



# SURFACE VEHICLE RECOMMENDED PRACTICE

**J400™****AUG2022**

Issued 1968-07  
Reaffirmed 2012-10  
Revised 2022-08

Superseding J400 OCT2012

## Test for Chip Resistance of Surface Coatings

### RATIONALE

SAE J400 is being revised to correct some technical errors and to make the standard easier to follow.

#### 1. SCOPE

This SAE Recommended Practice covers a laboratory procedure for testing and evaluating the resistance of surface coating to chipping by gravel impact. The test is designed to reproduce the effect of gravel or other media striking exposed paint or coated surfaces of an automobile. The specific intent of the test is to evaluate organic surface coatings or systems on flat test panels; however, it may be possible to extend this type of testing to finished parts or other types of materials such as anodized aluminum or plated plastics if the results are interpreted with respect to the limitations and intent implied by the original testing procedures and rating system.

This document may involve hazardous materials, operations, and equipment. This document does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this document to consult and establish safety and health practices and determine the applicability of regulatory limitations prior to use.

All dimensions are nominal unless otherwise noted.

#### 2. REFERENCES

##### 2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

##### 2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

SAE Chipping Rating Standards (part number EA-400)

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2022 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

**TO PLACE A DOCUMENT ORDER:** Tel: 877-606-7323 (inside USA and Canada)  
Tel: +1 724-776-4970 (outside USA)  
Fax: 724-776-0790  
Email: [CustomerService@sae.org](mailto:CustomerService@sae.org)  
<http://www.sae.org>

SAE WEB ADDRESS:

For more information on this standard, visit  
[https://www.sae.org/standards/content/J400\\_202208/](https://www.sae.org/standards/content/J400_202208/)

## 2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

### 2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

Young, T. and Hays, D., "Measurement of Chipping of Automotive Finishes," SAE Technical Paper 680046, 1968, doi:10.4271/680046.

## 3. SUMMARY OF METHOD

The test consists of projecting standardized road gravel by means of a controlled air blast onto a suitable test panel. The testing apparatus is called a gravelometer, designed to contain road gravel, a test panel holder, and a gravel projecting mechanism. The projecting mechanism, located in front of the test panel, consists of an air nozzle in the base of an inverted pipe tee. The stem of the pipe tee points upward and is located beneath a vibrating hopper into which the gravel is poured. The gravel, falling into the air blast, is projected toward and impacts upon the test panel, which is usually held perpendicular to the impinging gravel. All testing is conducted under controlled temperature conditions, generally room temperature (ambient) or  $-29^{\circ}\text{C} \pm 3^{\circ}\text{C}$  ( $-20^{\circ}\text{F} \pm 5^{\circ}\text{F}$ ). After the gravel impact, tape is applied to remove any loose paint chips remaining on the panel, and the degree of chipping is determined by visual comparison with the SAE Chipping Rating Standards<sup>1</sup>, by counting the number and sizes of all chips, or by other methods deemed suitable between the contractual parties involved.

## 4. EQUIPMENT AND MATERIALS

### 4.1 Gravelometer

A gravel projecting test apparatus which is constructed according to the design specifications shown in Figures 1A and 1B.

SAENORM.COM : Click to view the full PDF online 202208

---

<sup>1</sup>Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001—Identified as EA-400.

