

Supplement 2
(July 1, 1991)

Recommended Practice for Care and Handling of Sucker Rods

API RECOMMENDED PRACTICE 11BR (RP 11BR)
EIGHTH EDITION, OCTOBER 1, 1989

American Petroleum Institute
1220 L Street, Northwest
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Foreword

This supplement contains revisions authorized at the 1990 Standardization Conference as reported in Circ PS-1920 and approved by letter ballot.

Pages 13, 14 and 15. *Delete Par. 6.15 through 6.23 and renumber remaining paragraphs.*

Page 13. *Change Par. 6.14 to read:*

See Section 9, API Spec 11B for workmanship and finish requirements for this section.

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Supplement 1
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Foreword

a. This recommended practice is under the jurisdiction of the API Committee on Standardization of Production Equipment.

b. Detailed requirements applying to sucker rods are given in API Std 11B: *Specification for Sucker Rods*, which also is under the jurisdiction of the API Committee on Standardization of Production Equipment.

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NOTE: This recommended practice was originally published as Appendix A of the 9th Edition, Std 11B. In 1950 the 1st edition was published separately. This 8th edition supersedes the 7th edition and contains changes and additions authorized at the 1988 Standardization Conference as published in Circ PS-1858 and approved by letter ballot.

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RECOMMENDED PRACTICE FOR CARE AND HANDLING OF SUCKER RODS

SECTION 1 SELECTION OF API STEEL SUCKER RODS

1.1 General

The selection of API grade sucker rods for a beam pump installation depends on a variety of factors. The main factors include the applied stress, the environment and the metallurgy (grade) of the rod.

1.2 Stress Effects

1.2.1 Sucker rods need to be selected based on applied stresses. API RP 11L provides a procedure for calculating the applied loads or stress on a sucker rod string design.

1.2.2 The useful sucker rod strength is limited by the fatigue performance of the metal in a non-corrosive environment. This maximum useful strength is dependent on the metal's tensile strength as shown by Goodman.^{1,2} This relationship is the basis for Section 4 of this document. According to the Goodman diagram, sucker rods operating in a non-corrosive environment and in the proper stress range will theoretically exceed 10 million load reversals. However, the fatigue life can be dramatically decreased by improper installation, design, handling or operation even without any form of corrosion. Section 2 of this document discusses recommendations for the proper care, handling and installation of sucker rods.

1.3 Environmental Effects

1.3.1 There is a reduction in rod life if placed in a corrosive environment. Sucker rods will eventually fail even if not stressed, when placed in a corrosive environment. However, the life of the rod can be extended by the use of an effective corrosion inhibition program. In that case the expected life of a sucker rod will be the same as a rod in a non-corrosive environment. Section 3

of this document discusses how to effectively treat corrosive wells.

1.3.2 Another environmental concern is the use of the sucker rods in a production environment which contains hydrogen sulfide. A sucker rod placed in this environment can rapidly fail even though the corrosion effects are not readily apparent. NACE has defined a hydrogen sulfide environment as "sour" when the hydrogen sulfide partial pressure is greater than 0.05 psi or 0.0034 atm (0.345 kPa)³. Materials placed in sour environments with hydrogen sulfide partial pressures equal to or greater than this value can fail prematurely due to hydrogen embrittlement unless the materials are sulfide stress cracking resistant or unless an effective corrosion inhibition program is maintained.

1.4 Rod Grade Selection

1.4.1 For non-sour (sweet) environments the applied stresses determine which grade of rod is selected. However a corrosion inhibition program may be required to combat the damaging effects of corrosion and its associated life reduction.

1.4.2 Materials which are not susceptible to sulfide stress cracking usually possess a Rockwell C scale hardness of less than 23. Thus a grade C rod is the optimum rod to be used if the applied stresses are within its capabilities and a sour environment exists.

1.4.3 If the applied stresses require grade D rods and a sour environment exists, then these rods should not be used unless an effective corrosion inhibition program is applied.

1.4.4 The grade K rod is available for use when the other rod grades have not performed satisfactorily.

SECTION 2 TRANSPORTATION, STORAGE, AND HANDLING

2.1 General

2.1.1 Rods should be inspected on delivery and thereafter as necessary to ensure that damaged rods are not placed in regular storage or in service.

2.1.2 In all handling operations, care should be exercised to prevent rods or rod ends from contacts which might cause nicks or bends, or injury to the threads by jamming of the thread protectors. Further, the rods should never be handled in such a manner as to produce a permanent kink or bend. Kinked, bent, or nicked rods are permanently damaged and should be discarded.

2.1.3 Packaged rods should preferably be handled and stored as a package unit, until the rods are to be run in the well. When removing the rods from the package, care should be exercised to use proper tools so that the rods may not be damaged, especially by nicking.

2.1.4 Rods as delivered by the mills, are provided with thread protectors on both the pin and coupling ends. Whenever these ends are observed to be without such protection, they should be inspected and if undamaged, the protectors should be replaced. Protectors should not be removed, except for inspection purposes, until the rods are hung in the derrick or mast preparatory to running.

2.1.5 Thread protectors, rod boxes, couplings, upsets, and wrench squares should never be hammered for any reason. One blow can so damage any part of a rod or coupling as to result in early failure.

2.1.6 Wooden walkways should be provided if it is necessary for crew members to walk on the rod stack or rod pile during unloading or loading operations.

2.2 Unloading and Loading

2.2.1 Care should be taken to avoid damaging the rods when removing bulkheads and tie-downs used to secure the rods during shipment.

2.2.2 Rods in packages should always be lifted and laid down with a handling device so designed as to support the package without damage to the rods.

2.2.3 Unpackaged rods should be handled individually. They should never be thrown nor flipped from or onto a railway car truck or stack. During all handling operations, the rods should be supported at least at two points to prevent excessive sagging or damaging contacts of any nature. Skids when used should be made of material not abrasive to the rod.

2.2.4 Trucks and trailers for handling packaged rods should provide blockage directly under the crosswise supports of the package so that the rods themselves will

not be in contact with the blockage. Further, the packages should be stacked so that the bottom supports rest squarely on the top supports of the next lower package. Tie-down chains, straps, or cables should be placed in such position as to pass over the crosswise supports.

2.2.5 Trucks and trailers for handling unpackaged rods should provide cross supports near the rod ends and at least two other equally spaced intermediate positions. When flat beds are used, the supports should be of such thickness as to prevent the rod ends or couplings from resting directly on the bed. Cross supports, spacers, and blocks should be of material non-abrasive to the rod. The rod layers should be separated by spacers positioned directly above the bottom supports. The spacers should be thick enough to extend a few inches beyond the stack on both sides. If the spacers are not notched, the outside rods in each layer should be chocked with blocks to prevent the rods from rolling off the spacer. Tie-down chains, cables, or straps should be placed in such position as to pass over the ends of the spacers. They should be prevented from contacting the rods in the top layer.

2.3 Storage of Rods

2.3.1 Rods should be stored separately according to grade and size. They should be stored in such locations and in such manner as to minimize deterioration from exposure to acid or other corrosive atmospheres. They should be stacked off the ground on racks or sills made of or surfaced with a material not abrasive to the rods.

2.3.2 For packaged rods, a rack or sill should be provided under each support of the package. The packages should be stacked so that the supports are in vertical alignment. See Specification 11B: Sucker Rods, Par. 10.4 for packaging requirements.

