT
97	02/22/79	15	3818	0	0	3818
98	02/23/79	14	3500	0	0	3500
99	02/24/79	14	3462	1	372	3834
100	02/25/79	13	4315	0	0	4315
101	02/27/79	16	3612	0	0	3612
102	02/28/79	18	4267	0	0	4267
103	03/01/79	17	3416	0	0	3416
104	03/02/79	18	4430	0	0	4430
105	03/03/79	19	3914	1	331	4245
106	03/04/79	18	3849	1	331	4180
107	03/08/79	25	5678	2	661	6339
108	03/09/79	20	5585	0	0	5585
109	03/10/79	20	5399	2	538	5937
110	03/11/79	20	5018	2	828	5846
111	03/12/79	20	4760	4	1323	6083
112	03/13/79	25	5641	1	372	6013
113	03/14/79	25	6117	0	0	6117
114	03/15/79	19	5463	2	1159	6622
115	03/16/79	22	5425	1	869	6294
116	03/17/79	24	7372	2	620	7992
117	03/18/79	25	6883	0	0	6883
118	03/19/79	24	5627	4	1863	7490
119	03/20/79	29	7252	3	1448	8700
120	03/21/79	30	7713	2	538	8251

WATER ADDITIONS BY THE OPERATORS IN GALLONS

NO.	DATE	CRO LOG NO.	CRO LOG AMOUNT	MUT SEARCH NO.	MUT SEARCH AMOUNT	TOTAL AMOUNT
121	03/22/79	25	7099	5	1736	8835
122	03/23/79	25	7900	4	1489	9389
123	03/24/79	30	8750	2	413	9163
124	03/25/79	18	6507	3	1324	7831
125	03/26/79	24	7650	4	1365	9015
126	03/27/79	21	7500	1	414	7914

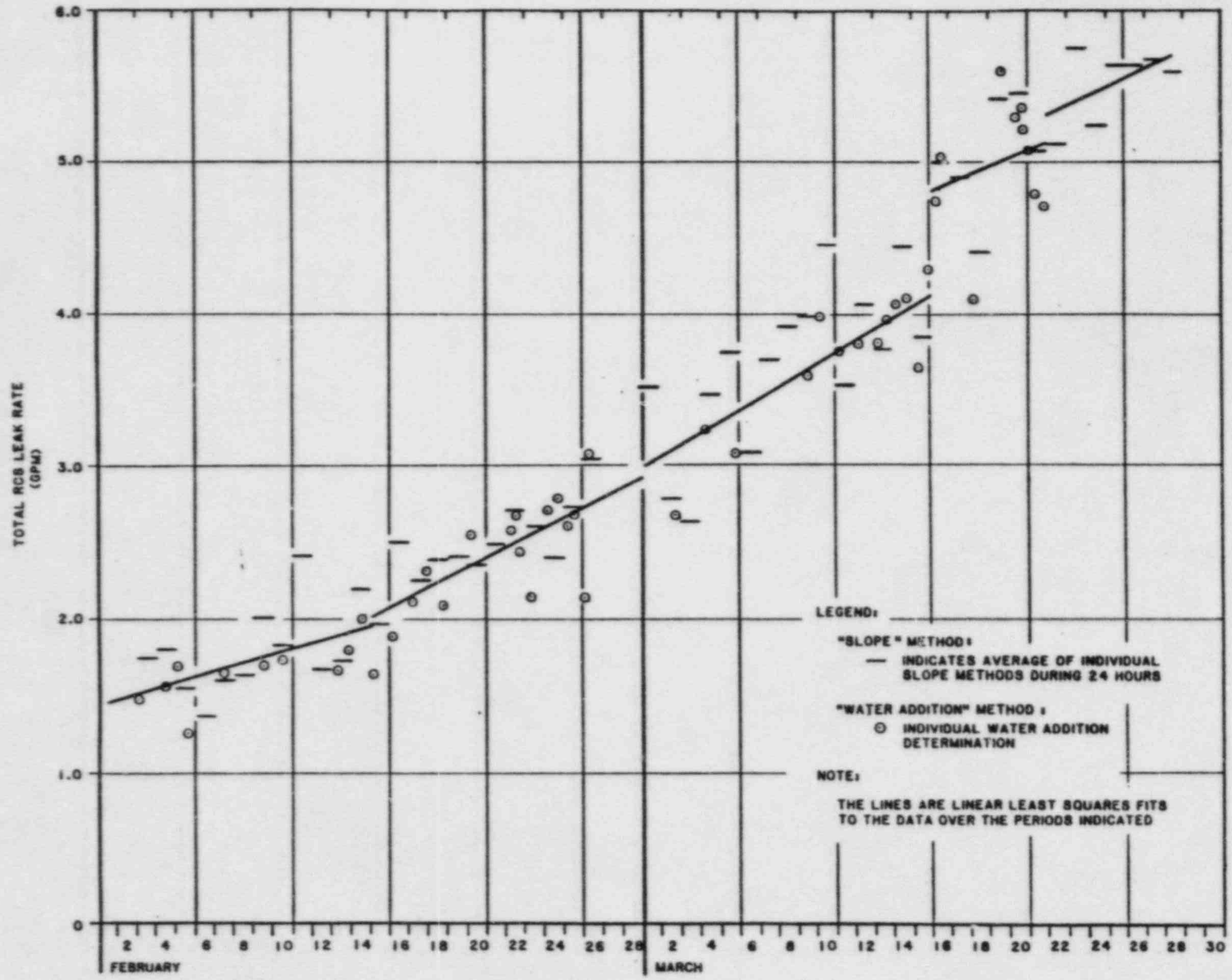
UNRECORDED WATER ADDITIONS IDENTIFIED BY
MAKE-UP TANK CHANGES

	DATE	TIME	STARTING LEVEL(in)	ENDING LEVEL(in)	COLD WATER ADDED (gal)	
					146	
	3/23/79	0550	59	66	216	1109
	3/23/79	0610	64	74	308	
	3/23/79	0930	65	76	339	
0	3/24/79	0225	79	82	92	307
1	3/24/79	0910	75	82	216	
2	3/25/79	0050	80	90	308	
3	3/25/79	0355	66	77	339	986
4	3/25/79	0730	67	78	339	
5	3/26/79	0420	70	78	246	
6	3/26/79	0455	68	75	216	1017
	3/26/79	0715	70	76	185	
08	3/26/79	1420	60	72	370	
09	3/27/79	0315	68	78	308	

TABLE 6

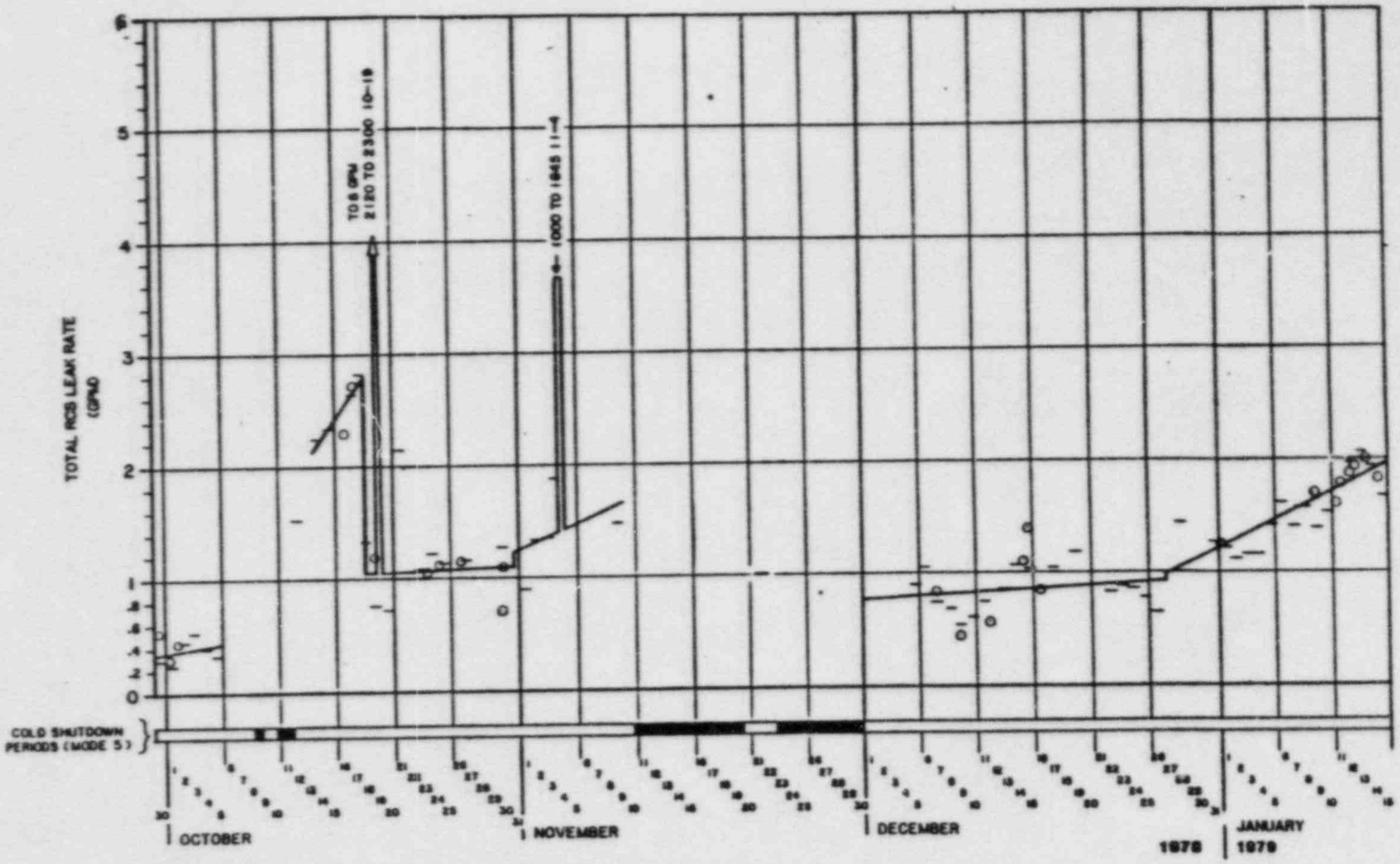
TOTAL REACTOR COOLANT SYSTEM LEAK RATES
Three Mile Iland Unit 2

DATE	LENGTH (Hr)	WATER ADDED (gal)		RCS PRESS (psig)	AVG TEMP (F)	PZR LEVEL (in)	MUT LEVEL (in)	TOTAL LEAK RATE (gpm)
3\16\79	24	6081	INITIAL	2171	581.63	229	70	5.86
			FINAL	2161	581.38	228	63	
3\19\79	24	7690	INITIAL	2172	581.00	224	73	7.10
			FINAL	2172	580.88	226	74	
3\20\79	23	8300	INITIAL	2172	580.88	226	74	8.33
			FINAL	2173	580.88	222	67	
3\21\79	24	8251	INITIAL	2173	580.88	222	67	7.56
			FINAL	2168	581.00	209	77	
3\22\79	25	8685	INITIAL	2168	581.00	209	77	7.82
			FINAL	2170	581.00	225	69	
3\23\79	24	9639	INITIAL	2170	581.00	225	69	8.99
			FINAL	2169	581.63	234	67	
3\24\79	24	9163	INITIAL	2169	581.63	234	67	8.22
			FINAL	2169	581.88	231	80	
3\25\79	23	7531	INITIAL	2169	581.88	231	80	7.70
			FINAL	2170	581.62	233	66	
3\26\79	25	9315	INITIAL	2170	581.62	233	66	8.30
			FINAL	2169	581.00	224	69	
3\27\79	24	7194	INITIAL	2169	581.00	224	69	6.57
			FINAL	2160	580.88	228	72	



TMI-2
ESTIMATE OF TOTAL RCS LEAK RATE
COMBINED SLOPE AND WATER ADDITION METHODS

(FEBRUARY AND MARCH 1979)



LEGEND:

"SLOPE" METHOD:

– INDICATES AVERAGE OF INDIVIDUAL SLOPE METHODS DURING 24 HOURS

"WATER ADDITION" METHOD:

○ INDIVIDUAL WATER ADDITION DETERMINATION

NOTE:

