



KAPA FAQs

What does “KAPA” stand for?

“KAPA” is an acronym for “Kiefner & Associates Pipe Assessment”.

What does KAPA do?

KAPA calculates an estimated failure pressure of a pipe affected by either a blunt metal-loss defect or a crack-like defect in accordance with several published methodologies that are widely used in the industry.

What method does KAPA use to estimate the failure pressure?

For blunt metal-loss defects, such as those caused by corrosion or removal of damaged metal by grinding, KAPA calculates the estimated failure pressure according to three methods: ASME B31G, the “Modified B31G” method also known as the “0.85-dL” method; and the “Effective Area” method. These last two were published in the public domain as a two-part series of articles in the August 6 and August 20, 1990 issues of the *Oil & Gas Journal*. They have also been described in various other industry reports.

For crack-like defects, such as those caused by SCC, KAPA calculates the estimated failure pressure according to the “log-secant” formula, also known as the “NG-18” equation, which has been published in the public domain in “Failure Stress Levels of Flaws in Pressurized Cylinders”, Kiefner, J. F., Maxey, W. A., Eiber, R. J., and Duffy, A. R., ASTM STP 536, 1973. KAPA accomplishes a further innovation by combining the Effective Area Method with the NG-18 equation.

Does KAPA give different results from RSTRENG?

For blunt metal loss defects, KAPA internally calculates the same failure pressure as RSTRENG. However, it reports the results very differently from RSTRENG (see also Why doesn't KAPA give the Safe Operating Pressure?) RSTRENG cannot be used to calculate the failure pressure of a crack-like defect.

Does OPS approve KAPA?

The Office of Pipeline Safety, being a governmental regulatory body, does not rate or “approve” any methods or products. However, the use of KAPA by a pipeline operator to evaluate metal loss due to corrosion certainly conforms to the provisions of 49 CFR Part 192 and 195. (See also Does KAPA comply with 49 CFR Part 192 or Part 195?)

Does KAPA comply with 49 CFR Part 192 or Part 195?

Yes. The operator’s use of KAPA to evaluate flaws such as corrosion conforms to Federal regulations, as follows. Paragraph 192.485(c) states “...the strength of pipe based on actual remaining wall thickness may be determined by the procedure in ASME/ANSI B31G or the

procedure in AGA Pipeline Research Committee Project PR3-805 (with RSTRENG Disk)". Paragraph 195.587 contains the same provision.

Paragraph 1.7 of B31G states that "alternative assessments using the actual corroded profile and fracture mechanics may be performed". This is exactly what the "Effective Area" method does, so use of tools such as RSTRENG or KAPA is already permitted in B31G as an extension of that document. Perhaps more to the point, the regulation refers to the procedure contained in the reference AGA report. It does not specify the use of the RSTRENG program itself. The procedure that the regulations refer to is the same "Effective Area" method as described in the Oil & Gas Journal articles and other reports (see [What method does KAPA use to estimate the failure pressure?](#)). In fact, one could perform the cited procedure by hand calculation, though it would be exceedingly tedious. Hence, RSTRENG, KAPA, and other tools have been developed by engineers to perform those calculations more rapidly and reliably.

Does the use of KAPA comply with IMP regulations for HCA's?

Yes. Paragraph 195.452(h) cites the same methods that KAPA uses to be among suitable methods for calculating the remaining strength of the pipe.

Does the use of KAPA conform to ASME B31.4 and B31.8?

Yes. Both documents refer to ASME B31G for evaluating the remaining strength of the pipe. Paragraph 1.7 of B31G states that "alternative assessments using the actual corroded profile and fracture mechanics may be performed". This is exactly what the "Effective Area" method does, so use of tools such as RSTRENG or KAPA is already permitted in B31G as an extension of that document.

Why doesn't KAPA give the Safe Operating Pressure?

