



FEB 14 1992

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of the Application of) Docket Nos. 50-390
Tennessee Valley Authority)

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - RESPONSE TO NRC QUESTIONS ON TVA'S
QA RECORDS CORRECTIVE ACTION PROGRAM (CAP) PLAN, REVISION 4

Enclosed is TVA's response to NRC's questions concerning the QA Records
CAP, Revision 4 (December 6, 1991). TVA met with NRC staff on
January 27, 1992, to discuss the questions and preliminary responses.
This meeting was beneficial in clarifying the staff's concerns and
establishing early dialogue between TVA and NRC technical personnel.

TVA is pursuing a careful and deliberate approach in the application of
sampling for this project. The sampling techniques are designed to
provide a flexible and realistic approach in assessing the condition of
many varieties of records. As a result, the QA records will have been
comprehensively assessed, and identified problems appropriately bounded
for extent of condition and resolution. To address the application of
these statistical methods, TVA is prepared to meet with the NRC reviewers
at their earliest convenience. We suggest the WBN site as the best
location for such a meeting because of the location of the project files.

As stated before, TVA is confident that through the effective
implementation of this CAP, the necessary QA Records will exist and be
retrievable in an acceptable manner with the required quality and
technical content to permit the licensing of WBN Unit 1.

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WBH Site Licensing will be in contact with the NRR Project Manager to further discuss these matters. Should there be a need for other information or clarification, please contact Paul L. Pace at 615-365-1324.

Sincerely,



John H. Garrity

Enclosure

cc (Enclosure):

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ENCLOSURE

WATTS BAR UNIT 1

RESPONSE TO NRC QUESTIONS OF JANUARY 30, 1992

CONCERNING TVA'S QUALITY ASSURANCE RECORDS CAP (REVISION 4)

NRC QUESTION 1:

Section 4.1.1 of the CAP refers to TVA's QA Topical Report (TVA-TR75-1A). The QA Topical Report has been superseded by the TVA Nuclear QA Plan (TVA-NQA-PLN-89), and this should be reflected in the next revision of the CAP.

TVA RESPONSE:

The viewer is correct in noting the TVA Nuclear QA Plan superseded the Topical Report. TVA's current licensing commitments and requirements related to records storage are contained in the TVA QA Plan, TVA-NQA-PLN-89. The QA Topical Report is referenced in paragraph 4.1.1 because the original records storage concerns (fire-rating of the vault and records storage) were in violation of the requirements (at that time) given in the Topical Report.

NRC QUESTION 2:

Section 4.1.2 of the CAP states that the Record Retrieval Guide is now available to users. Clarify whether or not the Record Retrieval Guide and its related documentation are treated as controlled documents in accordance with the TVA Nuclear QA Plan.

TVA RESPONSE:

The Records Retrieval Guide is not a controlled document. The purpose of the Records Retrieval Guide is to assist records retrievers in determining the location of records. It contains information to guide the user to the various indexes and indexing data bases used to retrieve records. The Records Retrieval Guide directs users to the specific tools used for retrieval such as the WBN Records List, Indexing Specifications, and Indexing Data Bases which are controlled to assure that only current information is used and to prevent unauthorized changes from being made. TVA is in the process of consolidating the various indexing data bases used for WBN records and centralizing the processing of records into the WBN records management system. As a result, the information now contained in the Records Retrieval Guide, Records List, and Indexing Specifications will be consolidated into a controlled document.

NRC QUESTION 3:

Section 4.3.2 of the CAP lists four ways that records can be "required." A fifth way would be the requirement to meet TVA commitments in licensing documents (for example, records required to meet TVA's commitment to Regulatory Guide 1.88 as given on pages 96 and 97 of the Nuclear QA Plan). This fifth way should be included in Section 4.3.2 of the CAP.

TVA RESPONSE:

A fifth category is not warranted. The four categories discussed in Section 4.3.2 of the CAP were developed to be inclusive of all QA records as defined by ANSI N45.2.9. This definition indicates that QA Records "furnish documentary evidence of the quality of items and of activities affecting quality." TVA licensing commitments often lead to the production of records within the four categories and, therefore, are implicitly addressed for all items and activities affecting quality. The four discussed categories of records provide the required "documentary evidence," not the documents used for verifying compliance with commitments. TVA controls commitments using a computerized management tracking system to assure commitments are satisfactorily accomplished. The records required by TVA's NQA Plan commitment to Regulatory Guide 1.88 and thereby ANSI N45.2.9 are QA records designated as such by TVA standards and procedures for all TVA Nuclear Power organizations. Therefore, TVA does not consider the activities or products associated with commitment compliance verification to represent quality related processes or records.

Given the above, TVA considers that the CAP as currently written best presents our actual plans and intentions and the suggested revision would not result in an improvement. However, if the staff finds the CAP would be improved by a revision in this area, TVA will revise the CAP upon request.

NRC QUESTION 4:

Section 4.3.4 of the CAP indicates that nonconformances will be considered design significant if they do not meet appropriate codes, standards, or licensing requirements. As in item 3, above, nonconformances to TVA commitments in licensing documents is a fourth set of nonconformances that should also be considered design significant and referred to in Section 4.3.4 of the CAP. This comment also applies to the fourth paragraph in Section 2.e of the ASRR (page 7).

TVA RESPONSE:

The determination of design significance during the ASRR applies to activities affecting hardware items of the plant and the hardware itself. As such, there is a subset of licensing requirements that are relevant factors in the criteria for evaluating significance. Although some licensing commitments may be related to design significance, licensing commitments may also apply to programmatic activities (e.g., a commitment to counsel an individual or revise a surveillance procedure) that do not apply to hardware items and, therefore, are not relevant to determining design significance. TVA has controls as described in the response to Question three to assure that all licensing

TVA RESPONSE TO 4: (Continued)

commitments are met and if nonconformances are found, to appropriately respond and notify NRC. TVA does not consider that all nonconformances to licensing commitments are a set of nonconformances that should automatically be considered design significant. For the reasons given in response to NRC Question 3, TVA considers the CAP as currently written would not benefit from a CAP revision.

NRC QUESTION 5:

The fifth bullet in CAP Section 4.4 states that WBN records from organizations at WBN will be filmed and indexed onsite. In this respect, clarify how TVA will treat WBN records from organizations not at the site.

TVA RESPONSE:

Records specific to WBN that are generated by TVA organizations not at WBN are processed through the Records Information Management System (RIMS) organization at their location; i.e., Knoxville, Chattanooga, or other TVA plant sites. This means the microfilming and indexing of these records is done at these locations. The index of the Watts Bar specific records will be copied into the WBN site indexing data base.

Records required to be furnished to TVA by vendors and contractors are defined in specifications and contract documents. These records are submitted to TVA through various line organizations where they are processed in accordance with applicable TVA procedures. The processing of vendor/contractor supplied records includes reviews of such records by TVA technical organizations of documents that contain engineering requirements necessary for equipment installation, operation, maintenance, and testing. The processing of vendor/contractor QA records into the records management system from the various line organizations is handled in the same manner as TVA generated records.

NRC QUESTION 6:

Attachment 4 to the CAP should not be considered a complete list of records required by regulation. For example, Attachment 4 could be interpreted to indicate that the only record required by 10CFR50, Appendix B, is a QA Plan. This point should be clarified.

TVA RESPONSE:

In order to clarify the intent of Attachment 4, the title of the attachment should have read, "QA Records Requiring an Exemption Request If Missing." If TVA finds deficiencies in any QA records, they will be aggressively pursued consistent with the corrective action strategies defined in the CAP. This will include notification to NRC of any missing records by means of the CAP Final Report as discussed in CAP Section 7.0. In the event of a future CAP revision, this information will be clarified.

NRC QUESTION 7:

Clarify the first sentence on page 10 of the ASRR which states: "The WPs/MRS generated during the timeframe of the CAPs/SPs (i.e., after 1987) will be evaluated." Does this mean that there will be a 100% independent assessment of these documents, or will a sampling plan be used?

TVA RESPONSE:

There will be a 100% independent assessment by the ASRR of the workplans (WPs) that were generated after 1987 (i.e., during the timeframe of the CAPs/SPs). Maintenance Requests (MRs) will be sampled. They are being reviewed at this time to determine the best sampling method to use.

NRC QUESTION 3:

What is meant by "Secondary deficiencies will be evaluated on a page basis . . ." on the middle of page 10 of the ASRR?

TVA RESPONSE:

Secondary deficiencies are counted differently than primary deficiencies due to the difference in their significance and because by their nature they do not invalidate the entire record. The deficiency rate for secondary deficiencies is calculated by dividing the number of pages with secondary deficiencies by the total number of pages contained in the records reviewed in a record type. An example of the application of this method is found in how the rate for secondary deficiencies was calculated for the ANSI record type, "Current Individual Plant Staff Member Qualifications, Experience, Training, and Retraining Records." In this case the results from sampling 60 records (consisting of 9643 pages) indicated that four records had nine pages with secondary deficiencies on them. Because each of these records consists of multiple pages, the deficiency rate for the ANSI record type was $9 / 9643 = 0.09\%$ for secondary deficiencies.

NRC QUESTION 9:

Section 6.b of the ASRR indicates that a record plan is developed for each CAP/SP which meets four specific criteria. Are these plans and the results of their implementation independently reviewed within TVA to ensure acceptability?

TVA RESPONSE:

Yes, the records to be generated by CAPs and SPs are identified in Project Plans as part of the deliverables to be produced by the programs. These plans and their implementation are reviewed, monitored, and audited by the Site QA organization as described in the Nuclear Performance Plan. In addition, other independent reviews are being performed as part of the ASRR to assess the adequacy of CAP/SP records.

NRC QUESTION 10:

The last paragraph on page 4 of the ASRR indicates that CAP records will be reviewed where they apply. We believe that this means that CAP records will be included in the record population(s) from which the samples for each "cell" on Figure 1 are randomly selected. Clarify whether this is the case. If so, the randomness of a selected sample (within each "cell") assumes even greater importance. Therefore, describe how samples are selected to ensure randomness. If not, what is meant?

TVA RESPONSE:

CAP records will be included in the record population(s) from which the samples for each "cell" on Figure 1 are randomly selected. The existence of CAP records in the population depends on the status of completion of CAPs. Samples are selected by using a random number generator to select components within each element. The record representing the ANSI type for each component selected is used for the review. The CAP records have an equal chance of being selected based upon their proportions within the respective ANSI group and components within an element. CAP records are also being assessed separately as described in our response to Question 9.

NRC QUESTION 11:

Delete or clarify what is meant by: "except where the ANSI record type in question has already been sufficiently sampled: [Middle of page 5 of the ASRR, Section 2.c(4)]. Our understanding from TVA's July 2, 1991 letter is that the ASRR is to "stand alone" and not rely on previous reviews.

TVA RESPONSE:

The ASRR is a "stand alone" review and does not rely on previous review data. The statement in paragraph 2.c.(4), page 5, of the ASRR description refers to the records contained in a component record package that are reviewed to fulfill the required sample size for an ANSI record type for an element. It will not be necessary to review all the records in the record packages for all selected components in order to satisfy the required sample size for each ANSI record type.

NRC QUESTION 12:

TVA responded to NRC's earlier question 13E by letter dated May 10, 1991. The weighting procedure described at the top of page 3 of CAP Attachment 6 (the ASRR) is taken from Reference 3 of the May 10 letter. We were unable to find Equation 2 of the weighting procedure in this reference. Explain the use of the equation.

TVA RESPONSE:

In this question NRC asks about equation (2) from page 8 of the ASRR, namely:

$$f_A = \frac{1}{N_A} \sum_i N_i f_i \quad (2)$$

It is true that this equation is not explicitly written down anywhere in Reference 3¹ of the May 10 letter, at least not in the same identical form. In a slightly different form, however, it is written as equation (3) of that reference and the idea for its use is discussed there in Section 7.