2.3.3 For unpackaged rods, at least four rack or sill supports should be provided and the end supports should be located approximately one foot from the rod ends. The rod layers should be separated by spacers placed directly above the rack or sill. The spacers should be thick enough to prevent the rods from contacting those in adjacent layers. If the spacers are not notched, the outside rods in each layer should be chocked with blocks to prevent the rods from rolling off the spacers.

2.3.4 Stored rods should be inspected at regular intervals. Any rust should be removed with a wire brush and a suitable protective coating applied.

2.3.5 When rods are returned to storage after use, the threads should be cleaned, lubricated, and covered with clean, undamaged thread protectors. The rod surfaces should be covered with a protective coating.

2.4 Field Distribution and Handling

2.4.1 When rods are taken from storage and loaded on trucks for field distribution, the same precautions should be observed in loading, transporting, and unloading as recommended herein for placing new rods in storage.

2.4.2 When rods are unloaded at the well, they should not be placed on the ground. It is recommended that they be placed on a transportable service rack. They should be located in such position that they will not be run over by a truck nor where heavy equipment may be set or dropped on them. Particular care should be taken to ensure that they are not walked on.

2.5 Running and Pulling

2.5.1 Single rods should be tailed into the mast. Special care should be taken to ensure that they do not touch the ground, other rods, or any part of the mast. Also during tailing do not allow the rods to be raised with elevator latches.

2.5.2 For maximum efficiency and to minimize the risk of damage to the rods, it is recommended that suitable hangers be provided in the mast.

2.5.3 Rod elevators, hooks, wrenches and other tools should be suitable for the job and in good condition. They should be inspected regularly for wear and other damage, and should be repaired or replaced when their continued use might result in damage to the rods. Special attention should be given to elevators and hooks to ensure that they are maintained and cleaned to avoid dropping the rod string.

2.5.4 In order to avoid cross threading, care should be taken that servicing equipment is so positioned that the rods, when hanging free in the rod elevators, are centered directly over the well. When stabbing the rod pin into the coupling, the rod should hang straight (without slack) so as to avoid cross threading. Should cross threading occur, the joints should be broken, a die run over the pin and a tap into the coupling; after which the threads should be cleaned, inspected and relubricated.

2.5.5 After removal of the thread protectors, the rod pin thread and face, and the coupling thread and face, should be thoroughly cleaned by brushing and flushing

if necessary, then inspected for damage. If rods are being rerun, the threads and faces should also be inspected for damage. Couplings or rods with damaged or excessively worn threads or faces should be reconditioned or discarded. Any nick, deformation, or foreign material on the shoulder or coupling faces may cause premature failure. The pins should always be relubricated after cleaning and inspection.

2.5.6 For best uniform makeup results, the use of either air or hydraulic power rod wrenches is recommended.

2.5.7 To obtain satisfactory results in makeup of sucker joints, the joint must be clean, undamaged, well lubricated and have a free-running fit to shoulder contact if applied circumferential displacement is to sufficiently preload the joint to prevent shoulder face separation during pumping.

2.5.8 On breaking out connections, particularly with hand wrenches, the joint should never be hammered, and the proper coupling and rod wrenches, with the assist of cheater bars, should be used if a joint is unbreakable by ordinary procedure.

2.5.9 Any hammered or over-torqued couplings should be discarded since hammering and over-torquing damages the coupling, faces, threads, and may strip the pin threads.

2.5.10 During makeup, the joint should be observed to determine that the coupling face makes proper contact with the shoulder face. When proper contact is not made, the joint should be broken, cleaned, inspected, and relubricated.

2.5.11 Whenever rods are pulled, they should be carefully inspected for damage before being rerun. Kinked, bent, or nicked rods are permanently damaged and should be discarded. (See Section 9 — API Spec 11B.)

2.5.12 In breaking the joints, care should be exercised that the threads and contact faces are not damaged.

2.5.13 If a rod hanger is not provided, the rods should be pulled and laid down in singles. The same care should be exercised in handling and stacking the pulled rods as herein recommended for new rods.

SECTION 3 CORROSION CONTROL BY CHEMICAL TREATMENT

(Superior numerals refer to references. See Appendix B for references and bibliography.)

3.1 Introduction

3.1.1 These recommendations for corrosion control of steel sucker rods by chemical inhibition were prepared by NACE Task Group T-1D-3 for inclusion in API RP 11BR and revised in 1986. These recommendations cover corrosion inhibition, wear reduction and corrosion prevention techniques for use from the manufacturing of sucker rods and couplings through installation and service in the well. Although many recommendations apply to aluminum, fiberglass and alloy sucker rods, they are not specifically addressed in the RP.

3.1.2 These recommendations are intended to suggest optimum corrosion control procedures which normally are economically desirable. They should not preclude consideration of less than optimum procedures; prolonged equipment life in some instances may not be economically justifiable.

3.1.3 Corrosion of sucker rods which are subjected to continual load reversals can lead to serious, multiple failures of rod strings. The life of rod strings can be extended significantly by the elimination or reduction of corrosion caused by exposure to corrosive environments. A cost effective effort should be made to minimize corrosion damage.

3.1.4 In these recommendations, corrosive environments on sucker rods are defined as (1.) atmospheric conditions encountered during transportation, storage, or well servicing (after manufacturing and whenever the rods are out of the well), (2.) inhole conditions.

3.2 Handle Chemical Inhibitors Safely

3.2.1 Many oil field chemical inhibitors are toxic and should be handled by procedures which prevent contact with skin, the inhalation of vapors, or uncontrolled release into the environment. The use of rubber gloves is recommended. Thus the handling precautions recommended by the manufacturer in the "Material Safety Data Sheet" should be followed.

3.3 Atmospheric Corrosion — Transportation and Storage

3.3.1 To prevent corrosive damage to sucker rods before they are placed in service, suitable protective coatings (hydrocarbon soluble) should be applied and maintained during transportation and storage. Coatings can also be used to minimize atmospheric corrosion during field service of the sucker rods.

3.3.2 The manufacturer should provide sucker rods and couplings free of mill scale with a suitable protective coating applied to all exposed surfaces. The coating should be adequate to provide protection against humid atmospheric conditions for a minimum of one year. Acceptable coatings should be readily removable using hydrocarbon solvents. Coatings which do not obscure surface/manufacturers markings are preferred.

3.3.3 The vendor, supplier, or agent should inspect shipments and warehouse stocks of sucker rods and couplings for visible signs of coating damage and corrosive attack. The vendor also should take necessary action to clean rust spots and to repair coating damage.

3.3.4 The purchaser should inspect sucker rods and couplings upon receipt for coating damage and corrosive attack. He also should make periodic inspections while the sucker rods are in local stock. The protective coating should be maintained during storage.

3.3.5 Used sucker rods that are stored for future service should be cleaned and coated for protection from atmospheric corrosion. Storage in excess of one year will require the use of coatings as recommended in 3.3.2. However, corrosion protection for less than one year can be obtained by dipping or spraying the rods and couplings with an oil based corrosion inhibitor.

3.4 Atmospheric Corrosion — Well Servicing

3.4.1 In severely corrosive atmospheric environments, sucker rods should be protected after removal from the well during well-servicing operations. This is of special importance in areas where hydrogen sulfide is produced, although the damage may be caused by oxidation rather than from the effects of the hydrogen sulfide. In some cases, oil with a high concentration of corrosion inhibitor is pumped into the tubing immediately before the rods are pulled, or the rods may be coated with a mixture of oil and corrosion inhibitor after the rods are laid down. An oily film is always beneficial.

