Supplement 1
April 1999

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Field Inspection of New Casing, Tubing, and Plain-End Drill Pipe

API RECOMMENDED PRACTICE 5A5
SIXTH EDITION, DECEMBER 1997

EFFECTIVE DATE: MARCH 1, 1998

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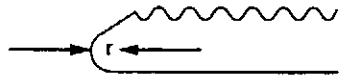
Supplement 1 to Field Inspection of New Casing, Tubing, and Plain-End Drill Pipe

Page 18, Table 4
for $4^1/_2$ – 11.60, Change 4.00 to 4.000
for 5 – 13.00, Change 4.439 to 4.369
for 7 – 23.00, Delete footnote "a" from 6.250

Page 19, Table 4
for $7^5/_8$ – 51.20, Change 6.1266 to 6.127

Page 50, Add new figure 6, Rounded Nose for External-Upset Tubing, and renumber and revise references to the figures following the new figure 6.



Size	Radius, r (See Note 1)
$2^3/_8$	$^3/_{32}$ inch
$2^7/_8$	$^3/_{32}$ inch
$3^1/_2$	$^1/_8$ inch
$4^1/_2$	$^1/_8$ inch

Notes:
1. These dimensions are for reference only and are not subject to measurement for determining product acceptance.
2. See API Standard 5B for details.

Figure 6—Rounded Nose for External-Upset Tubing

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Exploration and Production Department

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FOREWORD

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Field Inspection of New Casing Tubing and Plain End Drill Pipe

1 Scope

1.1 Included in this practice are the recommended procedures for field inspection and testing of new oil country tubular goods (OCTG). For the purpose of this document, OCTG is defined as including casing, tubing, pup joints, couplings, connectors, plain-end casing liners, and plain-end drill pipe. This recommended practice has been prepared to address the practices and technology commonly used in field inspection; however, certain parts may be suitable for mill inspections.

1.2 The recommended practices established within this document are intended as an inspection and/or testing guide, and nothing in this guide shall be interpreted to prohibit the agency or owner from using personal judgment, supplementing the inspection with other techniques, extending existing techniques, or reinspecting certain lengths.

1.3 This recommended practice covers the qualification of inspection personnel, a description of inspection methods and apparatus calibration and standardization procedures for various inspection methods. The evaluation of imperfections and marking of inspected new OCTG are included.

1.4 This document shall be used as a guide applicable to the methods for field inspection and shall not be used as a basis for acceptance or rejection. Acceptance or rejection of new API monogrammed OCTG shall be based on conformance with API Specification 5CT, API Specification 5D, and API Standard 5B.

2 References

2.1 The most recent editions of the following API documents are relevant to this recommended practice:

API	
Spec Q1	*Quality Programs*
RP 5A3	*Thread Compounds for Casing, Tubing, and Line Pipe*
Std 5B	*Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads*
Spec 5B1	*Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads*
RP 5C1	*Care and Use of Casing and Tubing*
Bull 5C2	*Performance Properties of Casing, Tubing, and Drill Pipe*
Spec 5CT	*Casing and Tubing (U.S. Customary Units)*
Spec 5D	*Drill Pipe*
Std 5T1	*Imperfection Terminology*
ASNT[1]	RP No. SNT-TC-1A
ASTM[2]	
E 10	Test Methods for Brinell Hardness of Metallic Materials
E 18	Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
E 110	Test Methods for Indentation Hardness of Metallic Materials by Portable Hardness Testers

3 Definitions

The following terms are used frequently in the nondestructive testing of OCTG:

3.1 AC field: The active magnetic field produced by the use of alternating current.

3.2 agency: The entity contracted to inspect new OCTG using the methods and criteria specified.

3.3 alternating current: (AC): Current that reverses its direction of flow at regular intervals.

3.4 ampere (A, I or amp): A unit of electrical current.

3.5 ampere-turns (NI): The product of the number of turns in a coil and the number of amperes of current flowing through it. This is a measure of the magnetizing strength of the coil. For example: 800 amperes in a 6 turn coil = 4800 ampere-turns (NI).

3.6 angle beam: A term used to describe an angle of incidence or refraction other than normal to the surface of the test object. This includes shear waves and longitudinal (compression) waves.

3.7 API: Abbreviation for American Petroleum Institute, headquartered in Washington, D.C.

3.8 arcing: Current flow through a gap, often accompanied by intense heat and light.

3.9 artificial discontinuity: See *reference indicator.*

3.10 ASNT: Abbreviation for American Society for Nondestructive Testing, headquartered in Columbus, OH.

3.11 ASTM: Abbreviation for American Society for Testing and Materials in West Conshohocken, PA.

3.12 back reflection: In ultrasonic testing the signal received from the back surface of the pipe wall.

[1]American Society for Nondestructive Testing, 1711 Arlingate Lane, P.O. Box 28518, Columbus, Ohio 43228.
[2]American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428.

3.13 backscatter: Secondary radiations resulting from the interaction between the primary gamma radiations from the source and the pipe wall.

3.14 black-crested thread: A thread that does not have a full crest because the original (black) mill surface has not been completely removed. (Also see nonfull-crested threads.).

3.15 black light: A colloquial expression used to describe long wave ultraviolet light (UV-A) with wavelengths in the range of 320 to 400 nanometers.

3.16 borescope: An optical instrument with an illuminating lamp for inspecting the inside surface of OCTG.

3.17 box end: The internally threaded end of integral joint OCTG, or the coupling end of threaded and coupled OCTG.

3.18 calibration: The adjustment of instruments, prior to use, to a known basic reference often traceable to the National Institute of Standards and Technology.

3.19 casing: Steel pipe used in oil wells to seal off fluids from the bore hole and to prevent the walls of the hole from sloughing off or caving. API casing sizes range from $4^1/_2$ to 20 inclusive.

3.20 cathode ray tube (CRT): A vacuum tube with a luminescent screen often used for viewing ultrasonic echo signals or for video readouts of computer stored data.

3.21 central conductor (shooting rod): A conductor that is passed through the bore of OCTG for the purpose of creating a circular or circumferential magnetic field in the OCTG. This term does not imply that the current rod must be centered in the bore of the OCTG.

3.22 chamfer: The conical surface at the end of threaded pipe (API round or buttress threads).

3.23 chatter: A wavy surface of the thread flank, root, crest, or chamfer, produced by a vibrating cutter insert.

3.24 chock: Block or wedge used beneath a length of pipe so that it cannot roll.

3.25 circular (circumferential) magnetic field: The magnetic field in or surrounding a current-carrying conductor, or OCTG, such that the magnetic field is oriented circumferentially within the wall of the OCTG.

3.26 circular (circumferential) magnetization: Circular magnetization is the production of a magnetic field in a pipe wall or coupling such that the magnetic field is oriented circumferentially.

3.27 classification: The action taken to categorize a length of new OCTG based on conformance with the contracted inspection requirements.

3.28 coil method: A method of magnetizing in which a length of OCTG is encircled by a current-carrying coil.

3.29 coil shot: A short pulse of magnetizing current passed through a coil surrounding a length of OCTG for the purpose of longitudinal magnetization.

3.30 color code: Paint band identification of OCTG classification in accordance with appropriate specifications.

3.31 continuous method: A method of searching for imperfections while the magnetizing current is being applied.

3.32 contour (verb): The gradual tapering by filing or grinding to prevent abrupt changes in the wall thickness.

3.33 contract: The documented agreement which specifies the terms of the inspections to be performed.

3.34 controlled area: A defined area in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of an individual in charge of radiation protection. (This implies that a controlled area is one that requires control of access, occupancy, and working conditions for radiation protection purposes.)

3.35 couplant: A material (usually a liquid) used between an ultrasonic transducer and the test specimen to conduct ultrasonic energy between them.

3.36 crest: The top of a thread.

3.37 cross threaded: Angular misalignment of internal and external threads relative to each other resulting in improper make-up.

3.38 CRT: See cathode ray tube.

3.39 cut: A gouge or distortion in two or more thread crests in a line either parallel to the pipe axis or at an angle across the threads.

3.40 DC field: Either a residual magnetic field or an active magnetic field produced through the use of direct current.

3.41 dead zone (ultrasonic): The distance from the front surface of the pipe to the nearest inspectable depth.

3.42 defect: An imperfection of sufficient magnitude or properties to warrant rejection of OCTG based on the stipulations of the latest edition of the applicable specification(s).

3.43 demagnetization: the process of removing part or all of the existing residual magnetism from OCTG.

3.44 detect: The act of locating an imperfection.

3.45 detector or **detector shoe:** A scanning shoe carrying one or more transducers. It is used to protect transducers from mechanical damage.

3.46 diameter tape: A measuring device consisting of a thin, flexible, metallic tape which can be wrapped around the

circumference of a length of OCTG and is graduated such that average diameter can be directly read from the scale. A diameter tape is also referred to as a pi tape.

3.47 differential wiring: Sensors electrically connected in opposed series such that the output of one sensor effectively opposes the other sensor. In search coils, the differential wiring results in equal and opposite voltages being developed when the magnetic field changes equally in each coil. Thus, no net voltage output is produced.

3.48 diffuse indications (magnetic particle): Indications that are not clearly defined as, for example, indications of subsurface imperfections.

3.49 direct current: Refers to an electric current flowing continually in one direction only through a conductor.

3.50 discontinuity: An irregularity in the product such as laps, seams, pits, and laminations. Also called a flaw or imperfection.

3.51 disposition: The action taken in conformance with API Specifications 5CT or 5D with regard to a defect in a length of new OCTG. The defect may be removed, cut off or rejected. See Section 9 of API Specification 5CT or Section 8 of API Specification 5D for restrictions.

3.52 dose rate: The amount of ionizing radiation energy absorbed per unit of mass and time of irradiated material. Measured in rem or rad.

3.53 dosimeter: A device that measures radiation dose, such as a film badge or ionization chamber.

3.54 DP: An abbreviation for drill pipe.

3.55 drift mandrel: A precision dimensioned cylinder sized to pass through a specified diameter and weight of pipe. It is passed through the pipe ID to locate obstructions and/or to assure compliance with appropriate specifications.

3.56 dry method: A magnetic particle inspection method in which the particles employed are in dry powder form.

3.57 dual transducer: An ultrasonic probe containing two piezoelectric crystals, one for transmitting and one for receiving.

3.58 eddy current: Circulating current caused to flow in the OCTG by varying magnetic fields.

3.59 electric-weld pipe: Pipe having one longitudinal seam formed by electric resistance welding (ERW) or electric induction welding without the addition of extraneous (filler) metal.

3.60 electromagnet (EM): When ferromagnetic material is surrounded by a current carrying coil, it becomes magnetized and is called an electromagnet.

3.61 electromagnetic inspection (EMI): A general term including primarily the eddy current and flux leakage methods for the detection of imperfections. Field Electromagnetic "Inspection Systems" may include equipment for performing additional inspections or services.

3.62 encircling coil: A coil surrounding the OCTG under test.

3.63 evaluation: The process of determining the severity of an imperfection which leads to determining whether the OCTG is acceptable or rejectable under the appropriate specification.

3.64 external thread: A thread on the outside surface of OCTG.

3.65 false indication: An indication that is not the result of magnetic forces. Examples are particles held mechanically or by gravity in shallow depressions or particles held by rust or scale on the surface.

3.66 false starting thread: A circumferential tool mark on a round thread chamfer that precedes the actual starting thread.

3.67 ferromagnetic: A term applied to materials that can be magnetized or strongly attracted by a magnetic field.

3.68 field end: The pipe end opposite the coupling, box or mill identification.

3.69 film badge: A package of photographic film worn like a badge by some workers in the inspection industry to measure exposure to ionizing radiation. The absorbed dose can be calculated by the degree of film darkening caused by the irradiation.

3.70 flank or **side:** The surface of a thread that connects the crest with the root.

3.71 fluorescence: The emission of visible radiation by a substance as the result of the absorption of ultraviolet light radiation.

3.72 fluorescent magnetic particle inspection: The magnetic particle inspection process employing a finely divided fluorescent ferromagnetic inspection medium that fluoresces when activated by black light.

3.73 flux density: The strength of a magnetic field, expressed in flux lines per unit area, i.e., gauss, kilogauss.

3.74 flux leakage: This is the magnetic field forced out into the air by a distortion of the field within the OCTG caused by the presence of a discontinuity.

3.75 flux lines: Imaginary magnetic lines used as a means of explaining the behavior of magnetic fields. Their conception is based on the pattern of lines produced when iron fil-

ings are sprinkled on a piece of paper laid over a magnet. Synonymous with *magnetic lines of force.*

3.76 frequency (Hz): Number of complete cycles of a wave motion per second of time. Unit of measure is called a Hertz.

3.77 full body: This term refers to inspection coverage of the entire surface area of the OCTG within the limitations of the inspection equipment used.

3.78 furring: Buildup or bristling of magnetic particles at the ends of a longitudinally magnetized length of OCTG i.e., at its poles.

3.79 gain control: A sensitivity adjustment on an amplifier or circuit.

3.80 gamma rays: High-energy, short wave length electromagnetic radiation emitted by a nucleus. Energies of gamma rays are usually between 0.010 and 10 Mev. gamma rays are penetrating and are best attenuated by dense material like lead or tungsten.

3.81 gauss (G): A unit of flux density or induction. Numerically, one gauss is one line of flux per square centimeter of area.

3.82 gaussmeter: See magnetometer.

3.83 grind, probe: Grinding performed to explore or determine the depth of an imperfection.

3.84 grind, radius: Grinding performed to remove sharp edges and/or abrupt changes in the wall thickness around exploratory grinds or imperfections.

3.85 grind, removal: Grinding performed to remove an imperfection or defect and make the product comply with the appropriate specification (refer to the latest edition of API Specification 5CT, Section 9, Disposition; and API Specification 5D, Section 8, Disposition).

3.86 grinding: Removing material from a surface by abrading, e.g., grinding wheel or file.

3.87 hall detector: A semiconductor element that produces an output electromotive force proportional to the product of the magnetic field intensity and a biasing current.

3.88 handling damage: Cuts, gouges, dents, flattened thread crests (mashed) or similar damage to the OCTG body, coupling or threads that occurred during handling (loading, unloading, shifts in transit, etc.).

3.89 hand-tight: Threaded joint that has been made up by hand without the aid of tongs.

3.90 hand-tight standoff: The length, at hand-tight engagement from the face of the coupling to the vanish point of the threads for round threads and the base of the triangle for buttress threads.

3.91 handling tight: Sufficiently tight so that the coupling cannot be removed except by use of a wrench.