The use of this equation is made necessary by the sampling method used by the ASRR. This method was developed to assure that sampling of ANSI record types would cover all the kinds of equipment that each ANSI record type applies to. This is accomplished by "directing" or "stratifying" the sample to force coverage of each "element" or equipment group related to a record type. While this helps us to gain a better understanding of the condition of the full range of records applications, it also causes a problem in the application of a pure classical statistical analysis of the sampling results. The reason for this is that when there is more than one element in the ANSI type, the sampling of the ANSI type can no longer be considered random in the sense required by the classical analysis. (This is most evident where the sub-populations of records for elements are of different sizes while we have held the sample size constant across the elements.) Therefore, we have developed a means of applying Bayesian mathematics along with equation (2) to obtain a more accurate description of the overall condition of the record type in question. This is more fully explained below and in the example provided in Attachment 1.

In the ASRR context, equation (2) simply expresses the relation between the deficiency fraction, f_A , for an ANSI type as whole, and the deficiency fractions, f_i , of the hardware element populations within the ANSI type. As stated above this equation is used in those cases where there is more than one element represented within each ANSI type. In such cases the sample of size n_0 , for the ANSI type, is allocated equally to all elements within the ANSI type. The records associated with each of these elements are selected randomly. Thus, the sample for the ANSI record type is comprised of records from 1 to 20 sub-populations (hardware elements), each of which is sampled randomly.

Since these sub-populations are sampled essentially randomly, a probability curve can be drawn, for each f_i , using the regular Bayesian mechanics for random samples. To then obtain the desired curve for the ANSI group as a whole, we must use the connection between f_A and the f_i , i.e., Equation (2).

1. Kaplan, S., "Bayesian Sampling for Quality Confidence - II," PLG-OS06, Revision 1, March 1991.

NRC QUESTION 13:

TVA's sampling statistics are based on Figure 2 in the same reference. Since this reference adopts a Bayesian approach, we have the following questions:

- (a) What is the justification for using a Bayesian as opposed to a standard classical approach?
- (b) What is the prior distribution of the defect fraction used to calculate the curves in Figure 2 of the reference? On what basis was it chosen?
- (c) What prior distributions will be used for the weighted average technique, and on what bases were they chosen?
- (d) What is the sensitivity of the results to the prior distributions used in (b) and (c) above?

TVA RESPONSE TO 13(a):

A Bayesian approach was chosen for assessing the condition of WBN records because it provides the additional flexibility required to handle the directed sampling and also the Extent of Condition sampling that may be required in the ASRR. In addition, the Bayesian Analysis permits us, and indeed requires us, to make use of all our evidence and information about the condition of WBN records to make a more realistic determination of the condition of each of the many types of records.

This is accomplished in the Bayesian approach by dividing our information about a record population into two categories. In one category is placed the sampling results for that population. In the other category is placed all the other evidence we have. This other evidence is encoded in what is termed a "prior" probability curve. (This curve expresses our state of knowledge prior to learning the sampling results in category 1.) This prior curve is then "updated" with the sampling results, via Bayes theorem, to establish the "posterior" probability curve. From this curve one can then give various confidence statements about the true defect fraction in the population.

Bayes theorem is the fundamental law governing the process of logical inference. It therefore includes the drawing of inferences from sampling data. The standard classical approach, in fact, may be regarded as an example of the Bayesian approach. It is a special case of the Bayesian approach in which the prior is chosen as a flat distribution on a linear scale from zero to one. In order to demonstrate this, TVA has performed the Bayesian calculations for this type of prior to show that the numerical results agree with those standard classical results given by NRC in question 14. The numerical results, for zero defects found in various sized samples, are shown in figures 1 and 2. We see here, among other things, that as the standard approach says, zero defects in a size 60 sample gives us just over 95% confidence that the defect rate is less than 5%. Figure 3 shows, as NRC says, that one also has 95/5 confidence after a sample of size 93 in which one defect was found.

TVA RESPONSE TO 13(a) (Continued):

Figure 4 shows, again in agreement with NRC's question 14, that 95/10 can be established with zero out of thirty, one out of forty-six, two out of sixty-one, or three out of seventy-five.

Moreover, in addition to the above, it is worth noting that in its implementation of the ASRR, TVA will do an extent of condition (EOC) study on any primary deficiency that is found in order to assure ourselves that we understand the root cause and extent of the deficiency. This means, in effect, that we are actually using the classical statistical approach wherever it applies. Thus, if zero deficiencies are found in the sample of size 60 we can say that we have 95/5 confidence in the classical sense (as well as 93/5 or 95/3 in the Bayesian sense).

On the other hand, if one or more deficiencies are found, then in the classical terminology we "reject" the population. What "reject" means in our case is that we do an EOC study in which we search for the cause and extent of the deficiencies and fix them. In the course of this EOC we use the Bayesian approach to determine when we have achieved 95/5 confidence in the "as-fixed" population.

Thus, in the ASRR we are using the Bayesian approach not "as opposed to" the classical approach, but rather in addition to it.

TVA RESPONSE TO 13(b):

Our state of knowledge about the condition of a certain population of items is defined prior to the selection of a sample to test the actual condition. This prior state of knowledge is expressed mathematically as a probability curve over the set of possible deficiency rates in the population.

The prior distribution used to calculate Figure 2 in Reference 3 of the May 10 letter, was a flat prior on a logarithmic scale between .001 and 1.0. This distribution was chosen, for this figure, just as a convenient way to give examples of Bayes theorem at work. It was not intended to reflect a realistic prior state of knowledge about any particular population, and in fact, simply by virtue of its flatness, is already somewhat unrealistic. The flat prior on the logarithmic scale says that, before we see any sampling results, we would give the same amount of credence to the prospect that the true defect fraction lies between .001 and .01 as we would give to the prospect that it lies between .01 and 0.1, and as we would give to the prospect that it lies between 0.1 and 1.0. In other words, it gives probability 1/3 to each of the three decades.

By contrast the classical prior, flat on the linear scale, says we have just as much credence that 95% of the population is defective as we have that 5% is defective, as we have that 50% is defective, and so on. It says that, before we saw any sampling results, we would have been willing to give you nine to one odds that the true defect rate was bigger than 10%. It says we would have given you four to one that the true defect rate was bigger than 20%, and so on.

This state of knowledge, expressed by the classical prior, is generally not a realistic state of knowledge about the deficiency rate in a population of quality records. The logarithmic flat distribution is a much more reasonable expression of the prior state of knowledge, but it is not perfect either. As stated previously, it was chosen just for an example. The priors that will actually be chosen for the ASRR study are discussed in the next question.

TVA RESPONSE TO 13(c):

As stated in our responses to 13(a) and (b), the development of a "prior" curve results from the consideration of collective knowledge about the population of records. This involves consideration of the knowledge available from various sources about the general condition of records as well as specific record categories and types.

When we come to choose a prior for the individual f_i , we will ask ourselves the appropriate question, namely:

"What do we know about the numerical value of the parameter f_i prior to receiving the results of the sampling of this population?"

Applying the Bayesian discipline, as in PLG-0682² for example, we will list all the evidence we have relevant to this question, and then put forth a prior representing the consensus of the ASRR Assessment team. This prior will be used in the calculations, and will be included along with the evidence, in a final report for each record type.

TVA RESPONSE TO 13(d):

The sensitivity of the results to the prior depends on the size of the sample and also the sample results. If the sample size is large the prior will make no difference. If the sample size is small to moderate the prior will definitely make a difference, exactly as it should.

For example, as we saw in the above, with the classical prior, and with zero defects in a sample of size 60, we have 95% confidence that the population defect rate is below 5%. With the flat prior on log scale, 3 decades, we have with these same sample results, 95% confidence that the population defect rate is below 3%.

With the classical prior and a sample of size 30, with zero defects, we have 95% confidence that the defect rate is below 9%. With the logarithmic prior we have 95% confidence that it is below 5%. Further results, using the flat logarithmic prior are given in Figures 5 and 6.

The flat prior on a logarithmic scale is closer to reality than the flat linear prior, but not as close as we would like either. A still more realistic prior would be something like that labeled PRIOR2 in Figure 7. This figure shows that prior updated with various sample results. Figure 8 shows the same results plotted in cumulative form. Comparing these with Figures 5 and 6 gives further understanding of the sensitivity to the prior.

Still more insight can be obtained from Figures 9 and 10, which compare a flat prior with a nonflat prior, both on a three decade log scale. These show very clearly the impact of "flatness" in the choice of prior.

2. Kaplan, S., "Expert Information versus Expert Opinions: Another Approach to the Problem of Eliciting/Combining/Using Expert Opinion in PRA," PLG-0682, Journal of Reliability and System Safety, Vol 35 ppg 61-72, 1992.

TVA RESPONSE TO 13(d): (continued)

As explained in our response to Question 13(c), the prior that is used for a given record population, as a matter of principle, expresses all the information we have about that population except for the actual results of sampling it randomly. This total use of information in the Bayesian Analysis allows the determination of a more realistic prior and, therefore, provides more meaningful conclusions.

NRC QUESTION 14:

Using a standard classical probability approach, the last several sentences of the second paragraph of Section 2.e of the ASRR would be correct if they were revised as follows:

A 95 percent confidence that there are less than 5 [not 3] percent deficiencies in the remaining population (95/5) [not 95/3] could be established by finding no deficiencies in a sample of 60. Similarly, satisfying 95/3 could be established by finding no deficiencies in a sample of 100 [not 60]. Similarly, satisfying 95/5 could be established by finding less than or equal to one deficiency in a sample of 93 [not 60]. A 95/10 could be satisfied by finding less than or equal to three deficiencies in a sample of 75.

Or the last sentence could say:

A 95/10 could be satisfied by less than or equal to two deficiencies in a sample of 61.

Or:

A 95/10 could be satisfied by less than or equal to one deficiency in a sample of 46.

Or:

A 95/10 could be satisfied by finding no deficiency in a sample of 30.

TVA RESPONSE:

This question has been responded to as part of the response to Question 13(a).

NRC QUESTION 15:

Whether using the sampling plan and acceptance criteria proposed in the ASRR or using a standard classical approach, the question arises as to what happens if the acceptance criterion is not met. We understand that the "extent of condition" will be determined and followed-up to reduce the probability of finding another deficiency in the same cell when the next sample is randomly selected. Clarify whether another random (though "stratified") sample will be tested for the new, improved, population.

TVA RESPONSE:

If the acceptance criteria is not met, or if there is any other reason to think we have discovered a "trend" or "bad spot" or "common cause" phenomenon in the records population, then an extent of condition study will be instituted to find the boundaries of the suspicious area. This area will then be intensively studied, and fixed. The residual area, by its definition, will have the suspicious parts excised, and thus would be expected to be in good shape. We will, however, conduct further random sampling in this area to confirm this expectation, as described in Section 10 of Reference 3.

An example of the application of extent of condition is provided in Attachment 2.