3.4.2 Failures of the threaded connections of sucker rods while downhole occur from a combination of corrosion, fatigue-inducing alternating stresses and by improper make-up. Because connection failures normally begin from within the joint, it is recommended that the couplings be dipped, brushed or sprayed with a properly selected oil-soluble, film-forming corrosion inhibitor. The procedure for selecting a proper inhibitor can be found in NACE MR-01-74. Additionally a mixture of refined oil or grease with a qualified inhibitor may be used before the joints are made up. This inhibitor treatment should reduce failures occurring in the pin and/or coupling threads. Proper circumferential displacement will develop maximum sealing force at the shoulders. This will tend to exclude well fluids from the threads. Use of too much inhibitor-oil mix in the coupling cavity may interfere with proper make up.

3.4.3 Accelerated corrosion can occur at breaks in protective coatings of new sucker rods, even when immersed in fluids that are not ordinarily corrosive, due to a galvanic couple between the new rod and the old tubing. Thus, new rods should be protected by an inhibitor treatment to develop a protective film on the metal as the coating is partially removed. Treatment

methods are presented below and are recommended when rods are pulled.

3.4.4 In order to provide initial protection to rods during and following installation, inhibitor should be added to the tubing before running the rods. As the rods pass through this concentrated inhibitor an initial protective film will be coated or applied on the rod. Most water soluble inhibitors are not good film formers and are not normally recommended for this purpose. If there is no packer, when the well is placed on production one tubing volume of fluid may be circulated into the annulus and then normal production continued. One guideline to the amount of inhibitor required is 0.2% of the tubing WHAR (volume, area) plus one annulus volume, i.e., 2000 ppm of inhibitor formulation. Another guideline is to add sufficient inhibitor to generate a column of inhibitor in the tubing longer than one rod length (e.g., 30 ft.). An alternate initial treating procedure is to add 5 gallons of inhibitor to the casing-tubing annulus before beginning production. Each time the rods are pulled and rerun one of the above large volume inhibitor treatments should be used to establish (or reestablish) the corrosion inhibitor film on the inhole equipment. Subsequent treatments with a smaller volume of inhibitor, to provide film repair, should be resumed routinely.

3.4.5 Corrosion inhibition immediately following installation often can be justified to extend sucker rod life. Adequate corrosion control measures can increase the number of load cycles (reversal of load each stroke) before failure. As the load conditions on a sucker rod string approach the upper design stress levels, the tolerance to even minute pitting attack is sharply reduced. Preventing the formation of small pits by starting treatment early and maintaining it effectively should prove cost effective.

3.5 Downhole Corrosion — Maintenance Treatment

3.5.1 There are many corrosion inhibiting products and application techniques which may be effective in protecting downhole production equipment. Selection of a particular method should be based on the specific application and treating economics. These economics should consider the treatment program effectiveness as it relates to equipment replacement frequency and lost production.

3.5.2 Batch and Flush Treatment. The batch and flush treatment is most widely used for rod pumped wells. In this technique a specific water dispersible, oil soluble corrosion inhibitor is injected into the well annulus and flushed down with produced brine or fresh water. Water soluble inhibitors are generally less film persistent than oil solubles and therefore normally not recommended for the batch and flush treatment. One rule of thumb for selecting initial inhibitor dosage is to use a volume of inhibitor which provides a concentration of 25 ppm of total fluid production between treatments. Treatment frequency may vary from twice weekly to monthly¹⁰ based on total production volume.

For example:

≤ 100 BFPD — Weekly or every two weeks using one gallon or 25 ppm inhibitor concentration.

100-300 BFPD — Weekly treatment using 25 ppm inhibitor concentration.

300-400 BFPD — Twice weekly using 25 ppm inhibitor concentration.

> 400 BFPD — Continuous treatment should be considered.

Adjustments in dosage and frequency should be optimized based on corrosion monitoring results.

Flush volumes are often calculated on the basis of annular fluid level. Approximately 1/2 to 1 barrel of flush (produced water or oil) per 1000 feet of fluid over the pump should be used.^{9,11} The flush can be supplied by pump truck or the well circulated into the annulus (through the chemical pot if one is used) for a time to achieve the desired volume. Care should be taken not to introduce air into the well during the flush process. It may be necessary to chemically remove oxygen from the flush fluid when a pump truck is used. If this is done, sufficient time should be allowed for the oxygen removal process to take place before the well is treated.

Prewetting the casing and tubing by flushing the annulus with well fluids before the inhibitor is introduced may be required to assure that the inhibitor reaches the fluid level without too much adhering to the steel above it. If the well is pumped high (i.e., the pump is set well above the producing zone), the casing I.D. below the pump intake will not be protected by batch inhibitor treatments. The casing below this point can be protected by running tail pipe to the top of the producing zone. However, the user must be aware that this can drastically reduce the pump volumetric efficiency if the liquid entering the tail pipe contains solution gas.

If contract treater trucks are used, circulation after treatment may not be part of the service. However, contractors may offer a preflush and postflush treatment with lease fluids carried by tank trucks. Also care should be taken when using truck treatments to ensure properly measured fluid volumes are used.

3.5.3 Continuous Treatment. With this procedure, inhibitor is injected into the casing annulus using a chemical feed pump with an inhibitor dosage of 25 to 50 ppm¹ of the produced fluid volume. Subsequent corrosion monitoring results should be used to modify the dosage. Initial treatment in wells that do not pump off should include an initial large batch treatment (e.g., 5 to 10 gallons) to ensure the annulus is loaded with treated fluid.

3.5.4 Circulation Treatment. The circulation treatment procedure is probably the most effective method for most wells. With this procedure, corrosion inhibitor is injected into the annulus and the produced fluids are diverted from the flowline to the tubing/casing annulus for a specific circulation period. Production is delayed during the circulation period.

Although there are many variations of circulation treatment the most common procedure is to circulate the well until the injected inhibitor slug returns to the surface. It is then injected into the annulus a second time. The well is then returned to normal production.

The inhibitor volume required for this treatment varies according to the fluid volume in the annulus and the well depth. A basic goal is to contact well surfaces with an inhibitor concentration in excess of 1000 ppm for one hour or longer. Inhibitor concentration and frequency are similar to those for the batch and flush treatment method as described in 3.5.2. However, treatment dosage and frequency should be optimized for effectiveness on a particular well.

Circulation treatment may not be feasible for wells where a long circulation time and a large delayed production volume are required. One major disadvantage of circulation treatment is the manpower required to circulate the well as well as the delayed production. Also, some wells build excessive pressure during circulation and should not be treated using this method.

3.5.5 Automated Treating. Devices are available to automatically inject a preselected amount of inhibitor into the annulus, followed by produced fluid circulation. This circulation is also done for a selectable amount of time. These devices permit batch treating and circulating as often as desired. Thus this technique is not manpower intensive and well suited for problematic wells. However, an economics analysis should be conducted to see if this technique is cost effective.

3.5.6 Squeeze Treatment. Effective and long lasting (up to 9 months) treatments can be made by squeezing chemical mixes into producing formations. However, in rod pumped wells squeeze applications must either be done via the casing annulus or the subsurface pump must be unseated to perform the technique.

With a squeeze treatment, a large volume of inhibitor mixed with crude, or diesel is displaced into the formation. The material adsorbs on the reservoir rock and desorbs over a long period to maintain the protective film. Normally an oil soluble inhibitor is used. Prior to any squeeze treatment, inhibitor compatibility with reservoir fluids and, more importantly, with the formation should be investigated to minimize formation damage and a decrease in production. It is for these reasons squeeze treatments are rarely used.