Kiefner & Associates believes that there is no one single definition of the "Safe Operating Pressure" that is uniformly suitable for all pipelines, all categories of construction or location, and all circumstances. In fact, we believe that the use of the term "Safe Operating Pressure" in B31G and RSTRENG is widely misunderstood and leads to potentially non-optimal decisions by the pipeline operator.

This circumstance arises from the fact that the acceptable flaw length tables in B31G (Part 2) presume that a pipeline operates at a hoop stress equal to 72 percent of SMYS. Many pipelines operate at lower pressures and can therefore tolerate larger flaws than would be safe at a stress of 72 percent of SMYS. Both B31G (Part 4) and RSTRENG indicate a "Safe Operating Pressure" to be the predicted failure pressure divided by a fixed factor of safety of 1.39 corresponding to the ratio of 100 percent of SMYS to the Class 1 design operating stress level of 72 percent of SMYS. These assumptions are not consistent with the way many pipelines operate.

We believe that the foregoing definition of "Safe Operating Pressure" may be appropriate for many pipelines, but not necessarily for all pipelines. The benchmark for assessment of a pipeline's integrity remains the hydrostatic pressure test. If a corrosion flaw passes a hydrostatic test at the pressure required for its location and category of service, then it is regarded to be "safe" for all intents and practical purposes. In fact, the presence of a "safe" corrosion flaw in the pipeline will not generally be known to the pipeline operator unless he also conducts in-line

inspection. Most pipelines were never required to be tested to 100 percent of SMYS prior to commissioning, or later in service. The minimum hydrostatic test pressure for liquids pipelines and for gas pipelines in Class 1 areas (operating at a hoop stress of 72 percent of SMYS) is 1.25 times the maximum operating pressure, or a test pressure of 90 percent of SMYS. However, many pipelines operate at pressure well below that level. For gas lines in other locations, the test pressure requirements are to lower pressure levels (75 of SMYS percent in Classes 2 and 3, and 60 percent in Class 4). It may be unnecessarily conservative to require that all corrosion flaws be capable of passing a test to 100 percent of SMYS when no other portion of the line is or historically was required to meet that requirement.

Instead of a “Safe Operating Pressure”, KAPA reports the Predicted Failure Pressure and also the Factor of Safety with respect to the maximum operating pressure. The operator can establish his own company policy requiring that in order to accept continued operation without making a repair, the Predicted Failure Pressure must exceed the operating pressure with a Factor of Safety suitable for the pipeline location and construction, in accordance with the operator’s risk targets. We believe that the choice of a “Safe Operating Pressure” is an important engineering and management decision that must take into account a number of factors including: the category of construction and location of the pipeline, the operating stress level, future assessment plans and intervals, the operator’s tolerance for risk, whether a repair can be made in a convenient and timely manner, and the overall scope and extent of other short-term and long-term mitigation measures, all factors that a simple spreadsheet cannot consider.

How much does KAPA cost?

KAPA is free. It may be downloaded, copied, and distributed freely and without restriction or licensing fees. Why? Because the pipeline industry already paid for the research to develop the underlying assessment theory (the NG-18 log-secant equation) and then paid for the development of various methodologies subsequently derived from it (ASME B31G, Modified B31G, and the Effective Area Method which is the concept behind RSTRENG). We believe it is unfair to expect operators to then pay high costs to use tools they have already paid for and that have been described at length in the public domain.

Can I get a customized version of KAPA?

Yes. Some pipeline operators still want a calculation of a “Safe Operating Pressure” or some other parameter, consistent with the operating company’s pipeline attributes and integrity management policies. Upon request, we will provide a customized version with the pipeline operator’s requested modifications and company logo prominently displayed to identify it as the operator’s special version. We will charge you for the cost of making these modifications, but usually these modifications involve only a couple of days of staff time to accomplish, so the costs are not great.

What do negative numbers in the results mean?

This circumstance could arise with incorrect input, typically in the metal loss grid. Make sure that the profile gives position coordinates in ascending order, that the units selected are consistent with the data entered, and that there is an entry in the metal-loss column for each profile spacing entry.

Does the grid spacing have to be uniform?