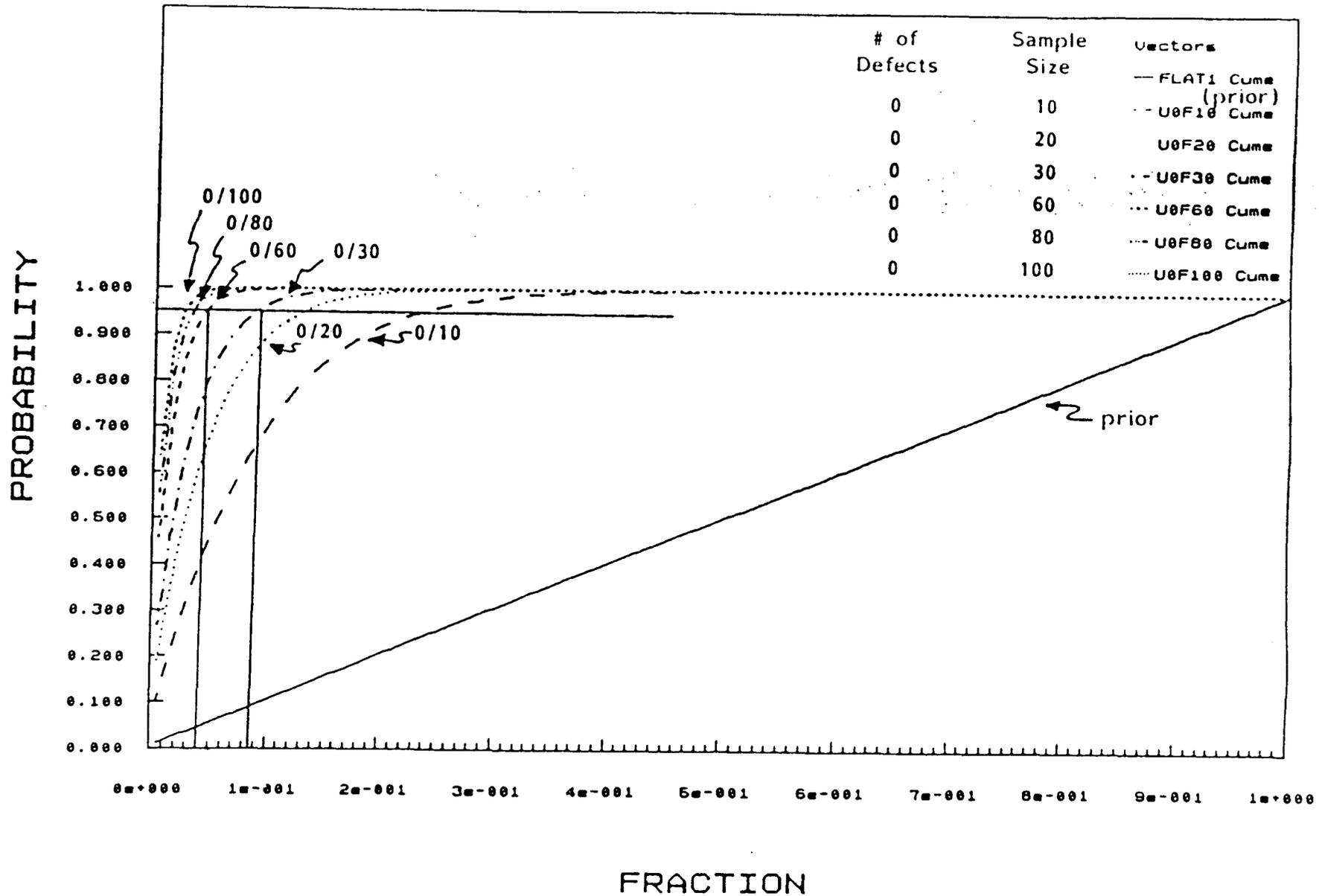


Figure 1. Bayes Examples (using flat prior on linear scale)

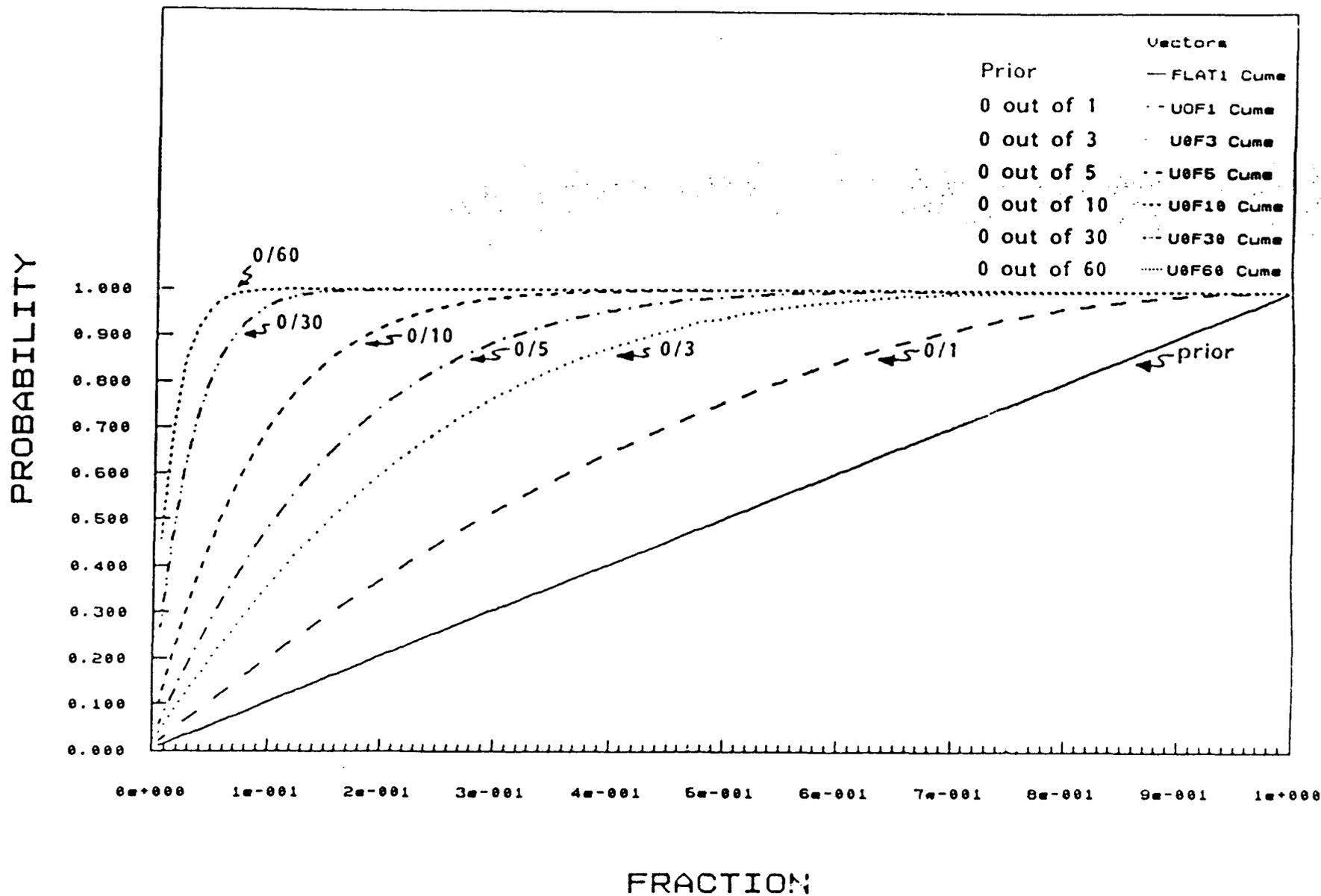


Figure 2. Bayes Examples (using flat prior on linear scale)