3.6 Inhibitor Selection

3.6.1 Most inhibitors used in producing operations are long chain polar organic compounds available in a myriad of different formulations. The inhibitor may be either oil or water soluble and water/oil dispersible. Regardless of the type, the solubility and dispersibility must: (1.) allow the inhibitor to reach the steel surface to form a protective film, (2.) be compatible with other treating chemicals used, and (3.) not create an emulsion that is difficult to break. Thus, care must be taken in selecting the inhibitor. Laboratory tests for corrosion effectiveness (wheel test), emulsion tendency and water quality tests before using an inhibitor in a given field can be a cost effective investment. Also, chemicals and any dilution solvents under consideration should be tested for potential emulsion forming and/or formation damaging characteristics.

3.7 Evaluation of Inhibition Programs

3.7.1 The economic pay-out of treating with the

properly selected and applied inhibitor should be high, with treatments providing excellent insurance against equipment failure and lost production.

3.7.2 Proper corrosion control requires the following:

a. Start with a new rod string.

b. Keep the rod string rust-free before use (no atmospheric corrosion).

c. Protect the rod string immediately upon installation using a properly selected and applied corrosion inhibition method even if the string is put in a well which produces mildly corrosive fluids.

d. Continue treatment, monitor results (using failures or visual inspection when the rods are pulled) and adjust it as needed.

3.7.3 Assistance in evaluating programs of inhibitor treatment can be obtained by consultation or by study. In starting, adjusting, stopping, or evaluating corrosion control inhibition programs, a careful study of the references and bibliography cited in Appendix B, may be helpful. Direct help can be obtained by consultation with recognized corrosion engineers, corrosion consultants, and service engineers from supply companies.

3.7.4 It is desirable to evaluate the efficiency of the treating program by comparing monitoring data to actual well failure history. Methods for this evaluation include well failure history along with visual inspection, corrosion coupon weight loss¹¹, weight loss of pony rods used as coupons, hydrogen probes¹², iron content analysis of produced fluids, copper-ion displacement tests.^{2,6,7,8}

3.7.5 Other less efficient but useful monitoring methods are available. Instantaneous corrosion rates can be measured, and the results can be used to determine the need for the effectiveness of a corrosion control program. Instruments can be used which measure changes in the electrical or polarization probes installed in flow lines.^{6,10}

3.7.6 Visual inspection of all downhole equipment (when the well is pulled for any reason) can be an effective evaluation technique.^{7,8} Inspection by additional non-destructive methods, as recommended in Section 6 of this RP, can provide a more reliable corrosion inhibition program evaluation. However, these methods usually cannot be economically applied at regular intervals for the sole purpose of corrosion evaluation. Pump repair reports and other equipment service records often reflect the onset of corrosion which may be well advanced before warning is given by the first rod failure.

3.7.7 It should be noted that surface installed corrosion monitoring tools only report corrosion rates for the condition at their point of installation. Often the development of a close correlation between surface monitoring results and downhole corrosion occurrence is needed.

3.7.8 Maintenance of a data gathering and analysis system is also essential to the successful optimization of a corrosion control monitoring program.

SECTION 4

ALLOWABLE SUCKER ROD STRESS DETERMINATION UTILIZING RANGE OF STRESS

4.1 In determining the allowable range of stress and allowable sucker rod stress for a string of sucker rods, it is recommended that the modified Goodman stress diagram shown in Fig. 3.1 be used. This gives the basic or fundamental rating which can be used where corrosion is not a factor. Since all well fluids are corrosive to some degree, if not inhibited 100 per cent, and since the corrosivity of well fluids varies greatly, it is of extreme importance that the stress values determined from this diagram be adjusted by an appropriate service factor, based on the severity of the corrosion. This service factor should be selected by each user as his experience indicates. It could be greater than one, although normally it will be less than one, varying inversely with severity of corrosion.

4.2 In applying this graph, separate diagrams can be prepared for each minimum tensile strength value. Separate diagrams showing load in pounds (KN) rather than stress can also be prepared for each grade and rod size.

4.3 Alternately, the desired value can be obtained by using one of the formulas shown in Fig. 4.1.

EXAMPLE

4.4 Assume a string of API Grade C rods with a minimum tensile strength of 90,000 psi (620 N/mm²) is being used and that a minimum downstroke stress of 15,000 psi (103 N/mm²) has been either measured or

calculated. At what peak polished rod stress may we operate this string in non-corrosive service?

Refer to Fig. 4.1, formula (2).

$$\begin{aligned} S_a &= (0.25T + 0.5625 S_{min}) \\ &= (90,000 \times 0.25 + 15,000 \times 0.5625) \\ &= 30,938 \text{ psi (non-corrosive)} \end{aligned}$$

Converting to load for different size top rods, this would be:

$$\begin{aligned} \frac{3}{8}'' &- 30,938 \times .307 = 9,498 \text{ lbs.} \\ \frac{1}{2}'' &- 30,938 \times .442 = 13,675 \text{ lbs.} \\ \frac{5}{8}'' &- 30,938 \times .601 = 18,594 \text{ lbs.} \\ 1'' &- 30,938 \times .785 = 24,286 \text{ lbs.} \end{aligned}$$

Metric Example

$$\begin{aligned} S_a &= (0.25T + 0.5625 S_{min}) \\ &= (0.25 \times 620 + 0.5625 \times 103) \\ &= 213 \text{ N/mm}^2 \end{aligned}$$

Converting to load for different size top rods, this would be:

$$\begin{aligned} 15.9 \text{ mm} &- 213 \times 197.9 = 42.2 \text{ KN} \\ 19.0 \text{ mm} &- 213 \times 285.0 = 60.9 \text{ KN} \\ 22.2 \text{ mm} &- 213 \times 387.9 = 82.6 \text{ KN} \\ 25.4 \text{ mm} &- 213 \times 506.7 = 107.9 \text{ KN} \end{aligned}$$

The above values should then be adjusted by an appropriate service factor.

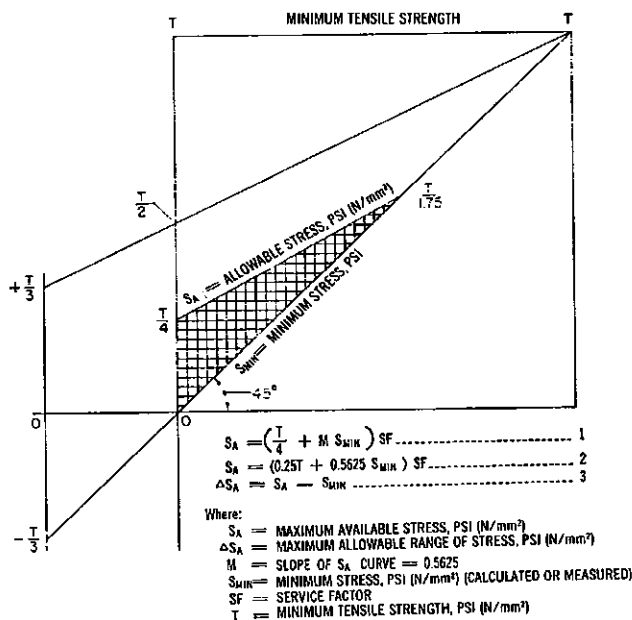


Fig. 4.1
MODIFIED GOODMAN DIAGRAM FOR ALLOWABLE STRESS AND RANGE
OF STRESS FOR SUCKER RODS IN NON-CORROSIVE SERVICE

SECTION 5

SUCKER ROD JOINT MAKEUP UTILIZING CIRCUMFERENTIAL DISPLACEMENT

5.1 General

5.1.1 For optimum performance it is imperative that all of the joints in the string of rods be made up to a given preload stress level in order to prevent separation between the pin shoulder and the coupling face during the pumping cycle.