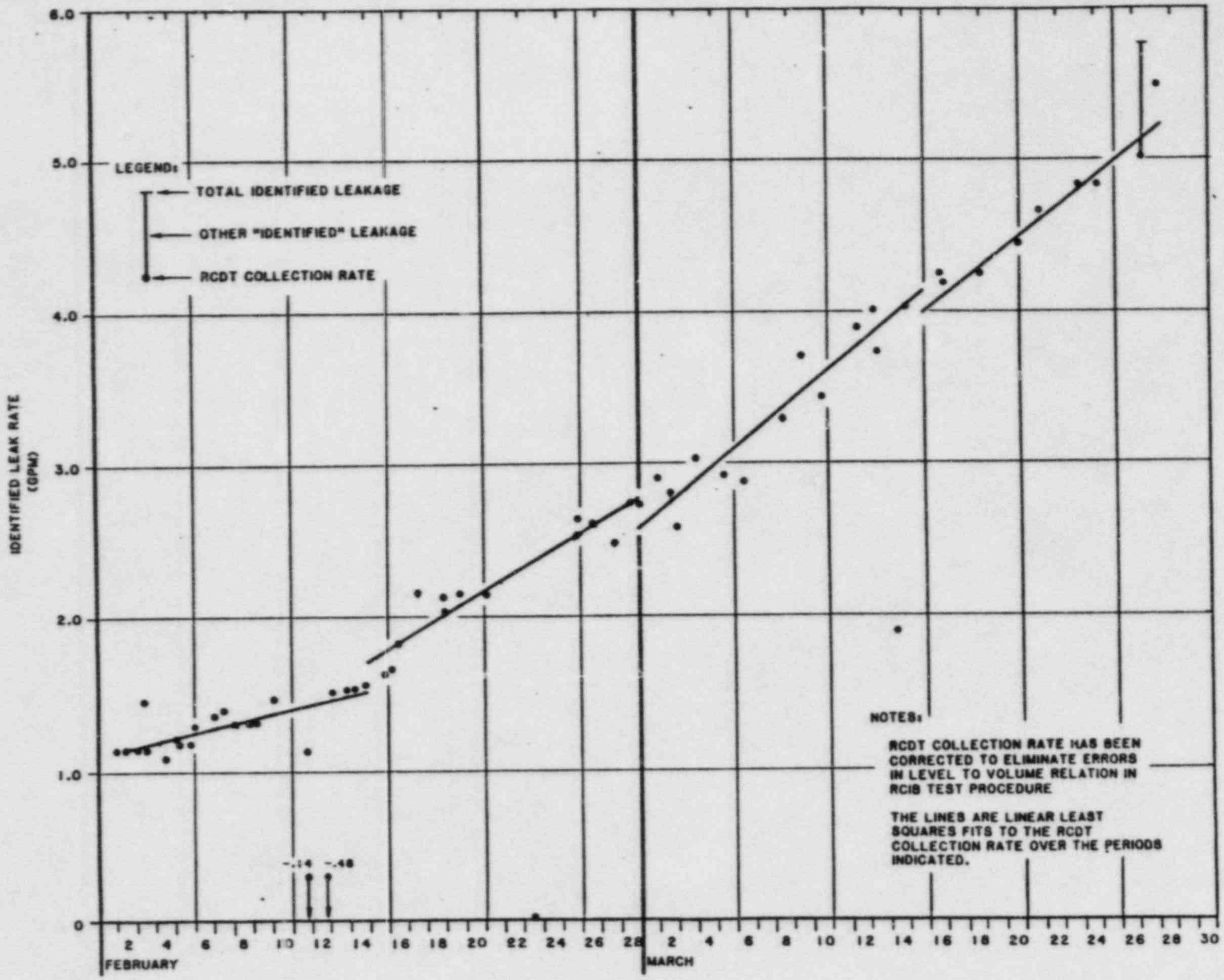
THE LINES ARE LINEAR LEAST SQUARES FITS TO THE DATA OVER THE PERIODS INDICATED

TMI-2

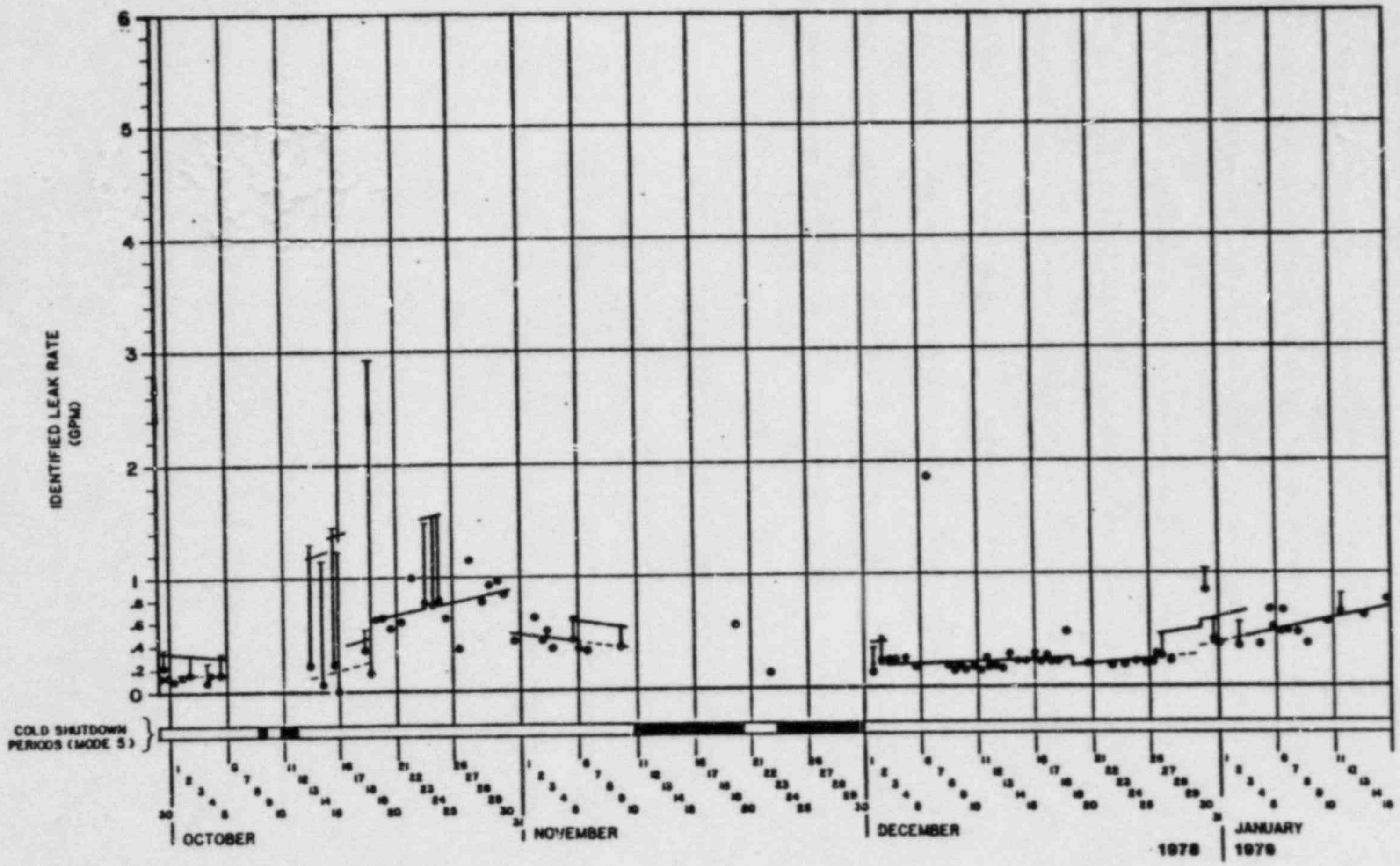
ESTIMATE OF TOTAL RCS LEAK RATE

COMBINED SLOPE AND WATER ADDITION METHODS

(OCTOBER 1978 THROUGH MID-JANUARY 1979)



TMI-2
RC DRAIN TANK COLLECTION RATE
AND OTHER IDENTIFIED LEAKAGE
(FEBRUARY AND MARCH 1979)



LEGEND:

TOTAL IDENTIFIED LEAKAGE

OTHER "IDENTIFIED" LEAKAGE

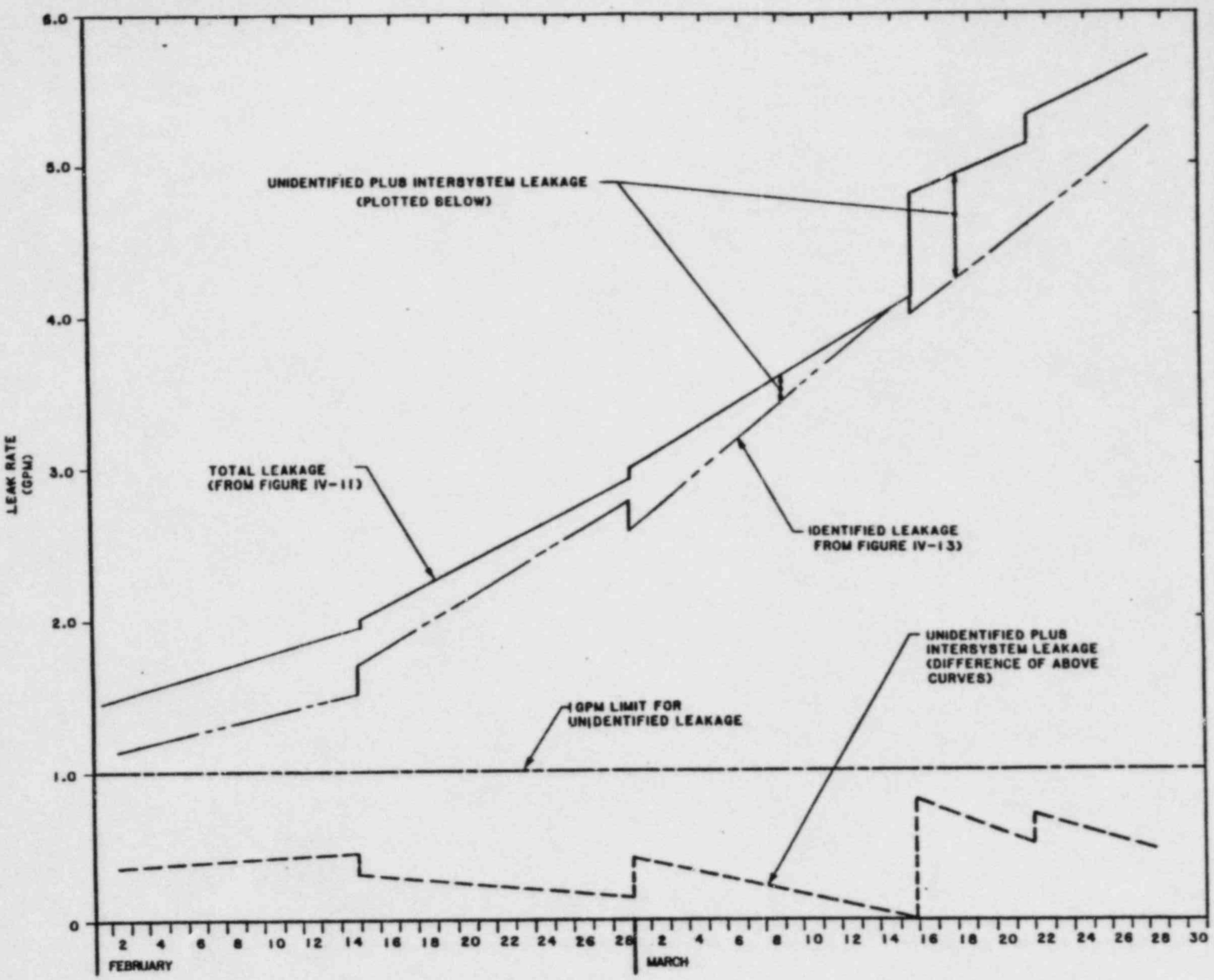
RCDT COLLECTION RATE

NOTES:

RCDT COLLECTION RATE HAS BEEN CORRECTED TO ELIMINATE ERRORS IN LEVEL TO VOLUME RELATION IN RCIB TEST PROCEDURE

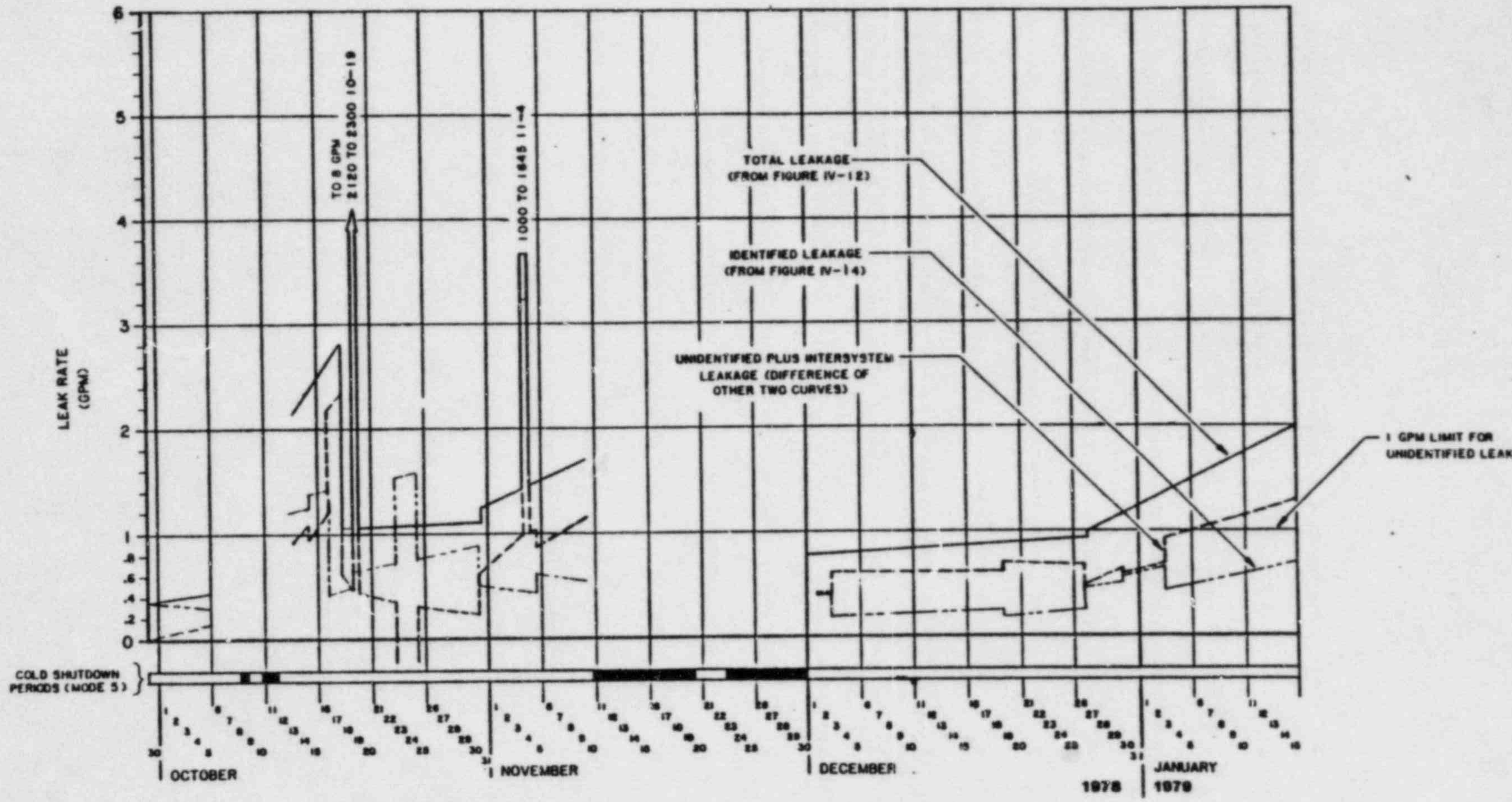
THE LINES ARE LINEAR LEAST SQUARES FITS TO THE RCDT COLLECTION RATE OVER THE PERIODS INDICATED WITH OTHER IDENTIFIED LEAKAGE ADDED WHEN IT WAS PRESENT AS INDICATED BY MORE THAN ONE RCIB TEST RECORD

TMI – 2
RC DRAIN TANK COLLECTION RATE AND
OTHER IDENTIFIED LEAKAGE
(OCTOBER 1978 THROUGH MID-JANUARY 1979)



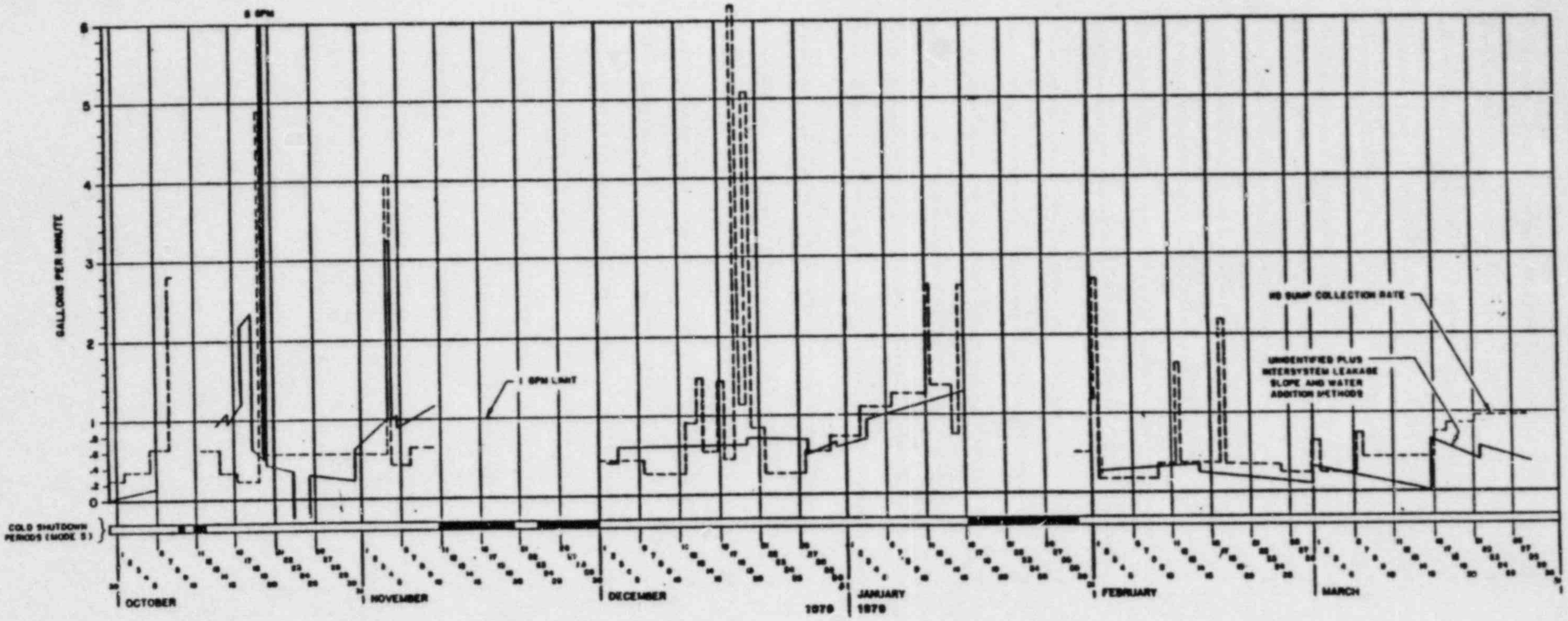
TMI-2
ESTIMATE OF UNIDENTIFIED LEAKAGE BASED ON TOTAL RCS LEAKAGE FROM COMBINED SLOPE AND WATER ADDITION METHODS AND IDENTIFIED LEAKAGE FROM RCIB TESTS

(FEBRUARY AND MARCH 1979)



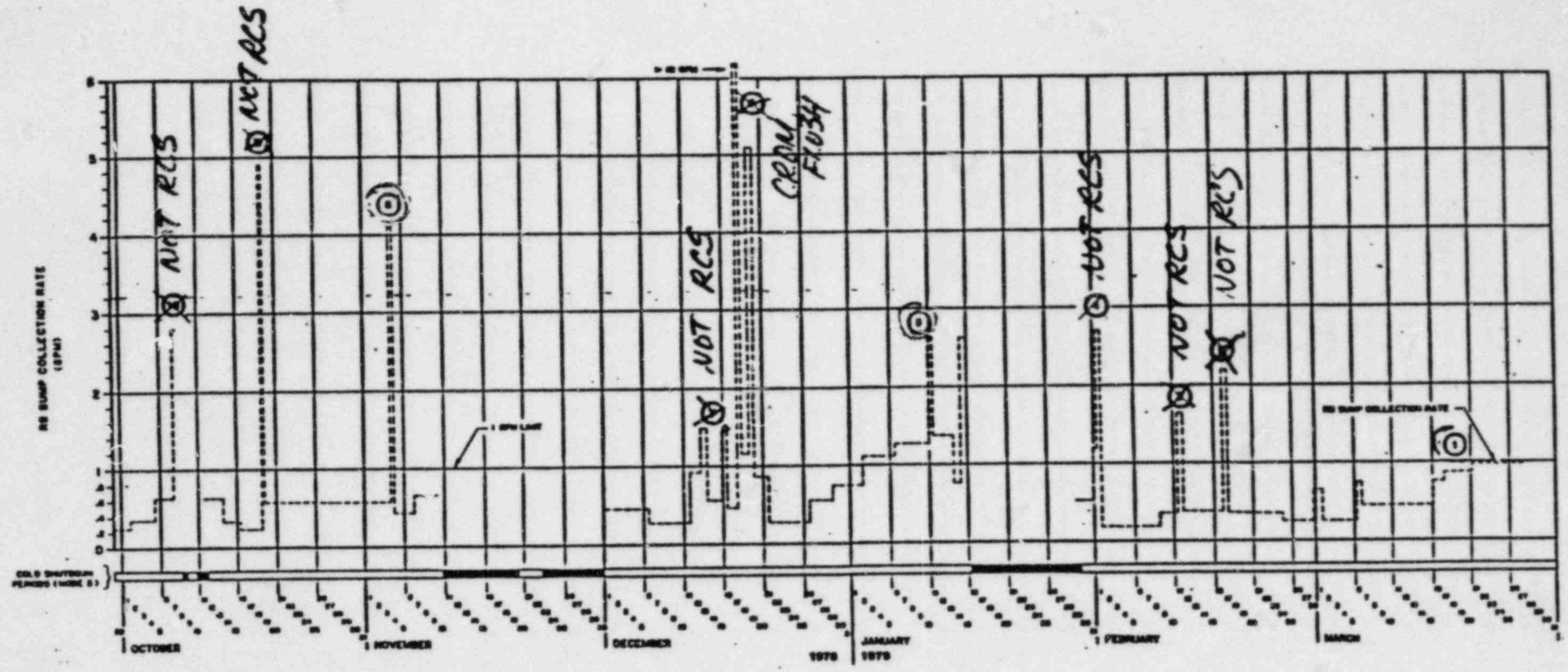
TMI-2
ESTIMATE OF
UNIDENTIFIED PLUS INTERSYSTEM LEAKAGE
BASED ON TOTAL RCS LEAKAGE
FROM COMBINED SLOPE AND
WATER ADDITION METHODS AND
IDENTIFIED LEAKAGE FROM RCIB TESTS