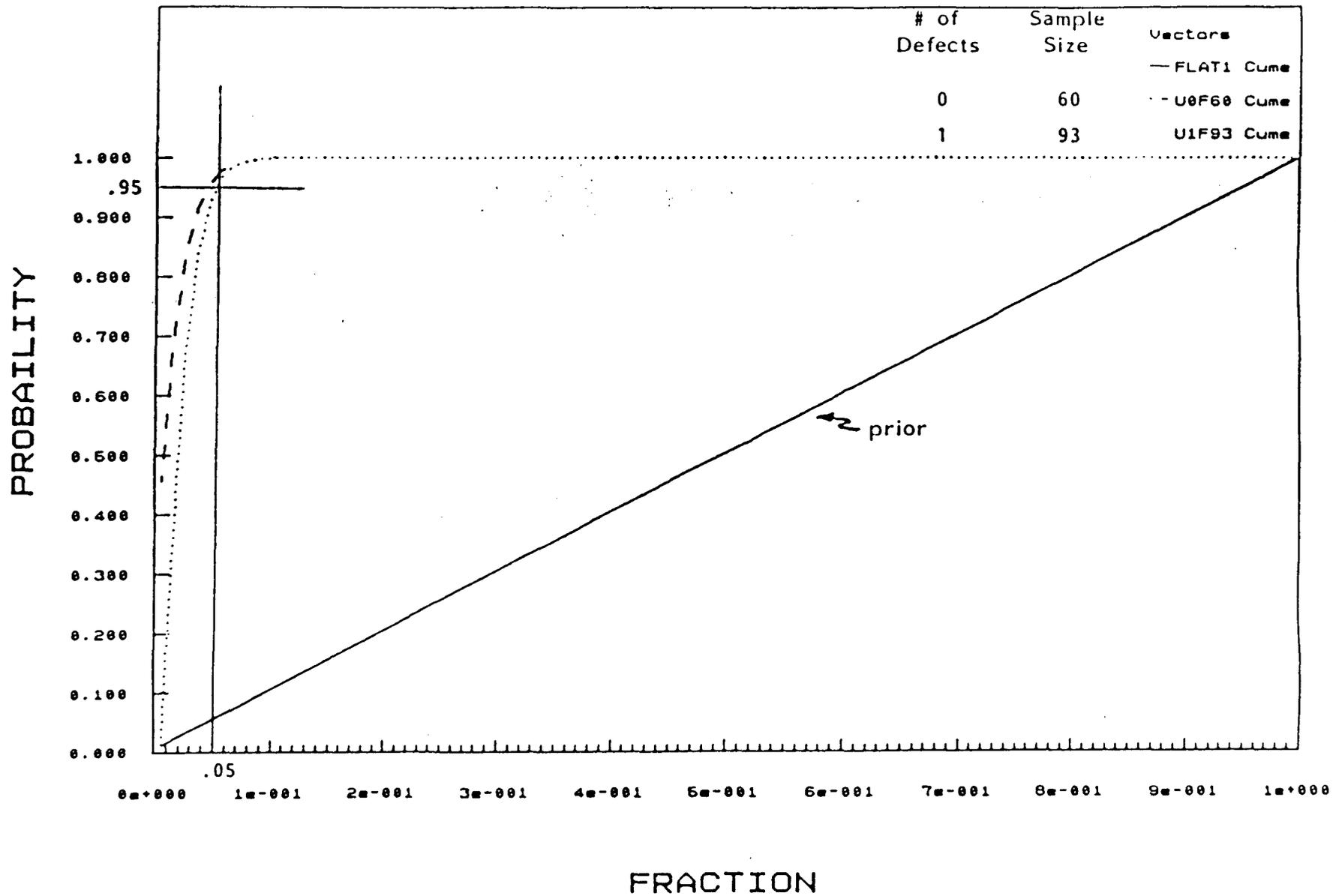


Figure 3. Ways to Get 95/5 Confidence--Classical

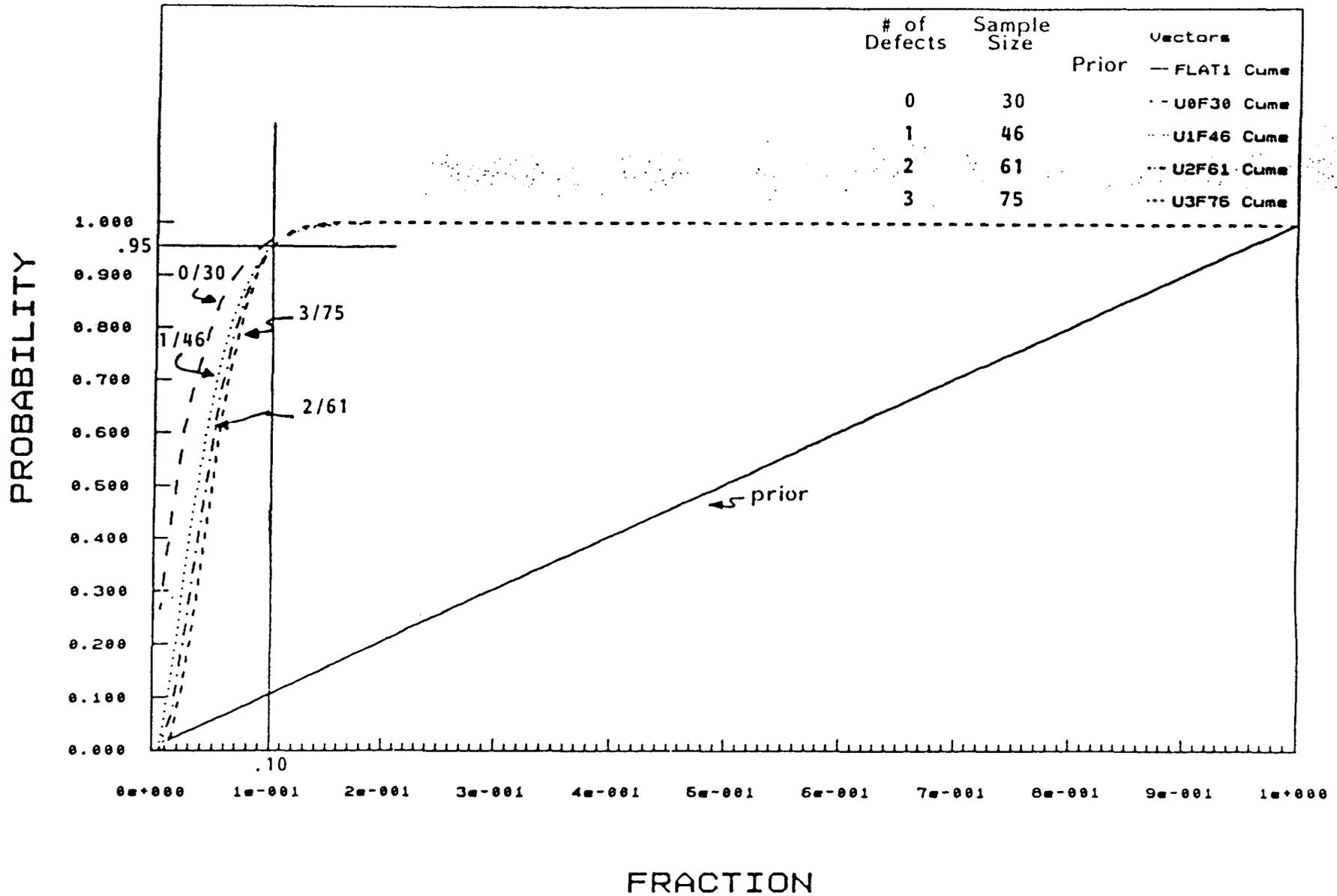


Figure 4. Ways to Get 95/10 Confidence--Classical

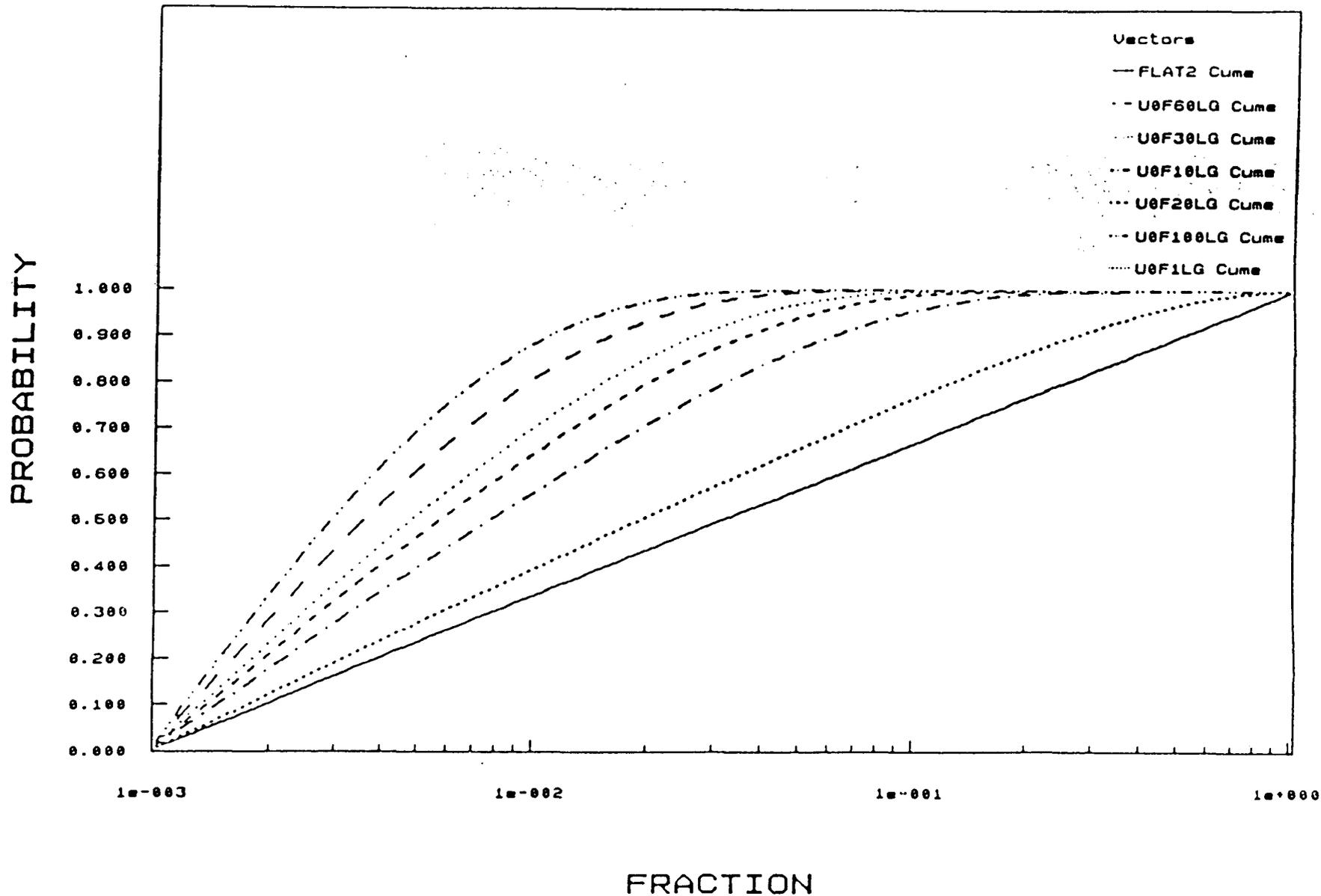


Figure 5. Bayes Examples on Log Scale

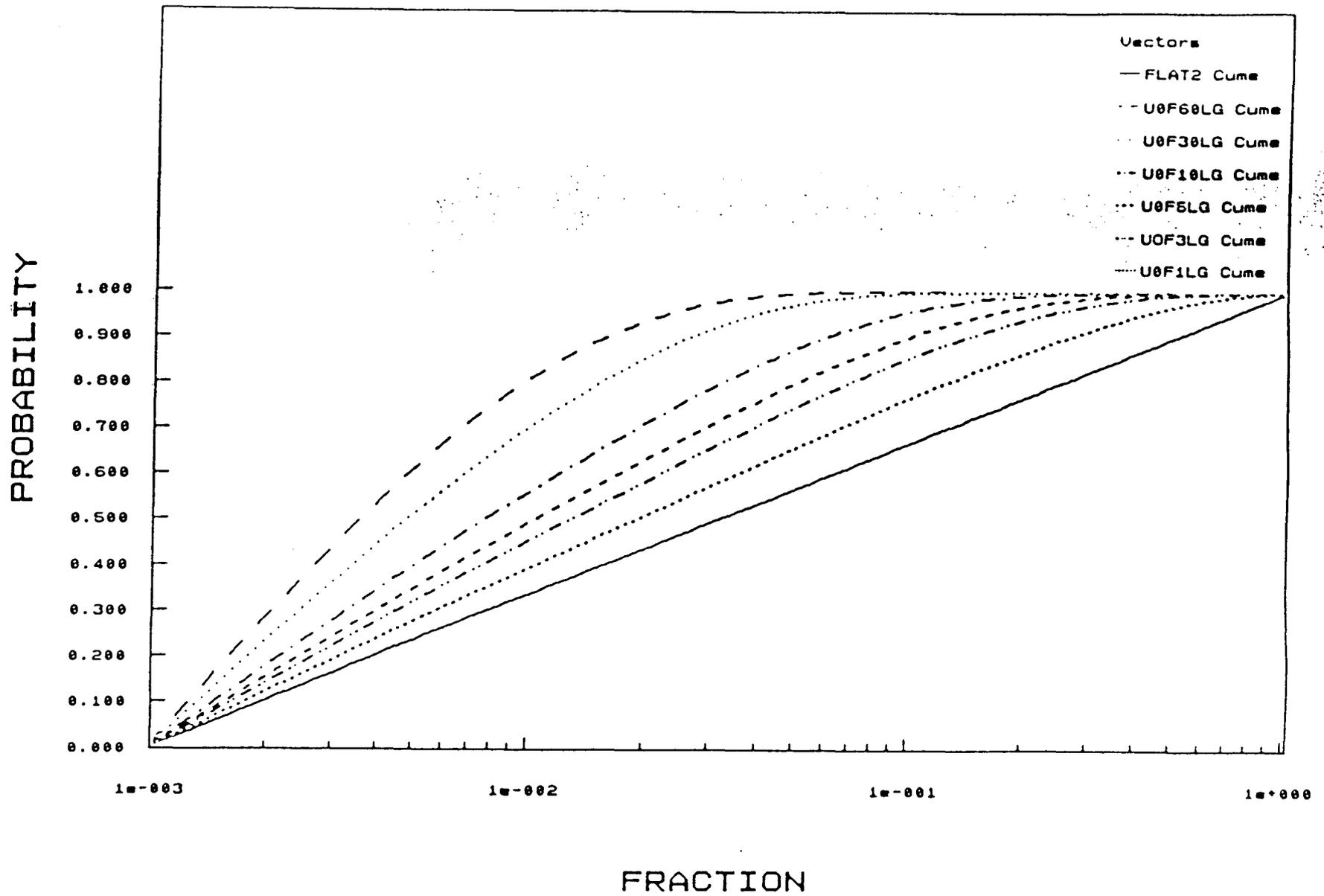


Figure 6. Bayes Examples on Log Scale

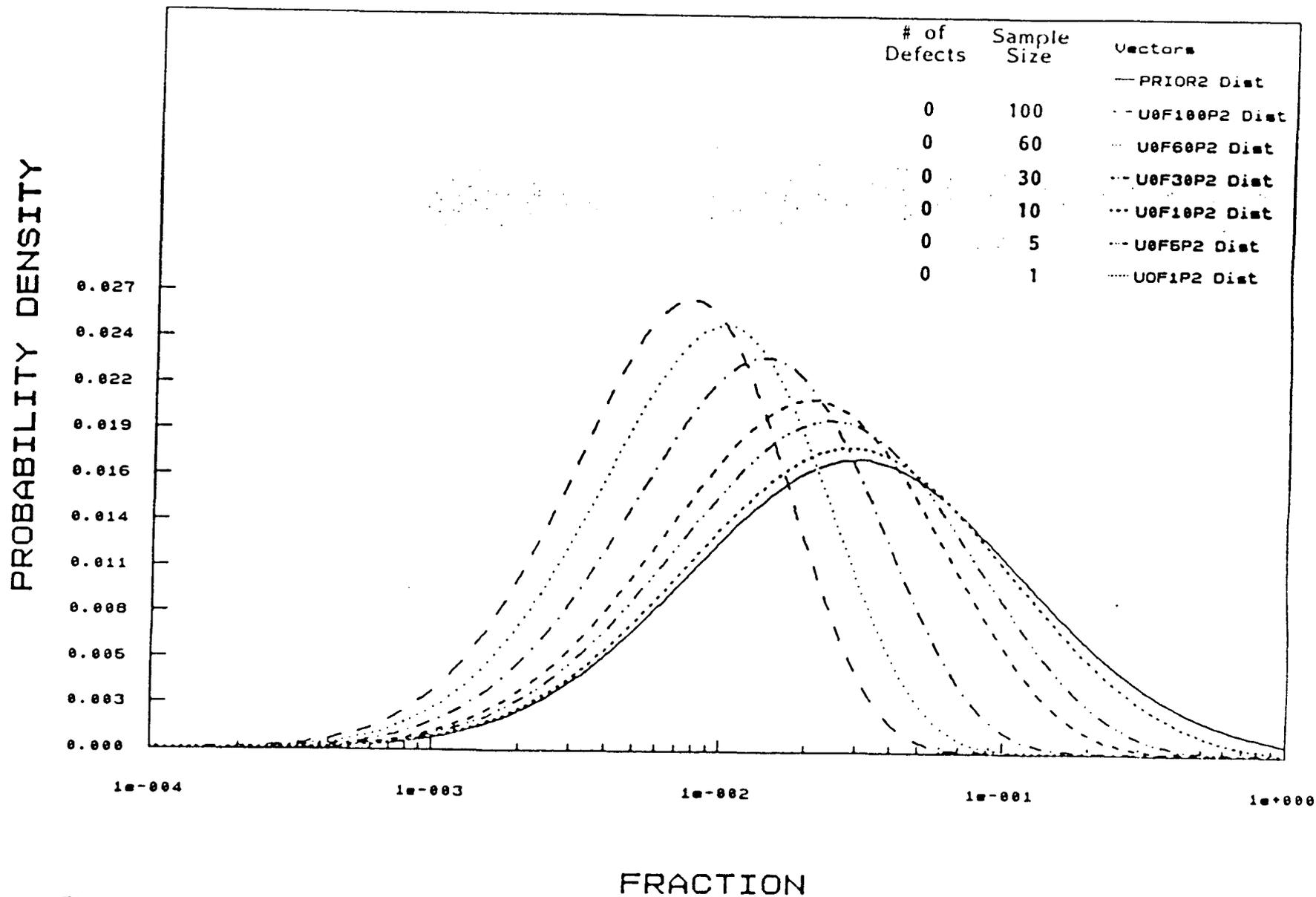


Figure 7. Bayes Examples on 4Log40

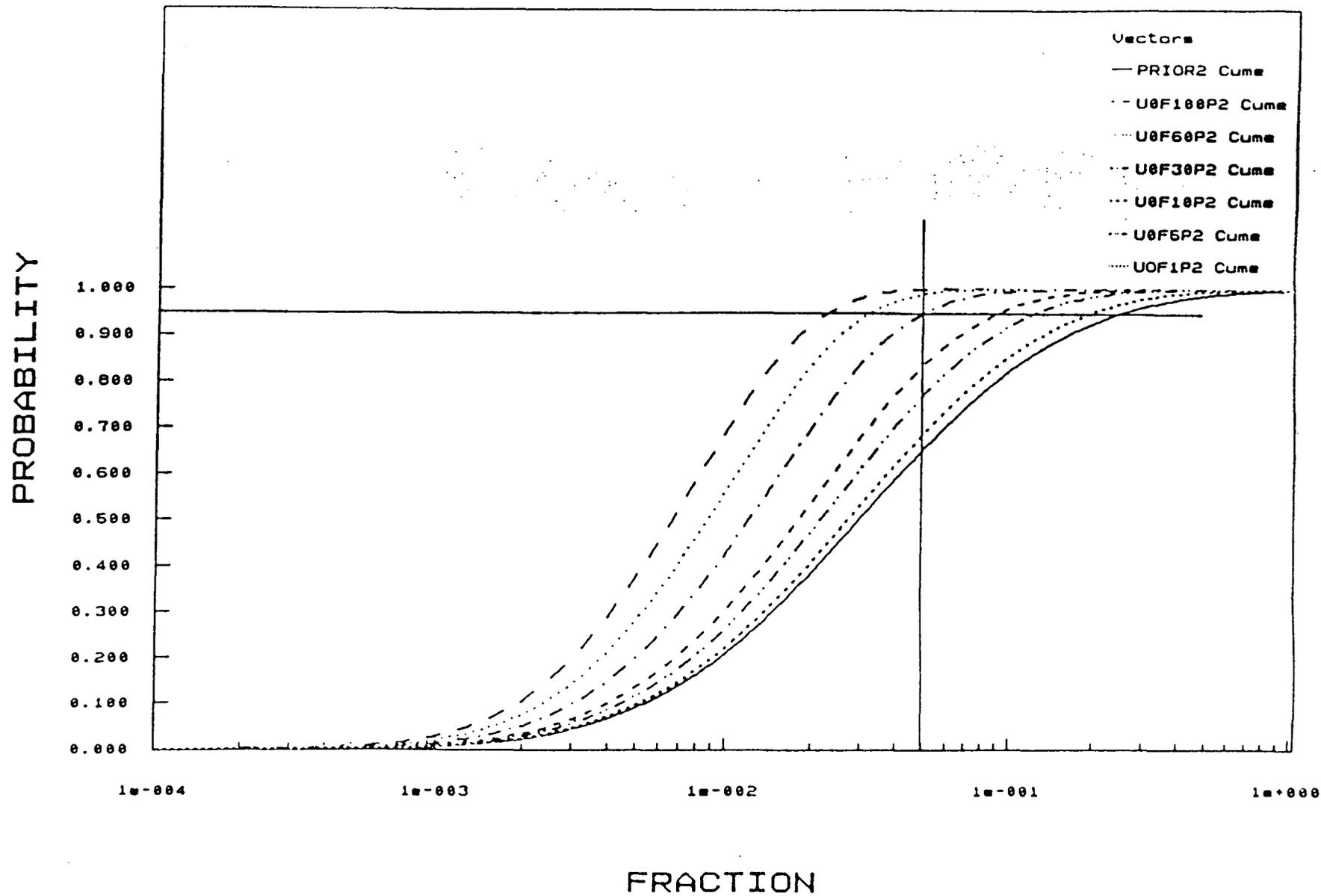


Figure 8. Bayes Examples on 4Log40

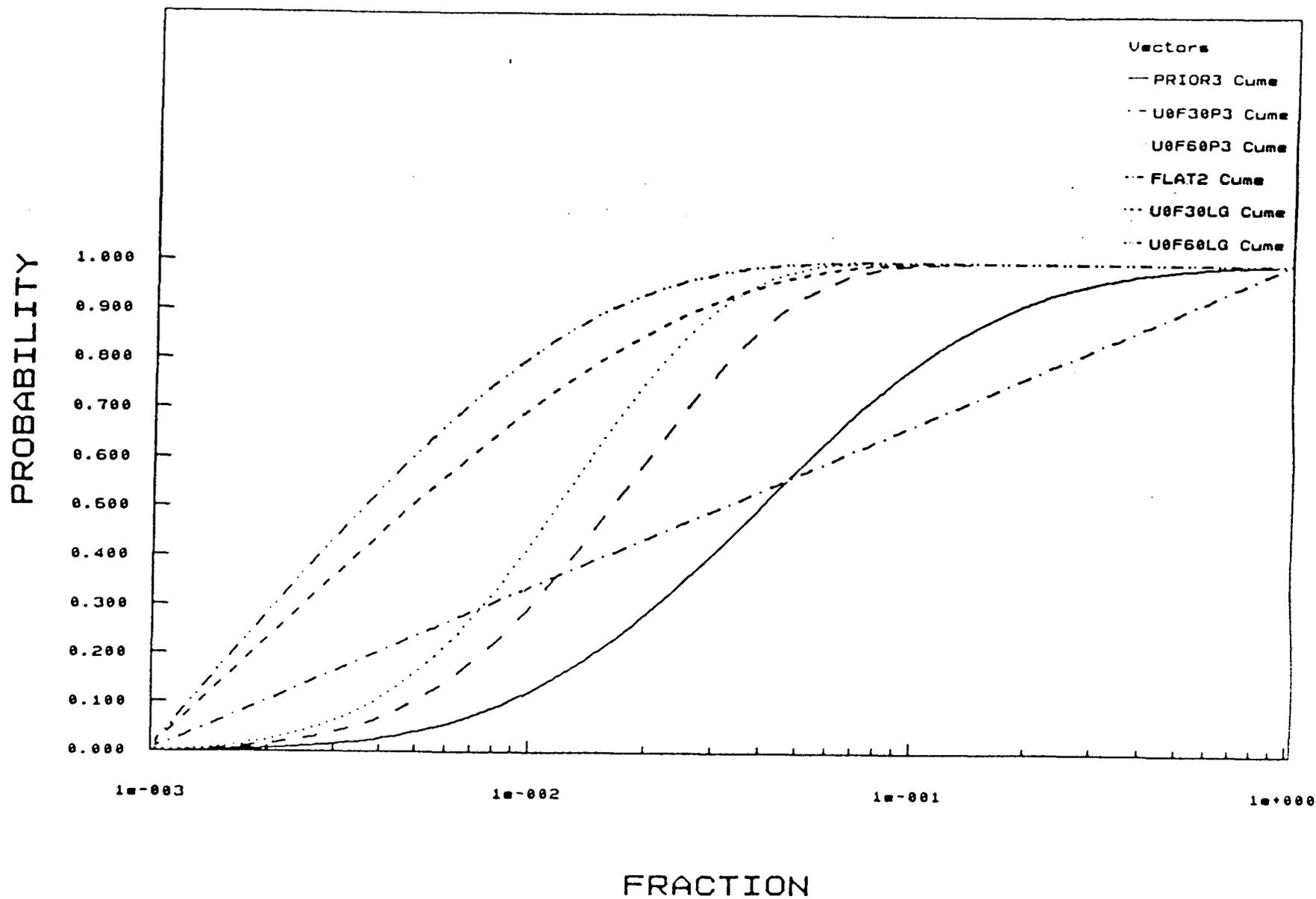


Figure 9. Comparison of Priors

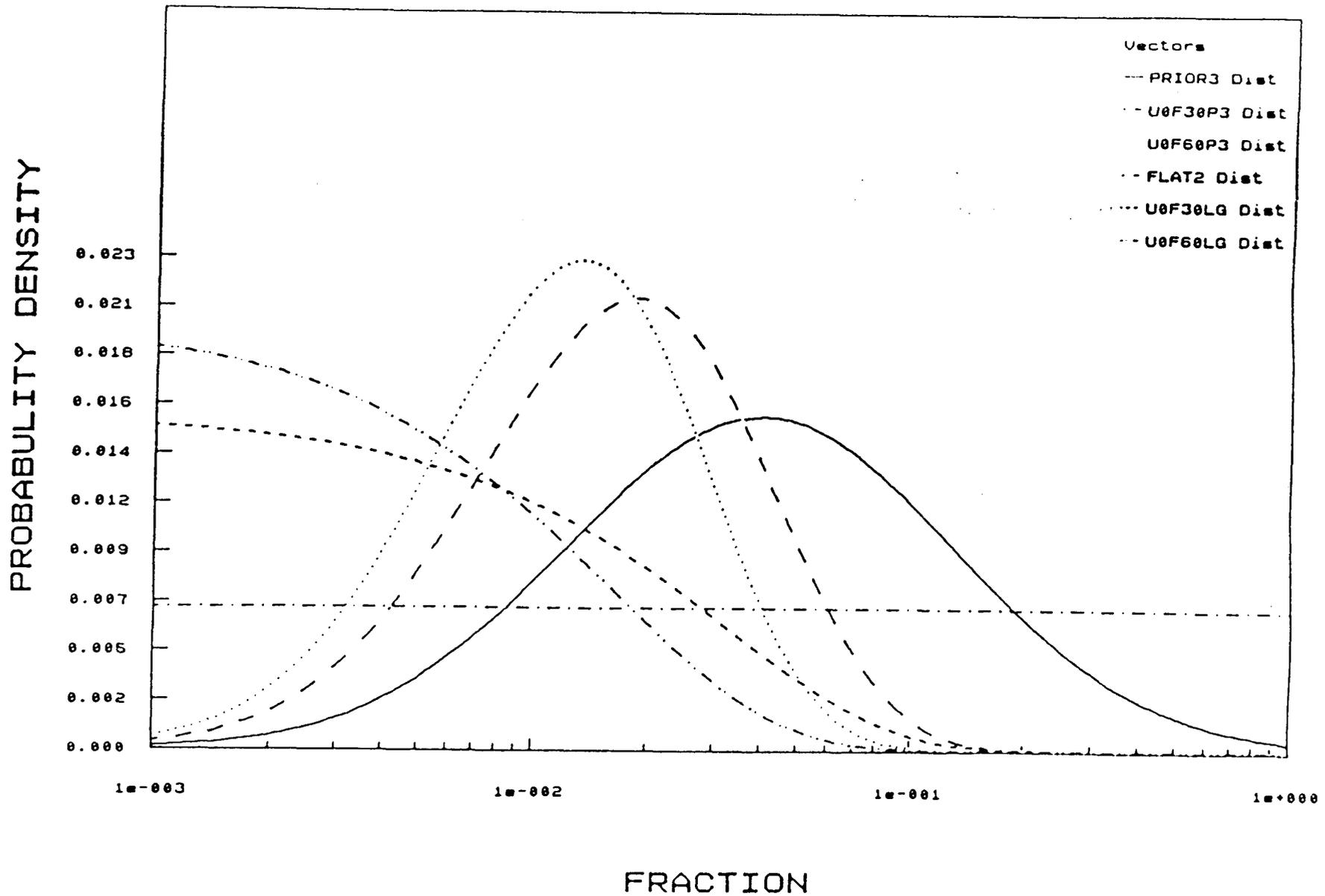
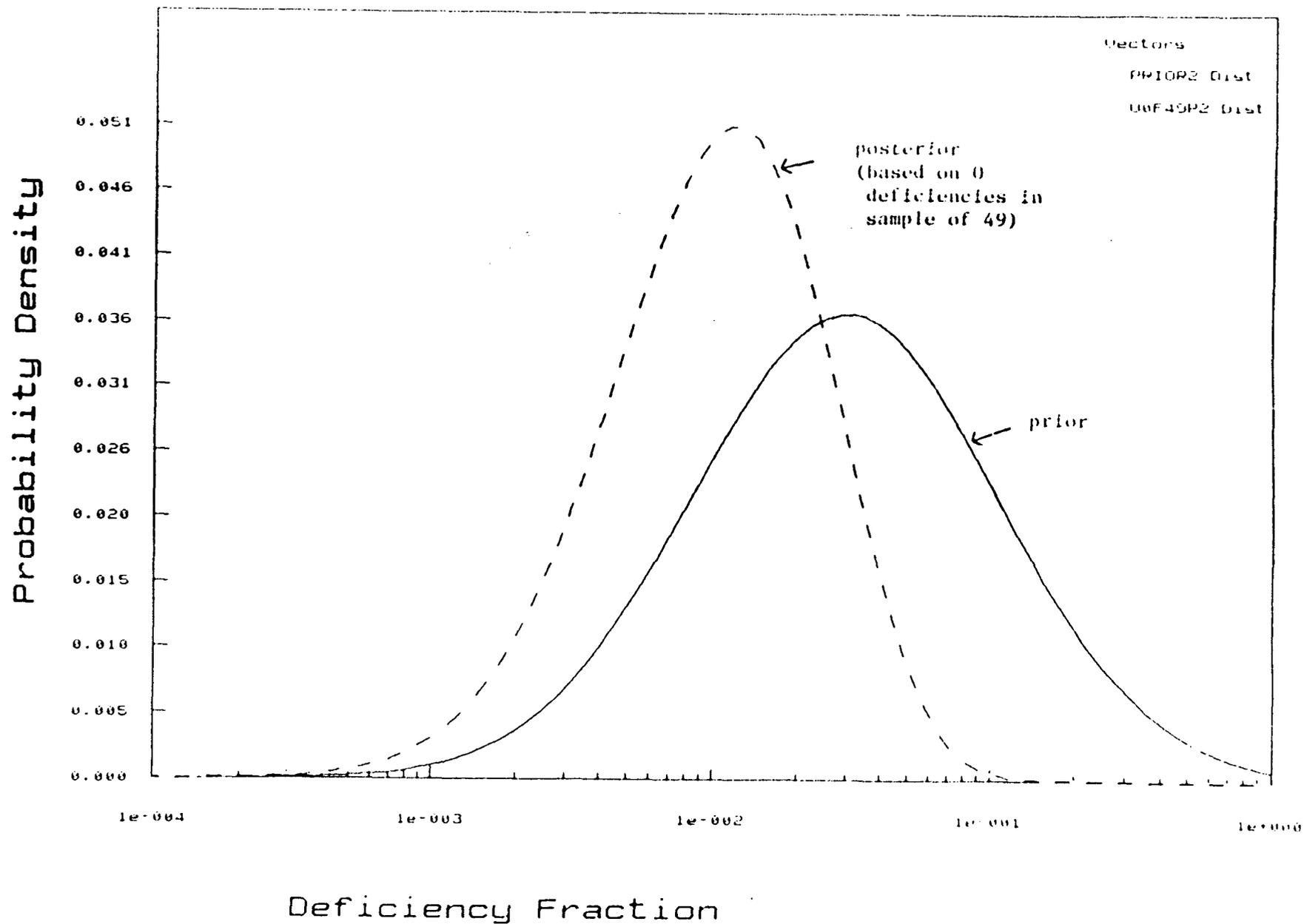


Figure 10. Comparison of Priors

FIGURE 2

SECONDARY DEFICIENCY FRACTION FOR ANSI TYPE H05
AS LINEAR COMBINATION OF ELEMENT 12
"SMALL BORE PIPING"



Attachment 1

EXAMPLE OF APPLICATION OF BAYESIAN ANALYSIS AND
WEIGHTED AVERAGE METHODOLOGY

This example concerns ANSI type H05, "Liquid Penetrant Test Final Reports." The population size and sample results for this type are summarized in Table 1. The population contains two elements: Element 10, "Large Bore Piping," and Element 12, "Small Bore Piping." As seen in the table, 0 primary and 4 secondary deficiencies were found during the sampling.

As an example we shall show how the weighted average technique is used to estimate the fraction of secondary deficiencies in the ANSI type as a whole.