3.92 hardness: A measure of the hardness of a metal, as determined by pressing a hard steel ball or diamond penetrator into a smooth surface under standard conditions. Results are often expressed in terms of Rockwell hardness number (HRB or HRC) or Brinell hardness number (BHN). Refer to ASTM E10, ASTM E18, and ASTM E110 for added information.

3.93 hardness value (hardness testing): The average of the valid readings taken in the test area.

3.94 hydrostatic test (hydrotest): Filling a length of OCTG with water, under pressure, and its ability to hold a certain pressure without leaking or rupturing.

3.95 ID (id): Literally, inside diameter.

3.96 imperfection: An imperfection is a discontinuity or irregularity in the product, sometimes called a flaw. For exact definitions and illustrations of specific imperfections, see API Standard 5T1.

3.97 indication: A response from nondestructive inspection that requires interpretation in order to determine its significance, e.g., a blip on the log or a powder buildup on the OCTG.

3.98 indicator (or readout): A device for displaying a condition, a current or a potential. Typical ones used on inspection instruments are galvanometers, De Arsenval (dial) or digital meters, CRTs, or warning lights.

3.99 induction: The act of inducing a magnetic field in a ferromagnetic body.

3.100 inspection: The process of examining OCTG for possible defects or for deviation from established standards.

3.101 inspection job: The inspection of one or more lots of OCTG by an agency subject to a single contract or subcontract as appropriate.

3.102 inspection system: The combination of equipment, procedures and personnel required for the detection of reference indicators.

3.103 inspector: An employee of an agency qualified and responsible for one or more of the inspections or tests specified in the contract.

3.104 integral joint: OCTG with one end threaded externally and the other end threaded internally. Integral joint OCTG has no coupling.

3.105 internal thread: A thread on the inside surface of OCTG.

3.106 interpretation: The process of determining the nature of the indication.

3.107 ionization chamber: An instrument that detects and measures ionizing radiation by observing the electrical current created when radiation ionizes gas in the chamber, making it a conductor of electricity.

3.108 isotope: Atoms with the same atomic number (same chemical element) but different atomic weights.

3.109 jointer: a length of pipe made up of two shorter pieces of pipe.

3.110 leakage field: This is the magnetic field forced out of the material into the air by distortion of the field within the material caused by the presence of a discontinuity.

3.111 leaker: A length of OCTG that will not hold hydrostatic pressure.

3.112 length: A complete section of pipe (the colloquial term is "joint").

3.113 licensed material: Radiation source material possessed, used or transferred under license issued by the appropriate government agency.

3.114 lift off: The perpendicular distance between detector shoe and the surface: sometimes called "standoff."

3.115 log: The strip chart record or readout of indications produced while inspecting with EMI or other electronic inspection equipment.

3.116 longitudinal magnetic field: Magnetization of OCTG in such a way that the magnetic flux runs substantially parallel to the axis of the OCTG.

3.117 longitudinal imperfection: An imperfection which has its principal direction or dimension approximately in the longitudinal direction.

3.118 loss of back reflection (ultrasonic): Absence of or a significant reduction of an indication from the back surface of the article being inspected.

3.119 magnetic field: The space around a magnet within which ferromagnetic materials are attracted is called a magnetic field.

3.120 magnetic particle field indicator: A device containing artificial flaws which is used to verify the adequacy or direction, or both of a magnetic field.

3.121 magnetic poles: The area on a magnetized OCTG where the magnetic field is "leaving or returning," usually at its end when longitudinally magnetized.

3.122 magnetic particles: Finely divided ferromagnetic material capable of being individually magnetized and attracted to distortions in a magnetic field.

3.123 magnetism: The ability of a magnet to attract or repel another magnet is called magnetism. Also recognized as a force-field surrounding conductors carrying electric current.

3.124 magnetizing force: The total force tending to set up a magnetic field in a magnetic circuit divided by its length. It is usually designated by the letter "H" and the unit is the "oersted."

3.125 magnetometer: Either a mechanical or electronic instrument for measuring magnetic field strength. An electronic magnetometer is also known as a Gaussmeter.

3.126 magnetomotive force (MMF): The product of the current and the number of turns in a current carrying coil.

3.127 manufacturer: The entity last responsible for manufacturing compliance with API Specification 5CT, API Specification 5D, and/or API Standard 5B.

3.128 marking: The term "marking" is used to refer to the assorted marks on tubular products, and includes inspection markings made with paint sticks and stencils, and ball-point paint tubes.

3.129 may: "May" is used to indicate that a provision is optional.

3.130 mill end: The pipe end having the coupling, box or mill identification.

3.131 mill grind: An area of the OCTG surface removed by grinding during the manufacturing process.

3.132 mill scale: An oxide of iron that forms on the surface of hot steel.

3.133 monitoring radiation: Periodic or continuous determination of the amount of ionizing radiation present in a region.

3.134 MPI: Abbreviation for magnetic particle inspection.

3.135 no-drift: A length of pipe which will not pass a specified drift diameter with reasonable pressure.

3.136 nondestructive evaluation (NDE): Same as nondestructive testing.

3.137 nondestructive testing (NDT): Inspection to detect internal, surface and concealed defects or imperfections in materials, using techniques that do not damage or destroy the items being tested.

3.138 nonfull-crested threads: Those threads on which the profiled or machined pipe surface still appears on the thread crests. (Also see black-crested threads.)

3.139 nonrelevant indication: Magnetic particle indications that can occur singly or in patterns as a result of leakage fields created by conditions that require no evaluation such as changes in section (like keyways and drilled holes), inherent material properties (like the edge of a bimetallic weld), magnetic writing, etc.

3.140 normal beam: A vibrating pulse wave train traveling normal to the test surface.

3.141 notch: See reference indicator.

3.142 oblique imperfection: An imperfection at an angle other than longitudinal or transverse.

3.143 OCTG: Abbreviation for oil country tubular goods. A term applied to casing, tubing, plain-end casing liners, pup joints, couplings, connectors, and plain-end drill pipe.

3.144 OD (od): Literally, outside diameter. Often used as an abbreviation for outside surface.

3.145 operator: The person present throughout the inspection or testing process who is responsible for the unit, operates the controls, and observes the readout to detect imperfections.

3.146 owner: The entity having ownership of the new OCTG at the time inspection is contracted, specifying the type of inspection or testing to be conducted, and authorizing its performance. The owner may be the purchaser.

3.147 perfect thread length: A design length from the end of pipe or coupling to a specified location.

3.148 permeability: (a) The ease with which material can become magnetized. (b) The ratio of flux density produced to magnetizing force, i.e., B/H.

3.149 permanent magnet: A magnet or body which retains a strong residual magnetic field.

3.150 personnel monitoring equipment: Device designed to be worn or carried by an individual for the purpose of measuring radiation dose received (e.g., film badges, pocket dosimeters, film rings, etc.)

3.151 pin end: The externally threaded end of a pipe without a coupling applied.

3.152 pipe: Includes oil field casing, tubing, plain end casing liners, pup joints, and plain-end drill pipe.

3.153 pit: A depression or cavity that may be caused by corrosion or removal of roll-in or extraneous material.

3.154 plain-end: Pipe end without threads or tool joint.

3.155 planar: This term refers to an imperfection lying in one geometric plane that is normally parallel to, and within, the outer and inner surfaces.

3.156 pole piece: The ferromagnetic portion of a magnetic circuit attached to the core used to shape and direct the magnetic field through the air gaps into the wall of the OCTG being inspected.

3.157 powder dry: An OCTG surface that is sufficiently dry to allow any type of powder, applied to the surface, to be blown from the surface without residue remaining.

3.158 power tight: A threaded connection that has been fully made up by mechanical means using power tongs or a screw-on machine.

3.159 precision caliper: A measuring device, usually with two legs or jaws, that can be adjusted to determine the thickness, diameter, and distance between surfaces. The device may be equipped with a vernier or dial.

3.160 precision ruler: A smooth edged strip (usually of wood or metal) marked off in units and used for measuring.

3.161 prime pipe: Pipe meeting all of the specified inspection and testing requirements.

3.162 probe: Transducer or search unit.

3.163 process capability: The ability of a process or NDT method to repeatedly detect a defect under normal conditions of variability. Sometimes related to confidence level.

3.164 pulse: A wave of short duration.

3.165 pulse-echo method: An ultrasonic test method that both generates ultrasonic pulses and receives the return echo.

3.166 pulser: Electronic device and probe for generating a controlled magnitude magnetic pulse for standardizing transducers.

3.167 pulse length (or pulse duration): The time from initial current flow until the magnetization current has decayed to one-half the peak magnitude.

3.168 purchaser: The entity that has purchased directly from the manufacturer the new OCTG being inspected. The purchaser may be the owner.

3.169 radiation safety officer: An individual engaged in the practice of providing radiation protection. He/she is the representative appointed by the licensee for liaison with the Nuclear Regulatory Commission and with "agreement states" radiation control branches.

3.170 radioisotope: An unstable isotope of an element that disintegrates spontaneously, emitting radiation.

3.171 reading (hardness testing): The number that is obtained from the instrument dial from a single penetration of the indenter into the surface of the OCTG.

3.172 readout: A device that visually indicates a condition, voltage, or current. Typical devices used in inspection requirements are galvanometers and CRTs.

3.173 recommended practice (RP): A standard to facilitate the broad availability of proven sound engineering and operating practices.

3.174 reference indicator: Real or artificial discontinuities in a reference standard which provide reproducible sensitivity levels for inspection equipment. Artificial indicators may be holes, notches, grooves or slots.

3.175 reference standard: A pipe, or pipe section, containing one or more reference indicators used as a base for comparison or for inspection equipment standardization.

3.176 reflection: The characteristic of a surface to change the direction of propagating acoustic waves; the return of sound waves from surfaces.

3.177 relevant indication: An indication resulting from a discontinuity.

3.178 residual field: The remaining magnetic field retained by ferromagnetic materials after they have been exposed to a magnetic force.

3.179 residual method: Inspection for imperfections utilizing the residual magnetic field.

3.180 resolving power (ultrasonics): The measure of the capability of an ultrasonic system to separate in time two discontinuities at slightly different distances.

3.181 root: The bottom of a thread.

3.182 scanner: A detector assembly carrying one or more transducers for detecting imperfections and defects in OCTG (see detector). Often the scanner is equipped with a magnetizer and is a part of it.

3.183 scatter: Secondary radiation which is emitted in all directions.

3.184 seamless pipe: A wrought steel tubular product made without a welded seam. It is manufactured by hot working steel, or if necessary, by subsequently cold finishing the hot-worked tubular product to produce the desired shape, dimensions and properties.

3.185 search coil: Small coil or coils mounted in a transducer shoe.

3.186 sensitivity: The size of the smallest discontinuity detectable by a nondestructive test method with a reasonable signal-to-noise level.

3.187 shall: "Shall" is used to indicate that a provision is mandatory.

3.188 shallow discontinuity: A discontinuity which has little depth in proportion to wall thickness.

3.189 shield: A layer or mass of material used to reduce the passage of ionizing radiation.

3.190 shoe: See detector shoe.

3.191 shoot: Pass a short-time pulse of high current through a conductor.

3.192 shot: Short-time pulse of current.

3.193 shot field: Residual magnetic filed induced by a short impulse of magnetizing current. Often it is generated using a battery or capacitor discharge magnetizer.

3.194 should: "Should" is used to indicate that a provision is not mandatory but recommended as good practice.

3.195 shoulder: A condition where an excess of metal appears adjacent to the last thread in one or more places around the circumference. Usually an excessive amount of black threads appear opposite the shouldered area. This condition may be caused by a hooked end, by threading the pipe off axis, or by a large pipe outside diameter.

3.196 signal: A response of electronic NDT equipment to an imperfection or defect.

3.197 signal-to-noise ratio: The ratio of the signal from a significant imperfection or defect to signals generated from surface noise.

3.198 skelp: A coil or strip of metal produced to a certain thickness, width, and edge configuration from which welded pipe is made.

3.199 skip: The path of the ultrasonic beam in the OCTG from the point of entry on the surface to the back surface and reflecting to the front surface again.

3.200 SOP: An abbreviation for standard operating procedures.

3.201 source: The origin of radiation; an x-ray tube or radioisotope.

3.202 standardization: The adjustment of instruments, prior to use, to an arbitrary reference value.

3.203 standardization check: A check of the standardization adjustments to ensure that they remain correct.

3.204 straightness: The degree to which the longitudinal axis of a length of OCTG parallels a straight line.

3.205 stress: The load per unit area.

3.206 subsurface discontinuity or imperfection: Any discontinuity that does not open onto the surface (either ID or OD).

3.207 surface speed: Velocity of the transducer shoe over the surface.

3.208 survey: An evaluation of the radiation levels incident to the presence and use of radioactive materials.

3.209 survey meter: A portable instrument which measures dose rate exposure of radiation intensity.

3.210 tally: The overall length of OCTG measured in $^{1}/_{100}$ of a foot. This dimension is commonly used when purchasing casing and tubing. At the well site, a "makeup" tally for round threads is commonly made by measuring from the last scratch on the pin to the far end of the coupling or box.

3.211 T & C: Abbreviation for threaded and coupled.

3.212 test (hardness testing): Two or more valid readings that have been made in the same test area. Readings are usable when they are within two Rockwell C numbers (HRC) of one another or four Rockwell B numbers (HRB) of one another.

3.213 test area (hardness testing): An area on OCTG that has been ground or filed smooth and flat to remove the decarburized surface material.

3.214 test block: Special precision blocks, used as standards to facilitate calibration of an inspection instrument.

3.215 third party inspector: See agency or inspector.

3.216 thread form: The profile of a thread in an axial (longitudinal) plane for a length of one pitch.

3.217 thread protector: A protection device placed on the end of OCTG to protect threads and seals from damage.

3.218 threshold: The investigation level established during EMI or UT inspection. Indications exceeding this level require further investigation.

3.219 tolerance: The permissible deviation from the specified value.

3.220 tool marks: Surface roughness on thread, chamfer, or counterbore surfaces caused by the machining action and condition of the cutting edge of single-point, die, or chaser tools; also can occur in the form of a longitudinal ridge across thread crests due to an improperly shaped or adjusted chaser.

3.221 torn threads (tears): Thread crests which have portions that are chipped, rough, or ragged.

3.222 transducer: Device which converts one form of energy to another. This term applies to all ultrasonic probes, search coils, eddy current probes and most other detectors.

3.223 transverse: Literally means "across" usually signifying circumferential or substantially circumferential in direction.

3.224 tubing: In petroleum production this is the tubular product used to bring the product to the surface. API sizes range from 1.050 OD to 9.625 OD inclusive.