(OCTOBER 1978 THROUGH MID-JANUARY 1979)



TMI-2
COMPARISON OF
RB SUMP COLLECTION RATE TO ESTIMATED
UNIDENTIFIED PLUS INTERSYSTEM LEAKAGE
BASED ON COMBINED
SLOPE AND WATER ADDITION METHODS

(OCTOBER 1978 THROUGH MARCH 1979)



○ PERIODS REVIEWED

NOTE:

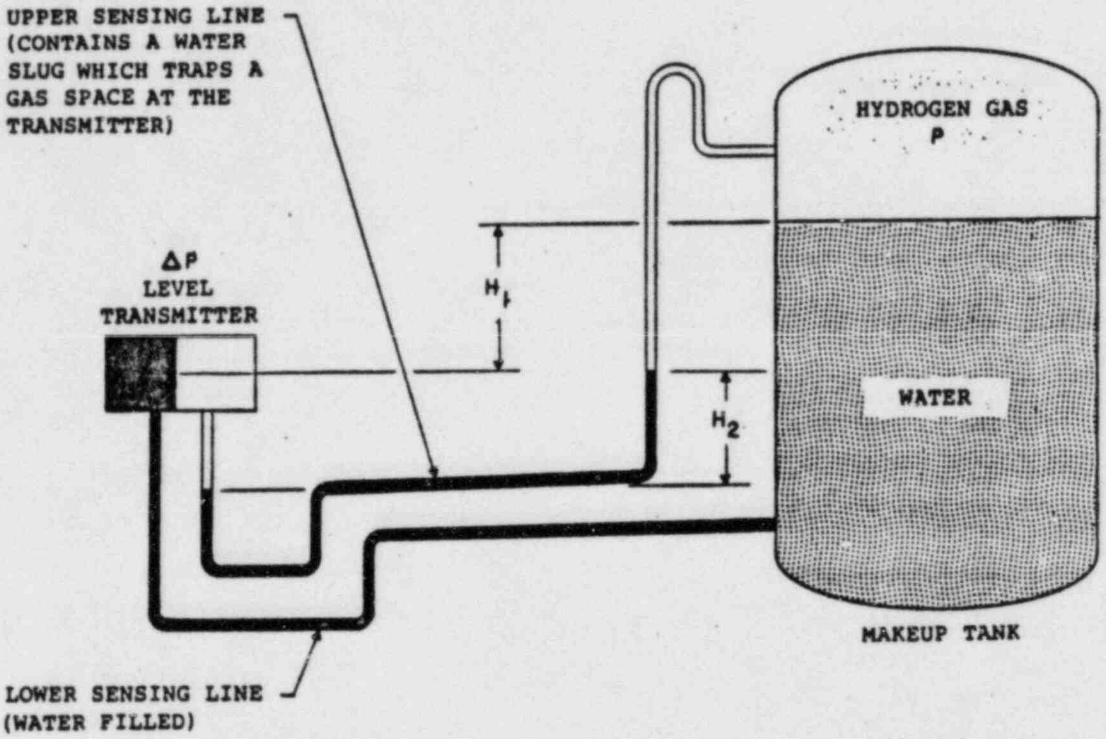
BASED ON 244 GALLONS PER PUMP-DOWN (14 INCHES)

TMI-2
RB SUMP COLLECTION RATE
BASED ON ALARM PRINTOUT
(OCTOBER 1978 THROUGH MARCH 1979)

NOT RCS PERIODS

$\Delta P \uparrow$ INDICATED LEVEL $\uparrow$

$\Delta P \downarrow$ INDICATED LEVEL $\downarrow$



NO WATER $\Delta P = \rho_g H_1$

WITH WATER $\Delta P = \rho_g H_1 - \rho_g H_2$

INCREASE P $\rightarrow$ H_2 DECREASES $\rightarrow$ ΔP INCREASES

$\uparrow$ INCREASES LEVEL

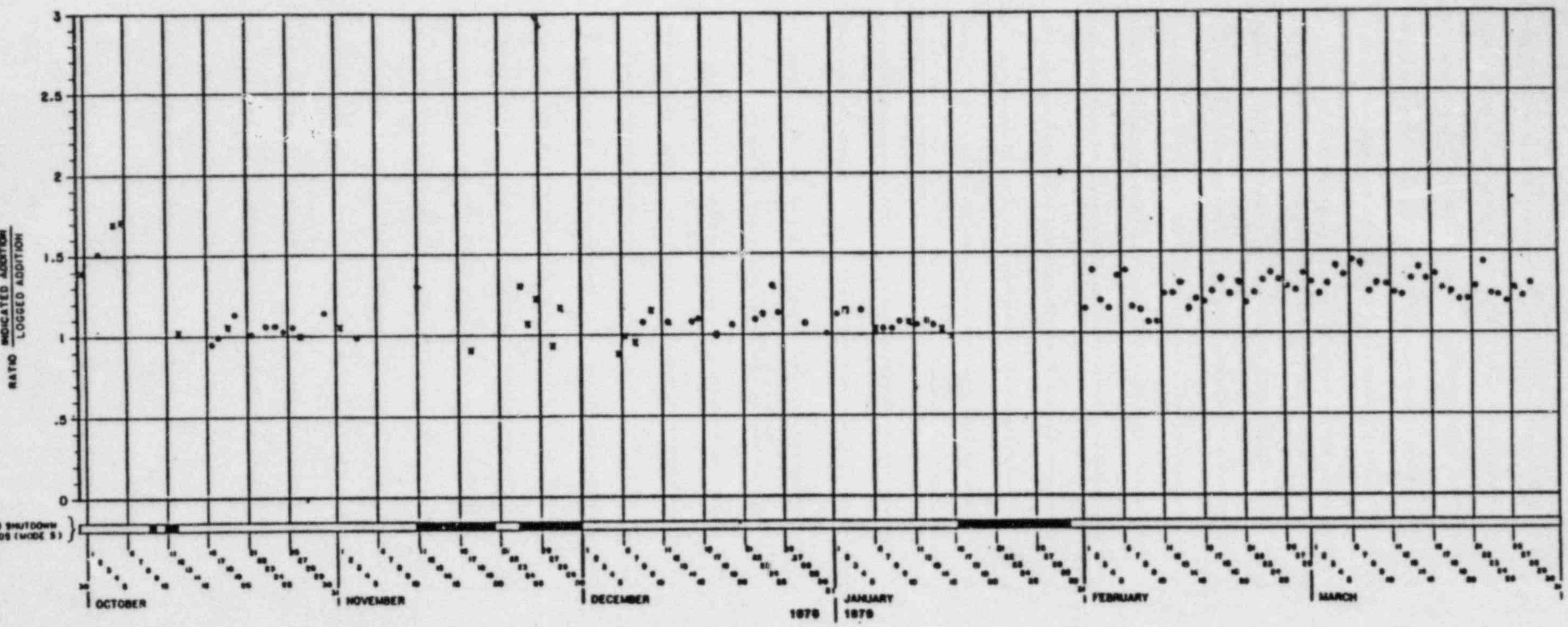
$\downarrow$ INDICATED LEVEL INCREASES

TMI-2

MAKEUP TANK AND LEVEL INSTRUMENT

SHOWING HYPOTHESIZED SOURCE OF LEVEL MEASUREMENT ERROR

(WATER SLUG IN UPPER SENSING LINE)



LEGEND:

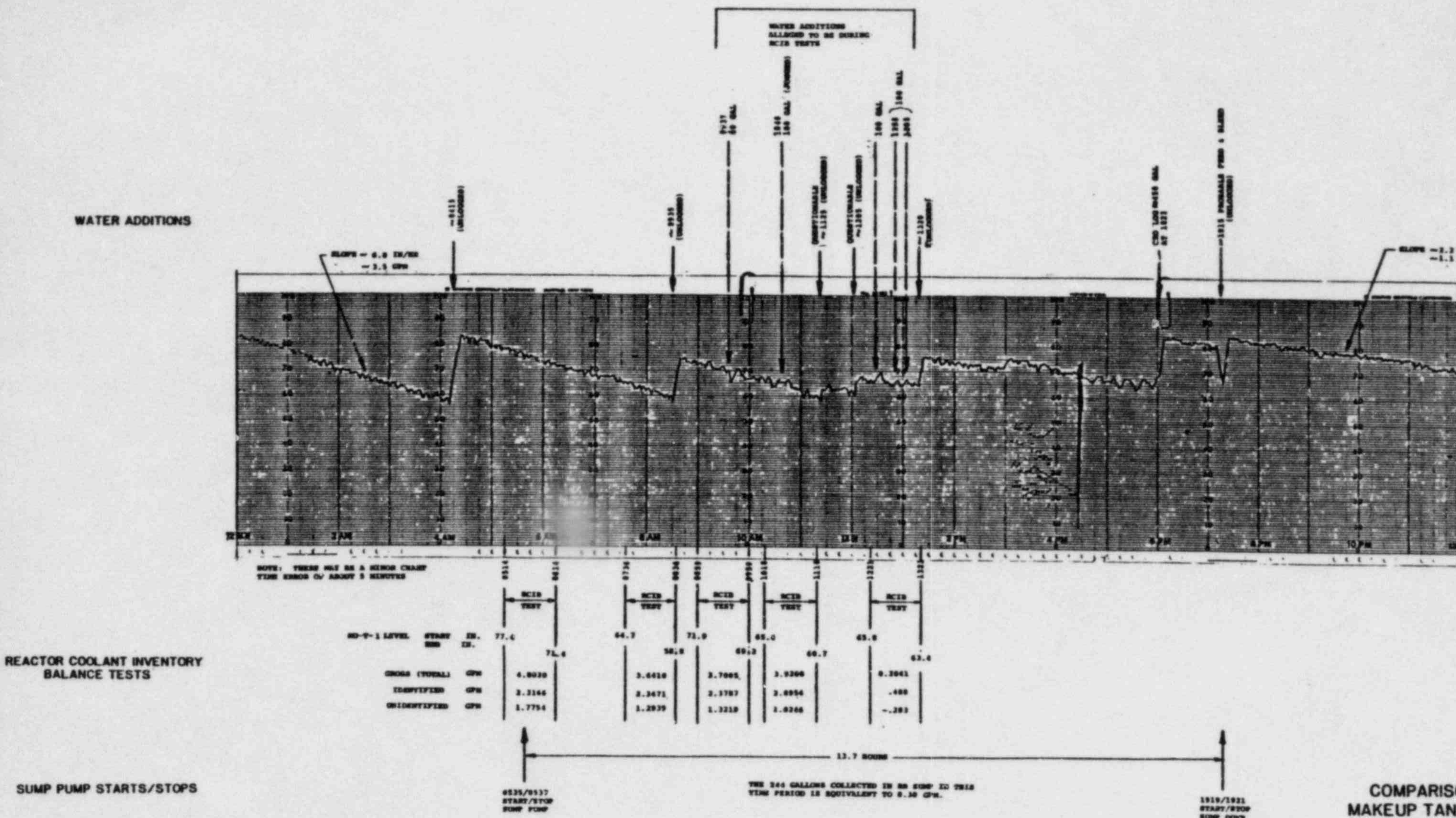
• 2 OR MORE ADDITIONS AS DATA

X 1 ADDITION AS DATA

TMI-2
MAKEUP TANK LEVEL RATIO
OF INDICATED AMOUNT OF WATER
ADDITION TO LOGGED AMOUNT
(OCTOBER 1978 THROUGH MARCH 1979)

WATER ADDITIONS

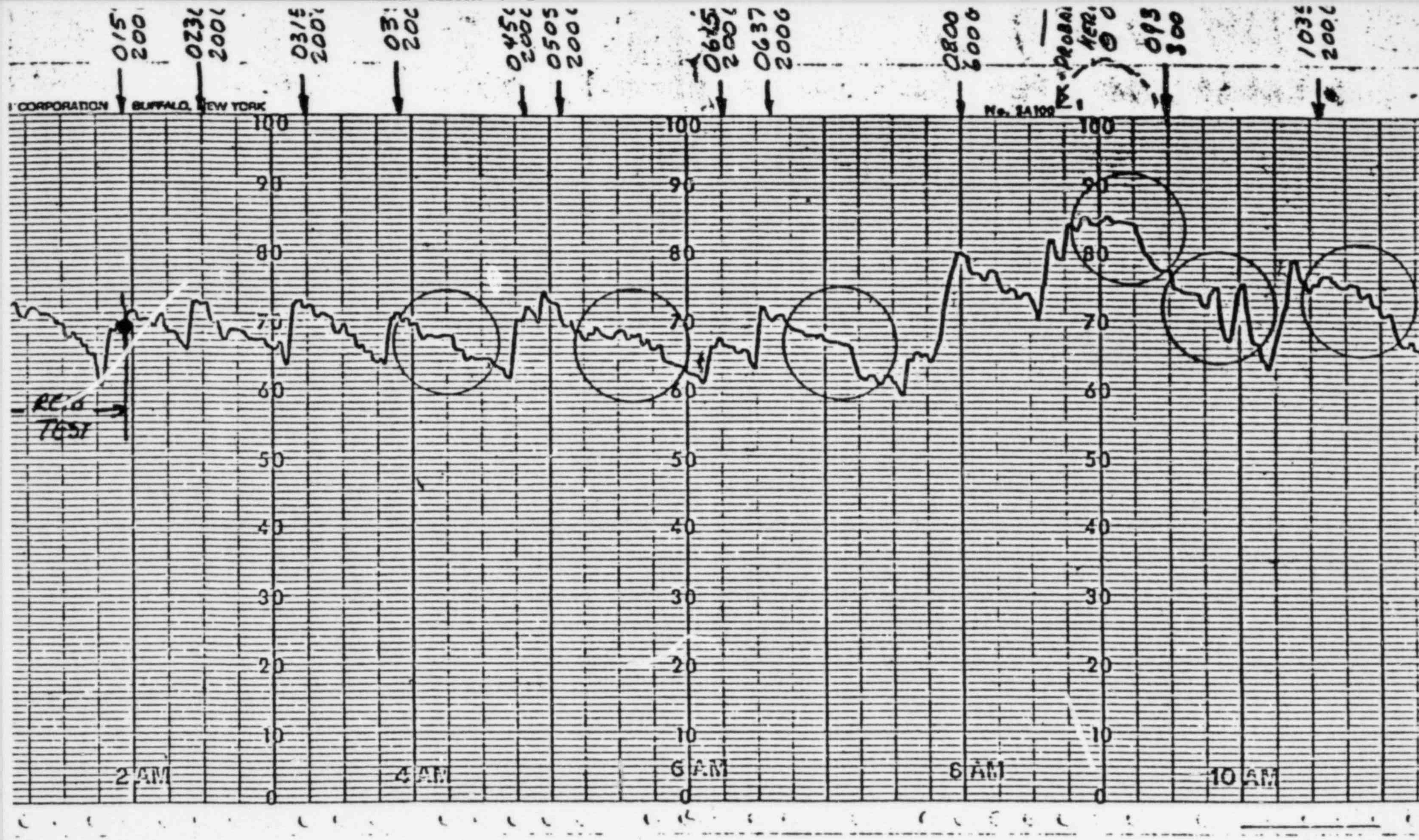
- EFFECT ON RCIB TEST RESULTS
  - ADDITIONS NOT INCLUDED IN CALCULATIONS
  - ADDITIONS INCLUDED IN CALCULATIONS
- REVIEW OF INDIVIDUAL ALLEGATIONS
  - METHODOLOGY
  - EXAMPLES



COMPARISON OF
MAKEUP TANK LEVEL,
RCIB TEST RESULTS
AND SUMP COLLECTION RATE
ON OCTOBER 18, 1978

REVIEW OF ALLEGATIONS
METHOD

- LOCATE PERIOD OF RCIB TEST ON MAKEUP TANK LEVEL CHART
  - COMPARE TIMES OF LOGGED ADDITIONS
  - CHECK FOR CHART MARKINGS
  - COMPARE TIMES OF OTHER LOGGED EVENTS
  - COMPARE VALUES OF MAKEUP TANK LEVEL FROM RCIB TEST RECORD TO LEVEL TRACE
- ESTABLISH WHETHER TRACE FLUCTUATIONS ARE TYPICAL OF THE DAY.
- COMPARE RATE OF MAKEUP TANK LEVEL CHANGE DURING TEST TO SLOPE OF TRACE BEFORE AND AFTER TEST PERIOD.
- CONFIRM PLANT WAS IN STEADY STATE.
  - CHECK EVENTS IN PROGRESS PER LOG
  - DETERMINE CHANGES IN PARAMETERS RECORDED AT BEGINNING AND END OF RCIB TEST



CORPORATION BUFFALO, NEW YORK
No. 2A100
0151 200
0230 2000
0315 2000
03: 200
0450 2000
0505 2000
0615 2000
0637 2000
0800 6000
0915 800
1035 2000
REC'D TEST
2 AM
4 AM
6 AM
8 AM
10 AM
100
90
80
70
60
50
40
30
20
10
0

3/19

EFFECT TO PARAMETER FLUCTUATIONS ON MAKEUP TANK LEVEL

PARAMETER	TYPICAL PARAMETER FLUCTUATION	RESULTING MAKEUP TANK LEVEL FLUCTUATION
AVERAGE TEMPERATURE	±0.3 TO 0.6°F	±1.0 TO 2.0 IN. (±30 TO 60 GAL.)
PRESSURE	±20 TO 40 PSI	±0.6 TO 1.2 IN. (±18 TO 36 GAL.)
PRESSURIZER LEVEL	±1.7 TO 3.4 PSI	±0.7 TO 1.4 IN. (±20 TO 40 GAL.)