Let f_T^S = fraction of secondary deficiencies for the ANSI type as a whole

f_{10}^S = fraction of secondary deficiencies for element 10

f_{12}^S = fraction of secondary deficiencies for element 12

Then from the data in Table 1,

$$f_T^S = .369 f_{10}^S + .631 f_{12}^S$$

Our approach will be to obtain probability curves for f_{10}^S and f_{12}^S and then combine these through equation (1) to obtain the probability curve for f_T^S .

Figure 1 shows the results for element 10. The prior curve "PRIOR2" is updated with the evidence of 4 deficiencies in a sample of size 88 to produce the posterior shown.

Figure 2 shows the corresponding results for element 12, using the sample evidence of 0 deficiencies out of 49.

Figure 3 shows the results of combining the posterior curves for elements 10 and 12, through equation (1), to obtain the final curve for f_T^S , the secondary deficiency fraction for the ANSI type as a whole.

Figure 4 shows the same results as Figure 3, but plotted in cumulative form. From this figure we read off 95% confidence that the deficiency fraction is less than 5%, easily meeting our criterion of 95/10 for secondaries.

TABLE I

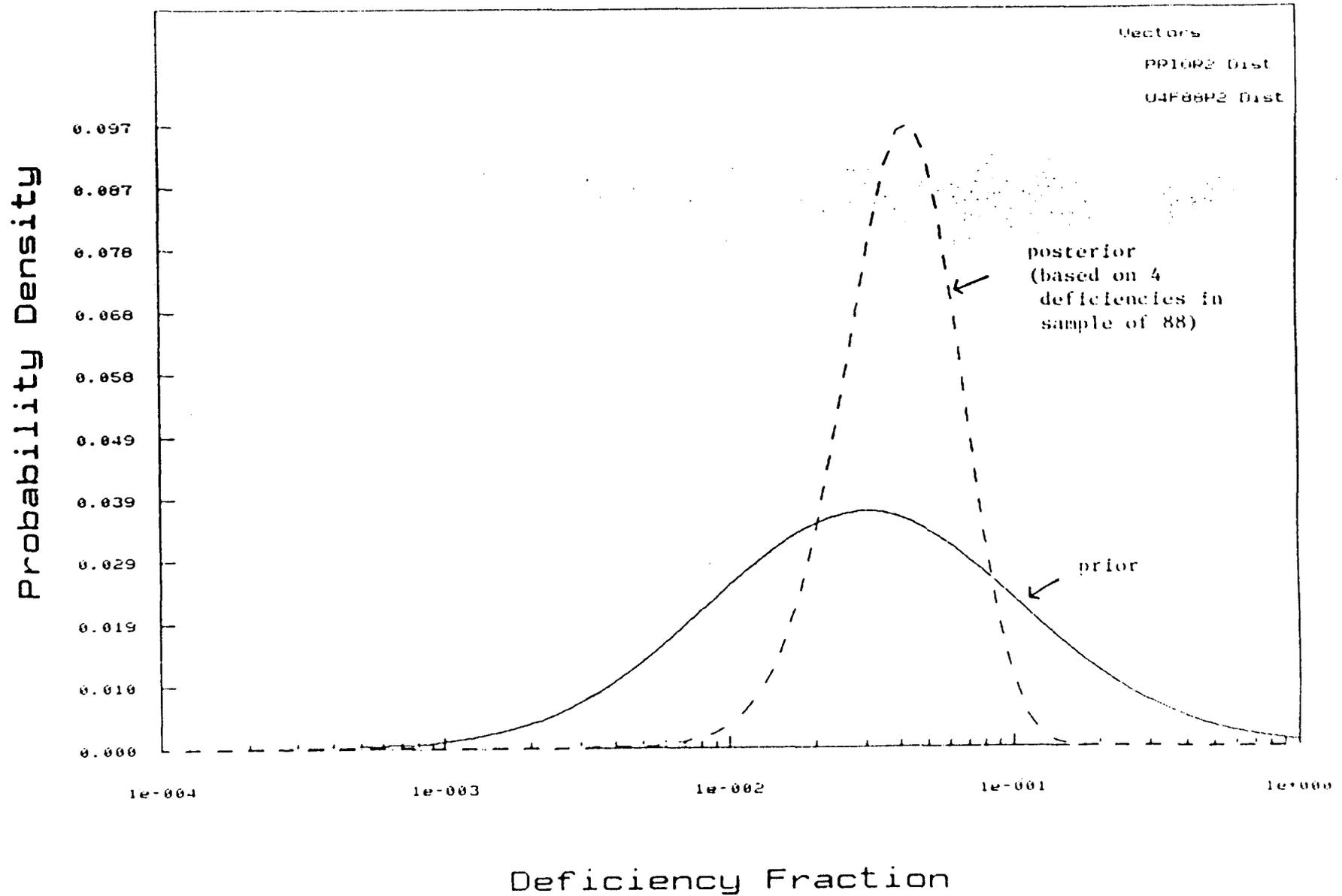
POPULATION DATA AND SAMPLING RESULTS
FOR ANSI TYPE H05

"Liquid Penetrant Test Final Reports"

Element	Population Size		Sample Size		Sample Results by Deficiency Category						Total Primary	Total Secondary