3.225 ultrasonic testing (UT): A nondestructive method of inspecting materials by the use of high frequency sound waves.

3.226 ultrasonic: Relating to frequencies above the audible range, i.e., in excess of 20 kilohertz (kHz).

3.227 ultraviolet light (UV): Light in the wavelength range shorter than visible light.

3.228 upset: A forged metal end of OCTG with increased wall thickness and diameter used for threading or welding.

3.229 vanish point: The location where the external thread runs out or terminates on the OCTG outside surface. The point where the lead of the chaser tool makes its final cut.

3.230 velocity, ultrasonic: The speed at which sound waves travel though a medium.

3.231 voltage (V): The unit potential causing the flow of current.

3.232 wet method: The magnetic particle inspection method employing ferromagnetic particles suspended in a liquid bath.

3.233 wetting agent: A substance which lowers the surface tension of a liquid.

3.234 wrench tight: When thread protector is tightened by hand using strap wrench, pipe wrench or thread protector wrench, i.e., 30-100 foot-pounds torque.

3.235 yoke: A U-shaped piece of soft magnetic material, either solid or laminated, around which is wound a coil carrying the magnetizing current.

3.236 yoke magnetization: A magnetic field induced in OCTG, or in an area of a OCTG, by means of an external electromagnet shaped like a yoke.

3.237 zero: The act of setting a dial indicating depth gauge for "zero depth." The past tense is "zeroed."

For definitions of specific types of defects and imperfections, refer to API Standard 5T1.

4 Application

4.1 BASIS FOR INSPECTION

This document contains practices recommended for use in the inspection of new OCTG subsequent to production by the manufacturer. The basis for performing an inspection may have its origin in either API Specification 5CT, API Specification 5D, API Standard 5B, or in a supplemental specification or contract prepared by the owner. The inspections

represented by the practices may be placed in one of three categories as follows:

a. Inspections specified in API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable.
b. Inspections specified as one of several options in API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable.
c. Inspections not specified in API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable.

4.2 APPLICABILITY OF INSPECTIONS

Some of the practices contained in this recommended practice are applicable to OCTG regardless of size and type. Other practices typically may have limited applicability. Table 1 indicates those inspections that are available in the field and covered by this recommended practice in relation to OCTG type. It is the owner's responsibility to specify which inspections are to be used when completing the ordering information (see Section 5) to accompany an inspection contract.

Table 1—Field Inspections Available

	Product Type (see key below)			
Inspection (see key below)	SMLS	EW	DP	CPLG
FLEMI	EQ	EQ	EQ	N.A.
FLMPI	All	All	All	N.A.
FLVI	All	All	All	All
UTFL	EQ	EQ	EQ	N.A.
UTW	N.A.	All	N.A.	N.A.
SEA	All	All	All	N.A.
UCMPI	N.A.	N.A.	N.A.	All
TESTED	All	All	N	N.A.
FLD	All	All	N.A.	N.A.
ALTFLD	All	All	N	N.A.
HRC or HRB	All	All	All	All
VTI	All	All	N.A.	All
API TG	All	All	N.A.	All

Notes:
1. Key to Inspection Applicability:
   - All — Inspection may be applicable throughout the diameter range.
   - EQ — Inspection may be applicable throughout the diameter range subject to equipment limitations.
   - N — Inspection usually is not applicable for this product.
   - N — Inspection usually is not applicable for this product.
   - N.A. — Not applicable.
2. Key to Inspection Abbreviations:
   - FLEMI[a] — full-length electromagnetic inspection
   - FLMPI — full-length magnetic particle Inspection (wet or dry MPI)
   - FLVI — full-length visual inspection
   - UTFL — full-length ultrasonic inspection
   - UTW — Ultrasonic inspection, weld line
   - SEA — End area inspection (wet or dry MPI)
   - UCMPI — Magnetic particle inspection for unattached couplings
   - TESTED — Hydrostatically pressure tested
   - FLD — full-length drifted
   - ALTFLD — full-length alternate drifted
   - HRC or HRB — Hardness tested, Rockwell C (or B)
   - VTI — Visual thread inspection
   - API TG[b] — API thread gauging
3. Key to Product Abbreviations:
   - SMLS — Seamless casing or tubing (including attached couplings)
   - EW — Electric welded casing or tubing (including attached couplings)
   - DP — Plain end drill pipe
   - CPLG — Unattached couplings

[a]For field inspections, typically includes wall thickness inspection and grade comparison.
[b]Procedures for API thread gauging are provided in API Recommended Practice 5B1, and not in API Recommended Practice 5A5.

4.3 REPEATABILITY OF RESULTS

Sources of Variation. Every inspection and measurement process is characterized by an inherent variability of results. The nondestructive inspections and measurements included in this recommended practice are characterized by additional inherent variability attributable to the following factors:

a. API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable, permits options in the selection of practices to be used in the inspection for specific attributes.
b. Within a single practice, API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable, permits options in the selection of calibration standards.
c. Each manufacturer of nondestructive inspection systems uses different mechanical and electronic designs.
d. Certain of the practices contained in this recommended practice are based on operation of the system at high, and even maximum, sensitivity without the use of the reference standards specified in API Specification 5CT or API Specification 5D, whichever is applicable.
e. Within the performance capability of a single nondestructive inspection system installation, there will not be perfect repeatability of results.

4.4 CONSEQUENCES OF VARIABILITY

4.4.1 Disposition

For any of the reasons given in 4.3, the results of field inspection may not duplicate corresponding inspections performed during manufacture. Variability within and among the results of practices contained in this recommended practice is to be expected. When field inspection results in the classification of OCTG as other than prime, it shall not be presumed that the material is defective until an evaluation has been performed in accordance with Section 18, to establish final disposition.

4.4.2 Responsibility for Rejections

In some cases, an OCTG inspected using practices described in this recommended practice may be classified as a reject even though it was inspected in conformance with API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable, and classified as an acceptable product in conformance with API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable, by the manufacturer. Responsibility for a rejection shall be based on the acceptance criteria contained in API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable, or an additional or more restrictive criteria previously negotiated with the manufacturer. Under no circumstances will the results of field nondestructive inspection stand alone as a basis for rejection without corroborating evidence that the material is properly classified as defective based on the evaluation(s) performed in accordance with Section 18 of this recommended practice. In case disposition is disputed between the purchaser and the manufacturer, the provisions of Section 9 of API Specification 5CT, Section 8 of API Specification 5D, or Section 2 of API Standard 5B, whichever is applicable, shall apply.

5 Ordering Information

5.1 In specifying the application of this Recommended Practice to an order for the inspection of new OCTG the owner should specify for each size and type of OCTG the following order information:

a. The inspection(s) to be applied.
b. The frequency of sampling for inspection.
c. The reference standard, if applicable.
d. The acceptance criteria.
e. The permissible disposition of all classifications of OCTG (see Table 19).
f. The instructions for marking.

5.2 The applicability of methods and procedures contained in this recommended practice in accordance with API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable, is indicated in the Applications paragraphs of Sections 10 through 19. Some procedures in this Recommended Practice are beyond the scope of the inspection requirements of API Specification 5CT, API Specification 5D, and API Standard 5B.

6 Quality Assurance

6.1 The agency performing field inspection shall have a quality program consistent with the provisions of API Specification Q1, ISO 9000 series, or equivalent.

The agency's quality program shall be documented and shall include written procedures for all inspections performed.

6.2 The agency's quality program shall include documented procedures for the calibration and verification of the accuracy of all measuring, testing, and inspection equipment and materials.

6.3 The agency's quality program shall include records which verify inspection system capability for detecting the required reference indicators. In order to meet the requirements of API Specifications 5CT and 5D, the verification of inspection system capability must address the following:

a. Standardization and Operating Procedures. The standardization procedures will vary with the different types of equipment, as a minimum the written procedure should address the method for assuring coverage (minimum 100 percent for longitudinal and transverse flaws), minimum notch response, and maximum signal to noise ratio. The written

operating procedures should provide the required steps, control settings and parameter limits such as, use of special electronic circuits, use of special detector array configurations (pig tails), and maximum velocities to be used.

b. Equipment Description. The equipment used to conduct the inspection should be described in sufficient detail to demonstrate that it meets the requirements of API Specifications 5CT or 5D.

c. Personnel Qualification. Documentation of qualification of inspection personnel shall meet the requirements of Section 5 of this recommended practice.

d. Dynamic Test Data Demonstrating the System Capabilities for Detecting the Reference Indicators. There are many methods of verifying system capability. Two methods are listed below:

1. Inspection system capability may be established by using statistical techniques for assessment of inspection performance. By establishing inspection system setup parameters and response amplitude of the applicable reference flaws, data points are established to determine the distribution of response amplitudes. This data then becomes the basis for establishing the capability of the inspection system.

2. Inspection system capability may also be demonstrated for each inspection order by use of a reference standard with the required reference notches. After the system is standardized according to the written procedures, the test standard is inspected at a number of positions to establish the reliability in all quadrants.

e. Reports shall include all system settings, strip charts (if applicable), traceability of calibration, standardization and setup procedure, and a map of the test standard.

6.4 The agency's quality program shall include provisions for the education, training and qualification of personnel performing inspections in accordance with this recommended practice.

7 Qualification of Inspection Personnel

7.1 GENERAL

This section sets forth the minimum requirements for qualification and certification (where applicable) of personnel performing field inspection of new OCTG.

7.2 WRITTEN PROCEDURE

Agencies performing inspection of new OCTG in accordance with this recommended practice shall have a written procedure for education, training and qualification of personnel. The written procedure shall include the following:

a. Establish administrative duties and responsibilities for execution of the written procedure.

b. Establish personnel qualification requirements.

c. Require documentation verifying all qualifications.

7.3 QUALIFICATION OF INSPECTION PERSONNEL

The qualification requirements and qualification of inspection personnel shall be the responsibility of the agency. The requirements for each applicable qualification shall include the following as a minimum:

a. Training and experience commensurate with the inspector's level of qualification.

b. Written and practical examinations with acceptable grades.

c. A vision examination.

d. Knowledge of the related sections of the applicable API standards and this document.

7.4 TRAINING PROGRAMS

7.4.1 All qualified personnel shall have completed a documented training program designed for that level of qualification. The program shall include the following:

a. Principles of each applicable inspection method.

b. Procedures for each applicable inspection method, including calibration and operation of inspection equipment.

c. Related sections of the applicable API standards.

7.4.2 Training may be given by the agency or an outside agent.

7.5 EXAMINATIONS

7.5.1 All inspection personnel shall have successfully completed the following examinations:

a. Written examinations addressing the general and specific principles of the applicable inspection method, the inspection procedures, and the applicable API standards.

b. A hands-on or operating examination that shall include apparatus assembly, standardization, inspection techniques, operating procedures, interpretation of results for appropriate levels, and related report preparation.

c. Natural or corrected vision to read J-2 letters on a Jaeger number 2 test chart at a distance of 12 to 15 inches. Equivalent tests such as the ability to perceive a Titmus number 8 target, a Snellen fraction 20/25, or vision examinations with optical apparatus administered by physicians are also acceptable.

7.5.2 Examinations may be given by the agency or an outside agent.

7.6 EXPERIENCE

All candidates for qualification shall have the experience required by the written procedure.

7.7 REQUALIFICATION

7.7.1 Requalification requirements shall be defined in the written procedure.

7.7.2 Requalification is required at least every five years for all personnel.

7.7.3 Requalification of personnel is required if an individual has not performed defined functions within the previous 12 months, or if an individual changes employers.

7.7.4 As a minimum requirement for requalification, all personnel shall achieve an acceptable grade on a written examination addressing the current applicable OCTG inspection procedures, and the applicable API documents.

7.8 DOCUMENTATION

7.8.1 Record retention and documentation are required for all qualification programs. The following are minimum requirements:

a. All qualified personnel shall receive a certificate stating their level of qualification.
b. The records of all qualified personnel showing training program completion, experience, and examinations shall be maintained by the agency and made available for review upon request.

7.8.2 All qualifications and related documents shall be approved by authorized agency personnel.

7.9 NDT PERSONNEL CERTIFICATION

7.9.1 A program for certification of NDT personnel shall be developed by the agency. The 1984 edition of the American Society for Nondestructive Testing (ASNT) Recommended Practice No. SNT-TC-1A may be used as a guideline.

7.9.2 The administration of the NDT personnel certification program shall be the responsibility of the agency.

7.9.3 API is neither responsible for administering the NDT certification program nor acting as a certifying agent in the program.

8 General Inspection Procedures

8.1 GENERAL

This section covers general procedures applicable to all inspection methods contained in this recommended practice.

8.2 DOCUMENTS AT JOB SITE

The following inspection related documents shall be available at the job site.

a. Applicable API documents listed in Section 2 of this recommended practice.
b. Additionally, when API thread gauging is being conducted, a copy of the latest edition of API Recommended Practice 5B1.
c. All applicable agency-controlled and qualified inspection procedure documents.
d. The field inspection contract or agency inspection order based on the contract.

8.3 PREINSPECTION PROCEDURES

8.3.1 Each inspection shall start with the correct equipment available and in good working condition.

8.3.2 Prior to equipment setup, the agency shall assure that the OCTG to be inspected is the OCTG the owner has ordered inspected by comparing the information on the job order with the OCTG markings, i.e., size, weight, grade, manufacturer, and whether seamless or welded.

8.3.3 All inspection should begin by uniquely numbering or renumbering each length with a paint marker. Place the sequence number on the outside surface, preferably on the coupling end, box end, or identified end and printed in white paint so that it can be read from the end of the length. Do not place numbers over mill paint stencils. Unique numbering of unattached couplings is not required, however, rejected couplings shall be identified and segregated from prime couplings. If a defect is found on a length of OCTG, complete all specified inspections on that length unless otherwise stipulated in the inspection contract.

8.4 RECORDS AND NOTIFICATION

As inspection progresses, maintain a record of the classification of the OCTG inspected. If at any time after 50 lengths or couplings have been inspected or tested, the reject rate exceeds 10 percent of the OCTG inspected, notify the owner or his representative. When appropriate, it is suggested that the manufacturer, or his representative, be notified in turn through the purchaser.

8.5 POST INSPECTION PROCEDURES

8.5.1 Classification

Classify each length of pipe or coupling into one of the categories listed below (see Section 20 for details):

a. Prime pipe with good connections or prime unattached couplings.
b. Prime pipe with defective connections.
c. Pipe that contains conditionable defects.
d. Pipe that contains nonconditionable defects.
e. Nonconditionable unattached couplings (rejects).
f. Unattached couplings requiring conditioning.
g. Pipe or unattached couplings not meeting special owner specified tests.