5.1.2 There are many inherent variables which affect joint makeup. Among these are the differences in materials, the smoothness of surface finishes and the lubricity of lubricants, as well as the operating characteristics and mechanical condition of the power tong equipment. As a result, applied torque has not proven to be the most accurate, nor the most practical means of measuring the preload stress level in a sucker rod joint.

5.1.3 Both test data and theoretical calculations show that circumferential displacement beyond hand-tight makeup of coupling and pin provides an accurate and repeatable means with which to measure and define the preload stress in a sucker rod joint.

5.1.4 In view of the foregoing, this recommended practice provides, for field use, a comprehensive set of circumferential displacement values and procedures covering their use, including a method for the calibration of power tongs.

5.2 Circumferential Displacement Values. Circumferential displacement as used herein is the distance measured, after makeup, between the displaced parts of a vertical line scribed across the external surfaces of the box and pin when they are in a shouldered hand-tight relationship prior to makeup. See Fig. 5.1 and 5.2.

5.2.1 The circumferential displacement values shown in Table 5.1 are the necessary and recommended displacements required to achieve an optimum preload stress. Values for a combination of materials and their application are listed in the column headings. Choose the correct column.

5.2.2 Because the interface surfaces of the joint are burnished or smoothed out on initial makeup, the displacement values on initial makeup are greater than those on subsequent makeup. While this difference in displacement occurs in varying degrees with all rod grades, it is observed to be consistent only in the Grade D Rod. Notice, the tabulated values for use when rerunning Grade D Rods are smaller than those for the initial makeup of new Grade D Rods.

5.2.3 It is impractical to establish displacement values for the initial makeup of Grade C and K Rods because of the inconsistency of observed test data with these materials. It is therefore recommended that new Grade C and K Rod joints be made up and broken, in the field, prior to final makeup on initial installation.

5.2.4 When new couplings are installed on previously used rods regardless of their grade, the displacement values listed in Table 5.1, Column 3, should be used.

TABLE 5.1
**SUCKER ROD JOINT CIRCUMFERENTIAL
DISPLACEMENT VALUES**
All dimensions in inches followed by equivalent in mm.

Rod Size	Running New Grade D Displacement Values		Rerunning Grades C, D, & K Displacement Values	
	Minimum	Maximum	Minimum	Maximum
1/2 (12.7)	5/32 (4.8)	3/16 (6.3)	1/32 (3.2)	5/32 (4.8)
5/8 (15.9)	3/16 (6.3)	1/8 (7.1)	1/32 (4.8)	5/32 (6.3)
3/4 (19.1)	1/8 (7.1)	11/32 (8.7)	1/32 (5.6)	17/64 (6.7)
7/8 (22.2)	11/32 (8.7)	12/32 (9.5)	1/32 (7.1)	23/64 (9.1)
1 (25.4)	13/32 (11.1)	15/32 (12.7)	12/32 (9.5)	17/32 (11.1)
1 1/8 (28.6)	15/32 (14.3)	21/32 (16.7)	16/32 (12.7)	19/32 (15.1)

NOTE: Above displacement values were established through calculations and strain gage tests.

5.3 General Recommendations, Power Tongs

5.3.1 The use of air or hydraulic power rod wrenches is recommended to assure best makeup results for all sizes of rods. However, it is imperative that the power wrenches be maintained in accordance with the manufacturer's recommendations.

5.3.2 When using power wrenches, it is recommended that the hydraulic power oil system be circulated until a normal operating temperature is reached and that this temperature be maintained within a reasonable level through calibration and installation of rods.

5.4 Calibration of Power Tong

5.4.1 Power tong must be calibrated to produce recommended circumferential displacement make-up values shown by Table 5.1. After initial calibration, it is recommended that the power tong calibration be checked each 1,000 feet (300 m) and be calibrated for each change in rod sizes.

5.4.2 There are three different methods employed in calibrating power tongs for various API Grade rods and field conditions. It is imperative to select the recommended method to suit your field conditions.

5.4.2.1 Calibration of Power Tongs for New API Grade D Rods

- a. Check condition outlined under Par. 5.1.1.
- b. Set the tongs operating pressure on the low side of the estimated value required to produce prescribed circumferential displacement value shown by Table 5.1.
- c. Screw the first joint together hand-tight, scribe a fine vertical line across the pin and coupling shoulder to establish hand-tight reference as shown by Fig. 5.1.

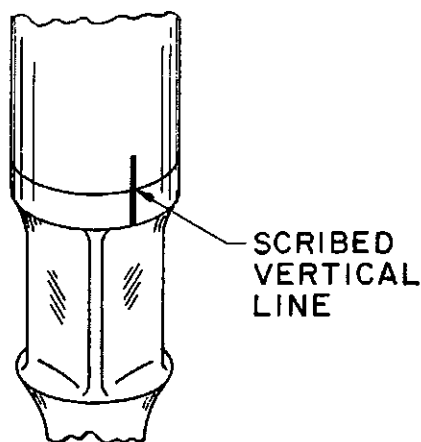


Fig. 5.1
HAND-TIGHT JOINT

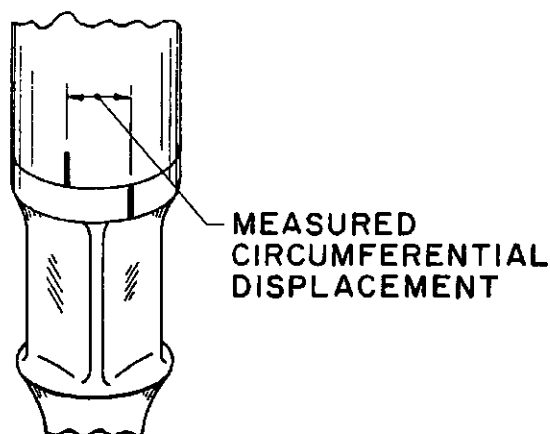


Fig. 5.2
MADEUP JOINT

- d. Loosen coupling to normal running position then up joint with power tong operating with the tong throttle depressed to the fully open position. Do not hit the throttle a second time after joint shoulder and tongs have stalled.
- e. Remove the tongs and measure the circumferential displacement between the scribed hand-tight vertical line as shown by Fig. 5.2.
- f. Increase or decrease the tong operating pressure to achieve the selected prescribed circumferential displacement as shown by Table 5.1.
- g. Repeat Steps d. through f. until proper displacement is achieved. Check calibration of tongs a minimum of 4 joints and for each 1000 feet thereafter and at each change in rod sizes.

5.4.2.2 Calibration of Power Tongs for API Grade C and Grade K Rods

- a. For the initial run of API Grade C and Grade K Rods, a constant correction factor cannot be recommended because of inherent variables involved. Therefore, it is imperative to make up and break the connection prior to calibration of power tongs if proper preload is to be assured.
- b. Once the joint is made up and broken, follow the same procedure as outlined in Par. 5.4.2.1, steps a. through g., using the appropriate circumferential displacement values in Table 5.1, Column 3.

