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Adopted: May 1, 2003

GRI-GM20*

Standard Guide for

"Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts"

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1. Scope

1.1 This guide is focused on selecting the spacing interval for taking destructive seam samples of field deployed geomembranes as a particular job progresses based on an installers ongoing record of pass – or – fail testing.

> Note 1: This is a complimentary guide to GRI GM14 which uses the method of attributes to achieve the same purpose. The difference, however, is that the topic of this guide is based on control charts that can be used on any size project, even very small ones. The method of attributes requires large projects which consist of more than 100 samples based on the typical sampling strategy of one destructive sample per 150 m (500 feet) of seam distance.

1.2 This guide is focused on production seaming of geomembranes. Caution should be exercised in using the guide for projects that involve complex geometries, multiple penetrations, or extreme weather conditions.

1.3 The primary target audiences for this guide are construction quality assurance (CQA) organizations, construction quality control (CQC) organizations, facility owner/operators and agency regulators having permitting authority.

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*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

1.4 The outcome of using the guide rewards good seaming performance resulting from a record of passing destructive seam tests. It also penalizes poor seaming performance resulting from a record of excessively failing seam tests.

1.5 This guide does not address the actual seam testing procedures that are used for acceptance or failure of the geomembrane seam test specimens themselves. Depending on the type of geomembrane being deployed one should use ASTM D 6392 as the seam testing protocol and GRI GM19 for the pass/fail specification values. The project-specific CQA plan should define the particular criteria if different from ASTM D 6392 coupled with GRI-GM19.

2. Referenced Documents

2.1 ASTM Standards:

D 6392	Standard Test Method for "Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods"

2.2 GRI Standards:

GM19	Standard Specification for "Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes"
GM14	Standard Guide for "Selecting Variable Intervals for Taking Geomembrane Destructive Seam Sample Using the Method of Attributes"

3. Summary of Guide

3.1 Use of this guide requires the establishment of an upper control limit (UCL) and lower control limit (LCL) of seam failure rates. It also requires the establishment of an initial, or start-up, sampling interval.

Note 2: The value of anticipated failure percentage is an important consideration. It dictates each decision as to a possible increase or decrease in interval spacing from the preceding value. The percentage itself comes from historical data of the construction quality assurance (CQA) organization or regulatory agency. It is related to a number of factors including criticality of installation, type of geomembrane, type of seaming method and local ambient conditions.

The actual value is admittedly subjective and should be made known in advance to the geomembrane installer before bidding the project. Use of an unrealistically low value of anticipated failure percentage, e.g., < 1.0%, will likely result in field difficulties insofar as decreased sampling intervals are concerned. Conversely, use of an unrealistically high value of anticipated failure percentage, e.g., > 8.0%, will likely result in very large sampling intervals and quite possibly sacrifice the overall quality of the seaming effort.

3.2 The guide requires the calculation of the seam failure rate beginning with the first sample's test result. Thus, it is an ongoing process.

3.3 When the failure rate exceeds the UCL, the sampling frequency, or interval, should be decreased. The establishment of this interval is an arbitrary decision.

3.4 When the failure rate drops beneath the LCL, the sampling frequency, or interval, should be increased. The establishment of this interval is an arbitrary decision.

3.5 When the failure rate is between the UCL and the LCL, the sampling frequency, or interval, should remain the same.

4. Significance and Use

4.1 Construction quality assurance (CQA) and construction quality control (CQC) organizations, as well as owner/operators and agency regulators can use this guide to vary the sampling interval of geomembrane seam samples (i.e., the taking of field samples for destructive shear and peel testing) from an initial, or start-up, interval. This initial interval is often 1 destructive seam sample in every 150 m (500 ft) of seam length.

4.2 The guide leads to increasing the sampling interval for good seaming practice (hence fewer destructive samples) and to decreasing the sampling interval for poor seaming practice (hence additional destructive samples).

4.3 Use of the guide should provide an incentive for geomembrane installers to upgrade the quality and performance of their field seaming activities. In so doing, the cutting of fewer destructive samples will lead to overall better quality of the entire liner project, since the patching of previously taken destructive samples is invariably of poorer quality than the original seam itself.