8.5.2 Marking

Mark the classification of each pipe and coupling with paint markings and apply all applicable inspection markings as described in Section 20.

8.5.3 Cleaning

Remove all magnetic powder and cleaning material from the Pipe and coupling surfaces. Do not contaminate nearby pipe during this process.

8.5.4 Count and Tally Lengths

Count and tally the lengths in each of the classification categories. Be sure to verify the totals after the initial count. Segregate the prime OCTG from all other OCTG when practical. Tally each length of casing and tubing using the overall length (including pin threads and coupling). By agreement between the owner and the agency, a "makeup" tally as described in the latest edition of 4.1.7.c of API Recommended Practice 5C1 shall be substituted on acceptable OCTG. An overall tally shall be used on rejected OCTG.

8.5.5 Thread Protection

After inspection, ensure that the threads are clean and dry. Lubricate the threads with a thread compound that meets the performance objectives of API Recommended Practice 5A3; however, the owner may direct a specific compound be used. Lubricate the full threaded area, including seals and thread roots, for the full thread circumference. In very cold climates, it may be necessary to warm the thread compound in order to apply it.

CAUTION: The Material Safety Data Sheets for thread compounds should be read and observed. Store and dispose of containers and unused compound in accordance with appropriate regulations.

8.5.6 Thread Protectors

Reinstall clean thread protectors and tighten them wrench-tight.

CAUTION: Solvents and other cleaning agents may contain hazardous materials. Solvents are normally volatiles and may build up pressure in containers. Material Safety Data Sheets should be read and the precautions observed when handling products of this type. Storage, transport, use,and disposal of excess materials and containers should be considered. Observe appropriate regulations relative to disposal of used solvents and generated waste materials.

8.6 JOB SITE CHECKLIST

Before leaving the job site, the agency shall ensure that the following items have been accomplished.

a. Pipe Racking. The agency shall ensure that each row of pipe has been properly secured (with chocks) for safety, and that no loose or unsecured pipe is left free to roll or fall from the racks. No pipe shall be left on the ground. Ensure that the pipe has been properly racked, and that all pipe has stripping between layers. Stripping shall be placed directly over the centerline of each sill.

b. Unattached Couplings. Unattached couplings shall be stored for protection against the environment. Unless otherwise specified by the owner, they shall be returned to their original shipping container.

c. Debris Removal. The job site shall be left neatly arranged and clean of all job related debris.

d. Solvent Disposal. Cleaning solvents used at the job site should be disposed of properly.

8.7 DOCUMENTATION

A field copy of the completed inspection report and supporting documents should be delivered to the customer or specified representative upon completion of the job. Defect terminology shall comply with API Standard 5T1, where applicable.

9 Acceptance Criteria, Disposition, and Responsibility

9.1 GENERAL

This section sets forth the principles for determining acceptance criteria, disposition, and responsibility for OCTG inspected in accordance with this recommended practice.

9.2 BASIS FOR ACCEPTANCE

API Specification 5CT, API Specification 5D, or API Standard 5B shall constitute the basis for acceptance of OCTG inspected in accordance with this recommended practice, except that additional or more restrictive criteria may be contracted between the owner and the agency.

9.3 RESPONSIBILITY FOR REJECTIONS

For the purpose of this paragraph, a rejection is any OCTG not classified as prime as a result of field inspection.

9.3.1 The manufacturer shall be responsible for rejects which, after evaluation, are demonstrated to be nonconforming to the requirements of API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable. Manufacturer responsibility for defects attributable to handling or shipping damage shall be limited to those conditions reported to the manufacturer at or prior to delivery to the purchaser. Rejection shall not be based solely on unevaluated imperfections or indications (see 9.3.3).

9.3.2 In an identical manner to 9.3.1, the manufacturer shall be responsible for rejects that, after evaluation, are demonstrated to be conforming to the requirements of API Specification 5CT, API Specification 5D, or API Standard 5B, whichever is applicable, but nonconforming to additional or more restrictive criteria for which the manufacturer is contractually liable (see 9.3.3).

9.3.3 In the event the manufacturer may be responsible for the rejection, but the purchaser and manufacturer are unable to agree that the OCTG is defective, a destructive test may be performed. If tests that require the destruction of material are made, any product that is proven to have not met the requirements of the specification shall be rejected. Disposition of rejected product shall be a matter of agreement between the manufacturer and purchaser.

9.3.4 Disposition of defects shall be in compliance with Section 8 of API Specification 5D or Section 9 of API Specification 5CT, whichever is applicable. Dispositions shall be recorded and shall be traceable to the OCTG inspection number (see 8.3.3).

10 Visual and Dimensional Inspection

10.1 GENERAL

This section provides descriptions, mechanical equipment requirements, and procedures for visual and dimensional inspection of new OCTG.

10.2 APPLICATION

The inspections described in this section are applicable to all sizes and all types of new OCTG.

10.3 EQUIPMENT, INCLUDING CALIBRATION

These requirements are applicable to equipment used for visual and dimensional inspection of new OCTG.

10.3.1 API Drift Mandrels

The diameter of the drift mandrel should be measured with a vernier caliper or micrometer having flat contacts. The instrument used should be calibrated using a known precision setting standard at least once every 4 months. The calibration check shall be recorded on the instrument and in a log book with the date of the calibration check, the due date, and the initials of the person who performed the check. Length measurements may be made using one of the devices listed in 10.3.3.

10.3.2 Precision Calipers (Micrometer, Vernier, or Dial)

The instrument should be calibrated using a known precision setting standard at least once every 4 months. The calibration check shall be recorded on the caliper and in a log book with the date of the calibration check, the due date, and the initials of the person who performed the check.

10.3.3 Length and Diameter Measuring Devices (Steel Rules, Steel Length or Diameter Measuring Tapes, and other Nonadjustable Measuring Devices)

Accuracy verification shall be defined as a visual check of markings' legibility and the general wear of fixed reference points. The verification procedure of these devices shall be documented.

10.3.4 Depth Gauges

The following conditions and checks apply to gauges used for imperfection evaluation in Section 18.

10.3.4.1 For external type depth gauges the following requirements apply:

a. Zero the gauge on a flat surface.
b. Check measuring accuracy of the gauge over a range of standard depths, at least once every 4 months or after repair or replacement.
c. Accuracy should be within 0.001 inch of actual depths of standard.
d. The calibration check shall be recorded on the gauge and in a log book with the date of the calibration check, the due date, and the initials of the person who performed the check.

10.3.4.2 For internal type depth gauges and wall thickness calipers the following requirements apply:

a. Set the gauge to read "zero" or a specified thickness when the contact points touch or when a standard thickness is placed between the contacts.
b. Check the measuring accuracy of the gauge over a range of standard thicknesses different from 10.3.4.2.a above, at least once very 4 months or after repair.
c. Accuracy of differential readings should be within 2 percent of the actual wall thickness of the thickest standard used.
d. The calibration check shall be recorded on the gauge and in a log book with the date of the calibration check, the due date, and the initials of the person who performed the check.

10.4 EXTERNAL SURFACE ILLUMINATION

10.4.1 Direct Daylight

Direct daylight conditions do not require a check for surface illumination.

10.4.2 Night and Enclosed Facility Lighting

The diffused light level at the surfaces being inspected should be a minimum of 50 foot-candles (500 Lux).

Illumination should be checked once every 4 months. The check should be recorded in a log book with the date, the reading, and the initials of the person who performed the check. This record should be available on site. Illumination should be checked whenever lighting fixtures change position or intensity relative to surfaces being inspected.

10.4.3 Night Lighting With Portable Equipment

The diffused light level at the surfaces being inspected should be a minimum of 50 foot-candles (500 Lux).

Proper illumination should be verified at the beginning of the job to assure that portable lighting is directed effectively for surfaces being inspected. Illumination should be checked during the job whenever lighting fixtures change positions or intensity relative to the surfaces being inspected.

10.4.4 Light Meter Calibration

Light meters used to verify illumination should be calibrated at least once a year. The calibration check shall be recorded on the meter and in a log book with the date of the calibration check, the due date, and the initials of the person who performed the check.

10.5 INTERNAL SURFACE ILLUMINATION

10.5.1 Mirrors for Illumination

The reflecting surface should be a nontinted mirror that provides a nondistorted image. The reflecting surface should be flat and clean.

10.5.2 Spotlights

A spotlight producing an intensity greater than 100 foot-candles (1000 Lux) at the maximum inspection distance may be used for illumination of inside surfaces.

A light source having documented demonstrated capability may be used for illumination of inside surfaces. The lens of the light source shall be kept clean.

10.5.3 Borescope Equipment

The borescope lamp should meet the requirements shown in Table 2.

The resolution of the borescope should be checked at the start of a job, and whenever all or part of the scope is assembled or re-assembled during a job. The date (not to exceed 0.040 in. in height) on a coin, or as an alternative Jaeger J4 letters placed within 4 inches of the objective lens, should be readable through the assembled borescope.

Table 2—Minimum Lamp Watts for Borescope

Pipe Inside Diameter	Minimum Lamp Watts
Less than 1 inch	10
1 inch to 3 inches	30
Over 3 inches to 5 inches	100
Over 5 inches	250

10.6 FULL-LENGTH VISUAL INSPECTION OF NEW OCTG (FLVI)

10.6.1 Description

A full-length visual inspection of the entire outside and inside surfaces excluding the threads shall be conducted to detect gouges, cuts, pits, dents, grinds, mechanical damage, lack of straightness, and other visually detectable imperfections. On electric weld pipe, special attention is given to weld flash and trim. Rolling each length and viewing the entire surface is required. The entire inside surface is inspected using a high intensity light, mirror or borescope (depending on size) meeting the requirements of 10.5.

10.6.2 External Visual Inspection Procedures

Lengths are inspected in groups by first rolling them together. Observe the pipe while rolling to detect straightness problems. Evaluate bent or bowed pipe in accordance with Section 18.

Use the following procedure for external visual inspection:

a. Identify the upper one-third of each length with a chalk mark.

b. Examine each pipe surface by walking the length of each pipe from one end to the other. The number of lengths inspected on each pass is dependent on the diameter.

c. After the top $^1/_3$ of this group has been inspected, roll each length $^1/_3$ of a turn and mark with chalk.

d. As each imperfection is found, it should be marked and evaluated according to Section 18.

e. Repeat the operations described in 10.6.2 until the entire outside surface of the pipe is covered by this technique.

10.6.3 Internal Visual Inspection Procedures

Inspect the entire inside surface, excluding the threads for imperfections.

Pipe sizes $10^3/_4$ and larger may be visually inspected from each end using an illumination source meeting the requirements of 10.5.1, 10.5.2, or 10.5.3.

For pipe sizes smaller than $10^3/_4$, the best quality inspections are done with a borescope. See 10.5.3 for illumination head recommendations on these sizes.

10.7 OUTSIDE DIAMETER VERIFICATION

When requested by the owner, the diameter of each length is verified to assure compliance with API Specifications 5CT and 5D.

10.7.1 Minimum and maximum diameter verification may be made with snap gauges.

10.7.2 Micrometers or mechanical calipers that display the readout in thousandths of an inch shall be used to measure actual diameter.

10.7.3 Diameter tapes should be used to measure average diameter.

10.8 STRAIGHTNESS

A visual inspection is performed to detect hooked ends or bowed pipe. Pipe to be examined should be placed on a rack or joists where it can be rolled while visually examining for straightness.

10.8.1 Pipe sizes $4^1/_2$ and larger are measured to determine the amount of straightness deviation whenever a visual examination has shown them to have hooked ends or to be bowed. This measurement is performed using a straight edge or taut string (wire) and a steel scale or rule.

10.8.2 Straightness should be evaluated in accordance with Section 18.

10.9 DRIFT TESTING

Casing or tubing is drifted throughout its entire length to detect ID reduction. Group 1 external upset drill pipe, except $3^1/_2$, 13.30 pounds per foot, shall be tested throughout the length of the end upsets. Cylindrical drift mandrels manufactured to the requirements in the latest editions of API Specifications 5CT, 5D, or this recommended practice are used for this test.

10.9.1 Drift Mandrel Specifications

Drift mandrel specifications are as follows:

a. Diameter. The minimum diameter of the cylindrical portion of a drift mandrel for bare casing, tubing, and drill pipe is tabulated in Tables 4, 5, and 8. Diameters for sizes and weights not included in the above-listed tables shall be calculated in accordance with Table 3.

A drift mandrel for internally coated pipe should be made of plastic or hardwood such as oak and, as a guide, may meet the dimensions specified in Tables 6 and 7. Because of the extra thickness added by the coating, a "no-drift" coated length may not be an API reject.

b. Shape. The mandrel shall be cylindrical in shape and may have attachments on one or both ends. Disk and barbell-shaped mandrels cannot be used. The ends of the drift mandrel extending beyond the specified cylindrical portion shall be shaped to permit easy entry into the pipe.

Sometimes pipe is drifted in the field to allow drilling with commonly used bit sizes. Drift sizes that are in use to allow passage of these commonly used bit sizes are shown in Table 4. Pipe passing this specified drift shall be marked as recommended in Section 20.

Note: Pipe rejected for failure to pass this specified or alternate drift shall not be the responsibility of the manufacturer unless the pipe was ordered to the applicable drift diameter.

Table 3—Drift Mandrel Dimensions

Product and Size (Inches)	Drift Cylindrical Portion	
	Minimum Length (Inches)	Minimum Diameter[a] (Inches)
Casing and Liners:		
Smaller than $9^5/_8$	6	d - $^1/_8$
$9^5/_8$ to $13^3/_8$, inclusive	12	d - $^5/_{32}$
Larger than $13^3/_8$	12	d - $^3/_{16}$
Tubing:		
$2^7/_8$ and smaller	42	d - $^3/_{32}$
Larger than $2^7/_8$	42	d - $^1/_8$
Casing Used in Tubing Service:		
$8^5/_8$ and smaller	42	d - $^1/_8$
Larger than $8^5/_8$	42	d - $^5/_{32}$
Drill Pipe:		
Group 1, all sizes of external upset, except $3^1/_2$, 13.30 lb/ft	4	d - $^3/_{16}$

[a]Minimum diameter does not apply to extreme-line casing or pin upset of integral-joint tubing. "d" is the tabulated inside diameter for the specified size and weight per foot. For casing, liners, tubing, and plain end drill pipe, it is equivalent to the specified outside diameter minus two times the specified wall thickness.