5.4.2.3 Calibration of Power Tong for re-running of all Grades of API Rods and New Couplings

Employ values shown in Table 5.1, Column 3 and follow same procedure as outlined in Par. 5.4.2.1, steps a. through g.

5.5 Use of Rod Wrenches For Manual Make-up

5.5.1 The use of rod wrenches is not recommended

for rod sizes larger than $\frac{3}{4}$ inch. Application of rod wrenches to achieve the desired preload is as follows:

5.5.1.1 Manual Make-up of New API Grade D Rod Strings

- a. Screw rod and coupling to a shouldered hand-tight position.
- b. Scribe a fine vertical line across the pin and coupling to establish a hand-tight reference as shown by Fig. 5.1.
- c. Apply necessary mechanical force to achieve recommended displacement values as shown in Table 5.1, Column 3.

5.5.1.2 Mechanical Make-up of API Grade C and Grade K Rods

- d. Apply mechanical force and make up joint once. Loosen and retighten to hand-tight position.
- e. Scribe a fine vertical line across the pin and coupling shoulder to establish a hand-tight reference as shown by Fig. 5.1.
- f. Apply necessary mechanical force to achieve recommended displacement values as shown in Table 5.1, Column 3.

5.5.1.3 Mechanical Make-up of Used Rods and New Couplings.

- g. Bring coupling and rod pin to a hand-tight position.
- h. Scribe a fine vertical line across the pin and coupling shoulder to establish a hand-tight reference as shown by Fig. 5.1.
- i. Apply mechanical force sufficient to achieve circumferential displacement as shown in Table 5.1, Column 3.

NOTE: The hand-tight position as used in Section 5 is attained when full shouldered adjustment is made.

SECTION 6 METHODS OF INSPECTION AND REQUIRED EQUIPMENT

6.1 Sucker rods and couplings can be inspected by using close visual examination, Eddy current, magnetic flux leakage methods (instrumented Magnaglow or Magnetic particle), and gages. Any of the above methods, or any combinations of them can result in an adequate inspection.¹

6.2 It is recommended that at least once a day, and prior to and after each run for a particular customer, or for each different rod size if the customer so requests it, that the Eddy current or instrumented magnetic flux leakage detectors be calibrated. For this purpose it is necessary that a standard test sucker rod with known discontinuities be available.

6.3 The test sucker rod should be a $\frac{3}{4}$ " diameter, 25' long rod with discontinuities located no closer than 3' from the ends. The discontinuities should be at least 1' apart and should be conical pits with sides at a 30° angle from the longitudinal axis of the rod. The flaw should vary in diameter from .005" to .030" in .005" increments, and vary in depth in .010" increments from .030" to .1", as verified by a pit gauge.

6.4 API P6 and P8 'no-go' and 'go' ring gages to inspect sucker rod pins, and API B2 and B6 'go' and 'no-go' box plug gages for sucker rod couplings should be used. All gages should be checked against Master Reference Gages according to gage certification specifications described in API Spec 11B, Section 8. Working gages should be checked against master gages at least once per week, or upon a size change.

6.5 A pit gage, micrometer gage and dial calibrator gage, and a Micro-finish comparator are also necessary.

General Recommendations Concerning The Inspection Procedure

6.6 New and used sucker rods should be handled strictly following Section 1 of this RP (Transportation, Storage and Handling), and Section 10 of API Spec 11B (Marking, Packaging and Thread Protection). In addition, the use of spreader bars and of lifting devices which lift the rods from above is considered essential.

6.7 Straightness: The rods should be visually inspected for bends by rolling. Those with an apparent bend should be further checked for total indicated runout following the procedures to follow.

6.8 Dimensional Tolerances: Rods should be carefully checked using micrometer gages (See Par. 6.15.)

6.9 Body Surface: It is recommended that only those electronic indications of defects which are corroborated by visual inspection be made reasons for rejection.

6.10 Upset and pin end: The sucker rod pin end, upset area, and 6" of the rod body adjacent to the upset should be inspected by fluorescent magnetic particle inspection or other similar techniques. The surface finish of the undercut end and adjacent radii should be checked with a micro-finish comparator. As with the rod body, the depth of stampings, make-up marks, etc., should be confirmed with a pit gage prior to rejection. Sucker rod pin threads should be checked with API P6 and P8 'no go' and 'go' ring gages to verify that the threads are properly manufactured and the pin shoulder is in compliance with Section 6, Spec 11B.

6.11 Coupling Inspection: Sucker rod couplings should be checked by fluorescent particle inspection or other similar techniques. API B2 and B6 'go' and 'no-go' box plug gages should be used to check coupling threads and parallelism in accordance with Section 6 of Spec 11B. Longitudinal seams and die marks are acceptable provided that grinding down to .0625" or less removes the seam or die mark.

6.12 Final Rejection: After the inspection company has finished inspecting rods and/or couplings, the user representative, together with the manufacturer's representative and the inspection company's personnel, should examine all rejected sucker rods and/or couplings to confirm that they do not meet the attached specifications. The user representative and manufacturer's representative will then decide what action to take on the rejected sucker rods and/or couplings.

Workmanship and Finish Specifications For New Sucker Rods and Sucker Rod Couplings

6.13 New sucker rods have a protective coating which should be removed prior to inspection by means of a hot solvent. New rods should not be shot-cleaned prior to inspection.

6.14 The following material under this title comes from Section 9, API Spec 11B. It is recommended they be followed.

6.15 Dimensional Tolerances for Rod Bodies. Final rod body should be manufactured to the following tolerances:

¹Definitions and descriptions of those and other methods of non-destructive testing refer to Stuart and Lloyds, Limited, *A Guide to Adm-destructive Testing of Tubes*, JSB48.

Rod Size inches	TOLERANCE	
	Diameter inches	Out-of-Round inches
$\frac{1}{2}$	+0.007	.010
	-.014	
$\frac{3}{8}$	+0.007	.010
	-.014	
$\frac{1}{4}$	+0.008	.012
	-.016	
$\frac{3}{16}$	+0.008	.012
	-.016	
1	+0.009	.013
	-.018	
1 $\frac{1}{2}$	+0.010	.015
	-.020	

6.16 Straightness Specifications

- a. Cold straightening of kinks is not acceptable.
- b. A kink is a short, tight bend measured with a 6" ruler or straight edge, with a gap in the middle greater than $\frac{1}{8}$ ".

6.17 Body Straightness

- a. The body is the rod length between the upset tapers.
- b. Bends can be measured by means of a straight edge held on the concave side of the bend. The amount of bend is the gap measured between the straight edge and the rod surface.
- c. Bends can also be measured by the total indicator runout (TIR) measured at the rod surface a known distance away from a support. TIR values are twice the amount of bend over the gage length.
- d. Because of the various types of bends, the measurement should be made at a distance of one foot from the support.
- e. For a gage length of 12 inches, the maximum allowable bend for all rod sizes $\frac{1}{8}$ " to 1 $\frac{1}{4}$ " is .065 (.130 TIR).

6.18 End Straightness

- a. End straightness will be measured by supporting the rod body at a distance of 1.5 feet (18 inches) from the rod pin shoulder. The amount of bend is measured via a dial indicator riding on the machined surface of the pin shoulder O.D. The maximum allowable TIR values for all rod sizes $\frac{3}{8}$ " to 1 $\frac{1}{4}$ " is .200". End straightness for 24 inch pony rods will be measured by supporting the rod body at a distance of 1.0 feet (12 inches) from the rod pin shoulder. The amount of bend is measured via a dial indicator riding on the machined surface of the pin shoulder O.D. The maximum allowable TIR value for all rod sizes $\frac{1}{2}$ to 1 $\frac{1}{2}$ inch is 0.130 inch.