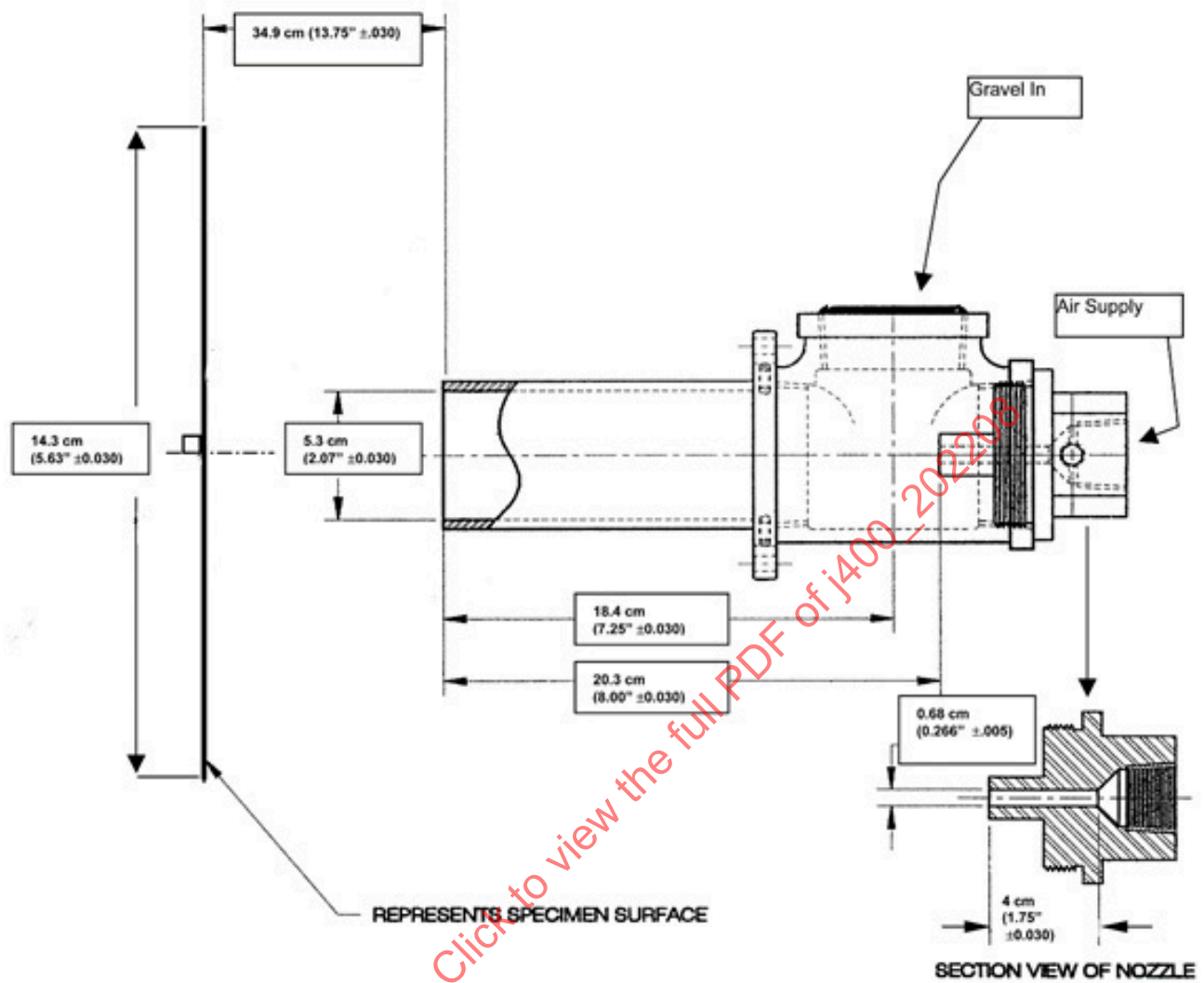


Figure 1A - Test apparatus with 90 degree impingement angle

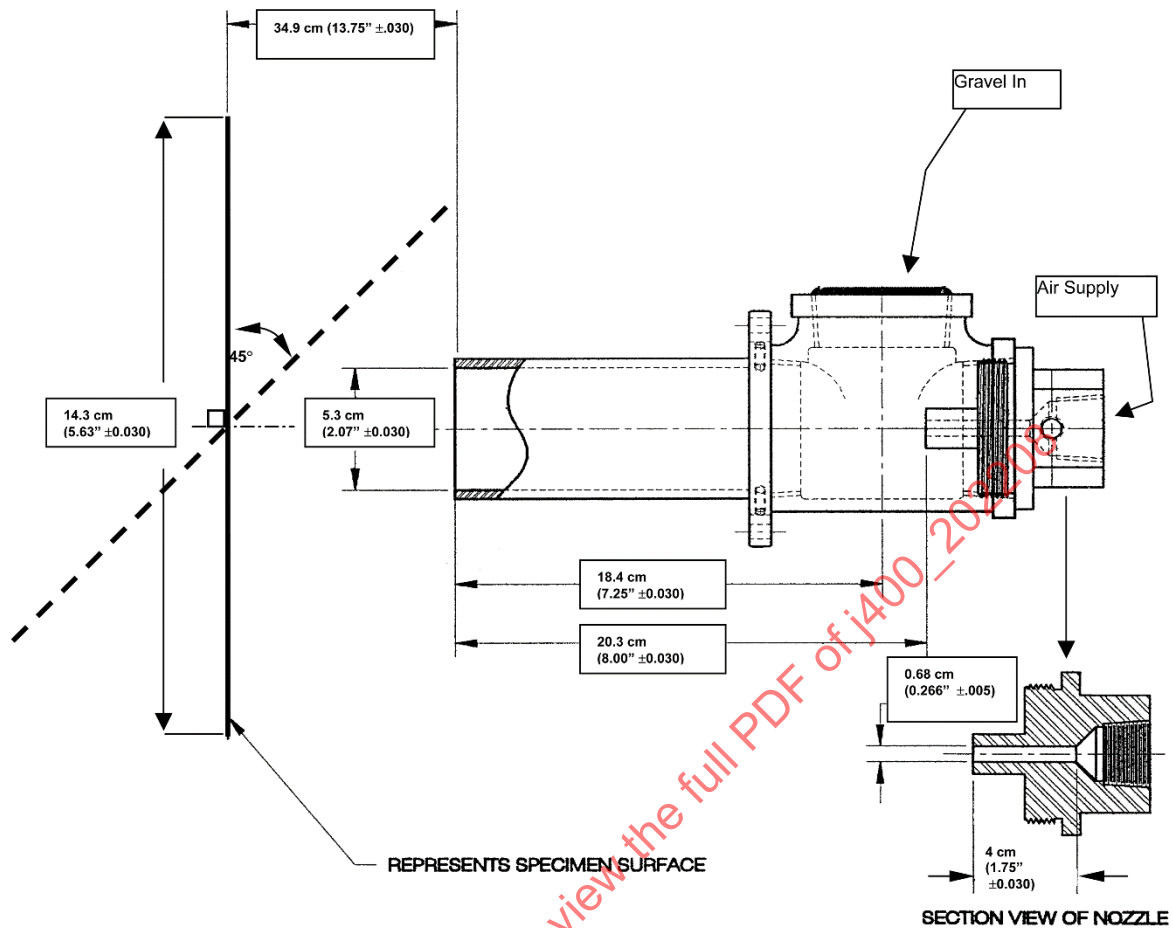


Figure 1B - Test apparatus showing rotated 45 degree impingement angle

## 4.1.1 Operation/Maintenance Checklist

The operation/maintenance checklist shown in Figure 2 shall be completed at least once a month for testers that are operated on a weekly basis and once every 6 months for testers that are operated less frequently.

NOTE: Values in chart are specific to the standard gravel testing protocol. Different specifications may be necessary for other media types.

If the answer to any of the following questions is NO, discontinue testing until the problem has been corrected.

Question	Yes	No	Data
Are the pipe joints free of leaks?			
Does the air pressure hold 483 kPa (70 psi $\pm$ 3 psi) for 10 seconds?			
Is the air pressure gauge calibrated?			
Date Last Calibrated:			
Date Last Replaced:			
Is nozzle orifice clear?			
Insert a 6.75 mm (17/64 inch) drill bit or 6.75 mm $\pm$ 0.01 mm (0.266 inch $\pm$ 0.005 inch) plug gauge into nozzle to verify that the nozzle orifice is clear			
Is the distance of nozzle to sample surface 55.25 cm (21.75 inch $\pm$ 0.030 inch)?			
Is the distance of gun barrel to sample 34.93 cm (13.75 inch $\pm$ 0.030 inch)?			
Is sample mounting bracket level top-to-bottom/front-to-back?			
Is the backer panel edge supported (not solid)?			
Is backer panel tight?			
Are the backer panel angles correct?			
Are stones hitting target in an even/centered position?			
Is the gravel screened?			
For older cabinet-type gravelometers, is the amount of gravel collected on screen less than 10 pints?			
Is the correct type and size of gravel being used?			
Does 1 pint of gravel empty from the hopper in 7 to 10 seconds?			
Is the filter clear of obstructions?			
Date of last filter cleaning or replacement			
For older type gravelometers, replace vibrator and bushings if gravel takes longer than 10 seconds to empty			
For gravelometers with electronic feed mechanisms, adjust vibrator speed and hopper height so that hopper empties in 7 to 10 seconds			
Compressor capacity and type:			