10.9.2 Drift Mandrel Verification Procedures

The following drift mandrel verification procedures should be followed:

a. The length of the cylindrical portion of the drift mandrel may be measured using a steel scale. Specified drift mandrel lengths are tabulated in Table 3.

b. The mandrel diameter shall be measured using a micrometer or mechanical caliper that displays the readout in thousandths of an inch. These measurements should be made with the drift mandrel and micrometer at the same temperature. Measurements shall be made at each end of the drift mandrel. Each measurement shall be made in two locations 90 degrees apart. The allowable mandrel tolerance should be -0.000 to +0.005 inch from the specified API dimensions. Drifts larger than +0.005 inch may be used for acceptance but not for rejection. In case of dispute, a precision steel drift mandrel made to the appropriate API dimensions shall be used to resolve whether the lengths are acceptable or rejectable.

10.9.3 Drifting Procedures

The following drifting procedures should be followed:

a. Select and measure the correct drift mandrel prior to starting the inspection job, and re-measure the mandrel a minimum of every 500 lengths thereafter.

b. The drift mandrel should be approximately the same temperature as the pipe being inspected.

c. Pass the drift mandrel through the entire length of each casing and tubing and through the upset length of drill pipe. The drift mandrel shall pass through the pipe or upset freely using a reasonably exerted force that does not exceed the weight of the drift mandrel.

Note: The drift should be inserted and removed carefully so that neither the threads nor the seals are scratched or damaged.

d. If the drift does not pass through the entire length of casing or tubing or the drill pipe upset, remove and clean the drift mandrel. The pipe shall be cleaned out if necessary. Check the pipe for sagging and provide additional support should the length require it.

CAUTION: Solvents and other cleaning agents may contain hazardous materials. Solvents are normally volatile and may build up pressure in containers. Material Safety Data Sheets should be read and the precautions observed when handling products of this type. Storage, transport, use, and disposal of excess materials and containers should be considered. Observe appropriate regulations relative to disposal of used solvents and generated waste materials.

e. Attempt the drift test again from the other end of the pipe. If the drift mandrel does not pass through the entire length on the second attempt, the length is considered a reject and identified immediately as a "no-drift."

10.10 VISUAL THREAD INSPECTION (VTI)

Visual thread inspection is a service for locating thread imperfections without the use of magnetic particles or thread gauges other than a profile gauge. This inspection applies to exposed round threads on casing and tubing and exposed buttress threads on casing. Visually evident manufacturing defects or mechanical damage to the threads are detected by this inspection.

Note: Extreme line threads are excluded from these inspection procedures. For extreme line threads refer to API Standard 5B.

10.10.1 Evaluation Tools

Though imperfections may be visually located during this inspection, the following tools may be used to evaluate the magnitude of the imperfections found:

a. A steel scale for accurately determining the L_c area on the pin and perfect thread length of internal threads (see note in 10.10.3.3).

b. Mirror for inspection of load flanks and roots of internal threads.

c. Bright light, meeting the requirements of 10.5.2, for inspection of internal threads.

d. Profile gauge, a necessary tool for detection of thread profile errors.

e. Flexible steel measuring tape for measuring circumferential nonfull-crested or black-crested thread length on buttress threads.

f. Additionally, a copy of the latest edition of API Standard 5B and this recommended practice shall be available on location.

10.10.2 Thread Repair

Repair of threads is not a part of this inspection. However, by agreement between the owner and the agency, cosmetic (minor) repair of threads may be done.

10.10.3 Visual Thread Inspection Procedures

10.10.3.1 Thread Protectors

Remove the thread protectors and stack them out of the way so that they will not be a work hazard. From this step, until the thread protectors are reinstalled, great care shall be used to ensure that two lengths of pipe do not strike each other and damage the unprotected threads. Pipe should never be loaded, unloaded, or removed to another rack without thread protectors installed. Never leave threads unprotected from moisture or condensation overnight. Use of a light corrosion inhibitor is recommended.

Note: Martensitic chromium steels (9Cr and 13Cr, API Specification 5CT, Group 2) are sensitive to galling. Special precautions may be necessary for thread surface treatment and/or lubrication to minimize galling.

Table 4—Drift Information for Casing

API Spec 5CT Table 20				API Spec 5CT Table 22 Drift Diameter (Inches) Extreme Line		
Designation						
Size	Weight	Inside Diameter (Inches)	Plain End and T & C	Finished Bored Members	Full-length Drifting	Alternate Drift Diameter (Not an API Requirement) (Inches)
1	2	5	6	11	12	
4 1/2	9.50	4.090	3.965	—	—	—
	10.50	4.052	3.927	—	—	—
	11.60	4.00	3.875	—	—	—
	13.50	3.920	3.795	—	—	—
	15.10	3.826	3.701	—	—	3.750
5	11.50	4.560	4.435	—	—	—
	13.00	4.494	4.439	—	—	—
	15.00	4.408	4.283	4.183	4.151	—
	18.00	4.2764	4.151	4.183	4.151	—
	21.40	4.126	4.001	—	—	—
	23.20	4.044	3.919	—	—	—
	24.10	4.000	3.875	—	—	—
5 1/2	14.00	5.012	4.887	—	—	—
	15.50	4.950	4.825	4.721	4.653	—
	17.00	4.892	4.767	4.686	4.653	—
	20.00	4.778	4.653	4.686	4.653	—
	23.00	4.670	4.545	4.595	4.545	—
	26.80	4.500	4.375	—	—	—
	29.70	4.376	4.251	—	—	—
	32.60	4.250	4.125	—	—	—
	35.30	4.126	4.001	—	—	—
	38.00	4.000	3.875	—	—	—
	40.50	3.876	3.751	—	—	—
	43.10	3.750	3.625	—	—	—
6 5/8	20.00	6.049	5.924	—	—	—
	24.00	5.921	5.796	5.766	5.730	—
	28.00	5.791	5.666	5.716	5.666	—
	32.00	5.675	5.550	5.600	5.550	—
7	17.00	6.538	6.413	—	—	—
	20.00	6.456	6.331	—	—	—
	23.00	6.366	6.241	6.156	6.151	—
	23.00	6.366	6.250[a]	—	—	—
	26.00	6.276	6.151	6.156	6.151	—
	29.00	6.184	6.059	6.108	6.059	—
	32.00	6.094	5.969	6.017	5.969	—
	32.00	6.094	6.000[a]	—	—	—
	35.00	6.004	5.879	5.925	5.879	—
	38.00	5.920	5.795	5.845	5.795	—
	42.70	5.750	5.625	—	—	—
	46.40	5.625	5.500	—	—	—
	50.10	5.500	5.375	—	—	—
	53.60	5.376	5.251	—	—	—
	57.10	5.250	5.125	—	—	—
7 5/8	24.00	7.025	6.900	—	—	—
	26.40	6.969	6.844	6.755	6.750	—
	29.70	6.875	6.750	6.755	6.750	—
	33.70	6.765	6.640	6.690	6.640	—
	39.00	6.625	6.500	6.550	6.500	—

Table 4—Drift Information for Casing (Continued)

API Spec 5CT Table 20				API Spec 5CT Table 22 Drift Diameter (Inches) Extreme Line		
Designation						
Size	Weight	Inside Diameter (Inches)	Plain End and T & C	Finished Bored Members	Full-length Drifting	Alternate Drift Diameter (Not an API Requirement) (Inches)
1	2	5	6	11	12	
7 5/8 (con't.)	42.80	6.501	6.376	—	—	—
	45.30	6.435	6.310	—	—	—
	47.10	6.375	6.250	—	—	—
	51.20	6.251	6.1266	—	—	—
	53.30	6.125	6.000	—	—	—
7 3/4	46.10	6.560	6.500[a]	—	—	—
	46.10	6.560	6.435	—	—	—
8 5/8	24.00	8.097	7.972	—	—	—
	28.00	8.017	7.892	—	—	—
	32.00	7.921	7.875[a]	—	—	—
	32.00	7.921	7.796	7.710	7.700	—
	36.00	7.825	7.700	7.710	7.700	—
	40.00	7.725	7.625[a]	—	—	—
	40.00	7.725	7.600	7.648	7.600	—
	44.00	7.625	7.500	7.550	7.500	—
	49.00	7.511	7.386	7.436	7.386	—
9 5/8	32.30	9.001	8.845	—	—	—
	36.00	8.921	8.765	—	—	—
	40.00	8.835	8.679	8.650	8.599	—
	40.00	8.835	8.750[a]	—	—	—
	43.50	8.755	8.599	8.650	8.599	8.625
	47.00	8.681	8.525	8.606	8.525	8.625
	53.50	8.535	8.500[a]	—	—	—
	53.50	8.535	8.379	8.460	8.379	—
	58.40	8.435	8.375[a]	—	—	—
	58.40	8.435	8.279	—	—	—
	59.40	8.407	8.251	—	—	—
	64.90	8.281	8.125	—	—	—
	70.30	8.157	8.001	—	—	—
	75.60	8.031	7.875	—	—	—
10 3/4	32.75	10.192	10.036	—	—	—
	40.50	10.050	9.894	—	—	—
	45.50	9.950	9.875[a]	—	—	—
	45.50	9.950	9.794[a]	9.804	9.794	—
	51.00	9.850	9.694	9.704	9.694	—
	55.50	9.760	9.604	9.614	9.604	—
	55.50	9.760	9.625[a]	—	—	—
	60.70	9.660	9.504	9.514	9.504	—
	65.70	9.560	9.404	—	—	9.500
	73.20	9.406	9.250	—	—	—
	79.20	9.282	9.126	—	—	—
	85.30	9.156	9.000	—	—	—
11 3/4	42.00	11.084	11.000[a]	—	—	—
	42.00	11.084	10.928	—	—	—
	47.00	11.000	10.844	—	—	—
	54.00	10.880	10.724	—	—	—
	60.00	10.772	10.616	—	—	—
	60.00	10.772	10.625[a]	—	—	—
	65.00	10.682	10.625[a]	—	—	—
	65.00	10.682	10.526	—	—	—

Table 4—Drift Information for Casing (Continued)

API Spec 5CT Table 20				API Spec 5CT Table 22 Drift Diameter (Inches) Extreme Line		
Designation						
Size	Weight	Inside Diameter (Inches)	Plain End and T & C	Finished Bored Members	Full-length Drifting	Alternate Drift Diameter (Not an API Requirement) (Inches)
1	2	5	6	11	12	
	71.00	10.586	10.430	—	—	—
$13^3/_8$	48.00	12.715	12.559	—	—	—
	54.50	12.615	12.459	—	—	—
	61.00	12.515	12.359	—	—	—
	68.00	12.415	12.259	—	—	—
	72.00	12.347	12.250[a]	—	—	—
	72.00	12.347	12.191	—	—	—
16	65.00	15.250	15.062	—	—	—
	75.00	15.124	14.936	—	—	—
	84.00	15.010	14.822	—	—	—
	109.00	14.688	14.500	—	—	—
$18^5/_8$	87.50	17.755	17.567	—	—	—
20	94.00	19.124	18.936	—	—	—
	106.50	19.000	18.812	—	—	—
	133.00	18.730	18.542	—	—	—

[a]Drift Diameter for most common bit size. Drift diameter shall be marked on the pipe.

10.10.3.2 Cleaning

Clean all exposed threads thoroughly. Ensure that no thread compound, dirt, or cleaning material remains on the threads.

CAUTION: Solvents and other cleaning agents may contain hazardous materials. Solvents are normally volatile and may build up pressure in containers. Material Safety Data Sheets should be read and the precautions observed when handling products of this type. Storage, transport, use and disposal of excess materials and containers should be considered. Observe appropriate regulations relative to disposal of used solvents and generated waste materials.

10.10.3.3 Thread Inspection Areas of Round and Buttress Threads

Determine the L_c length of pin end threads and record this number. Refer to Tables 9 and 10 of this recommended practice or the latest edition of API Standard 5B from which these tables were taken.

Note: Internal threads do not have an L_c area. All of the threads within the interval from the counterbore to a plane located at a distance J plus one thread turn from the center of the coupling or small end of integral joint are to be inspected to the L_c area requirements. This area is defined as the internal perfect thread length (PTL). The calculated perfect threads are listed in the Tables 9 and 10 of this recommended practice.

Thread classification depends on the location of an imperfection. Imperfections located in the L_c area of external threads or PTL of the internal threads have different criteria for acceptance and rejection than those outside these regions. Measurement may be required to determine if imperfections are in the L_c or box PTL.

10.10.3.4 Thread Examination

Slowly roll individual lengths at least one full revolution while examining the threads.

For external threads, inspect for imperfections on the face, chamfer, L_c, and non-L_c area. The thread profile gauge shall be applied to the threads to detect machining errors.

For internal threads, inspect for imperfections in the counterbore, PTL, and threaded area beyond the PTL. Seal ring grooves shall be inspected for fins, wickers, and ribbons that are loose or can become loose on each side of the groove. The profile gauge shall be applied to the threads to detect machining errors. Caution shall be used when applying the profile gauge to avoid damaging thread coating.

Exploratory grinding or filing to determine the depth of an imperfection is not permitted in the L_c area of external threads or the total length of internal threads.

