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# Standard Practice for Measuring Static Sealing Pressure Using Pressure-Indicating Film (PIF) in Transportation Applications[1]

This standard is issued under the fixed designation F2467; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers a standard means for measuring initial static sealing pressure in transportation applications.

1.2 It uses a pressure-indicating film (PIF) that will record the maximum load imprint of the seal-to-flange interfaces. The imprints will vary in intensity based on load across and along the interface.

1.3 These imprints can be used to determine if initial load on the gasket is adequate to attain a seal. These imprints may also indicate correct bolt torque sequence. These imprints may also be used to determine if the mating surface waviness or local flatness meets gasket requirements. Roughness is rarely found by PIFs because peak-to-peak wavelengths are too short. PIF is very good at finding waviness (peak to peak > 2.5 mm) and local flatness dips. PIFs provide an approximation of maximum pressures, and do not take into account relaxation of the joint after the torque sequence. Other methods involving dynamic measurement should be used if flange loading after relaxation is desired.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Terminology

2.1 *Definitions:*

2.1.1 *pressure-indicating film (PIF), n*— film that will, under varying clamp forces, give a varying imprint or color density that correlates directly with the joint clamp force applied in a given area.

## 3. Special Test Equipment and Materials

3.1 Pressure-indicating film (PIF) in the required pressure range(s).

3.2 A bolt micrometer or torque wrench for quantifying fastener load or sequence or both. For yielded fastener applications, torque versus yield or angle recording equipment is also required.

3.3 Subassembly test stand with one set of mating parts of the joint (minimum) and a complete set of fasteners. A new set of fasteners for each run shall be used if the torque loading is high enough to cause plastic deformation of the bolts.

3.4 A sufficient quantity of gaskets to complete the required number of tests as agreed upon between producer and user. Reuse of gaskets after initial tightening is not allowed, unless approved by the user.

3.5 Manual densitometer or automatic scanning device for reading color density (optional).

## 4. Summary of Practice

4.1 PIF is placed between a gasket or seal and one or both of the mating flanges. Using the specified torque sequence, the assembly is clamped together. After the specified waiting period, the system is unclamped and the PIF removed. The visible color pattern denotes where clamp pressure is present. The approximate pressure can be determined from color density using a reflective (optical) densitometer or an automatic scanning device in conjunction with a computer conversion program designed for the films. Follow the PIF supplier's guidelines with regard to how color density relates to pressure for a given PIF.

## 5. Significance and Use

5.1 This practice is a screening tool and should be used in conjunction with other more accurate real-time load-measuring techniques.

5.2 This practice covers the use of PIF, which is available in several load ranges. This practice also covers the use of a manual or automatic scanning device to read indicated load.

5.3 Limitations include those applications in which the PIF may be kinked, twisted, or buckled. PIF does not withstand elevated temperature, low temperature, or fluid aging and does not take into account any relaxation of bolts, gasket materials, or flange twisting, as it provides only the maximum attained pressure.

[1] This practice is under the jurisdiction of ASTM Committee F03 on Gaskets and is the direct responsibility of Subcommittee F03.10 on Composite Gaskets.

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## 6. Conditioning

6.1 Conditioning of the assembly or gaskets before test is not specified, but may be required, as agreed upon between the producer and user. No special conditioning of the PIF is required.

## 7. Sampling

7.1 The number of engine parts and components to be evaluated using this practice shall be agreed upon between producer and user.

7.2 Mating flanges in the test area shall be examined for nicks or scratches that may affect test results. Components shall be repaired or replaced as required.

## 8. Measurements

8.1 Measurement of the color density of the pattern can be done with a manual or automatic scanning device, densitometer, using the PIF supplier's recommended guidelines. PIF measuring accuracy can, however, be adversely affected by aging of the pressure pattern by artificial or natural light (limit exposure of film containing the pressure pattern to light sources, which can fade the resultant pressure pattern).

## 9. Procedure

9.1 Select the appropriate range of PIF. This may be done based on prior experience or by trial and error. Most sealing applications may start out using PIF in the low-pressure regions. Head or exhaust gasket joints typically use PIF in the medium- to high-pressure regions. Consult the PIF supplier guidelines to determine the proper film type to use based on expected load ranges. Head gasket coolant and oil sealing area evaluation will typically use medium PIF, while combustion sealing area evaluation will typically use high PIF. One-part PIF is preferred for head gasket system evaluations. It is preferable to have the glossy side oriented toward the gasket. If a two-part PIF is used, the two portions of PIF should only be brought together right before the test, and must be separated quickly after the test to avoid continuing color development, which can affect the result.

9.2 Using properly sized film, punch holes to allow clearance for fasteners, dowels, and so forth.

9.3 Properly clean parts to ensure they are free of fluids and other contaminants as this will affect color intensity.

9.4 Shim as necessary to compensate for PIF interference with joint clamp load. This is necessary only when the PIF template does not cover the entire flange surface (user only wants to measure a portion of a flange surface).

9.5 Loosely assemble the joint with the PIF on one or both sides of the joint.

9.6 Begin tightening the bolts in the pattern specified for the joint.

9.7 Tighten bolts in at least three increments to attain the final specified torque. This is to be done to avoid artificially high readings as well as over compression of the paper and rocking of the joint. Alternatively, production validation may use a multiple spindle to tighten bolts per the production process conditions.

9.8 Leave the joint assembled under final torque for the period of time recommended by the PIF supplier, usually 2 min minimum. Record the total exposure time under final torque.

9.9 Disassemble the joint by carefully relieving the torque from the fasteners using the reverse order of the initial torque sequence. Remove the PIF. Label the PIF with date of test, part level, test laboratory relative humidity and ambient temperature, PIF type (ultra low, super low, low; medium; high), bolt torque, and any other pertinent information.

9.10 Conduct visual inspection and measure color density using a densitometer following the PIF supplier's guidelines accordingly. Other automatic scanning devices may also be used as agreed upon between producer and user.

9.11 Take color photographs of the PIFs (optional).

9.12 To avoid fading of color density, store PIFs in a dark area, away from fluorescent or natural light.

## 10. Report

10.1 A report normally consists of just the PIF impressions and pressure readings along with the information as agreed upon in 9.9 and 9.10.

## 11. Keywords

11.1 gasket; PIF; pressure; pressure-indicating film