## Below-Ambient Testing Information (if required)

Question	Yes	No	Data
Are panels frozen prior to testing?			
How long are panels conditioned in freezer?			
What is the conditioning temperature?			
What is the ambient temperature?			
Time panels exposed to ambient prior to test			
How far is the QGR from freezer?			

Figure 2 - Checklist

## 4.2 Gravel

The gravel for this test shall be water-worn road gravel, not crushed limestone or rock. The gravel will pass through 15.86 mm (5/8 inch) space screen when graded but be retained on 9.53 mm (3/8 inch) space screen. It is important to note that mesh screen is not a substitute for space screen. The gravelometer has 9.53 mm (3/8 inch) space screen in the bottom to separate fractured pieces of rock and dust smaller than 9.53 mm (3/8 inch) so that the retained gravel on this screen may be reused. Because the gravel tends to blunt or fragment after repeated impacts, it should be changed at a regular frequency. For testers that are operated on a weekly basis, 2 pints of gravel shall be replaced with fresh gravel each month. For testers that are operated on less frequent basis, 2 pints of gravel shall be replaced with fresh gravel at least every 6 months.

Gravel must be washed prior to initial use.

Other media may be used as agreed upon by contractual parties.

NOTE: Pint measurements refer to a 1 pint container full to the top.

## 4.3 Paint Removal Tape

10 cm (4 inches) wide or 5 cm (2 inches) wide, 3M product #898 filament strapping tape or equivalent. Other tape may be used as agreed upon by contractual parties.

NOTE: The adhesion strength of the tape use makes a significant impact on how much separated paint is removed.

## 4.4 Temperature Conditioning Equipment

Gravelometer tests are usually run at ambient or a lower temperature, generally  $-29^{\circ}\text{C}$  ( $-20^{\circ}\text{F}$ ), which shall be mutually agreed upon by contractual parties. Tests conducted at different temperatures will employ the following:

### 4.4.1 Method A

A cold room or chamber in which the gravelometer and test panels are maintained at the specified temperature of testing.

For freezers that employ a defrosting mechanism, document the method of defrosting and any temperature changes.

NOTE: Check with the manufacturer of the apparatus before performing cold room testing.

### 4.4.2 Method B

A freezer in which the test panels are cooled to  $5.6^{\circ}\text{C}$  ( $10^{\circ}\text{F}$ ) below the test temperature before they are individually transferred and tested immediately in a gravelometer at room temperature located nearby.

### 4.4.3 Method C

Ambient: Room maintained at a temperature between  $20^{\circ}\text{C}$  ( $68^{\circ}\text{F}$ ) and  $30^{\circ}\text{C}$  ( $86^{\circ}\text{F}$ ).

## 4.5 Transparent Grid

A chip counting aid constructed of transparent plastic approximately  $3.2\text{ mm} \times 12.7\text{ cm} \times 12.7\text{ cm}$  ( $1/8 \times 5 \times 5$  inches), on which a  $10.16 \times 10.16\text{ cm}$  ( $4 \times 4$  inch) grid of  $2.54\text{ cm}$  (1 inch) squares has been etched or scribed.