Table 5—Drift Information for Tubing

Size	Nominal Weight, lb/ft T & C			Inside Diameter	Drift Diameter, Inches		
						Integral Joint	
	Nonupset	Upset	Integral Joint		T & C	Drifting Before Upsetting	Drifting After Upsetting
1.050	1.14	1.20	—	0.824	0.730	—	—
	1.48	1.54	—	0.742	0.648	—	—
1.315	1.70	1.80	1.72	1.049	0.955	0.955	0.955
	2.19	2.24	—	0.957	0.863	—	—
1.660	—	—	2.10	1.410	—	1.316	1.286
	2.30	2.40	2.33	1.380	1.286	1.286	1.286
	3.03	3.07	—	1.278	1.184	—	—
1.900	—	—	2.40	1.650	—	1.556	1.516
	2.75	2.90	2.76	1.610	1.516	1.516	1.516
	3.65	3.73	—	1.500	1.406	—	—
	4.42	—	—	1.400	1.306	—	—
	5.15	—	—	1.300	1.206	—	—
2.063	—	—	3.25	1.751	—	1.657	1.657
	4.50	—	—	1.613	1.519	—	—
$2^{3}/_{8}$	4.00	—	—	2.041	1.947	—	—
	4.60	4.70	—	1.995	1.901	—	—
	5.80	5.95	—	1.867	1.773	—	—
	6.60	—	—	1.785	1.691	—	—
	7.35	7.45	—	1.703	1.609	—	—
$2^{7}/_{8}$	6.40	6.50	—	2.441		—	—
	7.80	7.90	—	2.323	2.229	—	—
	8.60	8.70	—	2.259	2.165	—	—
	9.35	9.45	—	2.195	2.101	—	—
	10.50	—	—	2.091	1.997	—	—
	11.50	—	—	1.995	1.901	—	—
$3^{1}/_{2}$	7.70	—	—	3.068	2.943	—	—
	9.20	9.30	—	2.992	2.867	—	—
	10.20	—	—	2.922	2.797	—	—
	12.70	12.95	—	2.750	2.625	—	—
	14.30	—	—	2.640	2.515	—	—
	15.50	—	—	2.548	2.423	—	—
	17.00	—	—	2.440	2.315	—	—
4	9.50	—	—	3.548	3.423	—	—
	—	11.00	—	3.476	3.351	—	—
	13.20	—	—	3.340	3.215	—	—
	16.10	—	—	3.170	3.045	—	—
	18.90	—	—	3.000	2.875	—	—
	22.20	—	—	2.780	2.655	—	—
$4^{1}/_{2}$	12.60	12.75	—	3.958	3.833	—	—
	15.20	—	—	3.826	3.701	—	—
	17.00	—	—	3.740	3.615	—	—
	18.90	—	—	3.640	3.515	—	—
	21.50	—	—	3.500	3.375	—	—
	23.70	—	—	3.380	3.255	—	—
	26.10	—	—	3.240	3.115	—	—

Table 6—Drift Sizes for Bare and Coated Tubing

	Pipe		API Drift (Bare Pipe)		Plastic Drift for Coated Pipe	
Size	Lb/ft	ID	OD	Length	Thin Film Drift Size[a]	Thick Film Drift Size[a]
1.315	1.70	1.049	0.955	42	0.935	0.920
	1.72					
	1.80					
1.660	2.10	1.410	12.86	42	1.266	1.251
1.660	2.30	1.380	12.86	42	1.266	1.251
	2.33					
	2.40					
1.900	2.40	1.610	1.516	42	1.496	1.481
1.900	2.75	1.610	1.516	42	1.496	1.481
	2.76					
	2.90					
$2^{1}/_{16}$	3.25	1.751	1.657	42	1.637	1.622
$2^{3}/_{8}$	4.00	2.041	1.947	42	1.927	1.912
$2^{3}/_{8}$	4.60	1.995	1.901	42	1.881	1.866
	4.70					
$2^{3}/_{8}$	5.80	1.867	1.773	42	1.753	1.738
	5.95					
$2^{7}/_{8}$	6.40	2.441	2.347	42	2.327	2.312
	6.50					
$2^{7}/_{8}$	8.60	2.259	2.165	42	2.145	2.130
	8.70					
$3^{1}/_{2}$	7.70	3.068	2.943	42	2.923	2.908
$3^{1}/_{2}$	9.20	2.992	2.867	42	2.847	2.832
	9.30					
$3^{1}/_{2}$	10.20	2.922	2.797	42	2.777	2.762
$3^{1}/_{2}$	12.70	2.750	2.625	42	2.605	2.590
	12.95					
4	9.50	3.548	3.423	42	3.403	3.388
4	11.00	3.476	3.351	42	3.331	3.316
$4^{1}/_{2}$	12.60	3.958	3.833	42	2.813	3.798
	12.75					

[a]Tolerance for plastic drifts, plus 0.000, minus 0.010 inches.

Table 7—Drift Sizes for Bare and Coated Casing

	Pipe		API Drift[a] (Bare Pipe)		Plastic Drift for Coated Pipe	
Size	Lb/ft	ID	OD	Length	Thin Film Drift[b] Size	Thick Film Drift[b] Size
$4^{1}/_{2}$	9.50	4.090	3.965	6	3.945	3.930
$4^{1}/_{2}$	10.50	4.052	3.927	6	3.907	3.892
$4^{1}/_{2}$	11.60	4.000	3.875	6	3.855	3.840
$4^{1}/_{2}$	13.50	3.920	3.795	6	3.775	3.760
$4^{1}/_{2}$	15.10	3.826	3.701	6	3.681	3.666
5	11.50	4.560	4.435	6	4.415	4.400
5	13.00	4.494	4.369	6	4.349	4.334
5	15.00	4.408	4.283	6	4.263	4.248
5	18.00	4.276	4.151	6	4.131	4.116
5	21.40	4.126	4.001	6	3.981	3.966
5	24.10	4.000	3.875	6	3.855	3.840
$5^{1}/_{2}$	14.00	5.012	4.887	6	4.867	4.852
$5^{1}/_{2}$	15.50	4.950	4.825	6	4.805	4.790
$5^{1}/_{2}$	17.00	4.892	4.767	6	4.747	4.732
$5^{1}/_{2}$	20.00	4.778	4.653	6	4.633	4.618
$5^{1}/_{2}$	23.00	4.670	4.545	6	4.525	4.510

[a]From the latest edition of API Bulletin 5C2.
[b]Tolerance for plastic drifts, plus 0.000, minus 0.010 inches.

Table 8—Drift Information for Group 1 External Upset Drill Pipe

Designation			
Size	lb/ft	ID	Drift Diameter (Inches)
2 3/8	6.65	1.815	1.628
2 7/8	10.40	2.151	1.964
3 1/2	9.50	2.992	2.805
3 1/2	15.50	2.602	2.415
4	11.85	3.476	3.289
4	14.00	3.340	3.153
4 1/2	13.75	3.958	3.771
4 1/2	16.60	3.826	3.639
4 1/2	20.00	3.640	3.453

Table 9—Tubing Pin L_c and Box PTL

	Nonupset		External Upset		Integral Joint	
Size	Pin L_c	Box PTL	Pin L_c	Box PTL	Pin L_c	Box PTL
1.050	0.300	0.994	0.300	1.025	—	—
1.315	0.300	1.025	0.350	1.150	0.225	1.025
1.660	0.350	1.150	0.475	1.275	0.350	1.150
1.900	0.475	1.275	0.538	1.338	0.475	1.275
2.063	—	—	—	—	0.538	1.338
2 3/8	0.725	1.525	0.938	1.813	—	—
2 7/8	1.163	1.963	1.125	2.000	—	—
3 1/2	1.413	2.213	1.375	2.250	—	—
4	1.375	2.250	1.500	2.375	—	—
4 1/2	1.563	2.438	1.625	2.500	—	—

Table 10—Casing Pin L_c and Coupling PTL

		STC		LTC		Buttress	
Size	Nominal Weight	Pin L_c	Box PTL	Pin L_c	Box PTL	Pin L_c	Box PTL
4 1/2	9.5	0.875	2.500	—	—	—	—
4 1/2	Others	1.500	2.500	1.875	2.875	1.2535	3.7375
5	11.5	1.375	2.625	—	—	—	—
5	Others	1.625	2.625	2.250	3.250	1.3785	3.8620
5 1/2	All	1.750	2.750	2.375	3.375	1.4410	3.9250
6 5/8	All	2.000	3.000	2.750	3.750	1.6285	4.1125
7	17.0	1.250	3.000	—	—	—	—
7	Others	2.000	3.000	2.875	3.875	1.8160	4.3000
7 5/8	All	2.125	3.125	3.000	4.000	2.0035	4.4875
8 5/8	24.00	1.875	3.250	—	—	—	—
8 5/8	Others	2.250	3.250	3.375	4.375	2.1285	4.6125
9 5/8	All	2.250	3.250	3.625	4.625	2.1285	4.6125
10 3/4	32.75	1.625	3.375	—	—	—	—
10 3/4	Others	2.375	3.375	—	—	2.1285	4.6125
11 3/4	All	2.375	3.375	—	—	2.1285	4.6125
13 3/8	All	2.375	3.375	—	—	2.1285	4.6125
16	All	2.875	3.875	—	—	2.7245	4.6125
18 5/8	87.50	2.875	3.875	—	—	2.7245	4.6125
20	All	2.875	3.875	4.125	5.125	2.7245	4.6125

10.10.4 Categories of Imperfections

Types of imperfections that may cause thread rejection are listed below. Refer to 18.12 of this recommended practice or the latest edition of API Standard 5B for dimensional data for acceptance and rejection.

a. Threaded area imperfections:
   1. Broken threads.
   2. Cuts.
   3. Grinds.
   4. Shoulders or steps.
   5. Seams.
   6. Threads not full-crested (including black-crested threads).
   7. Laps.
   8. Pits.
   9. Dents.
   10. Tool marks.
   11. Fins.
   12. Dinges.
   13. Burrs.
   14. Torn threads (tears).
   15. Handling damage.
   16. Thick threads.
   17. Narrow threads (shaved threads).
   18. Galls.
   19. Improper thread height.
   20. Wicker (or whisker).
   21. Cracks.
   22. Chattered threads.
   23. Wavy or drunken threads.
   24. Improper thread form.
   25. Arc burns.
   26. Threads not extending to the center of the coupling (threads within the J-area may not be perfect).
   27. Imperfections, other than those listed above, that break the continuity of the thread.

Note: Threads that are not full crested have historically been and continue to be referred to as *black-crested threads* because the original mill surface has not been removed. The term black-crested thread is a useful descriptive term, however, it should be pointed out that there can also be nonfull-crested threads that may not be black.

b. Conventional chamfer area:
   1. Not present 360 degrees.
   2. Thread running out on the face.
   3. Razor edge.
   4. Feather edge.
   5. Burrs.
   6. False starting thread engaging actual starting thread.
   7. Mashes.
   8. Cuts.

Note: The surfaces of the chamfers need not be perfectly smooth. Chamfers on the pipe ends have no effect on the sealing capability of the threads.

c. Round or bullet nose for tubing:
   1. Radius transition not smooth.
   2. Sharp corners.
   3. Burrs.
   4. Slivers.
   5. False starting thread engaging actual starting thread.
   6. Mashes.
   7. Cuts.

Note: Dimensions are not subject to measurement to determine acceptance or rejection of the product.

d. Pipe end imperfections (inside and outside):
   1. Burrs.
   2. Fins.
   3. Dents/mashes.

e. Box face and counterbore imperfections:
   1. Tool marks.
   2. Mashes.
   3. Burrs.
   4. Arc burns.

f. Mill end makeup: Coupling makeup measurement is not part of visual thread inspection. However, if visual inspection reveals obvious makeup errors, evaluate in accordance with Section 18 of this recommended practice.

All imperfections listed in 10.10.4a through 10.10.4e, if detected, shall be evaluated in accordance with 18.12 of this recommended practice.

11 Hardness Testing

11.1 GENERAL

This section covers methods for hardness testing under field conditions. The purpose of this test may be to determine compliance with contractual hardness specifications. Brinell-type testing using visually measured impression diameters is outside the scope of this document.

11.2 APPLICATION

API Specifications 5CT and 5D contain no direct provision for surface hardness testing. The owner shall specify the test locations and acceptance criteria (hardness range).

Note: The API grade cannot be reliably determined by hardness testing alone.

11.3 EQUIPMENT

A wide variety of portable hardness testing equipment is available. Some types of hardness testers are good for general information only and vary in accuracy (see paragraph 1.1, Note 2, ASTM E110). Other types of hardness testers as described in ASTM E110 may also be employed.

11.4 CALIBRATION

11.4.1 Annual Calibration

Hardness testers shall be calibrated at least once a year and after each repair. The calibration shall be conducted by a certified agency issuing a certificate showing traceability to a statutory authority. The certificate shall identify the date of the check; the specified values of each certified hardness test block; the mean value of the tester readings on each block; and the initials of the person performing the check.

11.4.2 Four Month Verification

The accuracy of hardness testers that were used during any four-month period shall be verified at the end of that four-month period. This is accomplished by taking five readings on each of two certified hardness test blocks of different hardness values on the scale to be used. The mean of the five readings on any certified hardness test block shall be within the specified range of that block for the tester to be acceptable for use. Certified hardness test blocks are never to be used on both sides. One of the test blocks should be within ±5 hardness numbers at the low end of the range of values specified for the OCTG being tested. The other test block should be within ±5 hardness numbers at the high end of the specified range of values for the OCTG being tested. Each HRC certified hardness test block shall not have a mean value less than HRC 20. Each HRB certified hardness test block shall not have a mean value more than HRB 100.

11.5 STANDARDIZATION

Standardization shall be performed prior to each job or when the hardness range changes for the OCTG being tested. The hardness tester instructions supplied by the tester manufacturer shall be followed. For all types of testers, the procedure for checking the tester prior to performing tests is the same except for attaching the tester to the OCTG or the certified hardness test block.

11.5.1 The hardness testing equipment shall be checked to determine if the proper load cell has been installed and if the correct indenter is being used for the hardness range specified.

11.5.2 The indenter shall be examined prior to use. If it is chipped, spalled, distorted, or deformed, it is defective and requires replacement, per the manufacturer's instructions.

11.5.3 The test block shall have a hardness within the specified range of the OCTG to be tested.

11.5.4 The hardness test block shall be placed onto the anvil with the calibration (indented) side up. If both sides of the test block show use, the test block is not suitable for use.

11.5.5 Indentations shall be spaced no closer than $2^1/_2$ diameters from their center to the edge of the test block or 3 diameters from another indentation, measured center to center.

11.5.6 Contact surfaces and/or shoulders of a hardness test block, anvil, or indenter shall be clean and free from oil film.

11.5.7 Three readings shall be made on the certified hardness test block. The average of these readings shall be within the specified range of the test block. Any single reading shall not vary more than two Rockwell numbers from the specified mean value of the test block. No more than the first two readings may be discarded in order to reduce the probability of errors before the next three readings are used for averaging.

11.6 PROCEDURES

11.6.1 The acceptable hardness range, number of readings made on each prepared test area, and the location of the test areas are by agreement between the owner of the OCTG and the agency. Unless otherwise specified, grind, machine, or file the OCTG surface approximately 0.010 inch deep, for a length of approximately 2 inches to remove a possible decarburized layer. Before grinding, machining, or filing, the wall thickness should be determined to prevent reducing the wall thickness below that allowable. If the wall thickness is at or close to the allowable minimum, an alternative location should be selected. Ensure that the area is smooth and flat so that accurate readings can be obtained. Caution should be taken during grinding to avoid overheating the test area. A blue color indicates grinding practices are causing excessive heating. Contact surfaces of the test area and indenter shall be clean and free from oil film.

11.6.2 Attach the tester to the OCTG and test the OCTG according to the instrument operating procedures as specified by the hardness tester manufacturer.

11.6.3 Indentations shall be more than 3 diameters from each other and $^1/_4$ inch from the edge of the prepared area.

11.6.4 A test shall consist of two or more valid readings that have been made in the same test area. Readings are valid when they are within two Rockwell C numbers (HRC) of one another or four Rockwell B numbers (HRB) of one another. The readings, to the nearest whole number, shall be recorded on the OCTG surface adjacent to the test area using chalk or paint.