TABLE 3

Leak Rate Tests during which water was added to the RCS without correct entry into the computer and the effect of the discrepancy on the unidentified leak rate.

DATE	Test Starting Time	WATER ADD (Gal)	WHETHER ENTERED IN CRO LOG	EFFECT ON* LEAK RATE GPM	ORIGINAL MED. ED. LEAK RATE GPM	CORRECTED* LEAK RATE GPM
9/30/78	17:34	650	no	10.82	0.8954	11.72
10/2/78	23:04	600	no	10.0	0.4553	10.46
10/4/78	4:47	120	no	2.0	0.9204	2.92
10/14/78	15:03	150	no	2.5	0.8787	1.61
12/24/78	17:36	200	yes	3.33	0.1822	3.51
1/13/79	9:37	117	yes	1.95	0.2639	2.21
2/2/79	0:55	300	yes	5.0	0.7513	5.75
2/11/79	18:08	300	yes	5.0	-0.0603	4.94
2/23/79	11:07	150	yes	2.5	0.3217	2.82
3/15/79	4:50	90	no	1.5	0.0562	1.56
3/19/79	0:58	400**	yes	3.33	-0.1851***	3.15

*As it would have been calculated by the computer, without accounting for expansion in the RCS.
**200 gallons entered into the computer.
***Original computer result was 1.3926 gpm, which was corrected by hand calculations.