6.19 Surface Discontinuity Definitions

- a. Overfills: Longitudinal ridges formed during bar rolling when the bar is too large for the rolling pass it is entering.

- b. Underfill: Formed during bar rolling when the bar does not completely fill the rolling die. Also formed during rod end forging when there is insufficient material to fill the die.
- c. Folds (also called cold shut): Circumferential discontinuity produced when two surfaces of metal fold against each other without metallurgical bonding. This can occur when flash produced by one forging operation is pressed into the metal surface during a subsequent operation.
- d. Slivers: Loose or torn segments of steel rolled into the bar surface at the mill or formed during forging.
- e. Rolled-in-scale (also called a scab): A surface imperfection caused by scale, formed during a previous heating, which has not been eliminated prior to surface rolling.
- f. Lap: A longitudinal overfill rolled into the surface of the bar. Typically formed at the bar during a rolling pass.
- g. Seam: A longitudinal crevice in the rod which has been closed but without metallurgical bonding and has the appearance of a scratch or small longitudinal separation on the bar.
- h. Flash: Excess metal squeezed out between forging die faces.

6.20 Surface Finish

- a. When the depth of imperfections, pits, laps, folds, etc., cannot be measured, the defects will be removed by grinding with a smooth transition, then the rod diameter will be measured in the grounded out area to determine whether the rod meets the specifications which follow.

6.21 Surface Finish, Rod Body

- a. Imperfections such as rolled-in-scale, pits, slivers, mechanical damage, etc., when removed must be removed by grinding with a smooth transition. The rod is unacceptable if the removal of the imperfection results in a rod diameter below the minimum specified in Par. 6.15.
- b. Longitudinal overfills, underfills and seams are zero stress concentration points. Longitudinal overfills, underfills and seams which are found to be rounded bottom or flat are acceptable as long as they do not exceed $\pm .020$ ". Longitudinal overfills, underfills, and seams within the $\pm .020$ " diameter tolerance need not be removed.
- c. Transverse imperfections greater than .004" deep at any area of the rod are unacceptable and must be removed by grinding out with a smooth transition. Upon removal of the imperfection, the rod diameter must still meet the specifications in Par. 9.1 of Spec 11B.

6.22 Surface Finish, Upset

- a. Laps, folds, forging imperfections, underfills, flat

spots which occur in any area of the upset up to that point where the upset diameter equals the width of the wrench square may be reworked to a maximum depth of $\frac{1}{32}$ " provided that all tolerances are maintained and the grinding is done with a smooth transition.

- b. Transverse laps, folds, etc., which are continuous around the rod upper upset bead, greater than .0625", or are deeper than the wrench square width are unacceptable.
- c. Cracks which occur at the wrench square fillets or edges are reasons for rejection.
- d. Wrench square stampings which exceed a depth of $\frac{1}{32}$ " (.031") are reasons for rejection.

6.23 Pin End Surfaces and Threads

- a. The pin undercut end and adjacent radii, including threads, should be free of burrs or excessively rough edges, and should have a surface finish not to exceed 250 RMS. The presence of any such defects except end shear cracks anywhere on the pin end constitutes sufficient reason for rejection.
- b. The presence of end shear cracks past the root of the first thread is reason for rejection.
- c. Indexing or make-up marks deeper than $\frac{1}{16}$ " (.063") or which are sharp rather than rounded bottom are reason for rejection.

6.24 Coupling Inspection: Sucker rod couplings should be checked by magnaglow or by magnetic particle inspection. API B2 and B6 'go' and 'no-go' box plug gages should be used to check coupling threads and parallelism in accordance with Section 6 of Specification 11B. Longitudinal seams and die marks are acceptable provided that grinding down to .0625" or less removes the seam or die mark.

6.25 Sucker rod couplings should be checked for dimensional conformance as per Section 9, API Spec 11B.

6.26 New sucker rods and sucker rod couplings which fail to meet the above specifications and are rejected are non-API rods and/or couplings.

Used Sucker Rod Inspection

6.27 It is recommended that used sucker rods not be straightened or have scrapers removed prior to inspection. Severely bent or kinked sucker rods should be rejected. Rods with scrapers should be carefully inspected for corrosion attack.

6.28 Whenever possible the rod should be dipped in hot solvent to remove paraffin and easily removed scale.

6.29 Straightness: The rods should be visually inspected for bends by rolling. Those which have an apparent bend should be further checked for total indicated runout following the procedure contained in this section.

6.30 Rods with acceptable straightness should be shot-cleaned to remove surface deposits which may interfere with the inspection. The shot weight, size, shape and velocity should be such as to not shotpeen the rods. Thread protectors should be used to protect the threads from the shot-cleaning.

6.31 Used rods can be either downgraded or rejected depending on the criteria which follow.

- a. Hammer marks or stretching are reasons for rejection.
- b. Deformation of the pin seating face or damage to the pin itself or to the threads are reasons for rejection.
- c. The pins should be inspected by any of the techniques described in Section 1. It is suggested that rods be inspected using API P6 and P8 'no-go' and 'go' ring gages.

6.32 Class I used rods:

- a. No visible wear, otherwise the rod should be downgraded.
- b. Cracks and pits deeper than 20 mils (.020") are reasons for downgrading the rod.

6.33 Class II used rods:

- a. May have lost because of wear no more than 20% of the cross-sectional area. Otherwise the rod should be downgraded.
- b. Cracks and pits deeper than 40 thousandths (.040") are reasons for downgrading the rod.
- c. Rods with bends exceeding twice that allowed for new sucker rods in Par. 5.16 - 5.18 should be rejected.

6.34 Class III used rods: The user may desire to consider Class III rods as unfit for use.

- a. May have lost because of wear, no more than 30% of the cross-sectional area. Otherwise the rod should be rejected.
- b. Cracks and pits deeper than 60 thousandths (.060") are reasons for rejecting the rod.
- c. Bent rods can be cold straightened.
- d. Pits, defects, and wear occurring from the upper one-third of the cone of the upset to the pin shoulder can be ignored.

6.35 All rods which do not meet the above criteria, and Class III used rods if the user so desires, should be placed in the rejected — junk pile. Good couplings should be removed for inspection using approved wrenches.

6.36 It is suggested that a uniform coding convention be adopted to identify grades of used sucker rods. The following code is suggested:

Class I used sucker rod: One painted stripe.
Class II used sucker rod: Two painted stripes.
Class III used sucker rod: Three painted stripes.

6.37 Rejected rods should be marked with easily identifiable red paint.

6.38 It is suggested that a uniform color coding convention be adopted to identify API Class. The following color coding is suggested:

Uniform Color Code:

API Grade C — White
API Grade K — Blue
API Grade D — Carbon Steel — AISI 15XX (1) —
Brown
— Chrome-Moly — AISI 41XX (2) —
Yellow
— Special Alloy (3) — Orange

- (1) Generally manufactured from, but not limited to, AISI 15XX which can be effectively heat treated to the minimum ultimate tensile strength per Table 2.1 of Spec 11B.
- (2) Generally manufactured from, but not limited to, AISI 41XX which can be effectively heat treated to the minimum ultimate tensile strength per Table 2.1 of Spec 11B.
- (3) Any composition other than 15XX or 41XX which can be effectively heat treated to the minimum ultimate tensile strength per Table 2.1 of Spec 11B.