11.6.5 The hardness value shall be the average of the valid readings taken in the test area. The hardness value and/or the readings shall be recorded to the nearest whole number on the appropriate report form.

11.6.6 Standardization Checks. The tester shall be periodically checked on a certified hardness test block as defined in 11.5.3. Checking consists of two or more readings on the test

block in accordance with 11.5.7. The tester shall be checked as follows:

a. After every 100 readings.
b. Whenever the hardness tester is subjected to abnormal mechanical shock.
c. At the end of the inspection job.
d. Prior to rejection of any OCTG.

11.6.7 All tests that have been made between the last acceptable periodic check and an unacceptable check should be retested.

11.6.8 Rockwell readings that are below HRC 20 require that the readings be made again using the Rockwell B scale, unless readings below HRC 20 are permitted by an agreement between the inspection agency and the owner.

11.6.9 Rockwell readings above HRB 100 require that the readings be made again using the Rockwell C scale, unless readings above 100 are permitted by agreement between the inspection agency and the owner. To prevent indenter damage, caution shall be taken when readings above HRB 100 are encountered. Re-standardization should be done after such readings.

12 Magnetic Particle Inspection (MPI)

12.1 GENERAL

This section provides material requirements, equipment requirements, descriptions, and procedures for wet fluorescent or dry magnetic particle inspection of new ferromagnetic OCTG.

OCTG subjected to MPI may retain significant residual magnetism. See Section 14 regarding measurement of residual magnetism and demagnetization.

The magnetism of OCTG may be accomplished in a number of ways that may limit the application of the method.

Section 18 of this recommended practice describes the use of MPI for evaluation of imperfections.

12.2 APPLICATION

12.2.1 End Area Inspection (SEA)

Note: This inspection was formerly called special end area inspection.

The SEA inspection is used principally to detect transverse and longitudinal defects on the inside and outside surfaces of the end areas. This includes the pins, couplings, exposed threads, upsets, special upsets, integral connections, and ends of pipe. In addition to MPI, the exposed threads and end areas are visually inspected.

12.2.2 Unattached Couplings (UCMPI)

Inside and outside surfaces shall be inspected for longitudinal defects using magnetic particle inspection. In addition, both surfaces shall be visually inspected.

12.2.3 Full-Length Magnetic Particle Inspection (FLMPI)

The length of casing, tubing, pup joints, or plain-end drill pipe is inspected full length including upsets and attached couplings for longitudinal defects using magnetic particle inspection. Threads are excluded in this procedure. The owner may specify that the inspections be performed only from one surface or from both surfaces.

12.3 EQUIPMENT AND MATERIALS

12.3.1 Internal Conductors

A circumferential magnetic field is induced in OCTG by inserting an insulated conductor inside the product, completing the circuit to the power supply, and energizing the current to the appropriate value given in 12.6.1.

The power supply includes an ammeter for indicating applied current. An audible or visible annunciator may be used to indicate inadequate current.

The conductor shall be insulated from the OCTG surface to prevent electrical contact or arcing.

Note: For OCTG 16 or larger, the center of the conductor should be positioned within 6 inches of the center of the product.

12.3.2 Coils

A longitudinal magnetic field is induced by a coil placed around the product, and applying current to achieve the requirements of 12.6.2.

The power supply requirements of 12.3.1 apply.

The number of turns of the coil should be clearly marked on the coil.

Flexible coils made up of conductor cable shall be tied or taped to keep the turns close together.

12.3.3 Yokes

Yokes are hand-held magnetizing devices used to detect imperfections in any orientation on the same surface to which the yoke is applied.

Yokes have either fixed or articulated legs and may be energized by either AC or DC current. For some applications, adjustable legs are preferred for OCTG because the legs can be adjusted to maintain contact on the inspection surface, regardless of contour.

12.3.4 Magnetic Particle Field Indicators

Acceptable field indicators (e.g. slotted shims, strips, pie field indicators) should be able to hold magnetic particles in a field of approximately 5 gauss.

To verify longitudinal external magnetic fields, the indicator should be positioned on the outside surface with the artificial imperfection aligned in the transverse direction.

To verify circumferential or transverse external magnetic fields, the indicator should be positioned on the outside sur-

face with the artificial imperfection aligned in a longitudinal direction.

Note: The external magnetic particle field indicators show the presence and orientation of a magnetic field. Because flux lines may not leave a ferromagnetic material containing a uniform residual circular field, indications on a magnetic particle field strength indicator are not always possible. This is particularly true with couplings and EW pipe. Magnetometers may be used to indicate the relative strength of a magnetic field and are covered in Section 12.

12.3.5 Magnetic Particles

Magnetic particles are used to indicate imperfections that cause magnetic flux leakage. Particles may be applied either dry or in suspension (wet).

12.3.5.1 Dry Magnetic Particles

Dry magnetic particles should contrast with the product surface.

The mixture should consist of different size particles with at least 75 percent by weight being finer than 100 ASTM sieve size and a minimum of 15 percent by weight finer than 325 ASTM sieve size. The particle mixture should not contain contaminates such as moisture, dirt, sand, etc.

As a supplementary practice, there may be a particle manufacturer's batch or lot check of particles for high permeability and low retentivity.

12.3.5.2 Wet Fluorescent Magnetic Particles

Fluorescent magnetic particles are suspended in a solution. The solution must be low viscosity (5 cSt), nonfluorescent, flash point above 200°F,. and able to wet the surface completely. Particles glow when exposed to black light.

Wet fluorescent particles should be applied with low velocity flow to prevent washing away weakly held indications. Recirculating systems, spray containers, or other means should be used to obtain complete and uniform coverage.

12.3.6 Illumination Equipment and Optical Aids

These devices are used to provide illumination and visual aid for surface examination of new OCTG.

12.3.6.1 For visible light inspection refer to 10.4, 10.5.1, and 10.5.2 of this recommended practice. Borescopes are optical aids that may be used to view the inside surfaces beyond the end area. Refer to 10.5.3 of this recommended practice for equipment details.

12.3.6.2 Black light is employed to illuminate the accumulation of fluorescent-dyed magnetic particles. Black light should be provided by an appropriately filtered mercury arc lamp or other source. It should be capable of providing wave lengths at or near 365 nanometers and a minimum intensity of 1000 microwatts/cm^2 at the inspection surface under working conditions. Intensity should be measured with the black light sensor on the inspection surface and directed toward the black light source.

12.3.6.3 The ambient visible light intensity during black light inspection, measured at the inspection surface, shall not exceed 2 foot-candles (20 lux).

12.4 GENERAL PROCEDURES

12.4.1 When capacitor discharge units are used as magnetizing sources, the OCTG should be insulated from metal racks and adjacent OCTG to prevent arc burns.

Note: Partial demagnetization may occur in a magnetized length of OCTG if it is not sufficiently separated prior to magnetizing the next adjacent length.

12.4.2 The OCTG surface shall be clean and free from all dirt, grease, loose scale, or other substances that have detrimental effects on particle mobility. It should be free of coatings that are sticky or have a thickness that hinders the effectiveness of the inspection.

CAUTION: Solvents and other cleaning agents may contain hazardous materials. Solvents are normally volatile and may build up pressure in containers. Material Safety Data Sheets should be read and the precautions observed when handling products of this type. Storage, transport, use, and disposal of excess materials and containers should be considered. Observe appropriate regulations relative to disposal of used solvents and generated waste materials.

12.4.3 In addition to the procedures in 12.4.2, dry particle inspection shall be conducted in accordance with the following:

a. The surface shall be dry.

b. Dry particles should be applied with a blower, bulb, or suitable sprinkler to provide a light uniform distribution over the external surface and the internal surface as size permits. A non-ferromagnetic trough should be used to place particles on the internal surface of small diameter OCTG. Dry magnetic particles shall not be reused.

Note: Wind or other inclement weather may be detrimental to the uniform application of magnetic particles to the surface. Therefore dry magnetic particle inspection should not be attempted when uniform application of the magnetic particles over the surface is not possible. Dampness of the inspection surface reduces the mobility of the magnetic particles.

12.4.4 A separate white light visual inspection is required when doing magnetic particle inspection using black light.

12.4.5 After inspection, the magnetic particles (either dry or suspended in solution) shall be removed from the surfaces with suitable means that will not damage the OCTG.

12.4.6 Residual Magnetic Fields. When using a residual magnetic field for inspection, magnetize only enough lengths to maintain the work load for the current workday. Any lengths not inspected on the day that they are magnetized shall be remagnetized prior to MPI.

12.4.7 Magnetic Particle Indication. All imperfections that accumulate magnetic particles shall be evaluated and dispositioned as described in Section 18.

12.5 CALIBRATION

12.5.1 Ammeters

Ammeters shall be calibrated at least once every 4 months, after repair, and whenever an erratic response is indicated. The calibration check shall be recorded on the meter and in a log book with the date of the calibration check, the due date, and the initials of the person who performed the check.

12.5.2 Light Meters

Refer to 10.4.4 of this recommended practice for calibration requirements.

12.5.3 Coils

Prefabricated coils (excluding flexible coils) shall be verified at least once every 4 months, by comparing resistance or magnetic flux values to those initially established.

The calibration check shall be recorded on the coil and in a log book with the date of the calibration check, the due date, and the initials of the person who performed the check.

12.5.4 Yokes

AC yokes shall be capable of lifting 10 pounds at the maximum pole spacing that would be used for inspection.

DC yokes shall be capable of lifting 40 pounds at the maximum pole spacing that would be used for inspection.

Yokes shall be tested for lifting power every 4 months using a steel bar or plate of the appropriate weight or a calibrated magnetic weight lift test bar. The calibration check shall be recorded on the yoke and in a log book with the date of the calibration check, the due date, and the initials of the person who performed the check.

12.6 STANDARDIZATION

12.6.1 Internal Conductor Systems

For battery or rectified AC power supply, a minimum magnetizing current of 300 amperes per inch of specified OCTG outside diameter should be used when the energy source is a battery power supply or 3-phase rectified AC.

For capacitor discharge units, see Table 11 for magnetizing current recommendation.

12.6.2 Coils

The number of coil turns and current required are imprecise but should not be less than 500 ampere-turns per inch of specified OCTG outside diameter. Amperage should be set as high as possible without furring (dry magnetic particles) or particle immobility (wet magnetic particles).

12.7 PERIODIC CHECKS

12.7.1 Ammeters indicating magnetizing current may be monitored with each application of current. For internal conductor systems, the current shall be as recommended in 12.6.1. For coils, the current should not vary more than 10 percent of the selected value in 12.6.2.

12.7.2 Strength and direction of magnetic fields may be confirmed with equipment as described in 12.3.4. at the start of each day, after meal breaks, whenever an element of the inspection equipment is repaired or replaced, and after every 50 lengths of OCTG are inspected, or at least once in every 4 hours of continuous operations. See note in 12.4.3.

12.7.3 All OCTG inspected between an unacceptable check and the most recent acceptable check should be reinspected.

12.7.4 Wet Fluorescent Magnetic Particle.The solution shall be mixed according to the manufacturer's instructions and agitated either continuously or periodically. Concentration shall be between 0.1 and 0.4 percent by volume. Settling test time is one hour for oil-based carriers and thirty minutes for water-based. Settling tests should be done in a vibration free nonmagnetic environment.

The concentration of the solution shall be checked prior to use.

The concentration of the solution in recirculating systems shall be verified at least once during each shift.

The black and ambient visible light intensity levels shall be verified at least once during each shift.

Table 11—Recommended CD Minimum Amperage

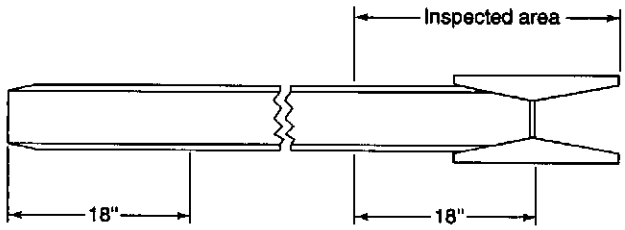
	Pulse Duration Less Than or Equal to 40 Milliseconds	Pulse Duration Greater Than 40 Milliseconds
One Pulse	240 times specified pipe weight per foot	110 times specified pipe weight per foot
Two Pulses	180 times specified pipe weight per foot	N/A
Three Pulses	145 times specified pipe weight per foot	N/A

12.8 END AREA INSPECTION (COMMONLY REFERRED TO AS SEA)

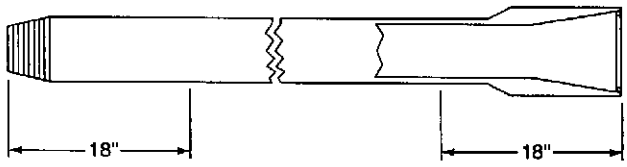
SEA Inspection performed in accordance with this recommended practice may be beyond the inspection requirements for end areas as defined in API Specifications 5CT and 5D. This inspection is performed primarily to detect seams, laps, forging laps, upset cracks, pits and underfill, thread imperfections, quench cracks, rolled-in slugs, and mechanical damage.

12.8.1 Inspection Areas

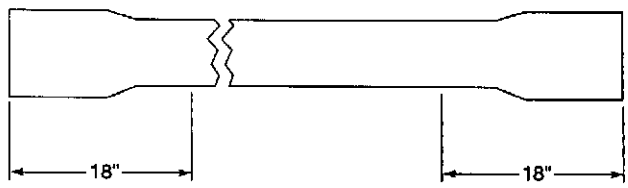
When this inspection is done in conjunction with an automated inspection system, the inspection area shall be equal to or greater than the area not covered by the automated inspection system. When done as a separate inspection the end areas shown in Figure 1 shall be cleaned of all grease, thread compound, dirt, and any other foreign matter and inspected as defined in Table 12. When using dry magnetic particle techniques, all surfaces to be inspected shall be powder dry.



(A) Tubing and casing wih coupling



(B) Tubing or casing with intergral connections



(C) Plain end drill pipe

Figure 1—Inspection Distances for Different Types and Combinations of Tubes and Connections

Table 12—End Area Inspection (SEA) Coverage (Measured From the End of the Pipe)

Surface	Distance
Outside (all sizes)	18 inches
Inside (nonupset products)	2.5 times the outside diameter (D) or 18 inches whichever is less
(upset products)	Length of upset including runout interval

12.8.2 Sandblasting or Other Methods

By agreement between the owner and the agency and when environmental conditions permit, the outside surface may be sandblasted or other effective methods used to remove mill varnish and mill scale. Sandblasting of threads is prohibited.