## 4.6 Chipping Rating Standards

A photographic transparency, depicting the size and shape of each chip. See Figure 3 for representation of this transparency. Figure 3 IS A REPRESENTATION ONLY. SAE Chipping Rating Standards (part number EA-400) are available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

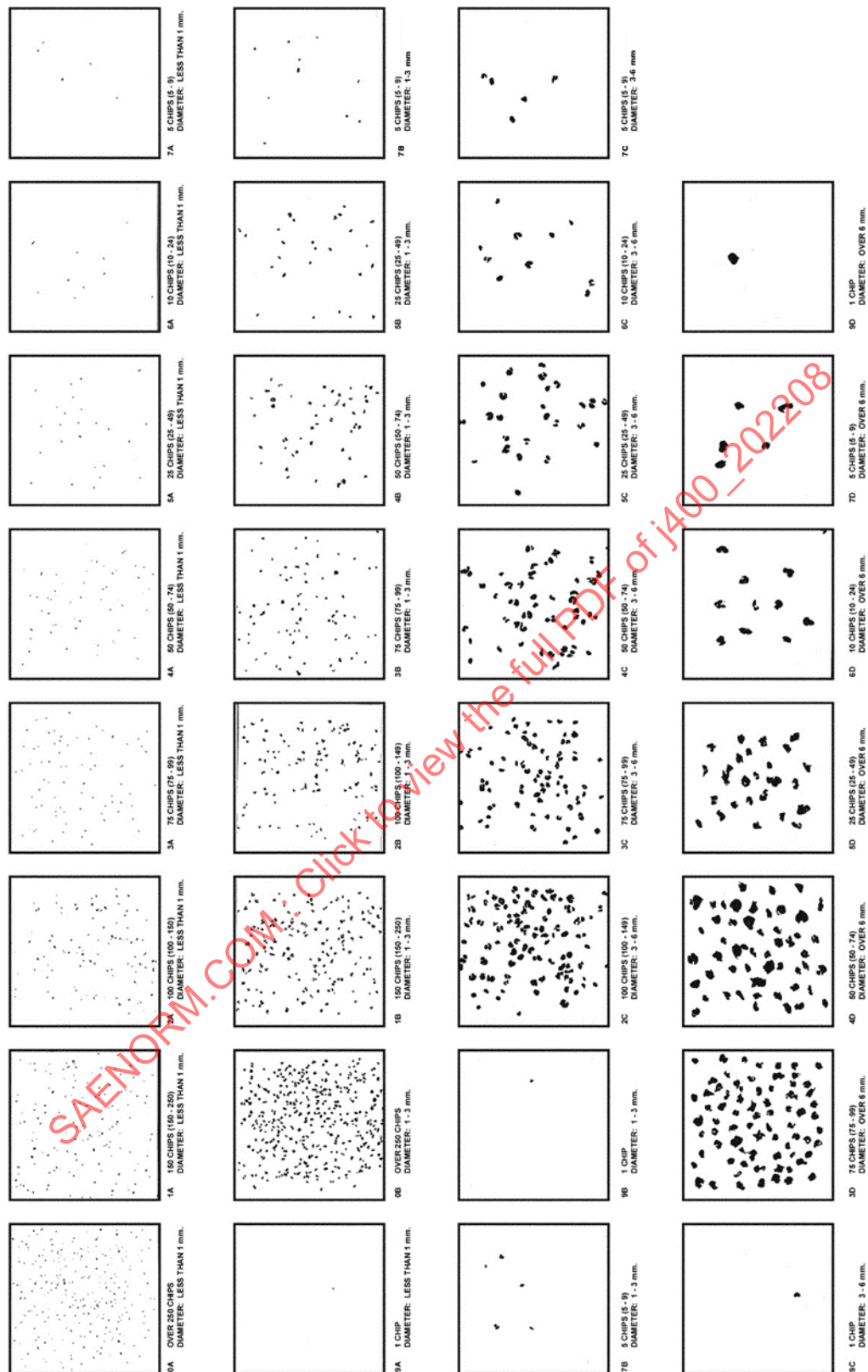


Figure 3 - Chipping rating standards (representation only)

## 4.7 Test Specimens

It is recommended that three replicates of each test specimen be exposed in the gravelometer. The number of replicates will be agreed upon between contractual parties. The test specimens are typically flat and 10.16 × 30.48 cm (4 × 12 inches) in size in order to fit into the panel holder of the gravelometer. The test panel material, the panel's thickness or gauge, and preliminary surface treatments (such as phosphating or anodizing) should be the same for all tests in any series and as representative as possible of the actual part. Any deviations in these parameters may produce misleading test results.