	Records	Pages	Records	Pages	1	2	3	4	5	6		
10 Large Bore Piping	14,300	41,900	30	88	0	0	0	0	0	4	0	4
12 Small Bore Piping	43,800	71,500	30	49	0	0	0	0	0	0	0	0
		113,400									0	4

FIGURE 1

SECONDARY DEFICIENCY FRACTION FOR ANSI TYPE 1105
AS LINEAR COMBINATION OF ELEMENT 10
"LARGE BORE PIPING"



We now turn to the question of whether ANSI type C10, as fixed, satisfies our 95/5 acceptance criterion for primary deficiencies.

What evidence do we have relevant to this question? We originally took a sample of size 60 from this population and found 7 deficiencies, all from the same "cause." In reliability language we would say that we found 7 "failures," all from the same "failure mode."

This failure mode has now been fixed, resulting, in effect, in a new "post fix" population. We are thus asking for the failure rate of the fixed population or equivalently, the failure rate of the original population minus that of the fixed failure mode.

To this question we have firstly the evidence of a sample of size 53 with zero failures. That is, the 7 original deficiencies can no longer be counted as failures, because that failure mode has been fixed. On the other hand we certainly cannot count them as successes, either. The proper treatment is to count them as "no tests," leading to the interpretation of the original sampling evidence as 0 failures in 53 trials, as it relates to the post fix population.