REVIEW OF TABLE 3 OF NRC
MAY 23, 1984 MEMORANDUM

- VERY LARGE "CORRECTED" LEAK RATES INDICATE POSSIBLE MISINTERPRETATION

- NEED TO MATCH MAKEUP TANK LEVEL CHART WITH RCIB PRINTOUT AND WITH CRO LOG

- CHART TIME ERRORS

  9/30
  10/2
  10/4
  10/14

- CRO LOGGING ERRORS

  12/24
  2/2
  3/19

- PROBABLE ADDITIONS, BUT RC DRAIN TANK LEVEL CHANGE IS UNUSUAL

  2/11 - Slight RCDT Level Decrease
  2/23 - Almost Zero RCDT Level Change

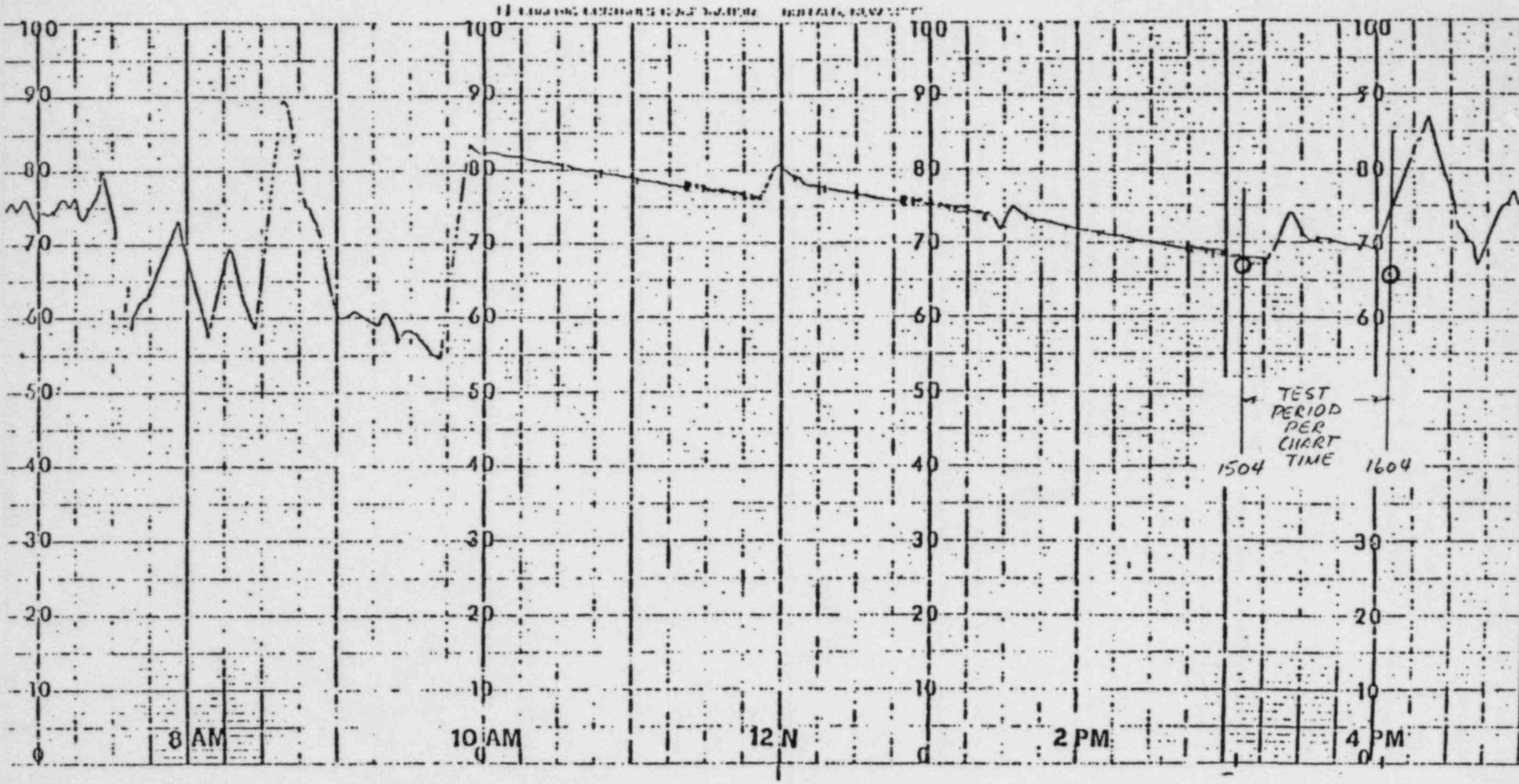
- ADDITION

  1/13

- "JOGGED" ADDITION

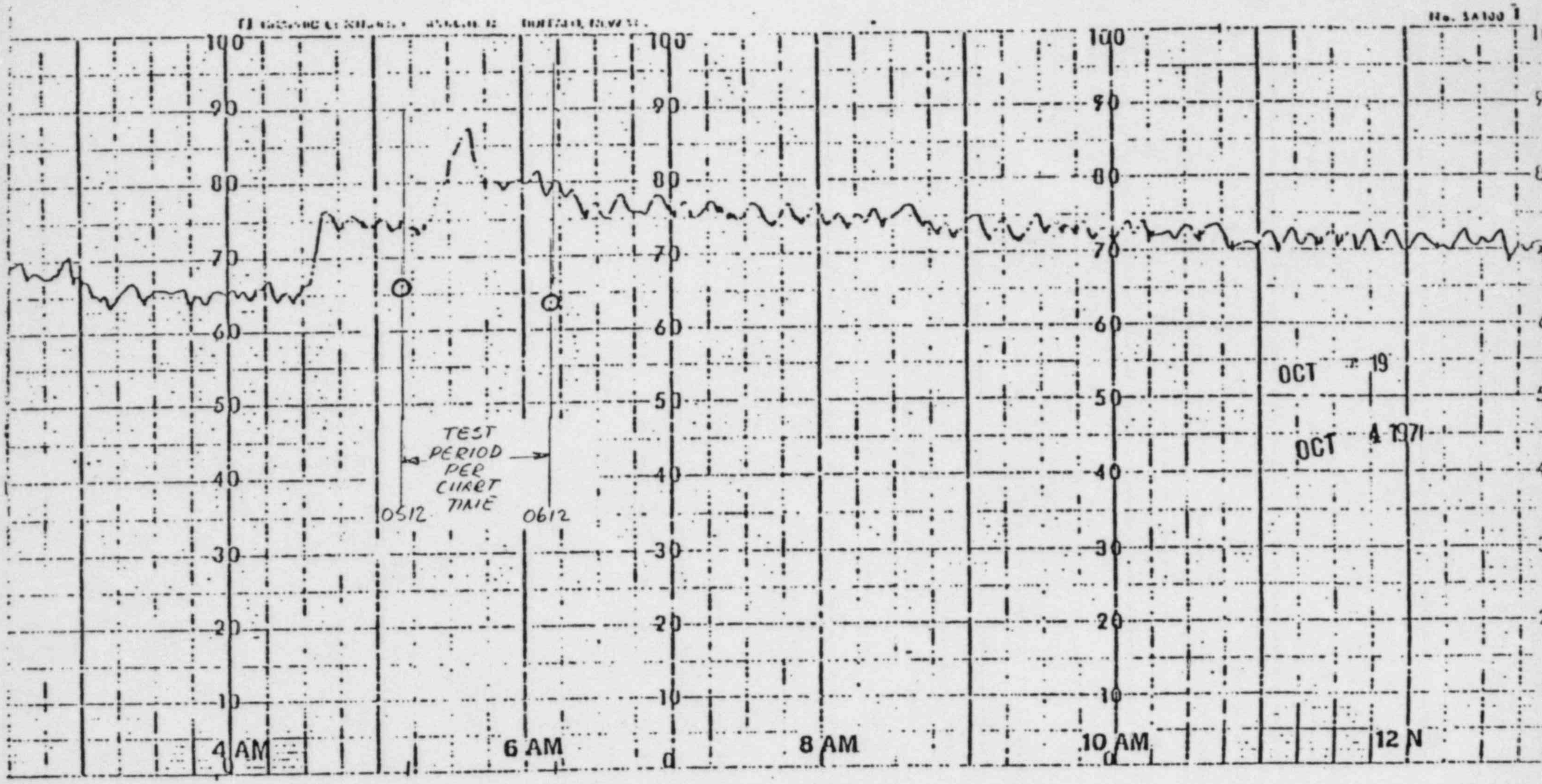
  3/15

REVIEW OF TBL 3

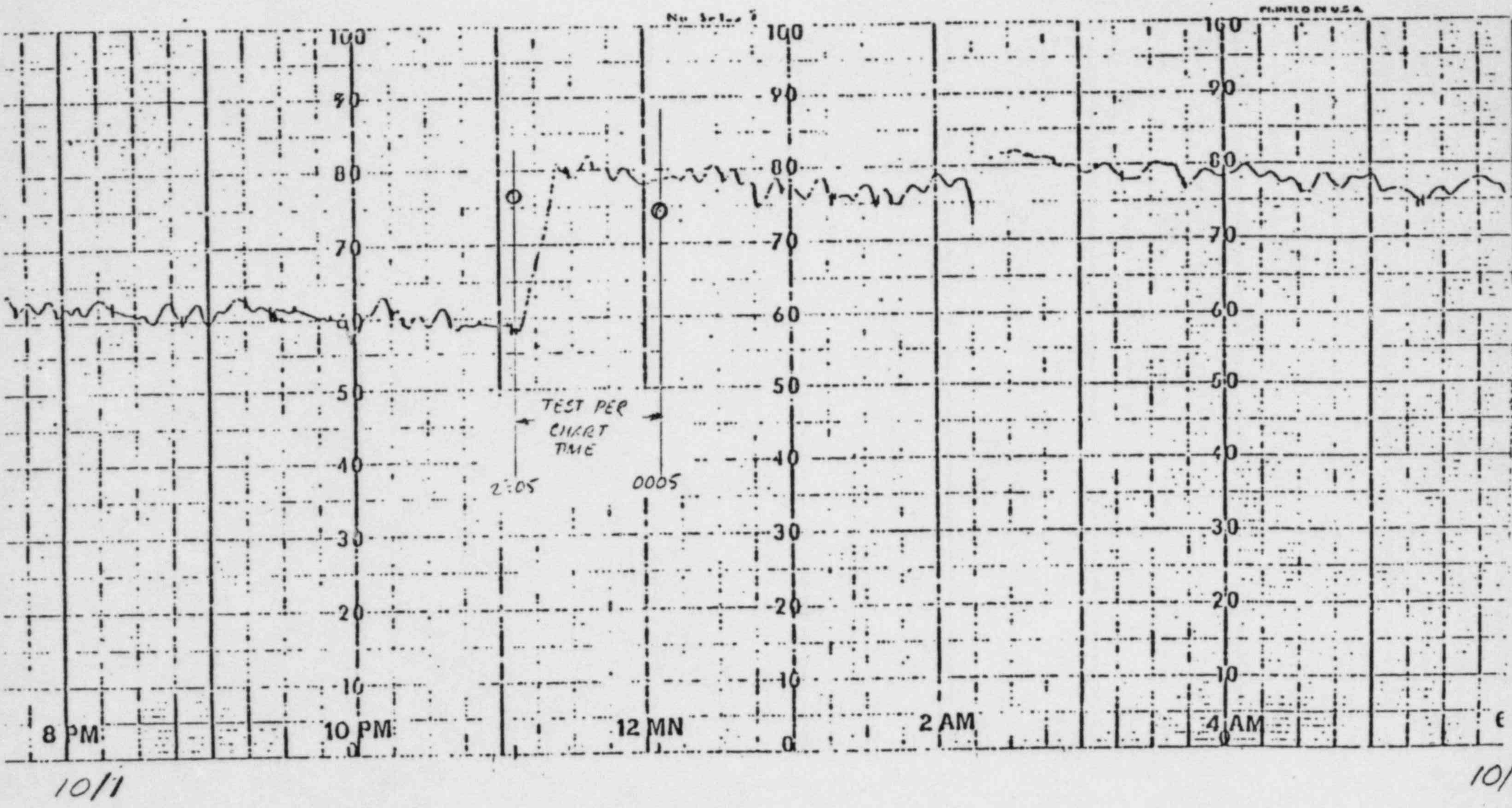


100
90
80
70
60
50
40
30
20
10
0
8 AM
10 AM
12 N
2 PM
4 PM
TEST PERIOD PER CHART TIME
1504
1604

10/14


TEST PERIOD PER CHART TIME
0512
0612
4 AM
6 AM
8 AM
10 AM
12 N
OCT 19
OCT 4 1971

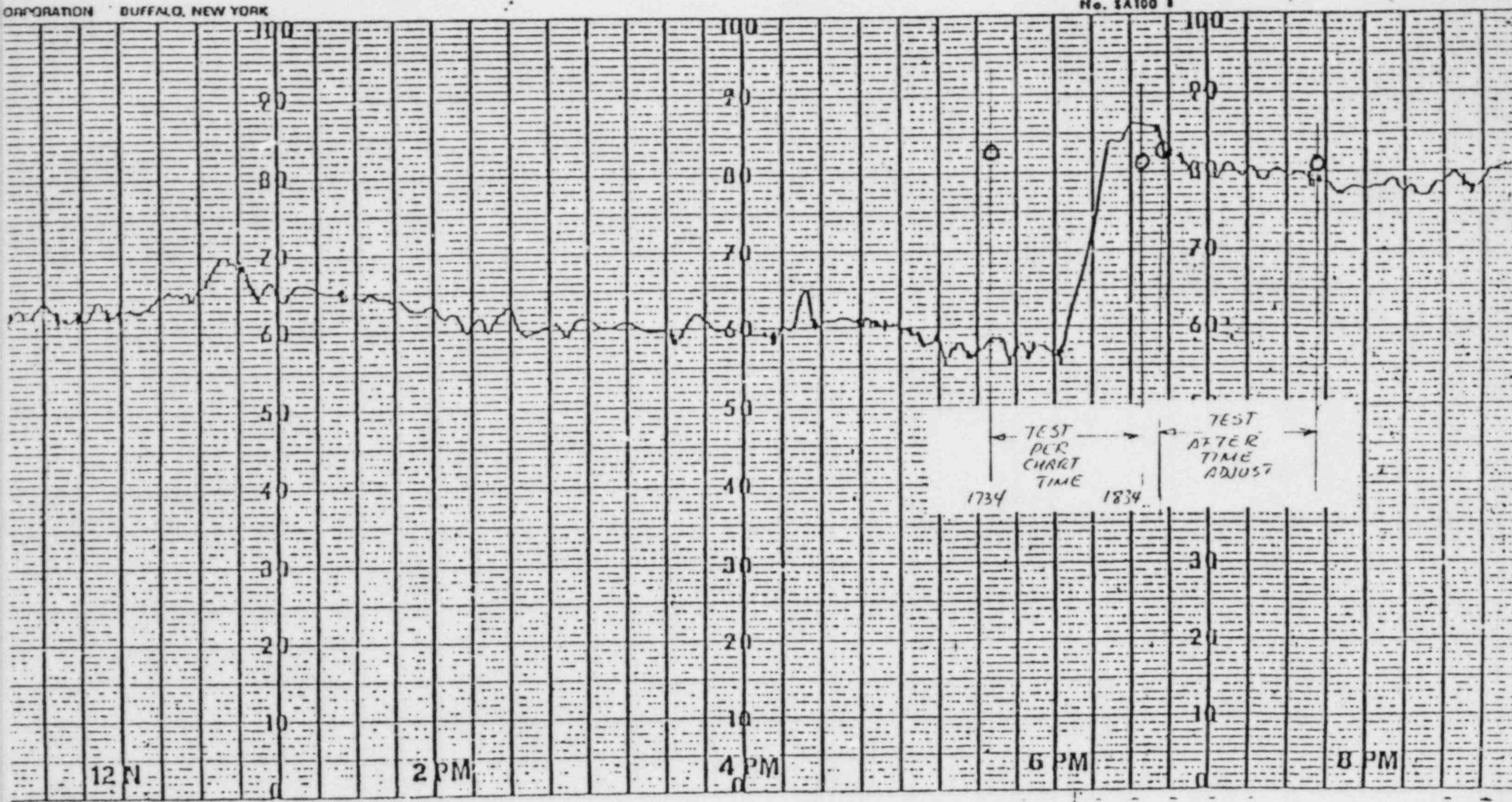
10/4



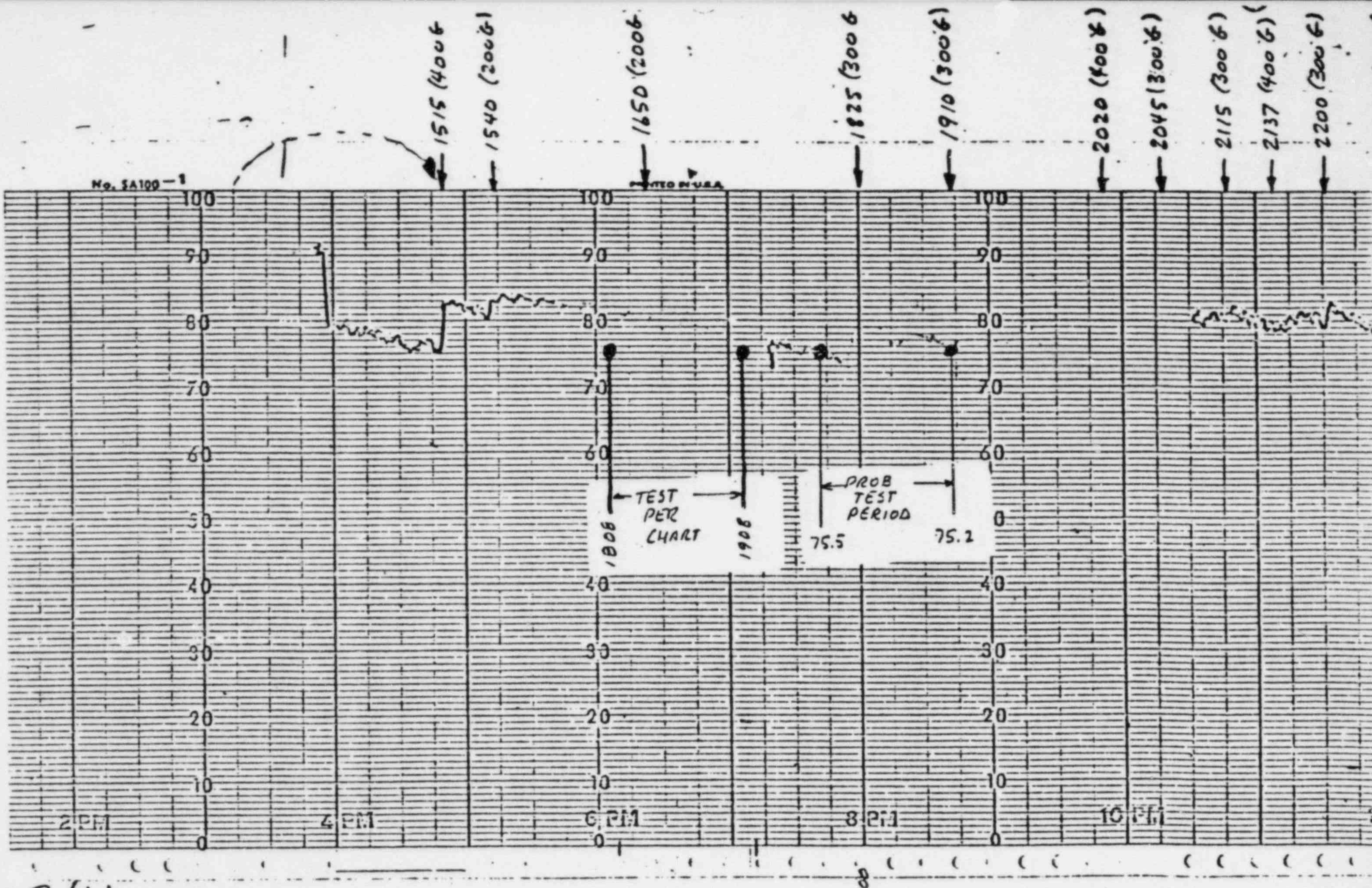
100
90
80
70
60
50
40
30
20
10
0
8 PM
10 PM
12 MN
2 AM
4 AM
TEST PER CHART TIME
2:05
0005
10/1
10/2

ORPORATION BUFFALO, NEW YORK

No. SA100 1



9/30

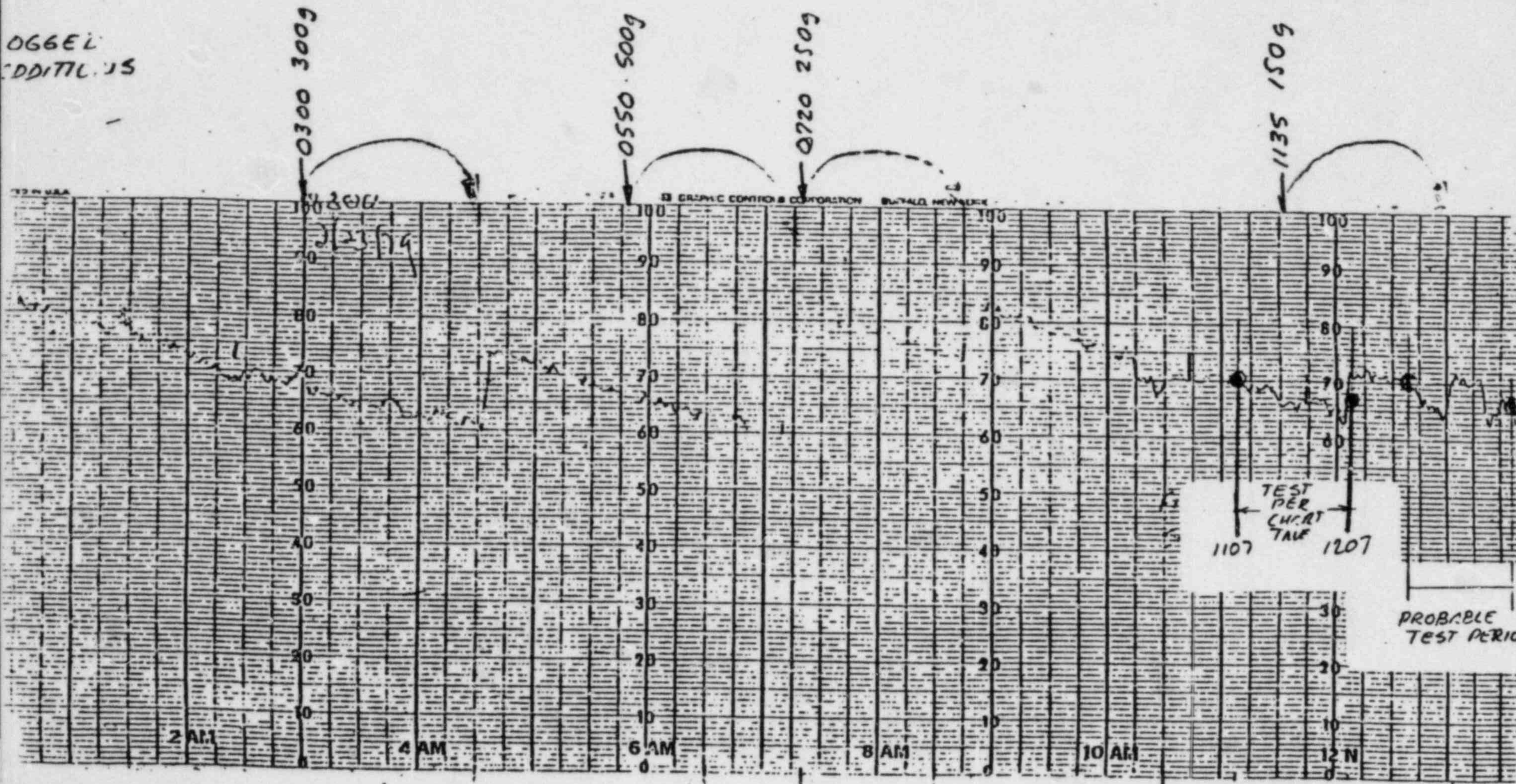


2/11

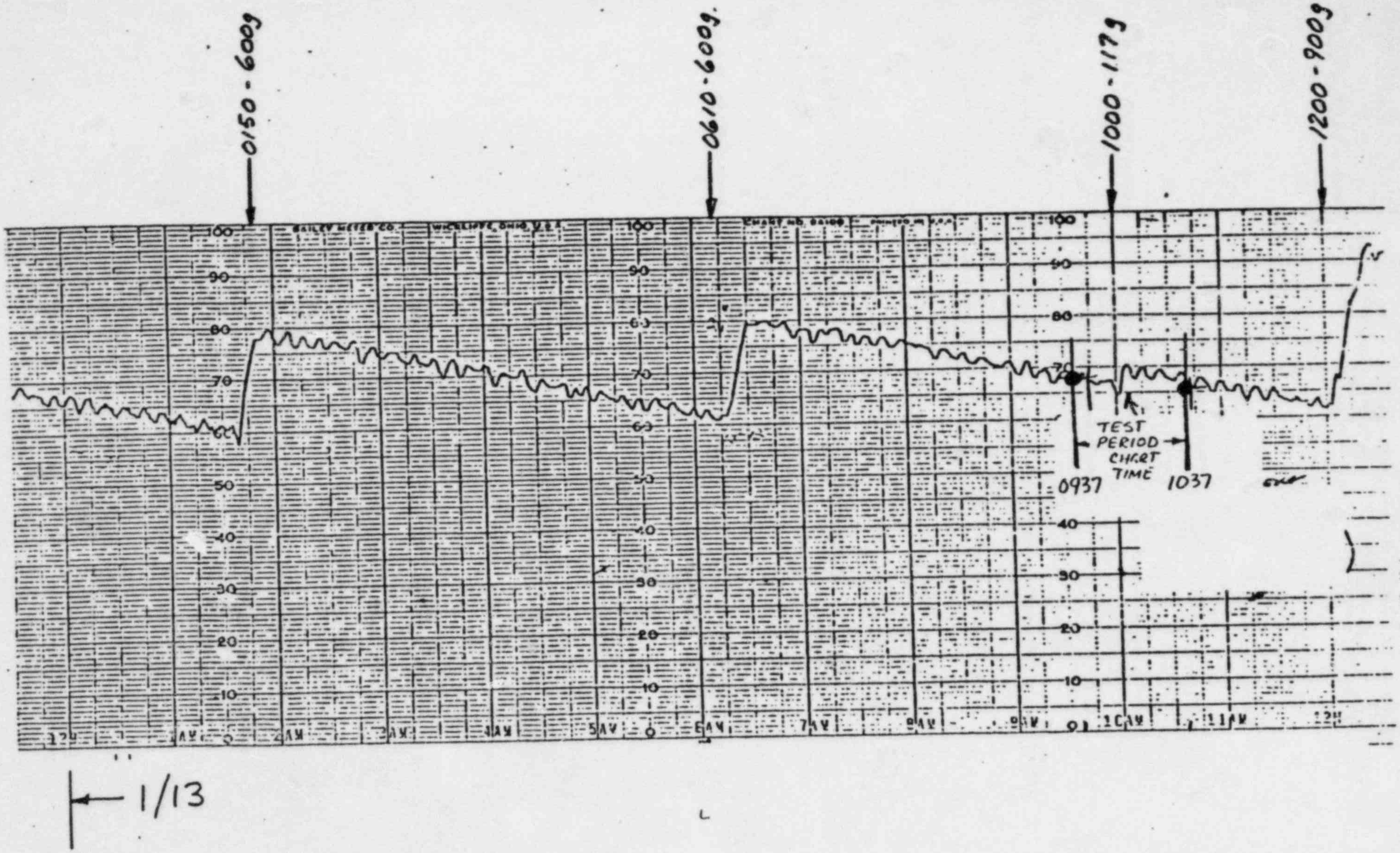
2/11 AGREES W/LOG ~1½ HR CHART ERROR.