For profiled test specimens, or nonstandard test specimens, limits for uniform thickness, uniform backing, and uniform specimen holders must be determined and agreed upon by contractual parties.

## 5. SETUP AND PROCEDURES

### 5.1 Setup

#### 5.1.1 Paint or process the test panels as specified for the systems under test.

It should be noted that the chipping test results will be dependent upon the nature of the coating's formulation, the method and degree of drying or curing of the various coats, and the film thickness involved. Uniformity of film thickness is extremely important, and each component of the system should be controlled as uniformly as possible.

#### 5.1.2 The test specimens must reach the test temperature for a minimum of 15 minutes prior to testing in accordance with the appropriate method specified in 4.4.

In the conditioning environment, proper heat transfer can be facilitated by separating the test specimens so that the conditioned air can circulate freely about the specimen.

#### 5.1.3 Fill a 0.473 L (1 pint) container to the top with grated/screened gravel.

During exposure of multiple specimens, no more than 10 pints of gravel shall be allowed to collect on the sizing screen. Once 10 pints have collected on the screen, scrape the gravel across the screen so that the small rocks will fall beneath the screen. Remove the gravel that remains on top of the screen from the gravelometer for re-use. Remove and discard any stones that have lodged in the screen.

#### 5.1.4 Other media can be used as agreed upon by contractual parties.

#### 5.1.5 Adjust air pressure on the gravelometer to 483 kPa ± 21 kPa (70 psi ± 3 psi) with the air valve open. Other air pressures can be used as agreed upon by contractual parties.

For older cabinet type gravelometers, keep lid to gravel chamber on the gravelometer closed during this operation as safety precaution.

#### 5.1.6 Set feed rate so that the hopper empties in 7 to 10 seconds/pint.

#### 5.1.7 Set the impingement angle depending upon customer requirements. The default impingement angle is 90 degrees unless otherwise specified (see Figures 1 A and 1B).

### 5.2 Procedure

#### 5.2.1 For specific operation of gravelometer devices, please consult the operating manual for your device.

#### 5.2.2 There are two ways to operate a test on these units. A Timed Test is a test that shuts off the machine after the preset amount of time has passed. A Manual Test requires the operator to shut off the machine after the desired amount of time has passed.

#### 5.2.2.1 Timed Test

- a. Make sure the control switch is set to STOP.
- b. Set the test timer to the desired test time. This should be set to meet the requirements of 5.1.6.
- c. Turn the main power switch to ON.
- d. Flip the control switch to TIMED START.

#### 5.2.2.2 Manual Test

- a. The manual test requires the operator to manually stop the test. Once started, it will not stop by itself.
- b. Make sure the control switch is on OFF.
- c. Switch the main power control switch.
- d. Switch the control switch to MANUAL.
- e. After the desired amount of time has passed, flip the control switch to OFF.

5.2.3 Once the test is complete, remove the test panel from the specimen holder by pulling back on the specimen clamp and pulling out the test specimen.

5.2.4 Remove the rocks from the return receptacle and screen before reuse.

5.2.5 If necessary, allow panels to return to room temperature and dry with a soft cloth to remove any condensed moisture.

5.2.6 Using the tape referenced in 4.3, remove all loose or damaged paint.

5.2.7 Cover the tested area of the specimen with a strip of tape or multiple strips of tape side by side. Firmly adhere the tape to the test specimen by applying uniform pressure. (Uniform pressure can be applied by using items like a tongue depressor or a pencil eraser.) There can be no air bubbles trapped beneath the tape.

5.2.8 Remove the tape by pulling straight up.

5.2.9 Apply new strip(s) of tape to the specimen and repeat the paint removal process in the opposite direction.

5.2.10 Continue this procedure using new strips of tape until all loose or damaged paint is removed.

5.2.11 Other tapes or loose paint removal methods may be used as agreed upon by contractual parties.

5.2.12 Determine the degree of chipping by one of the following methods of the Gravelometer Rating System.