This evidence is used in Figure 1 to update our prior state of knowledge (represented by the curve PRIOR2) about the deficiency rate in ANSI C10.

Figure 2 shows the same results in cumulative form. From this figure we observe that we have 95% confidence that the deficiency fraction is less than 4%. We could conclude, therefore, on the basis of the original sample, that this ANSI group passes our acceptability criterion for primary deficiencies.

In addition to this, however, we now have the evidence of the confirmatory sample of size 7. Updating figures 1 and 2 with this additional evidence we obtain figures 3 and 4 showing 95% confidence that the primary deficiency fraction is less than 3.5%, based on both the original and confirmatory samples.

FIGURE 3

SECONDARY DEFICIENCY FRACTION FOR ANSI TYPE H05,
AS LINEAR COMBINATION OF ELEMENTS 10 AND 12

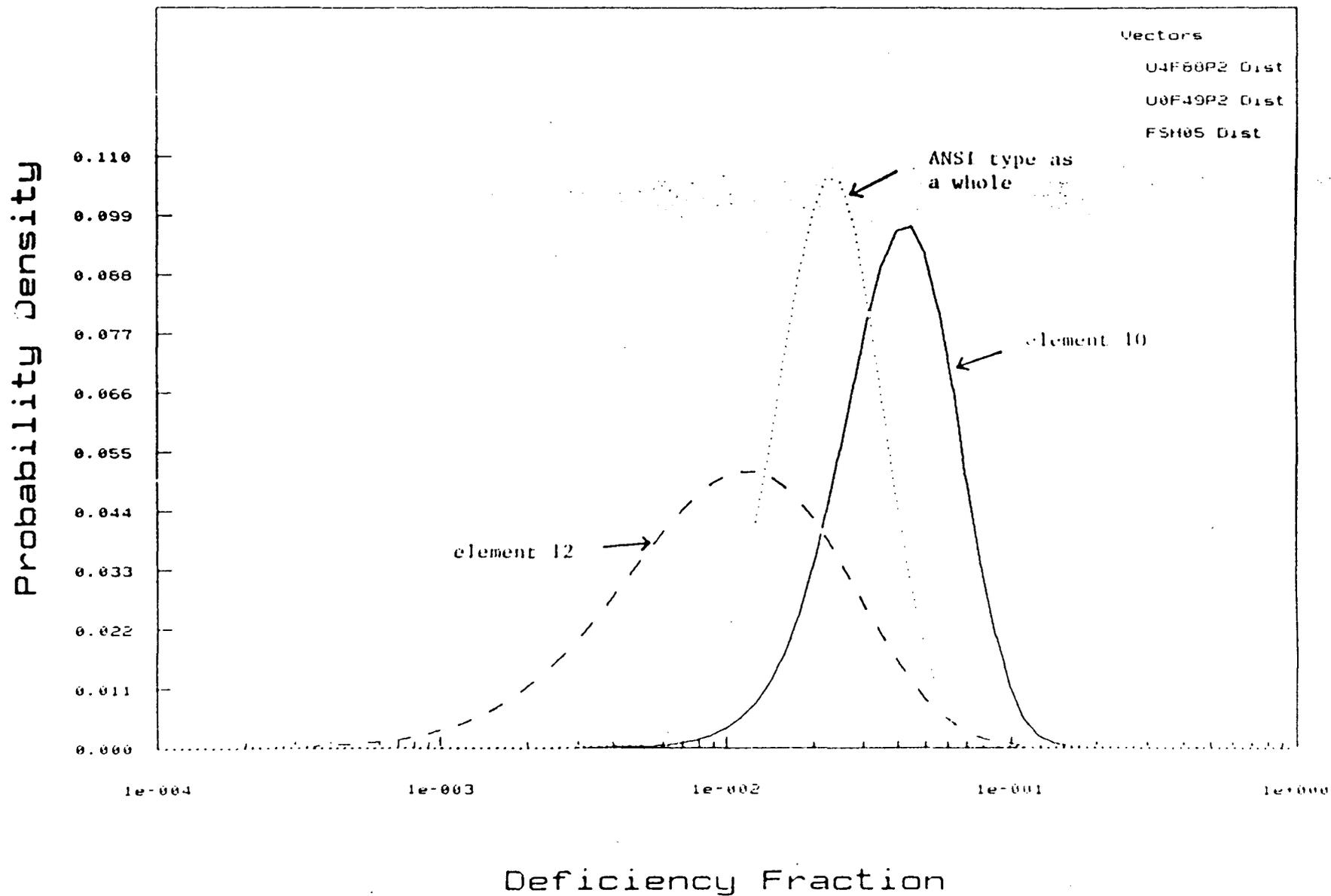
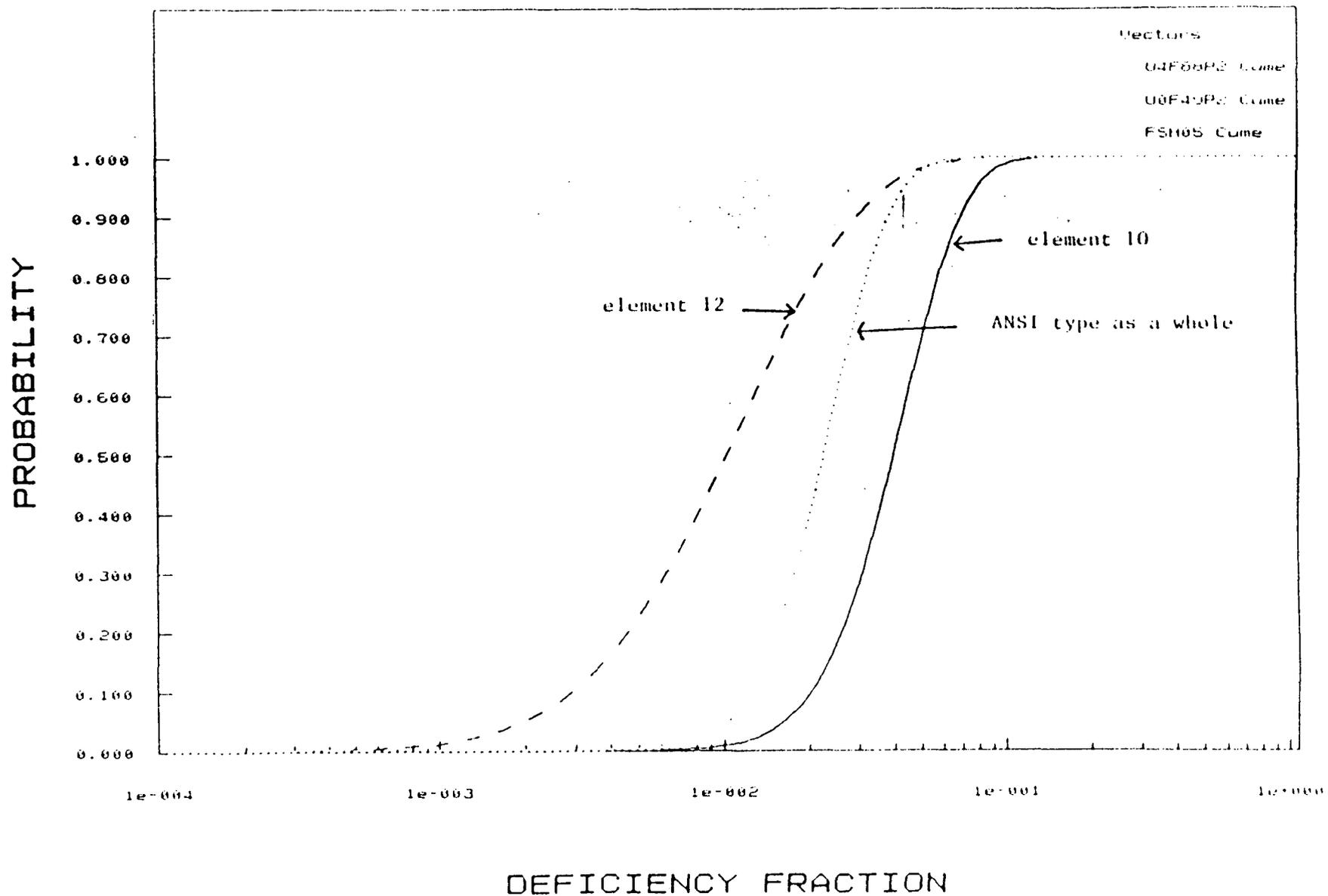


FIGURE 4

SECONDARY DEFICIENCY FRACTION FOR ANSI TYPE H05 AS LINEAR COMBINATION OF ELEMENTS 10 AND 12



Attachment 2

EXAMPLE OF APPLICATION OF EXTENT OF CONDITION EVALUATION USING BAYESIAN ANALYSIS

This example concerns ANSI type C10 titled, "Reports of Pre-Installation Tests." This type has a single element, "cables," a total population of about 22,600 documents. The sample of 60 records showed 7 primary defects, all of these in category 1, "non-retrievable records." Accordingly, an EOC study is being undertaken to find the root of this problem.

The first step in an EOC study, as described in Reference 1, is to understand the nature of the defects and the causative factors leading to them. The second step is to delineate the "suspect area" or subpopulation in which these factors are operative.

In the present example the EOC team carried out these steps by first identifying the cause of all 7 non-retrievable records as being ambiguously worded test procedures and conflicting direction between the test procedures and their governing specifications. These led personnel to be uncertain as to whether the megger test was required or not.

The study team then discerned the fact that the ANSI type C10 record population could be broken into three subpopulations termed respectively, "terminations," "meggers," and "data sheets." All of the 7 missing records were located in the megger group as shown in Table 1. The study group thus identified the megger test records as the suspect subpopulation.

The third step in an EOC study is to "fix" the suspect subpopulation. In the present example the study did this, in effect, by finding alternate records¹ for all records in the megger group. For this reason the ASRR team considers that the suspect population (i.e., the megger group) may be regarded within the meaning of Reference 1 as "fixed" with respect to records missing as a result of the ambiguous procedures.

The next step in an EOC is to take further samples, if necessary, from the residual subpopulation to confirm that the "true" suspect area has been identified. In the present example we are highly confident that the megger subpopulation is the only one in which these "ambiguity deficiencies" occurred. We could thus make the judgment that confirmatory sampling of the residual population in this case is unnecessary. Nevertheless, just to assuage any doubts, we have in fact taken an additional random confirmatory sample of size 7, all of which were terminations and all of which had no primary deficiencies (Table 2).

¹The alternate records chosen were functional test records as allowed by the applicable IEEE standard. WBN's established procedures/programs mandated the generation of functional test documentation.

the question of whether ANSI type C10, as fixed, satisfies our criterion for primary deficiencies.

What is relevant to this question? We originally took a sample of 53 from this population and found 7 deficiencies, all from the same failure mode. In reliability language we would say that we found 7 failures from the same "failure mode."

The failure mode has now been fixed, resulting, in effect, in a new "post-fix" population. We are thus asking for the failure rate of the fixed population. Equivalently, the failure rate of the original population minus the failure rate of the fixed failure mode.

What is the evidence? We have firstly the evidence of a sample of size 53 with zero failures. The 7 original deficiencies can no longer be counted as failures because that failure mode has been fixed. On the other hand we can count them as successes, either. The proper treatment is to count them as 0 failures, leading to the interpretation of the original population as 0 failures in 53 trials, as it relates to the post-fix population.

Figure 1 is used to update our prior state of knowledge about the curve PRIOR2) about the deficiency rate in ANSI C10.

The same results in cumulative form. From this figure we have 95% confidence that the deficiency fraction is less than 3.5%. We conclude, therefore, on the basis of the original sample, that the population passes our acceptability criterion for primary deficiencies.

Thus, however, we now have the evidence of the confirmatory sample. Updating figures 1 and 2 with this additional evidence we have 95% confidence that the primary deficiency rate is less than 3.5%, based on both the original and confirmatory samples.