2/23

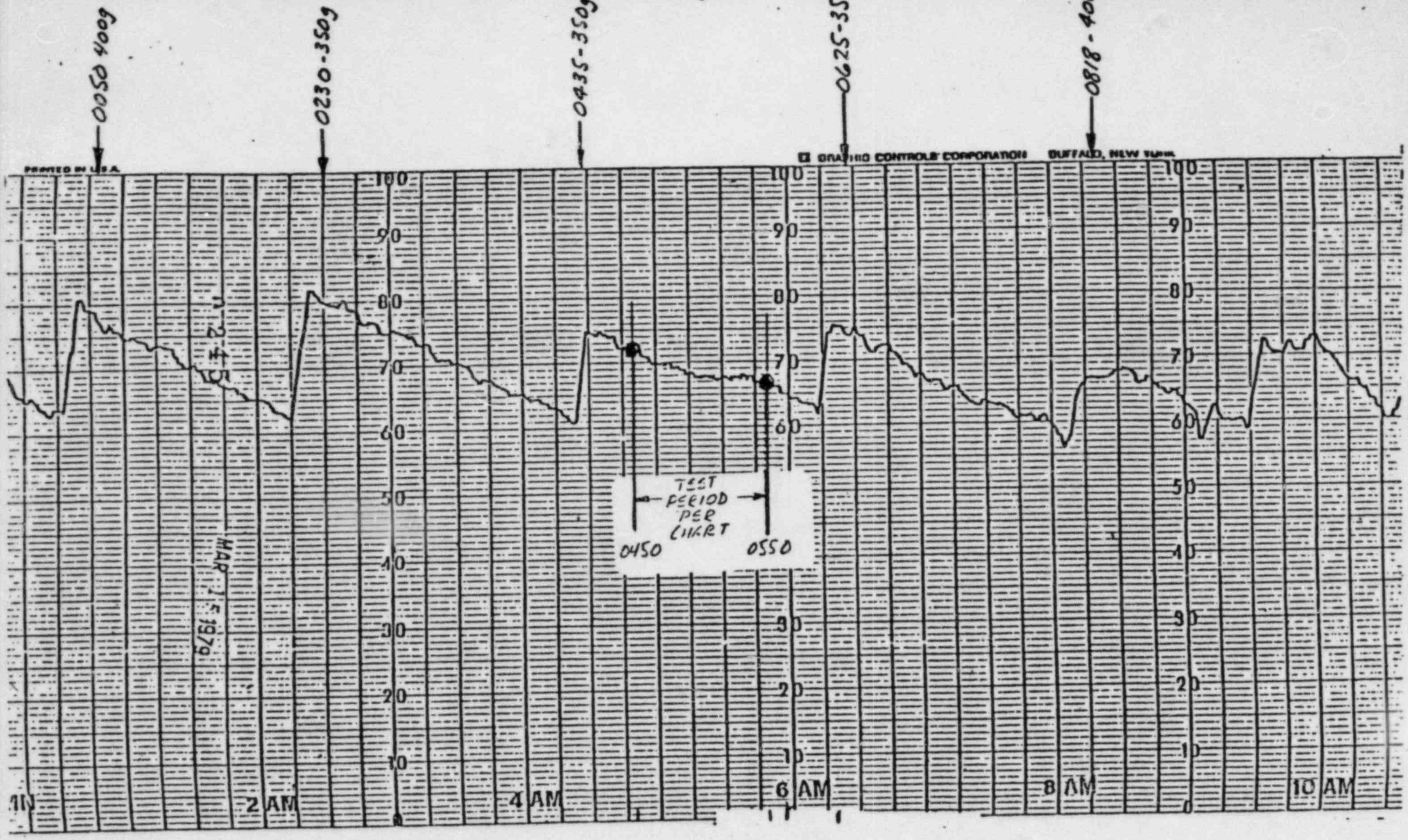
OGGEL
CDDITIC.US



/23

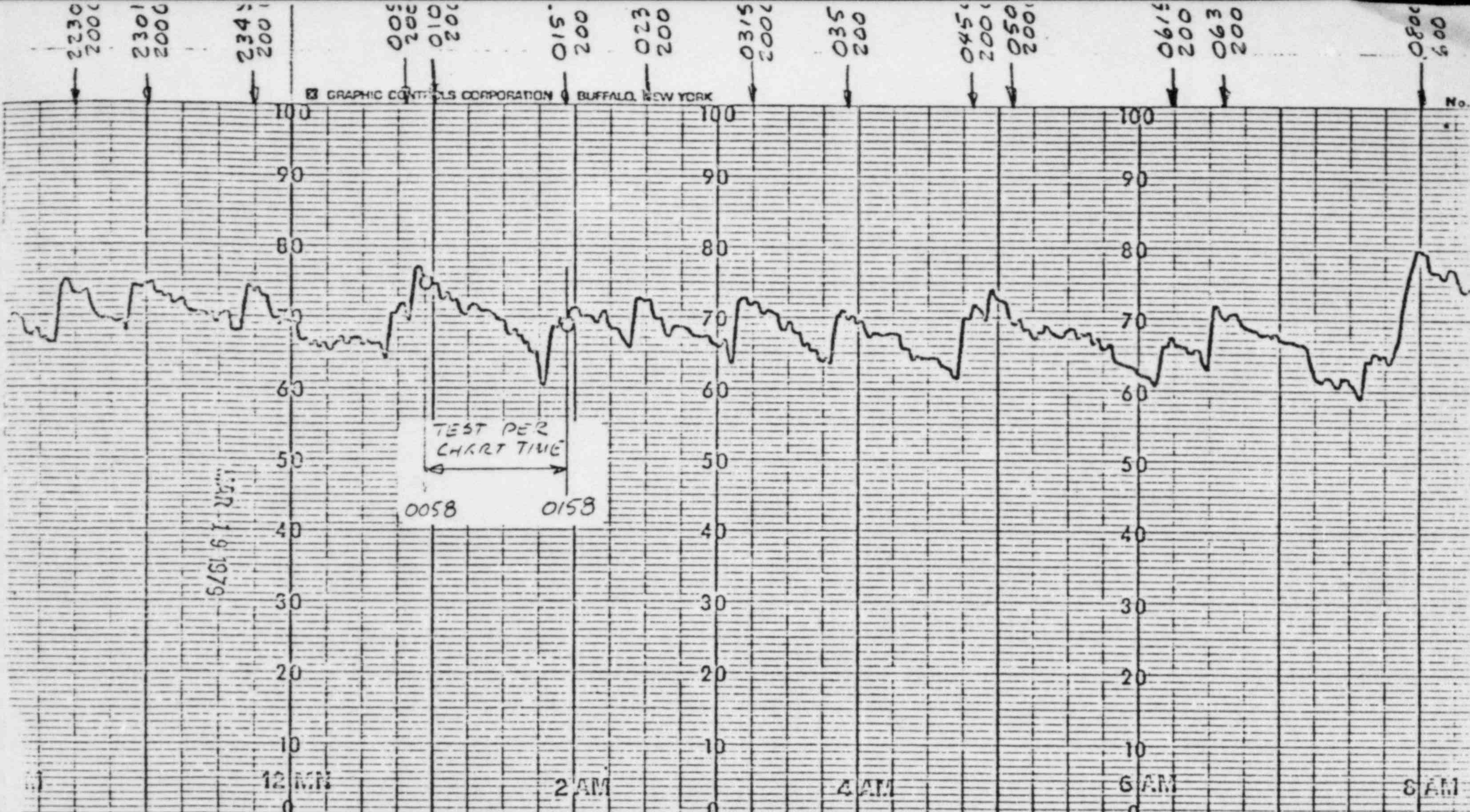

0150 - 6009
0610 - 6009.
1000 - 1179
1200 - 9009
BAILEY METER CO. WICKLIFFE, OHIO U.S.A.
TEST PERIOD CHART TIME
0937
1037
1/13

1'13


0050 400g
0230-350g
0435-350g
0625-35
0818-40
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
PRINTED IN U.S.A.
TEST PERIOD PER CHART
0450
0550
MAR 15 1979
MN
2 AM
4 AM
6 AM
8 AM
10 AM

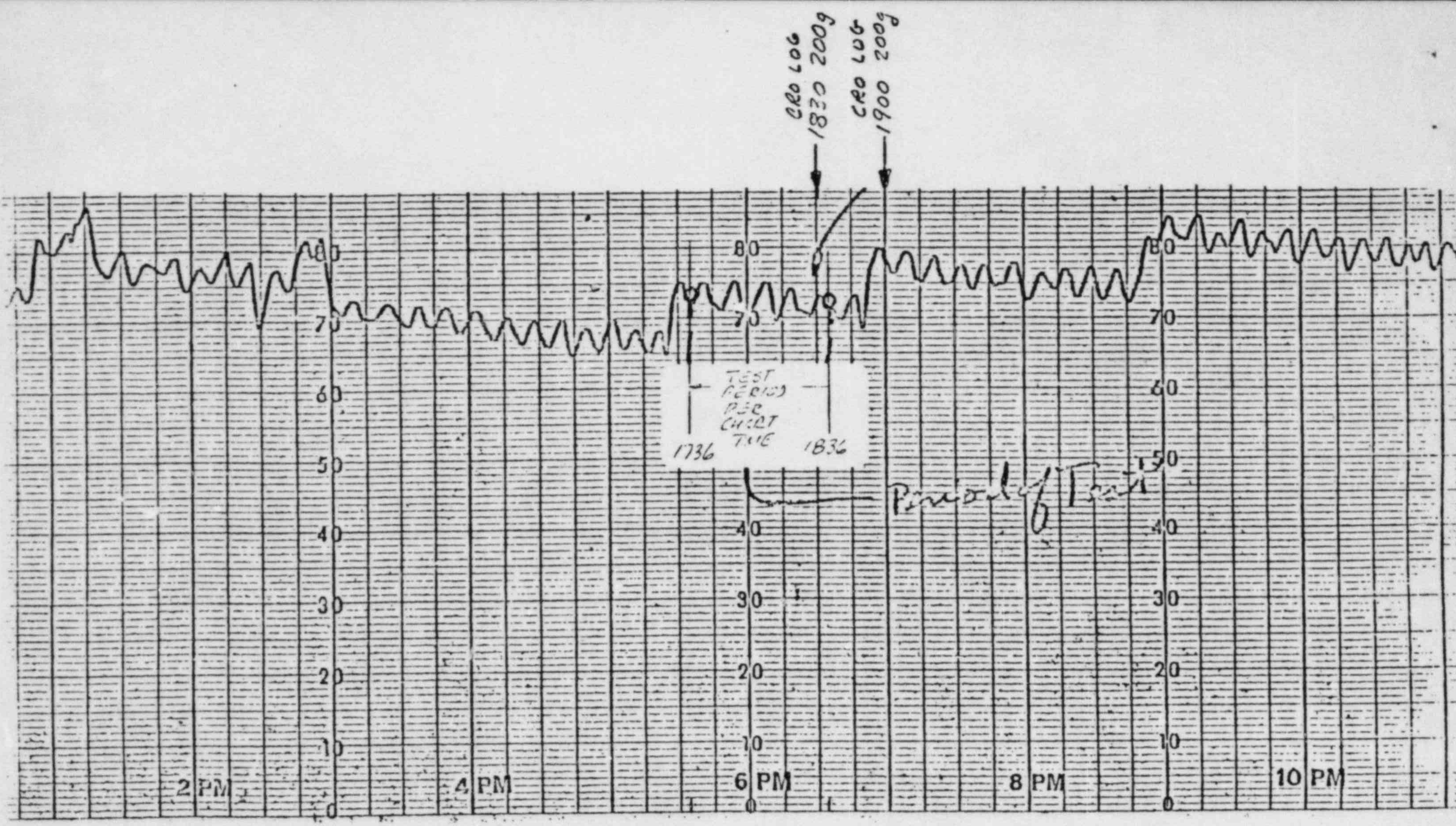
3/15

3/15



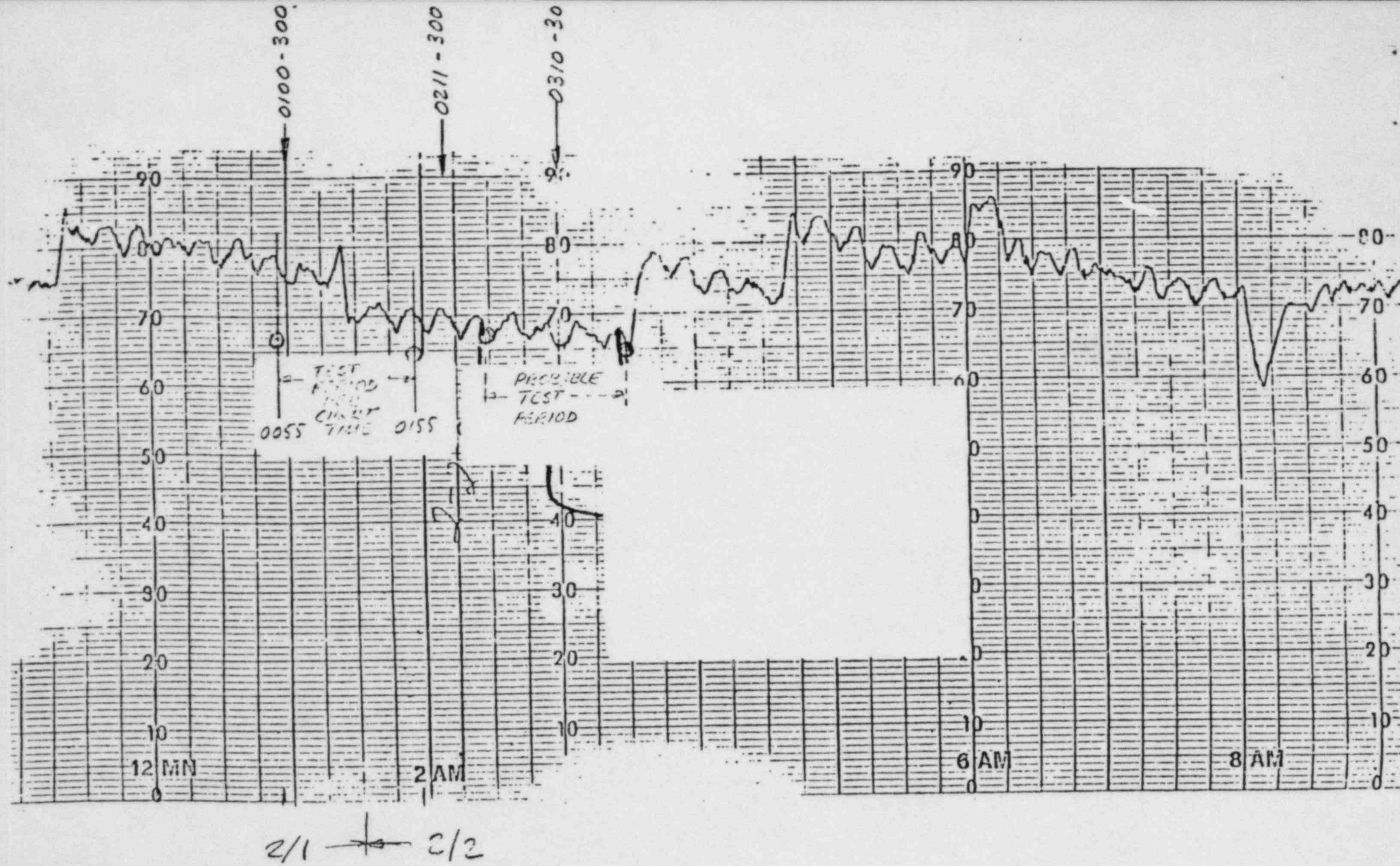
2230 2000
2301 2000
2345 200
0058 200
0100 200
0158 200
0230 200
0315 2000
0350 200
0450 2000
0500 2000
0615 200
0630 200
0800 600
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
No.
100
90
80
70
60
50
40
30
20
10
0
12 MN
2 AM
4 AM
6 AM
8 AM
TEST PER CHART TIME
0058
0158
MAR 19 1979

3/18-3/19

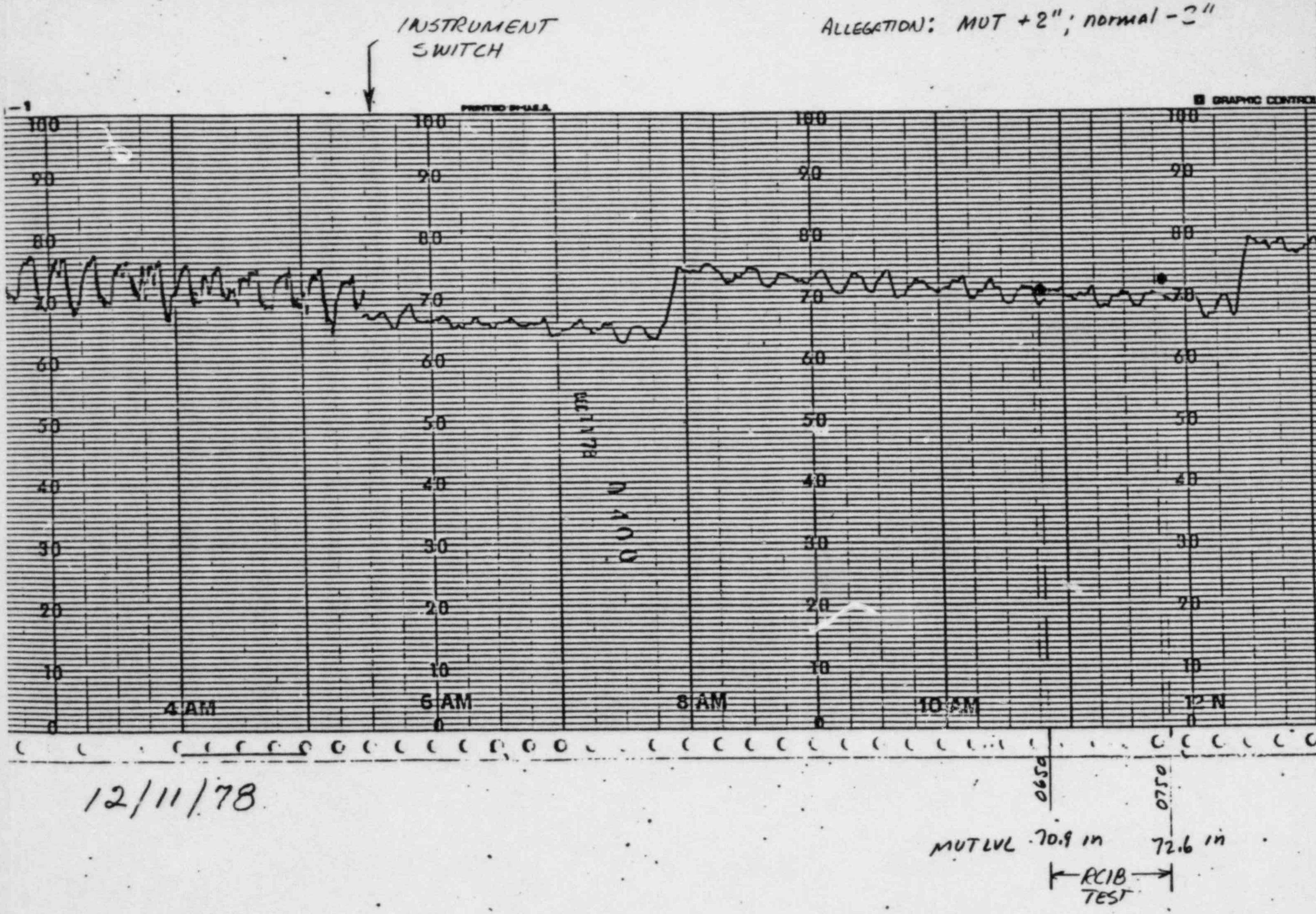


CRO LOG
1820 2009
CRO LOG
1900 2009
TEST PERIOD PER CHART TIME
1736
1836
Period of Test
80
70
60
50
40
30
20
10
0
2 PM
4 PM
6 PM
8 PM
10 PM