Note 3: It is generally accepted that field patching of areas where destructive samples had been taken using extrusion fillet seaming is less desirable than the original seam which was made by hot wedge welding.

4.4 Control charts, as described in this guide, offer a counterpoint to the more rigorous method of attributes which is the topic of GRI-GM14. A major difference is that the method of attributes requires at least 30 test results to begin the process and many more for continuation. Thus, it is applicable to large projects. Control charts, on the other hand, can be utilized on projects of extremely small size beginning with the test results of the first sample evaluated.

5. Suggested Methodology

Using the concepts embodied in control charts, the following is the suggested methodology.

5.1 Assumption of Control Limits – Assume that a typical small-project sample failure rate is 4.0%. This allows for the setting of an UCL = 5.0% and a LCL = 3.0%.

5.2 Setting of Initial Sample Spacing and Variation – Assume that an initial sample spacing is one per 500 ft (150 m) and that increment variations above and below the control limits are 200 ft (60 m).

5.3 Example Situation – As shown in Table 1, assume that the first 13-samples resulted in passing tests and that the 14th was a failure. Thus the initial sampling interval of 1 per 500 ft (150 m) must be reduced to 1 per 300 ft (90 m) since the failure rate immediately becomes 7.1%. With additional passing test results, this failure rate drops below 5.0% after the 20th sample. The interval is then opened to the original value of 1 per 500 ft (150 m). With continued passing test results, the failure rate drops below 3.0% after the 33rd test results. The interval is then opened to 1 per 700 ft (210 m) until the project is finished after the 40th sample. The process can be followed graphically as shown in Figure 1.

Table 1 – Example Situation in the Field

Sample No.	Seam Test Result (Pass/Fail)	Failure Rate (%)	Spacing: 1 per ? (feet)	Sample No.	Seam Test Result (Pass/Fail)	Failure Rate (%)	Spacing: 1 per ? (feet)
1	Pass	0	500	21	Pass	4.8	500
2	Pass	0	500	22	Pass	4.5	500
3	Pass	0	500	23	Pass	4.3	500
4	Pass	0	500	24	Pass	4.2	500
5	Pass	0	500	25	Pass	4.0	500
6	Pass	0	500	26	Pass	3.8	500
7	Pass	0	500	27	Pass	3.7	500
8	Pass	0	500	28	Pass	3.6	500
9	Pass	0	500	29	Pass	3.4	500
10	Pass	0	500	30	Pass	3.3	500
11	Pass	0	500	31	Pass	3.2	500
12	Pass	0	500	32	Pass	3.1	500
13	Pass	0	500	33	Pass	3.0	500
14	Fail	7.1	300	34	Pass	2.9	700
15	Pass	6.7	300	35	Pass	2.8	700
16	Pass	6.2	300	36	Pass	2.8	700
17	Pass	5.9	300	37	Pass	2.7	700
18	Pass	5.6	300	38	Pass	3.6	700
19	Pass	5.3	300	39	Pass	2.6	700
20	Pass	5.0	300	40	Pass	2.5	700

5.4 Commentary – For the example given, the 40 samples that were taken cover 19,800 ft (6030 m) of seam length. This is approximately the same as if fixed increment sampling at 1 per 500 (150 m) were monitored throughout. In that case the seam length covered would have been 20,000 ft (6100 m).

