

TECHNICAL INSPECTION SERVICES, INC

Quality Audit – Quality Control  
Houston, Texas 77034

5202 South Shaver  
Telephone 713-947-7796  
Fax 713-947-7796

**RE: Rockshield test data at request of Tuff-N-Nuff Industries**

This proposal is offered to cover the testing of rockshield materials for pipeline protection. Rockshield materials are available in many different forms, but all of the materials must perform the same tasks. In addition to the performance properties, the rockshield must be practical to apply. The flexural properties at low temperature would indicate how well the plastic sheets would lend themselves to winter construction.

The two most important functions of a rockshield are: to protect the corrosion coating from impact damage during backfilling, and to protect the pipe and coating on a long-term basis from contact with rocks or other objects during operation of the pipeline.

The third function of a rockshield is that it has adequate shear strength characteristics.

The fourth major concern with rockshield materials (as well as other pipeline coatings) is that they do not shield the passage of cathodic protection currents.

This proposal is divided into four parts to address these four topics.

I. Impact Protection

The most widely accepted test for impact resistance of pipeline coatings is found in ASTM G14. The exact procedure calls for 2-3/8" OD pipe samples and a V-notch support. Most adaptations of the method follow the applicable procedures and calculations and simply state the type of specimen and support used. The point most commonly used is the 5/8" diameter tup described in G14. However, there has been interest expressed in the behavior of rockshields when impacted with sharp objects. At this laboratory, we have developed a 90-degree angle chisel point on the impactor to address this concern.

- I. A. Impact Resistance; 5/8" Diameter Spherical Impactor; ASTM G14
  - 1.) Baseline determination on FBE
  - 2.) Determination with rockshield in place
  
- B. Impact Resistance; Chisel Point Impactor; Non-standard Modification of G14
  - 1.) Baseline determination on FBE
  - 2.) Determination with rockshield in place

## II Protection from Damage during Operation

The most popular penetration resistance test for pipeline coatings is ASTM G17. This procedure involves the use of a 1/4" diameter blunt rod and a specific weight. The weight is applied for several days until the maximum penetration has been reached, and the rod stops moving. The test is often conducted at room temperature and at 150F. It could be performed on a flat steel plate to determine the penetration resistance of the rockshield alone without the contribution of the corrosion coating. A larger point, such as a 1/2" diameter blunt rod with a correspondingly higher weight may be more realistic for foam materials. As stated above, there is interest in the behavior with sharp objects. The same chisel point used for the modified impact test can be adapted to the penetration test. The compressive strength of the rockshield is important in determining the load that the material can support with a given deformation during a short-term loading situation. The shear strength test will give an indication of the toughness of the material under shear loading conditions due to soil stress.

- II. A. Penetration Resistance: 1/2" diameter blunt rod; Non-standard Modification of G 17
  - 1.) Rockshield alone 75F

2.) Rockshield alone 150F

B. Penetration Resistance: Chisel point; Non-standard Modification of G17

1.) Rockshield alone 75F

2.) Rockshield alone 150F

C. Compressive Strength on stacked layers

Similar to ASTM D1621 75F

III. A. Shear Strength: Punch Tool

Similar to ASTM D732 75F

IV Cathodic Protection Shielding of Tuff-N-Nuff samples only.

A sheet of the material may or may not have obvious paths through which moisture, and thus current, could pass. We have developed a flange-type apparatus at this laboratory that can confirm the passage of cathodic protection current through a highly conductive salt solution with the rockshield inserted between an anode and an intentional holiday in a coated steel sample.

Another method that may be used on selected materials involves setting up two tanks filled with a salt solution or moist sand. Coated pipe samples are prepared with intentional holidays and then wrapped with the rockshield. The pH of the solution near the pipe is kept near 7 or slightly acidic and is oxygenated to increase its corrosivity. The anode of a cathodic protection circuit is placed in the other tank and connection to the first tank is made by means of a salt bridge tube. This arrangement keeps the anode products from interfering with the reactions at the holidays without restricting the flow of CP current. Potential and current flow are monitored for a period of 7 days. After exposure, the pipes are examined for evidence of corrosion or for evidence of the functioning of the cathodic protection.

IV. A. Flange method on free film

B. Simulated CP Arrangement 2 pipes, 2 holidays per pipe, 7 days

## I. Impact Protection

### A. 5/8" Diameter Ball Bearing Impactor

<u>Material</u>	<u>Impact Str.</u>	<u>Std.Dev.</u>	<u>Increment</u>	<u>Weight</u>	<u>D/S</u>
FBE Alone	22.2 in-lbs	3.5 in-lbs	1 inch	3 lbs	0.29
* FBE + A	37.3 in-lbs	3.5 in-lbs	1 inch	3 lbs	0.29
* FBE + B	127.5 in-lbs	3.5 in-lbs	1 inch	5 lbs	0.29
* FBE + C	185.0 in-lbs	21 in-lbs	5 inches	5 lbs	0.24
FBE + D	31.2 in-lbs	1.7 in-lbs	1 inch	3 lbs	0.59
FBE + E	36.4 in-lbs	4.9 in-lbs	1 inch	3 lbs	0.20

### B. Chisel Point Impactor

<u>Material</u>	<u>Impact Str.</u>	<u>Std.Dev.</u>	<u>Increment</u>	<u>Weigh</u>	<u>D/S</u>
FBE Alone	13.5 in-lbs	2.3 in-lbs	1 inch	3 lbs	0.44
*FBE + A	29.5 in-lbs	2.3 in-lbs	1 inch	3 lbs	0.44
*FBE + B	84.2 in-lbs	3.1 in-lbs	3 inches	5 lbs	0.96
*FBE + C	150.0 in-lbs	11.3 in-lbs	5 inches	5 lbs	0.44
FBE + D	22.2 in-lbs	2.8 in-lbs	1 inch	3 lbs	0.36
FBE + E	24.6 in-lbs	4.1 in-lbs	1 inch	3 lbs	0.25

\* **Tuff -N-Nuff**

## Introduction

Five types of rockshield materials were sent to this laboratory for testing. They were labeled A through E. A brief physical description and the schedule of testing follows:

### Materials and Test Schedule:

- A. Tuff-N-Nuff mat of extruded 0.05" diameter strings, <0.20" thick. Tests IA, IB, II and III.
- B. Tuff-N-Nuff mat of extruded 0.05" diameter strings, 0.25" thick. Tests IA and IB.
- C. Tuff-N-Nuff mat of extruded 0.05" diameter strings, 0.375" thick. Tests IA and IB.
- D. Black Foam, 25 mil backing, 0.25" holes on 2" centers, 0.35" thick. Tests IA, IB, II, III and IV.
- E. Black Grid, hard foamed plastic, 0.3" centers, 0.13" thick. Tests IA, IB, II, III and IV.

### Tests:

- I. Impact Protection (ASTM G14 and similar)
  - A. 5/8" Ball Bearing
  - B. Chisel point
- II. Compressive Strength (Similar to ASTM D1621)
- III. Shear Strength (Similar to ASTM D732)
- IV. Cathodic Protection Shielding (Tuff-N-Nuff samples only)