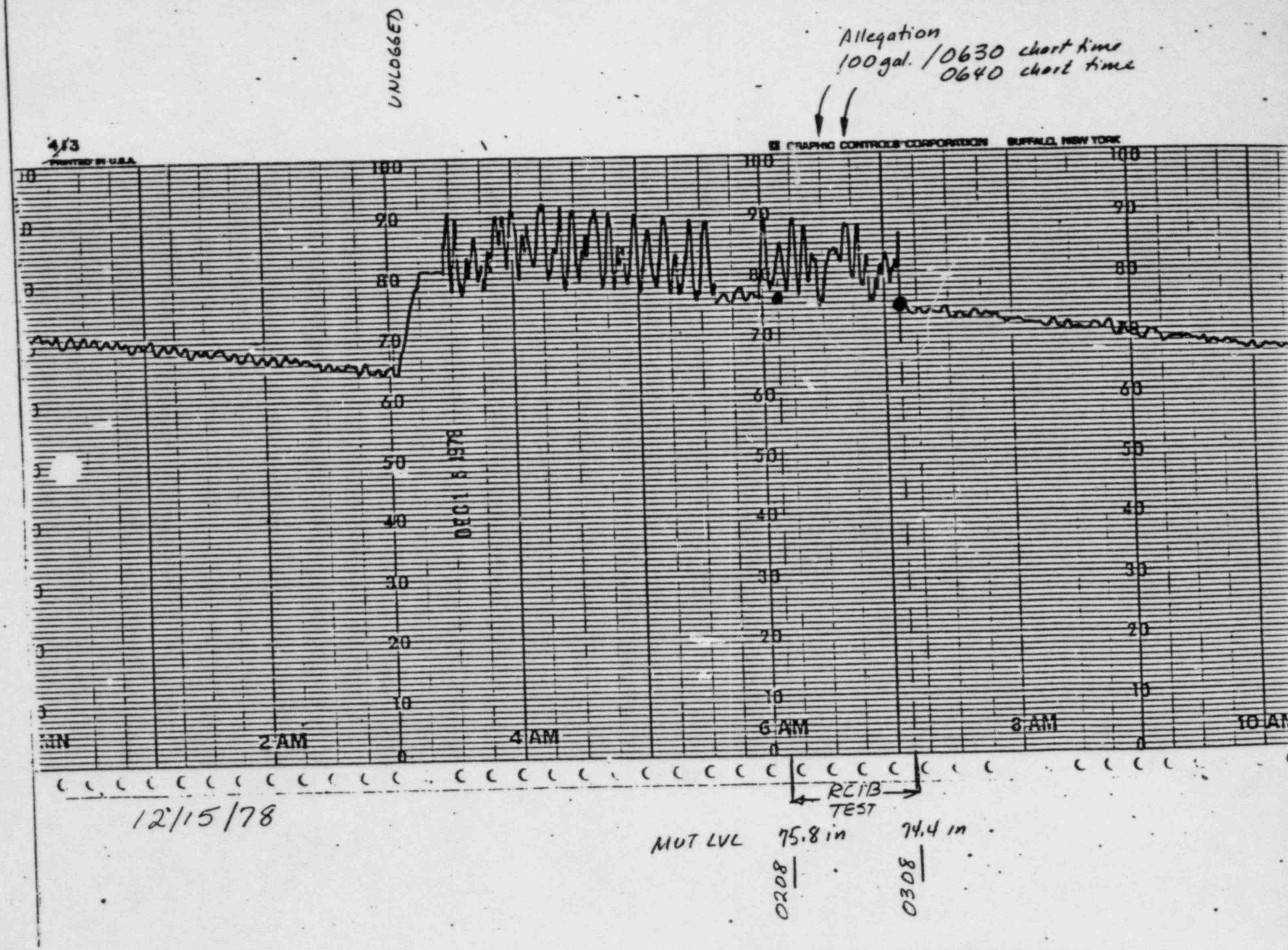
12/24



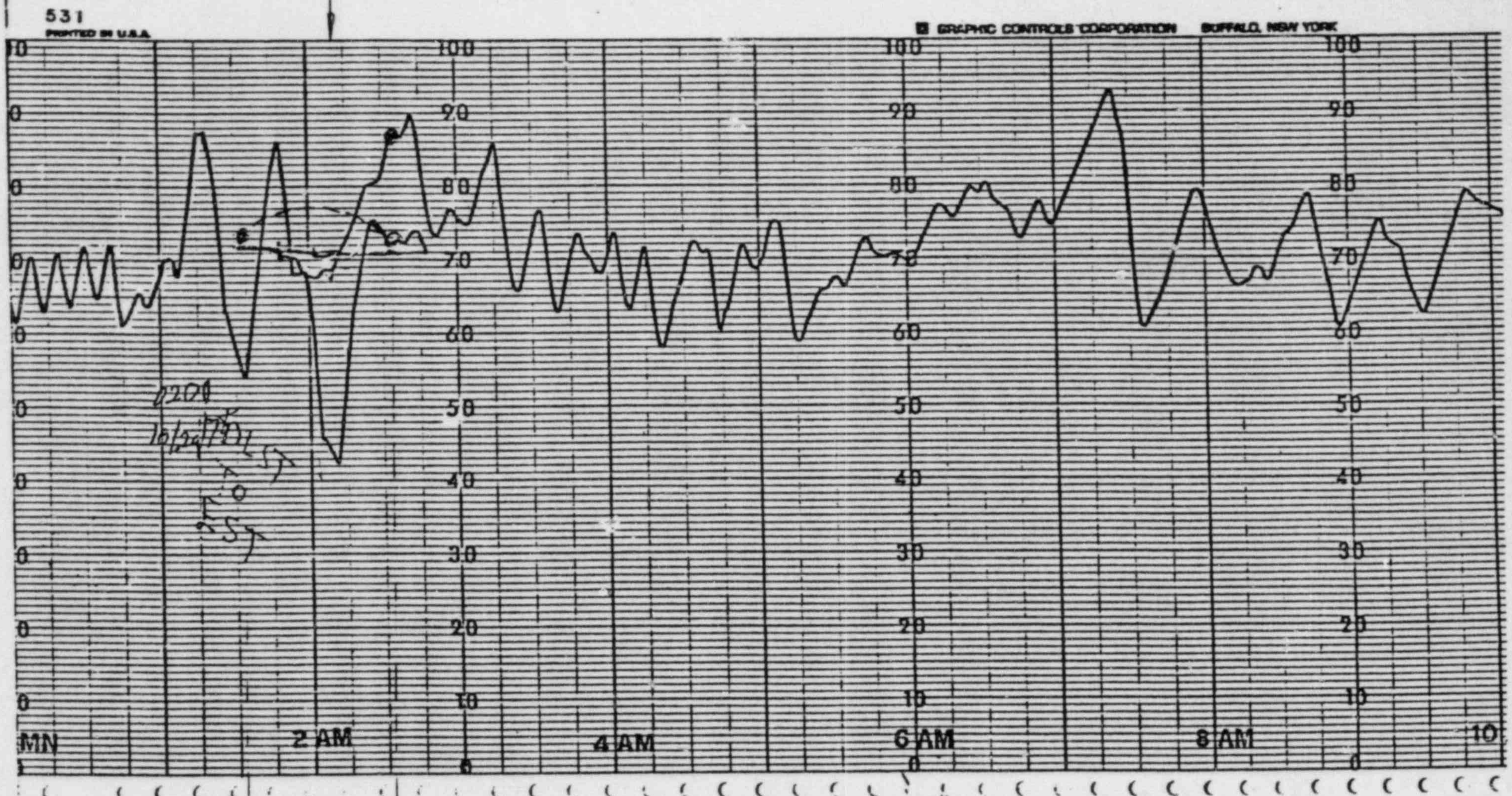
0100-300
0211-300
0310-30
TEST PERIOD PER CHART TIME
0055
0155
PROBABLE TEST PERIOD
12 MN
2 AM
6 AM
8 AM
90
80
70
60
50
40
30
20
10
0
2/1
2/2



ALLEGATION: MUT +2"; normal -2"
INSTRUMENT SWITCH
GRAPHIC CONTROLS
PRINTED IN U.S.A.
4 AM
6 AM
8 AM
10 AM
12 N
0650
0750
MUT LVL 70.9 in
72.6 in
RCIB TEST
12/11/78


UNLOGGED
Allegation
100 gal. / 0630 chart time
0640 chart time
4/13
PRINTED IN U.S.A.
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
100
90
80
70
60
50
40
30
20
10
0
DEC 15 1978
MN
2 AM
4 AM
6 AM
8 AM
10 AM
12/15/78
RCIB TEST
MUT LVL
75.8 in
74.4 in
0208
0308

CRO LOG
0211 330 gal. -
EST = 0311 DST



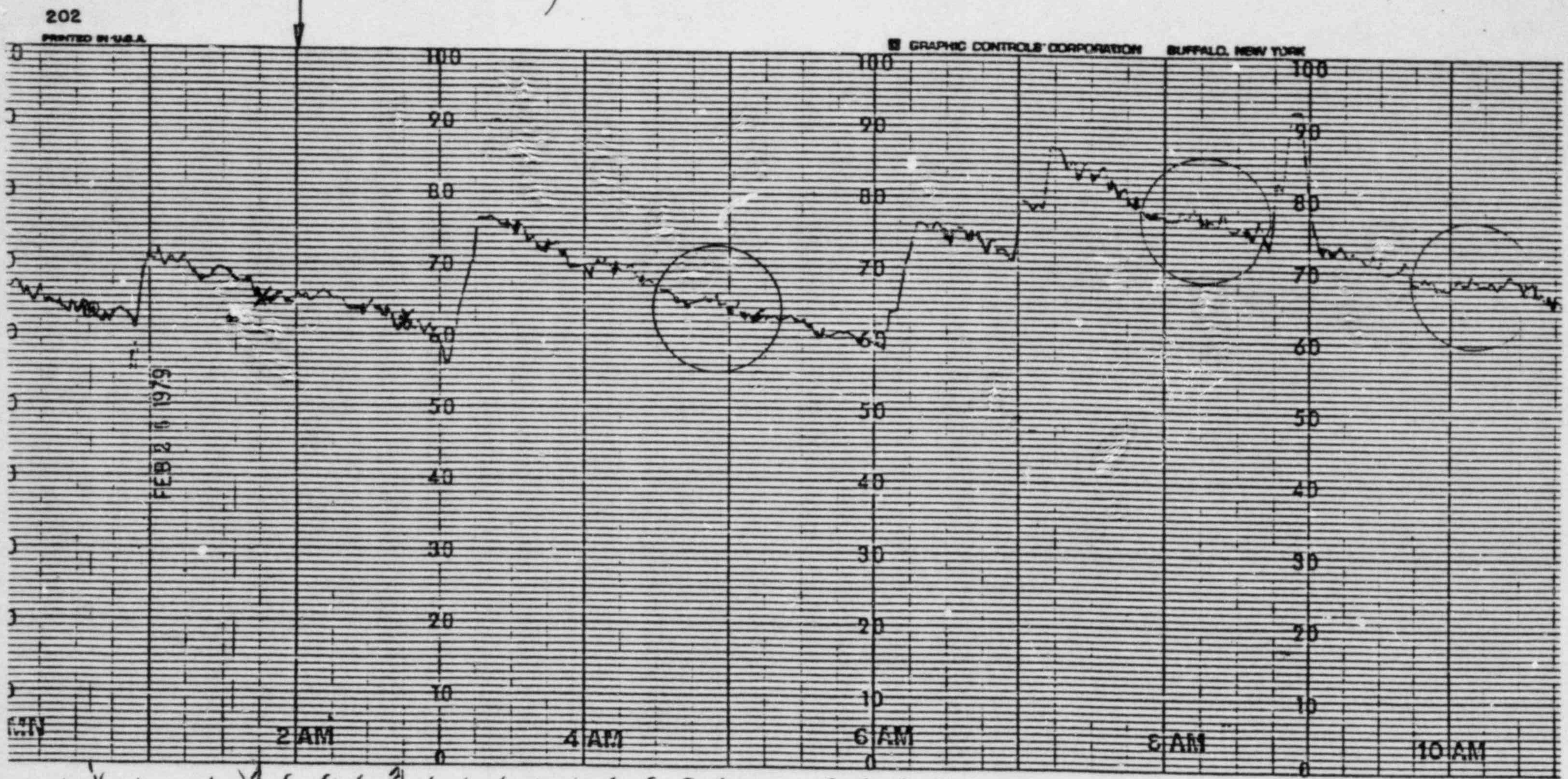
10/29/78

MUTLVL 73.79 in 87.135 in

0132 0232 ← ALL DST

TAVE CHANGE +6.2 °F
PLANT NOT STEADY STATE.

ALLEGATION:
120 gal at 0200 chart time
(JOGGED)



MVT LVL 65.1 in 62.0

0038 0138

2/26/79

CONFIRMED WATER ADDITIONS
NOT INCLUDED IN RCIB CALCUALTION

1.	JANUARY 13, 1979 (0937 TO 1037)	117 GAL. ADDED AT 100	RECORDED IN CRO LOG.
2.	FEBRUARY 11, 1979 (1808 TO 1908)	300 GAL. ADDED AT 1825	RECORDED IN CRO LOG.
3.	FEBRUARY 12, 1979 (2120 TO 2220	ABOUT 150 GAL. ADDED AT ABOUT 2130	NOT RECORDED IN CRO LOG.
4.	FEBRUARY 23, 1979 (1107 TO 1207)	150 GAL. ADDED AT 1135	RECORDED IN CRO LOG.

NOTES

1. TESTS ON 2/11 AND 2/12 HAD A DROP IN RC DRAIN TANK LEVEL. TEST ON 2/23 HAD ESSENTIALLY NO CHANGE IN RC DRAIN TANK LEVEL.