Original Primary
Deficiencies

0
7
0

7

Post-Fix Primary
Deficiencies

0
0
0

FIGURE 1

PRIMARY DEFICIENCY FRACTION FOR ANSI TYPE C10

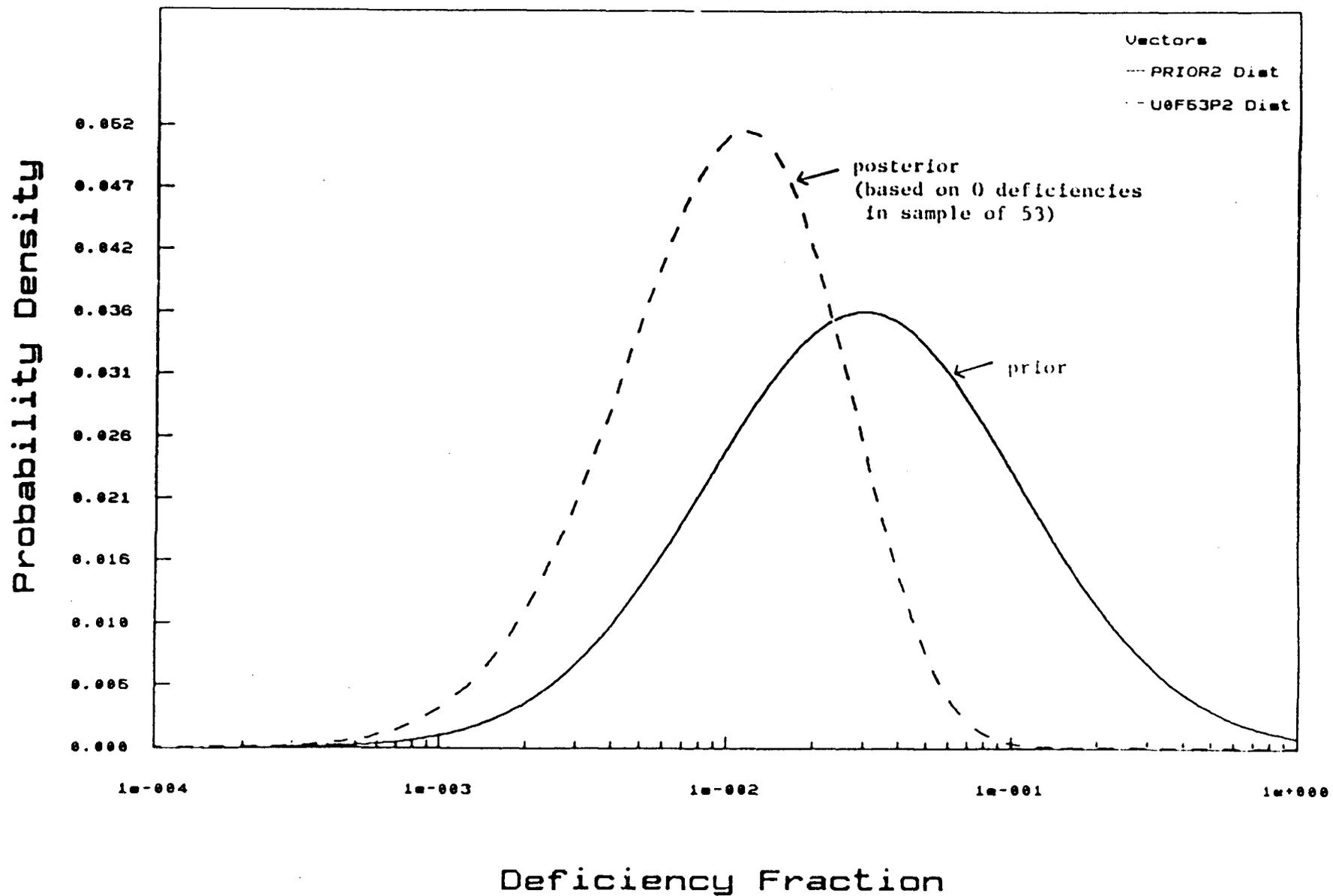


FIGURE 2

PRIMARY DEFICIENCY FRACTION FOR ANSI TYPE C10

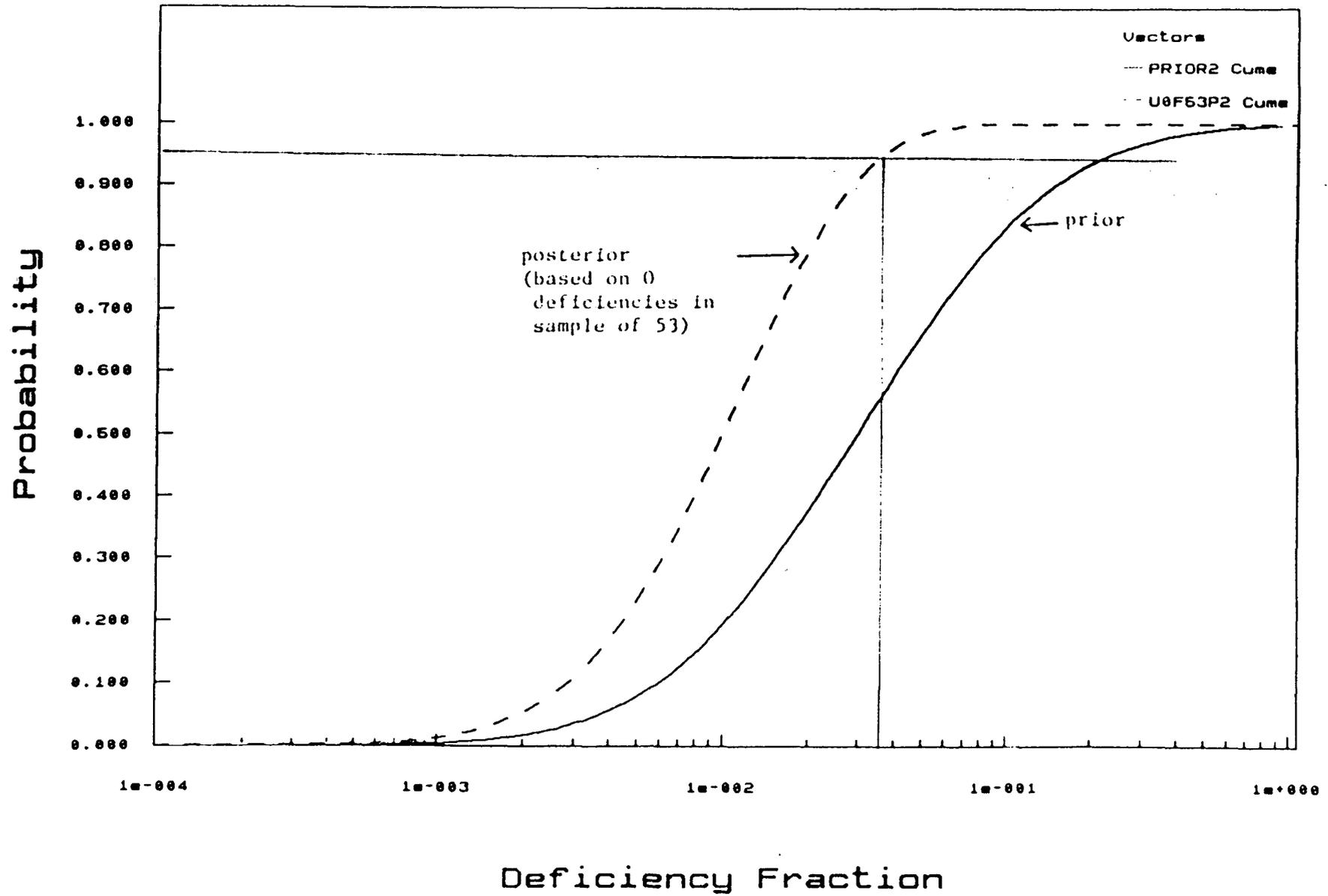


FIGURE 3

PRIMARY DEFICIENCY FRACTION FOR ANSI TYPE C10
USING BOTH ORIGINAL AND CONFIRMATORY SAMPLES

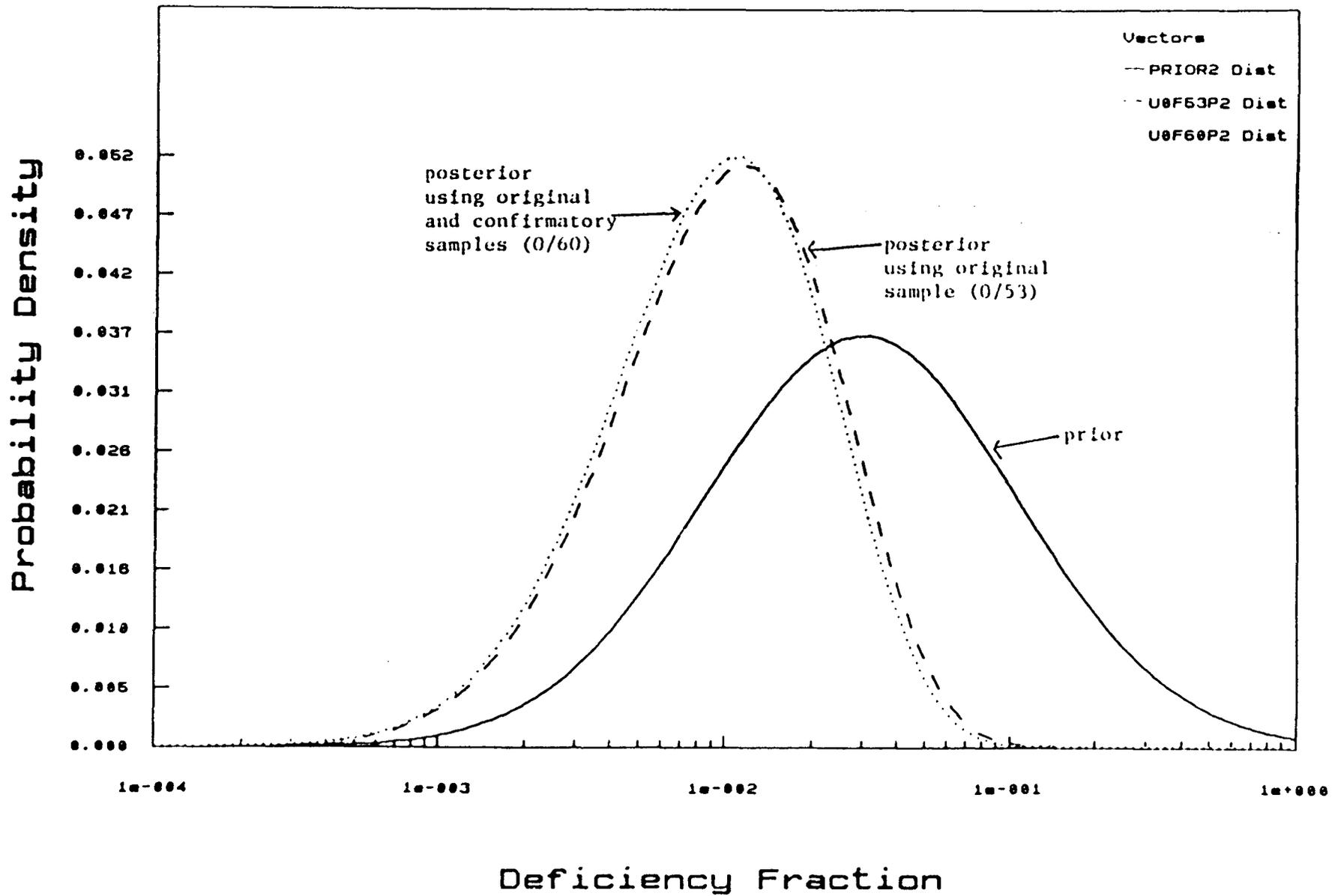


FIGURE 4

PRIMARY DEFICIENCY FRACTION FOR ANSI TYPE C10 USING BOTH ORIGINAL AND CONFIRMATORY SAMPLES