Used Sucker Rod Coupling Inspection Specifications

6.39 Inspections of used sucker rod couplings should be done by using any of the techniques described in Section 2. No coupling classes are necessary; couplings shall be either acceptable or rejected.

6.40 API B2 gages should be used to check coupling threads and face parallelism.

6.41 The following constitute reasons for coupling rejections:

- a. The remaining diameter is less than the original diameter at the rod upset shoulder.
- b. Cracks are present.
- c. Longitudinal seams and die marks are reasons for rejection provided that after grinding the coupling does not conform to Par. 6.41.a.
- d. There is evidence of hammering.
- e. There is deformation of the seating face. The seating face could be ground to meet API specifications.
- f. There is visible thread damage.
- g. There is visible surface corrosion.
- h. There is flaring at the shoulder.

SECTION 7

INSTALLATION OF POLISHED ROD CLAMP ON POLISHED ROD

7.1 Install polished rod clamp per manufacturer's instruction tag (Ref. Spec. 11B, Par. 14.2.2).

7.2 Polished rod must be void of dirt and grease where clamp is located.

7.3 Polished rod clamp must be void of dirt and grease in gripping area.

7.4 Hanger bar must be perpendicular to well head, in line with well bore and void of dirt and grease.

7.5 Place polished rod clamp in clean area on polished rod and tighten nut (or nuts) to hand tight.

7.6 For proper torque, follow manufacturer's instruction tag attached to clamp (Ref. Spec. 11B, Par. 14.2.2).

APPENDIX A
REFERENCES AND BIBLIOGRAPHY
(Section 1)

1. Goodman, John: *Mechanics Applied to Engineering*, 9th Ed., Longmans, Green, and Co., London, p. 634.
2. Kommers, J. B.: "Effect of Range of Stress and Kind of Stress on Fatigue Life," *Proceedings ASTM*, Vol. 30, 1930, Philadelphia, p. 272.
3. "Sulfide Stress Corrosion Cracking Resistant Metallic Material for Oil Field Equipment," MR-01-75, NACE, Houston, 1980.

APPENDIX B

REFERENCES AND BIBLIOGRAPHY

(Section 3, Corrosion Control by Chemical Treatment)

B.1 References

1. C. C. Nathan, Correlations of Oil-Soluble, Water-Dispersible Corrosion Inhibitors in Oil Field Fluids, *Corrosion*, 18, 282t (1962) August.
2. John Knox and Roy Stout, Simple Screening Test for Determination of Inhibitor Film Persistence, *Corrosion*, 16, 554t (1969) October.
3. P. J. Raifsnider, V. P. Guin, C. L. Barr, and D. L. Lilly, Radioactive Tracer Studies on Squeeze Inhibition of Oil Wells, *Materials Protection*, 4, 18 (1965) July.
4. J. K. Karver and H. R. Hanson, Corrosion Inhibitor Squeeze Technique—Field Evaluation of Engineered Squeezes, *Journal Petroleum Technology*, (AIME-SPE), 17, 80 (1965) January.
5. J. K. Karver and F. A. Morgan III, Corrosion Inhibitor Squeeze Technique: Laboratory Adsorption-Desorption Studies, *Materials Protection*, 4, 69 (1965) July.
6. J. M. Kilpatrick, Measure Corrosion Rate Now, *Oil and Gas Journal*, 62, 155 (1964) March 16.
7. Corrosion of Oil and Gas Well Equipment, National Association of Corrosion Engineers and the American Petroleum Institute, 1968.
8. H. E. Waldrip, Petroleum Production Corrosion, *Materials Protection*, 5, 8 (1966) June.
9. W. J. Frank, "Here's How to Deal with Corrosion Problems in Rod-pumped Wells", *Oil and Gas Journal*, p. 63 (May 31, 1976).
10. NACE Publication 1984: Monitoring Internal Corrosion in Oil and Gas Production Operations with Hydrogen Probes, *Materials Protection*, 6, 23 (1984) June.
11. NACE RP-07-75: Preparation and Installation of Corrosion Coupons and Interpretation of Test Data in Oil Production Practice, NACE, Houston (1976).
12. R. L. Martin, Inhibition of Corrosion Fatigue of Oil Well Sucker Rod Strings, paper number 15 at *Corrosion/79*.

B.2 Bibliography

- K. L. Larrison, Oil Well Corrosion Treatment-Polarization Testing for Field Testing Inhibitors, *Materials Protection*, 6 61 (1967) April.
- R. R. Annand, An Investigation of the Utility of Instantaneous Corrosion Rate Measurements for Inhibitor Studies, *Corrosion*, 22, 216 (1968) August.
- P. Mehdizadeh, R. L. McGlasson and J. E. Landers, Effect of Organic Corrosion Inhibitors on Corrosion Fatigue, *Corrosion*, 23, 53 (1967) March.

D. R. Fincher, Special Techniques Cut Corrosion Costs, *Petroleum Engineer*, 33, B-30 (1961) February.

J. P. Barrett Oil and Gas Well Corrosion Inhibitors, *Materials Protection*, 5, 43 (1966) July.

P. Mehdizadeh, R. L. McGlasson and J. E. Landers, Corrosion Fatigue Performance of a Carbon Steel in Brine Containing Air, Hydrogen Sulfide and Carbon Dioxide, *Corrosion*, 22, (1966) December.

Alexei P. Maradudia Drill Pipe, Casing, Tubing, Sucker Rods: Corrosion Failures and Methods of Combatting Corrosion, *Materials Protection*, 4, 45 (1965) December.

Sucker Rod Symposium, *Petroleum Equipment and Services*, 23 19-30 (1965) July-August.

E. D. Junkin Jr. and D. R. Fincher, Oil Field Corrosion Inhibitors Evaluated by Film Persistency Test, *Material Protection*, 2, 18 (1963) August.

Rita Wieland and J. R. Bruce, Corrosion Inhibitor Screening Test for Oil Wells, *Materials Protection*, 1, 24 (1962) August.

Protective Coatings in Petroleum Production, Report of NACE Technical Committee T-6E on Protective Coatings in Petroleum Production, *Corrosion*, 17, 281t (1961) May.

William E. Billings and David Morris, Effect of Acid Volume and Inhibitor Quantity on Corrosion of Steel Oil Field Tubing in Hydrochloric Acid, *Corrosion* 17, 208t (1961) May.

B. E. Gordon, P. J. Raifsnider, and D. L. Lilly, Corrosion Monitoring in Oil Wells with a Radioactive Specimen, *Materials Protection* 6, 21 (1966) November.

Cooperative Evaluation of Inhibitor Film Persistency Test, Report of NACE Technical Unit Committee T-1D on Control of Oil Field Equipment Corrosion by Chemical Treatment, *Materials Protection*, 8, 69 (1966) October.

H. E. Bush and J. C. Cowan, Characterization and Performance Studies: Corrosion Inhibitors in Oilfield Fluids, *Materials Protection*, 3, 28 (1966) September.

S. Evans and C. R. Doran, "Batch Treatment Controls Corrosion in Pumping Wells", *World Oil*, p. 55 (February 1, 1984).

A. C. Nestle, "Organic Inhibition of Oil and Gas Wells," *Materials Protection*, Vol. 7 (1), p. 31 (Jan. 1968).

L. S. Shehorn, "Corrosion Monitoring on Rod-Pumped Wells Using Linear Polarization Probes," SPE Paper 9363 (1980).

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