No. Spacing between the metal loss measurement points can be uniform or irregular. However, the longitudinal positions of the metal loss measurements must be in ascending order.

What if I don't know the toughness of the material?

It is not necessary to enter the toughness in order to perform an assessment of blunt metal loss such as corrosion. The toughness is required in order to evaluate a crack-like flaw.

Can I run an analysis for metal loss deeper than 80% of the nominal wall?

We have set up KAPA to give you a warning when the depth of metal loss exceeds 80% of the pipe wall thickness. It is generally the practice to repair the pipe when the metal loss exceeds 80% of the pipe wall rather than try to make an assessment, because in most cases this amount of metal loss leaves very little remaining material as a pressure boundary. However, if one proceeds past the warning message KAPA will still run the calculations and produce an accurate assessment even for metal loss deeper than 80% of the pipe wall thickness.

Can I use KAPA to evaluate internal corrosion?

Yes. The assessment principals are the same for internal and external corrosion. However, the user should recognize that the depth and extent of metal loss might be more difficult to determine with the same accuracy and confidence as with external corrosion if corrosion measurements are made from outside the pipe, because the internal corrosion is not visually accessible. Also, it is assumed that with external corrosion, the corrosion process will be halted by repairing the coating even if the pipe is still sound, whereas the internal corrosion process may continue over time.

Can I use KAPA to evaluate corrosion on bends?

Yes. Metal loss on field bends, induction bends, and elbows can also be evaluated similarly to metal loss on straight pipe.

Can I use KAPA to evaluate corrosion affecting welds?

Yes. Metal loss affecting or intersecting DSAW longitudinal seams and high-frequency ERW seams can be evaluated similarly to corrosion in the pipe body provided no selective corrosion mechanism or SCC is present. If selective corrosion or SCC is present, such features should be evaluated as crack-like flaws (see Can I use KAPA to evaluate SCC?). Metal loss affecting SMAW girth welds can be evaluated similarly to metal loss in the base metal, but it would be prudent to assure by inspection that significant workmanship flaws are not present in or near the corroded portion. The use of KAPA or any other method for assessing metal loss affecting acetylene girth welds is not recommended if there is uncertainty associated with overall weld quality and properties.

Can I use KAPA to evaluate MIC?

KAPA can be used to evaluate the remaining strength of pipe affected by microbe-induced corrosion (MIC), if the remaining wall thickness can be accurately ascertained. Note that MIC can result in metal loss that is highly irregular in profile such that difficulties may arise with obtaining accurate measurements of the depth and extent of metal loss. If accurate measurements cannot be made, a valid assessment is not possible by any method.

Can I use KAPA to evaluate SCC?

Crack-like features such as SCC can be assessed using KAPA if the depth and length of the SCC feature or colony is known, along with the material toughness. While this is also true in principal for features on ERW bond lines, one must use an appropriate value for the toughness of the bond-line, which may be exceedingly low. Such features should generally be repaired rather than relying on an assessment.

Can I use KAPA to evaluate dents?

Corrosion associated with a rock indentation can be evaluated similarly to corrosion in straight unindented pipe. Mechanical damage in the form of a scrape or gouge that has been completely ground out to a smooth contour leaving a remaining wall thickness of at least 60% of the pipe wall thickness, and where the indentation was not severe, can be evaluated using the B31G result. Neither KAPA nor any other assessment technique is suitable for evaluating severe mechanical damage where the damage has not been treated by grinding.

Can I use KAPA for other forms of metal loss?

Yes. Blunt, smooth metal loss from other causes can also be evaluated using KAPA. Such causes include removal of imperfections by grinding, such as laminations, arc burns, minor scrapes, or pits from arc gouges or lightning strikes.

Many situations concerning ERW seam flaws, SCC, mechanical damage, or other forms of damage require some experience, specialized knowledge, and accurate data to properly recognize and assess their severity. If there is any question about the safety of such features, it may be most prudent to repair the pipe, or contact Kiefner & Associates at (614) 888-8220 for further guidance.