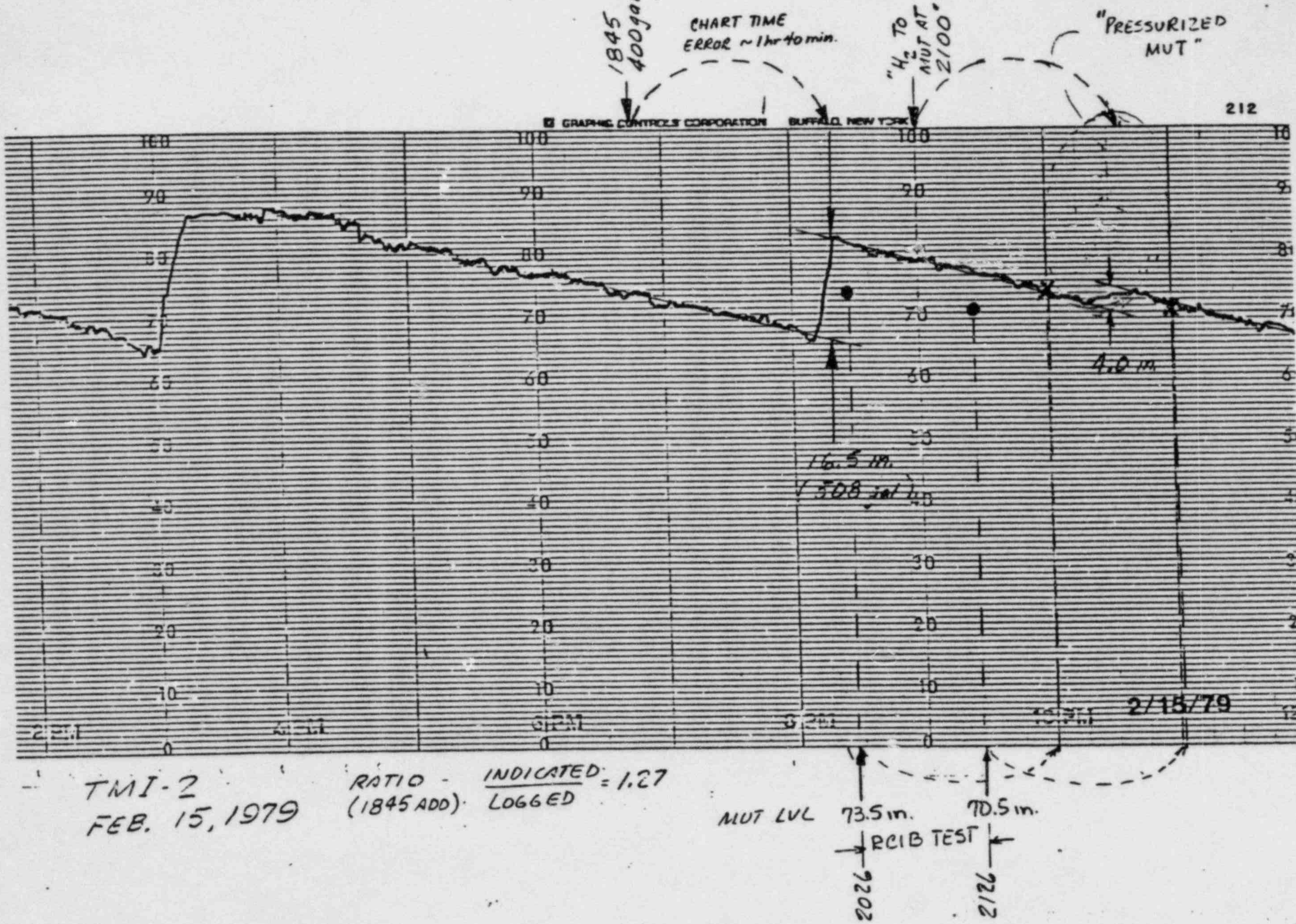
HYDROGEN ADDITIONS

- EFFECT ON RCIB TEST RESULTS

- REVIEW OF INDIVIDUAL ALLEGATIONS

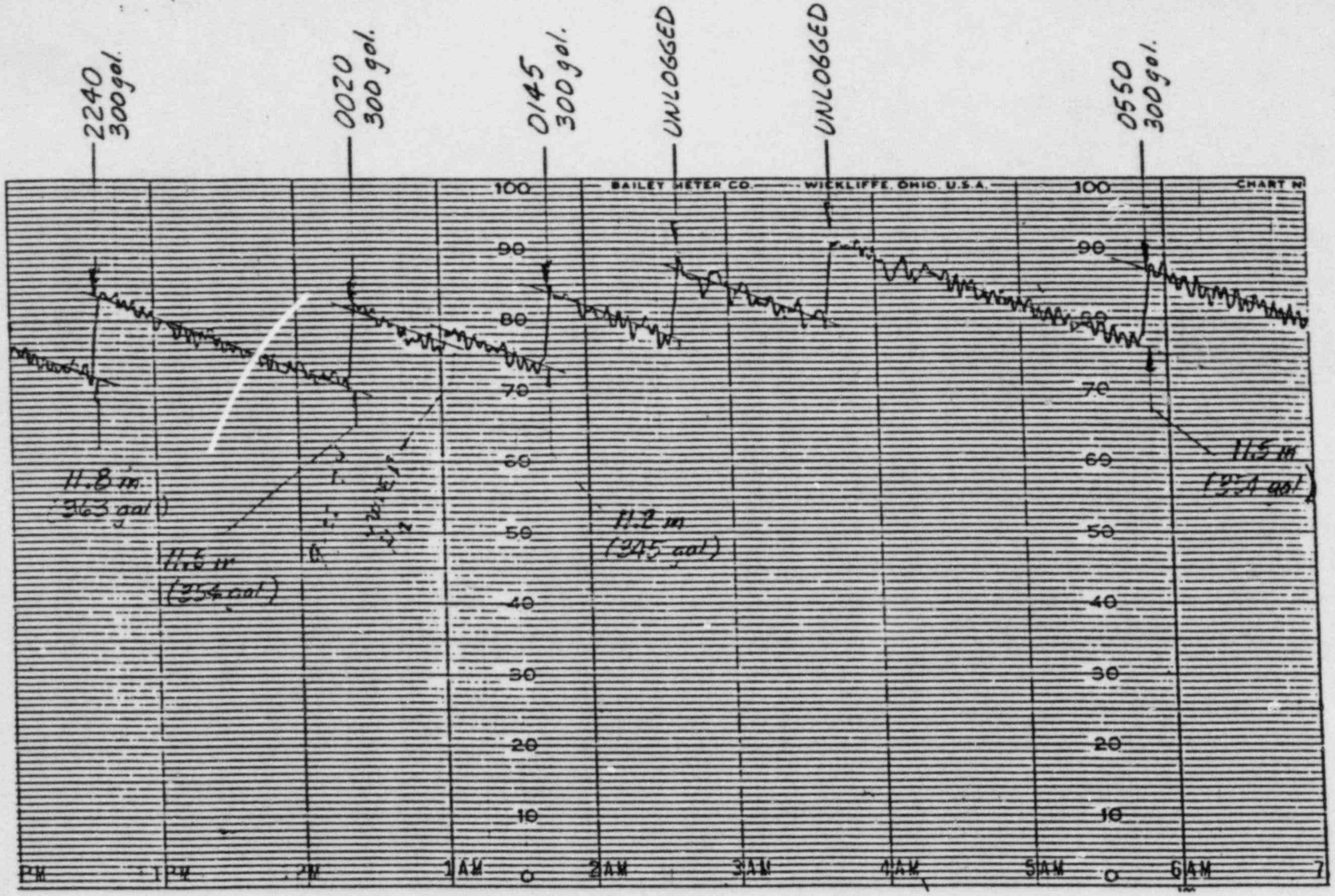
  - METHODOLOGY

  - EXAMPLES



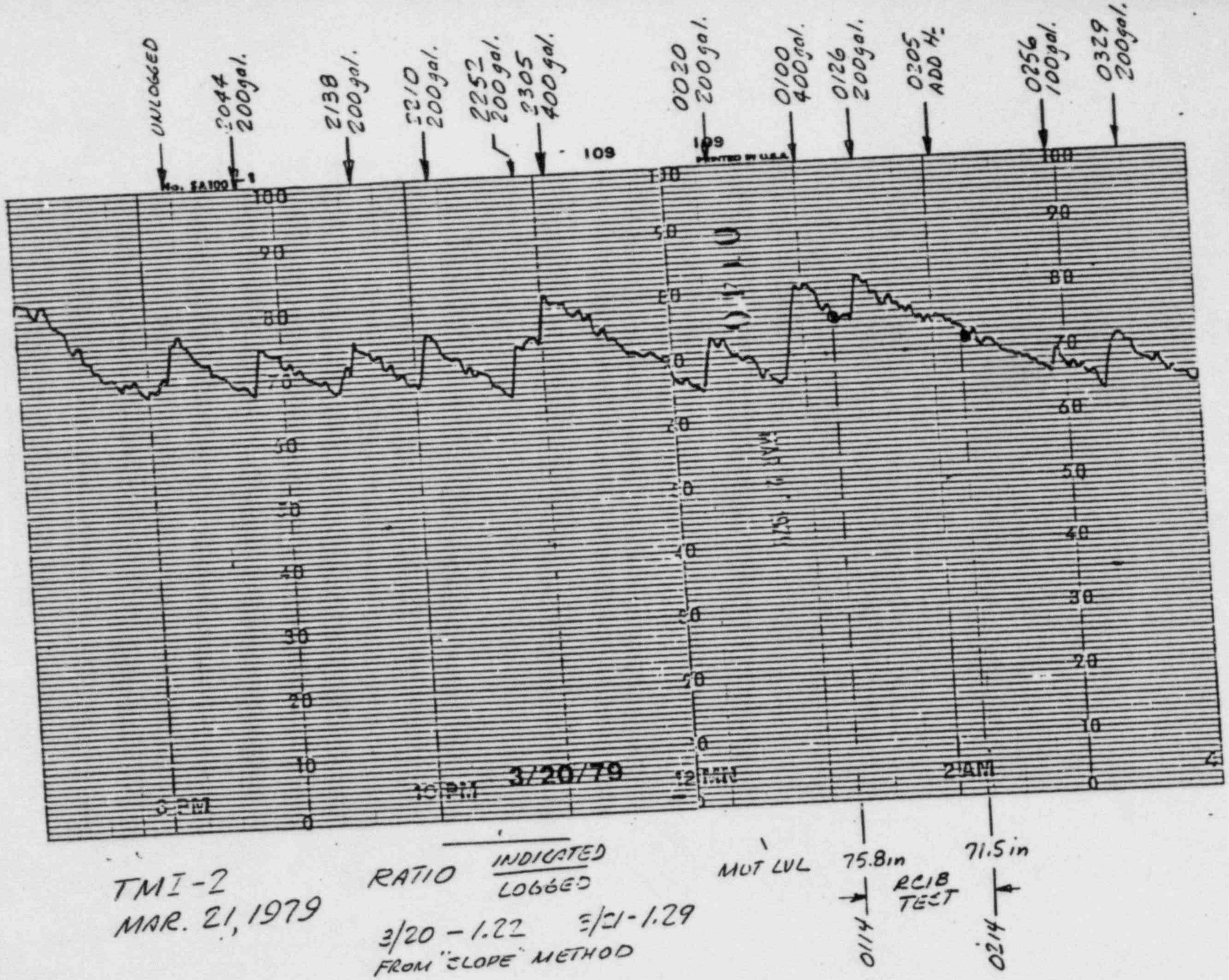
TMI-2
FEB. 15, 1979

RATIO - (1845 ADD) $\frac{\text{INDICATED}}{\text{LOGGED}} = 1.27$



TMI-1
SEPT. 22, 1974

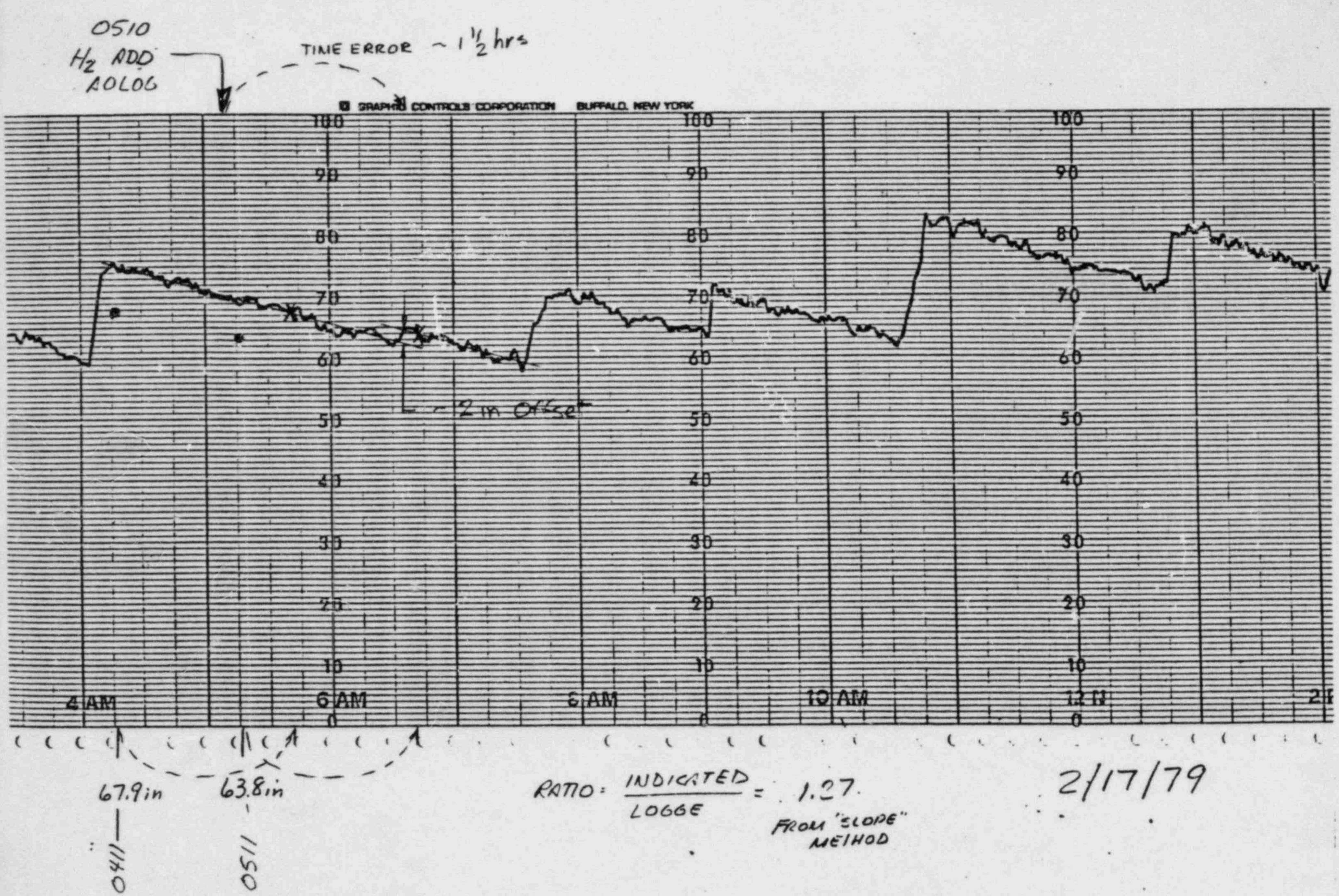
AVERAGE RATIO $\frac{\text{INDICATED}}{\text{LOGGED}} = 1.18$



TMI-2
MAR. 21, 1979

RATIO $\frac{\text{INDICATED}}{\text{LOGGED}}$

3/20 - 1.22 3/21 - 1.29
FROM "SLOPE" METHOD


0510
H_2 ADD
AOLOG
TIME ERROR ~ 1½ hrs
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
100
90
80
70
60
50
40
30
20
10
0
4 AM
6 AM
8 AM
10 AM
12 N
~2 in Offset
67.9in
63.8in
0411
0511
RATIO: INDICATED / LOGGE = 1.27
FROM "SLOPE" METHOD

2/17/79

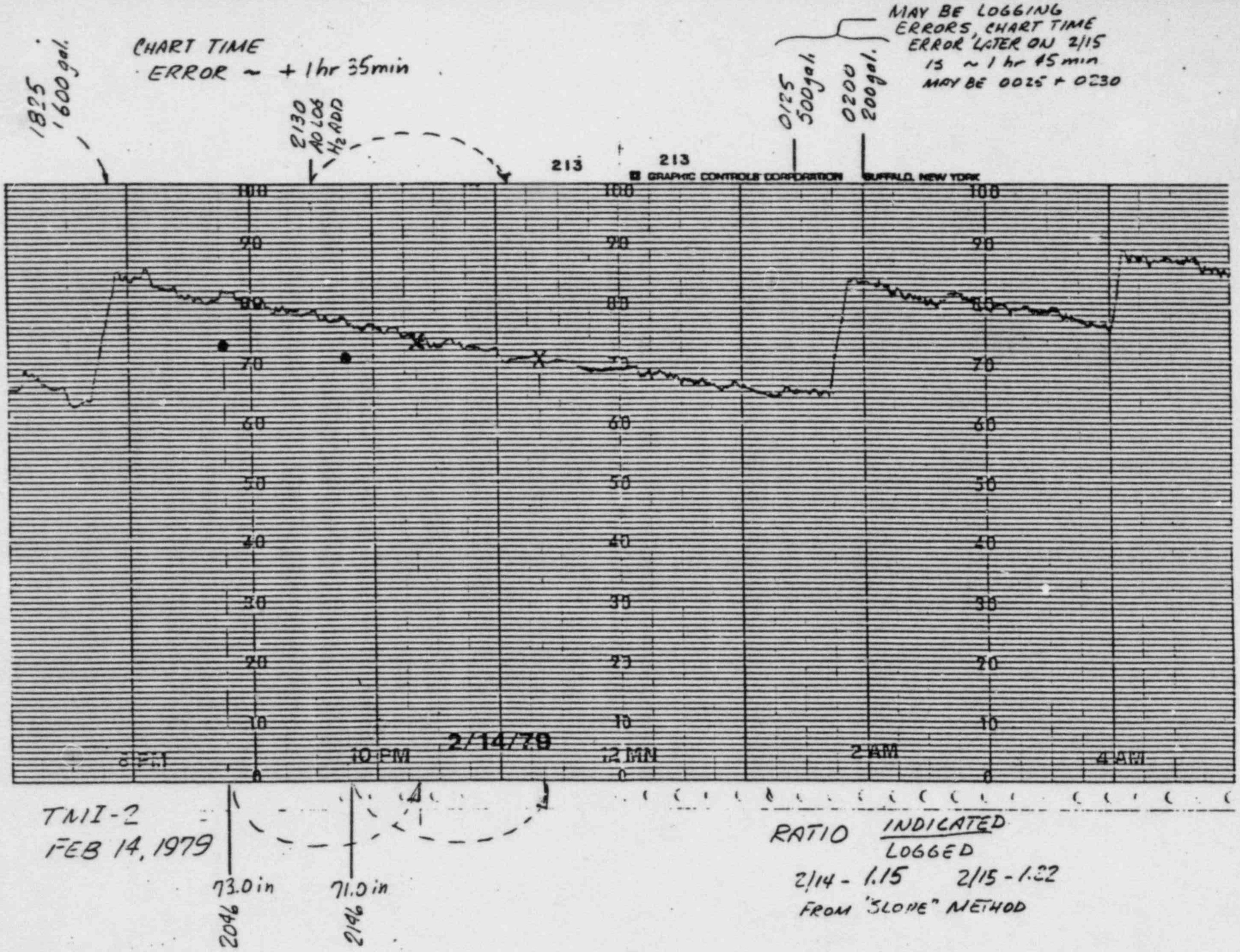


CHART TIME
ERROR ~ + 1hr 35min
1825
1600 gal.
2130
AO LOG
H_2 ADD
0125
500 gal.
0200
200 gal.
MAY BE LOGGING
ERRORS, CHART TIME
ERROR LATER ON 2/15
IS ~ 1 hr 45 min
MAY BE 0025 + 0230
213
213
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK
100
90
80
70
60
50
40
30
20
10
0
8 PM
10 PM
2/14/79
12 MN
2 AM
4 AM
TMI-2
FEB 14, 1979
73.0 in
2046
71.0 in
2146
RATIO INDICATED / LOGGED
2/14 - 1.15 2/15 - 1.22
FROM "SLOPE" METHOD

CONFIRMED AND EFFECTIVE HYDROGEN ADDITIONS DURING RCIB TESTS

DATE TIME	LOG ENTRY	EFFECT ON INDICATED MAKEUP TANK LEVEL
2/15/79 2026 TO 2126	CRO LOG @ 2100	4 IN. OFFSET (ABOUT 120 GAL.)
2/17/79 0411 TO 05	AO LOG @ 0510	2 IN. OFFSET (ABOUT 60 GAL.)

WATER AND HYDROGEN ADDITIONS
(September 18, 1978 to March 27, 1979)

1. WATER ADDITIONS DURING RCIB TESTS

Recorded RCIB Tests	Number of RCIB Tests During Which Water Additions Made	Number of Water Additions Not Entered Into RCIB Tests	Alleged Water Additions Not Entered During RCIB Tests by F&B/NRC
174	28 24-Logged and Entered in RCIB Test 3-Logged and Not Entered 1-Not Logged and Not Entered	4 (~2%) 3-Logged and Not Entered 1-Not Logged and Not Entered	63 (4-Verified by MPR)

2. HYDROGEN ADDITIONS DURING RCIB TESTS

Recorded RCIB Tests	Alleged Hydrogen Additions During RCIB Tests	Breakdown of Alleged Additions		
		Hydrogen Additions That Were Logged and Shown on Makeup Tank Trace	Hydrogen Additions That Were Logged But No Sign on Makeup Tank Trace	Hydrogen Additions That Were Not Logged and No Sign on Makeup Tank Trace
174	14 10-F&B 4-NRC	2	8	4