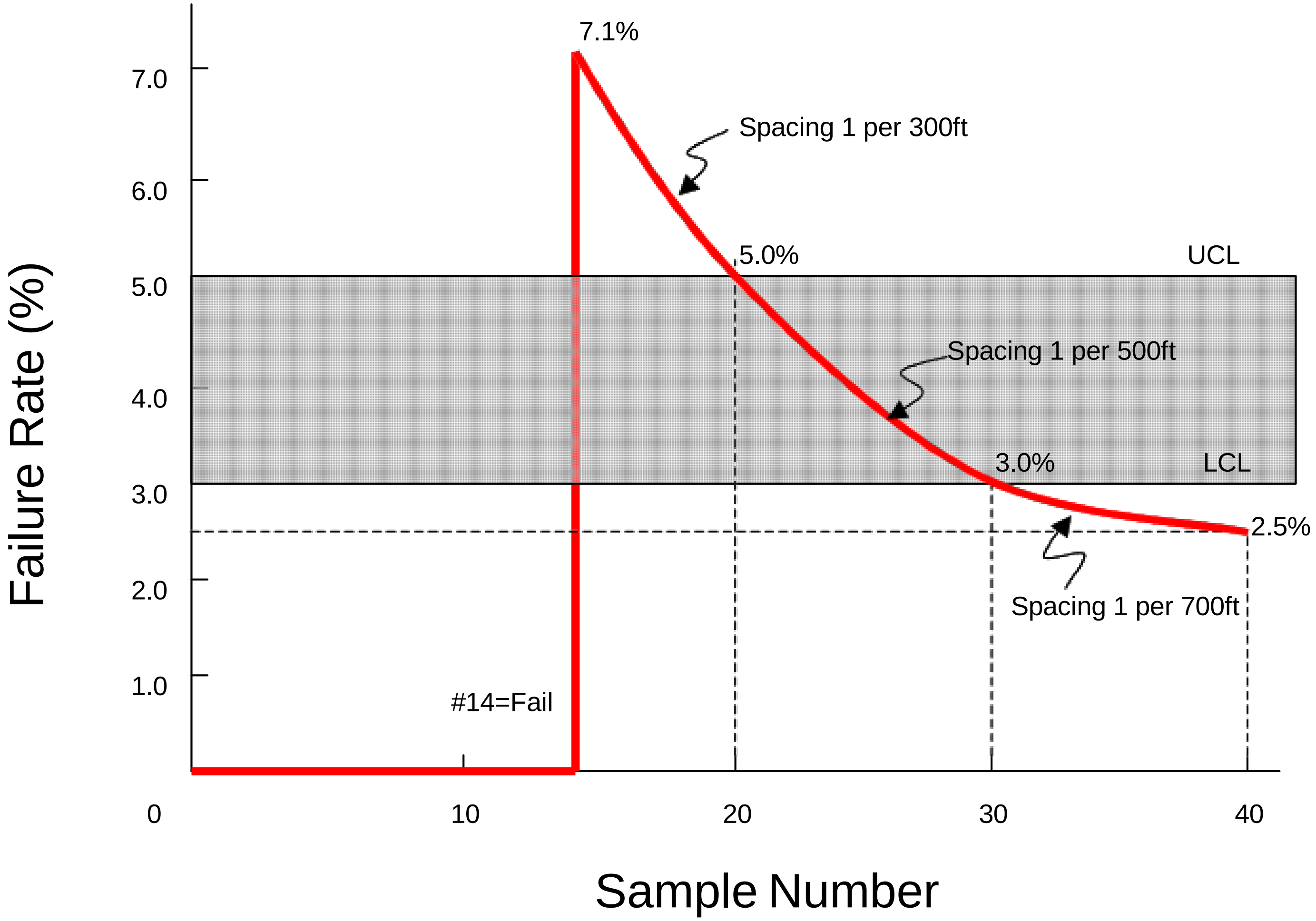

Fig. 1 – Plot of the Hypothetical Data Given in the Illustrated Example

6. Conclusions

This guide illustrates by means of hypothetical examples how a CQA and/or CQA organization can modify the sampling interval for taking destructive samples from a geomembrane seaming project. It is based on a control chart (requiring the setting of UCL and LCL values) which is common to statistical control methods. The methodology uses continuous sampling and related test results to proceed from one decision to the next until the project is complete.

The results of using this guide for the above purpose is to reward good seaming performance by taking fewer destructive samples, and to penalize poor seaming performance by taking additional destructive samples. In the example illustration, the situation resulted in similar number of destructive samples as if a fixed sampling interval was used. Had no failures resulted, far fewer destructive samples would have been necessary. Conversely, if more failures resulted, more destructive samples would have been necessary. These consequences are embodied in the concept of statistical sampling.