12.8.3 Inspection Procedure

The steps for inspection are the minimum requirements and may vary depending on the OCTG condition and the options agreed to between the owner and the agency. Visual thread inspection shall meet the requirements outlined in Section 10 of this recommended practice. The recommended procedure is as follows:

a. Remove the thread protectors and clean the ends and threads, as required. After removal of thread protectors, great care must be used to ensure that threads are not damaged.

CAUTION: Solvents and other cleaning agents may contain hazardous materials. Solvents are normally volatile and may build up pressure in containers. Material Safety Data Sheets should be read and the precautions observed when handling products of this type. Storage, transport, use and disposal of excess materials and containers should be considered. Observe appropriate regulations relative to disposal of used solvents and generated waste materials.

b. Magnetize the ends with a circular magnetic field in accordance with 12.3.1. As an alternative, an active transverse DC magnetic field may be applied if its strength and direction have been verified with equipment as described in 12.3.4. Its strength at both the inside and outside surfaces shall have been demonstrated to be equal to or greater than that of a circular field induced in accordance with 12.3.1. Inspection requires multiple revolutions of the OCTG in the magnetic field.

c. Inspect the outside and inside surfaces, including threads, using MPI. The illumination requirements of 12.3.6.1 for visible light and 12.3.6.2 for black light apply.

d. Inspect the outside surfaces on each end with either an active or residual longitudinal DC field or an active longitudinal AC field.

Note: Excessive ampere-turns (A-t) may produce furring of dry magnetic particles and lack of mobility of fluorescent particles on the outside surface that may conceal indications.

e. Inspect the inside surface on each end with either an active or residual longitudinal DC field.

f. Evaluate all imperfections in accordance with Section 18 of this recommended practice.

g. Do not leave magnetic particles or cleaning materials on the threads or OCTG overnight.

h. Threads should be covered as soon as possible and should not be left unprotected overnight.

i. Apply thread compound and protectors in accordance with Section 8 of this recommended practice.

CAUTION: The Material Safety Data Sheets for thread compounds should be read and observed. Store and dispose of containers and unused compound in accordance with appropriate regulations.

12.9 INSPECTION OF UNATTACHED COUPLINGS (UCMPI)

This inspection is performed to detect seams, cracks, laps, pits, thread imperfections, rolled in slugs, and mechanical damage. Visual thread inspection shall meet the requirements outlined in Section 10 of this recommended practice. The recommended procedure is as follows:

a. Either wet or dry magnetic particles may be used. Clean the threads as required.

CAUTION: Solvents and other cleaning agents may contain hazardous materials. Solvents are normally volatiles and may build up pressure in containers. Material Safety Data Sheets should be read and the precautions observed when handling products of this type. Storage, transport, use, and disposal of excess materials and containers should be considered. Observe appropriate regulations relative to disposal of used solvents and generated waste materials.

b. Magnetize the couplings with a circular magnetic field. For battery or rectified AC power supplies, see 12.6.1. For capacitor discharge units, see Table 13. for magnetizing current recommendations. As an alternative, an active transverse DC magnetic field may be applied if its strength and direction has been verified with equipment as described in 12.3.4. Its strength at both the inside and outside surfaces shall have been demonstrated to be equal to or greater than that of a circular field induced in accordance with 12.3.1. Inspection requires multiple revolutions of the OCTG in the magnetic field.

c. Inspect the outside and inside surfaces, including threads, using MPI. The illumination requirements of 12.3.6.1 for visible light and 12.3.6.2 for black light apply.

d. Inspect the outside surface with either an active or residual longitudinal DC field.

Table 13—Recommended CD Minimum Amperage Circular Magnetization for Unattached Couplings (Based on the Coupling Equivalent Weight Per Foot)

Size Designation	1 Pulse	2 Pulses	3 Pulses
1.050	784	588	473
1.315	1086	814	656
1.660	1206	904	728
1.900	1447	1085	874
$2^3/_8$	2125	1593	1284
$2^7/_8$	3037	2278	1835
$3^1/_2$	4708	3531	2845
4	5332	3999	3221
$4^1/_2$	6407	4805	3871
5	5196	3897	3139
$5^1/_2$	5644	4233	3410
$6^5/_8$	8961	6721	5414
7	8450	6338	5105
$7^5/_8$	11642	8732	7034
$8^5/_8$	14889	11167	8995
$9^5/_8$	16786	12590	10142
$10^3/_4$	17634	13225	10654
$11^3/_4$	19218	14413	11611
$13^3/_8$	21792	16344	13166
16	27924	20943	16871
$18^5/_8$	41910	31433	25321
20	35065	26299	21185

e. Longitudinal magnetization is achieved by using the magnetizing current recommended in Table 14, or may be calculated from the following formulas:

$$L_{cpg}/D_{cpg} < 2.0 \quad (1)$$
$$NI = (1200\text{-}130\ L_{cpg}/D_{cpg})D_{coil}$$

$$L_{cpg}/D_{cpg} > 2.0 \quad (2)$$
$$NI = 940\ D_{coil}$$

Where:

L_{cpg} = *Specified length of coupling*

D_{cpg} = *Specified diameter of coupling*

D_{coil} = *Inside diameter of coil*

NI = *Required ampere-turns*

Note: Excessive ampere-turns (NI) may produce furring of dry magnetic particles and lack of mobility of fluorescent particles on the outside coupling surface that may conceal indications.

f. Inspect the outside and inside surfaces of each coupling.

g. Evaluate all imperfections in accordance with Section 18 of this recommended practice.

h. Do not leave magnetic particles or cleaning materials on the threads or coupling overnight.

12.10 FULL-LENGTH MAGNETIC PARTICLE INSPECTION (FLMPI)

This inspection is performed to detect cracks, laps, seams, rolled-in slugs, mechanical damage, and other imperfections in the pipe body and weld.

Table 14—Recommended Longitudinal Magnetization Amp-Turns for Unattached Couplings

		Coils Inside Diameter (Inches)					
		6	8.5	10	13	16	24
Size Designation	Coupling Outside Diameter (Inches)	Amp Turns (NI)					
1.050 to 4	All	5640	7990	9400	12220	15040	22560
4 1/2	5.000	6225	8819	10375	13488	16600	24900
5	5.563	6289	8909	10481	13625	16770	25154
5 1/2	6.050		8967	10550	13714	16879	25319
6 5/8	7.390		9116	10725	13942	17159	25739
7	7.656		9154	10769	14000	17230	25845
7 5/8	8.500			10853	14109	17365	26047
8 5/8	9.625			10953	14239	17525	26288
9 5/8	10.625				14367	17683	26524
10 3/4	11.750				14449	17784	26676
11 3/4	12.750					17895	26842
13 5/8	14.375					18042	27064
16	17.000						27148
18 5/8	20.000						27396
20	21.000						27463

Note: If the coil size used is not listed in the above table, either calculate the correct amp-turn requirement using the formulas in 12.9.e or use the next higher amp-turn value from the table.

12.10.1 Magnetization

Induce a circular magnetic field in accordance with 12.3.1.

12.10.2 Internal Full-length Inspection

If a full-length inside surface MPI (threads excluded) is specified, the following procedures should be used:

a. Distribute dry magnetic particles on the inside surface to obtain complete coverage (360 degrees), by rolling the pipe a minimum of one and one-half turns.

b. A borescope should be used for inspection. The borescope requirements of 10.5.3 apply.

c. After the initial internal inspection, the pipe shall be rolled sufficiently to expose the area previously covered with particles and shall be reinspected as outlined above.

12.10.3 External Full-length Inspection

The following procedures should be used when inspecting an outside surface full length:

a. A marking method is required to assure one hundred percent of the surface area is inspected.

b. Inspect each pipe surface by walking the length of each pipe from one end to the other. The number of lengths inspected on each pass is dependent on the pipe diameter.

c. It may be necessary to inspect the entire surface in segments by incrementally rotating the pipe. In such cases a procedure shall be developed to insure complete coverage.

d. Dry or wet magnetic particles are applied to the segments that are inspected on each length with sufficient overlap to ensure complete surface coverage. The illumination requirements of 12.3.6.1 for visible light and 12.3.6.2 for black light apply.

12.10.4 Evaluation of Imperfections

Evaluate all imperfections in accordance with Section 18 of this recommended practice.

13 Electromagnetic Inspection (EMI)

13.1 GENERAL

This section describes the EMI equipment and methods for detecting longitudinal and transverse imperfections in the tube body (excluding the ends) of ferromagnetic OCTG.

Pipe subjected to EMI may retain significant residual magnetism. See Section 14 regarding residual magnetism and demagnetization.

13.2 EQUIPMENT

EMI systems may be of the flux leakage or eddy current type.

13.2.1 In flux leakage equipment, a strong magnetic field is applied to the region of the pipe under the sensors. The sensors detect magnetic flux fields that leak from the pipe at the location of imperfections.

13.2.2 In eddy current equipment, an electric field is induced in the OCTG by one or more exciter coils. One or more sensor coils detect a change in the normal flow of currents due to the presence of imperfections.

13.2.3 Flux leakage is the most commonly used technique in field applications; therefore, the balance of this section does not address eddy current systems.

Note: Most field EMI inspection systems contain electromagnetic scanners for the detection of longitudinal, transverse, and volumetric imperfections; a method for wall thickness and eccentricity inspection; and may also contain equipment for making a grade comparison. Typically, these systems incorporate these four inspection stages in one unit that is field-portable or permanently mounted in a facility. This section will address only the electromagnetic inspection portion of EMI systems. Equipment and procedures for wall thickness and grade comparison portions of EMI systems are addressed in Sections 15 and 16, respectively.

13.2.4 Longitudinal imperfections are detected by passing the magnetized pipe through a rotating scanner. A combination of the longitudinal velocity and the rotating speed of the scanner and/or pipe shall result in overlapping coverage of paths of adjacent detectors.

13.2.5 Transverse imperfections are detected by passing the magnetized pipe through a fixed encircling scanner.

13.2.6 Volumetric imperfections may be detected by either longitudinal or transverse scanners.

13.3 APPLICATION

13.3.1 API Specifications 5CT and 5D provide EMI as one of the alternate methods for pipe body inspection (except for H-40, J-55, K-55, and nonquenched and tempered E-75 or N-80) and inspection of the EW weld seam (except for the weld seam of P-110 and Q-125 grade pipe). All other EMI inspections performed in accordance with this recommended practice are beyond the inspection requirements of API Specifications 5CT and 5D.

13.3.2 EMI systems may be used for the inspection of all sizes of pipe within the size range of the equipment.

13.3.3 EMI systems as defined in this recommended practice are not capable of full coverage inspection to the ends. Full coverage inspection of the end areas requires use of magnetic particle inspection or other inspection method(s) with demonstrated capability of detecting defects as defined in API Specifications 5CT and 5D.

13.4 CALIBRATION

This section includes the minimum requirements necessary to ensure that inspection equipment is operating to its intended capability. Practices should be stipulated by agreement between the owner and agency prior to commencement of the inspection service.

13.4.1 Active Field Systems

Ammeters (reading magnetizing current) should be calibrated at least once every 4 months, after repair, and whenever erratic response is indicated. The calibration check shall be recorded on the meter and in a log book with the date of the calibration check, the due date, and the initials of the person who performed the check.

13.4.2 Dual Coil Systems

The polarity of the magnetic fields shall be non-opposing. This should be checked with a compass or magnetometer at least once every 4 months and after any repairs are performed on the assembly or magnetizing circuit.

13.4.3 Residual Field Systems (Central Conductor Method for EMI)

Ammeters should be calibrated at least once every 4 months, after repair, and whenever erratic response is indicated. The calibration check shall be recorded on the meter and in a log book with the date of the calibration check, the due date, and the initials of the person who performed the check.

13.4.4 Magnetic Pulsers

When used to establish sensitivity levels, the output signal from a magnetic pulser shall be calibrated every 4 months and after any repairs. The pulser shall produce reproducible pulses. The calibration is to be recorded on the pulser or power supply and in a log book and should specify the date of the calibration, the due date, and the initials of the person performing the calibration.

13.4.5 Instrumentation

Instrument readouts for determining rotational and linear speed should be calibrated once every 6 months.

13.5 STANDARDIZATION

13.5.1 General standardization of electromagnetic inspection equipment shall be performed at the beginning of each job. A reference standard of the same specified thickness and curvature as the material being inspected should be used. The standard's material should have magnetic properties similar to those of the OCTG being inspected. Using a piece of the material to be inspected is the best way to assure similar magnetic properties. The reference standard should be of a length sufficient for dynamic standardization checks. If the standard is to be a piece of the material to be inspected, it should be provided by the owner. Additional checks of standardization shall be performed as follows:

a. At the beginning of each inspection shift and after meal break.
b. At least once every 4 hours of continuous operation or every 50 lengths inspected, whichever occurs first.
c. After any power interruption.
d. Prior to equipment shutdown during a job.

e. Prior to resuming operation after repair or change to a system component that would affect system performance.

f. All OCTG inspected between an unacceptable check and the most recent acceptable check should be reinspected.

13.5.2 For the inspection standardization, reference notch length, width, and location shall be in accordance with the requirements of Section 9 of API Specification 5CT or Section 8 of API Specification 5D. Notch depth shall not exceed the depth required by Section 9 of API Specification 5CT or Section 8 of API Specification 5D. Notches, including those having depths less than the requirements of API, are used to establish equipment sensitivity. Reference signal amplitude shall not be used to determine acceptance or rejection. See Section 18 of this recommended practice for evaluation procedures.

Note: Notch widths used in field inspection are typically 0.020 inch or less. Notch depth for field inspection to $12^1/_2$ percent acceptance criteria is typically 10 percent of the specified pipe wall thickness. Notch depth for field inspection to 5 percent acceptance criteria is as specified by API Specifications 5CT or 5D.

13.5.3 As an alternate to the above notches, with the owner's permission, a drilled hole may be used. The hole diameter shall be in accordance with the requirements of Section 9 of API Specification 5CT or Section 8 of API Specification 5D. When standardizing EMI equipment using drilled holes, the inspection system shall have the demonstrated capability of meeting the notch requirements of Section 9 of API Specification 5CT or Section 8 of API Specification 5D. Reference signal amplitude shall not be used to determine acceptance or rejection. See Section 18 of this recommended practice for evaluation procedures.

13.5.4 Reference notches should be placed so they can be removed without reducing the wall thickness to less than the minimum allowable thickness. A reference standard that contains a drilled hole shall be clearly identified as a reject. Drilled holes should be placed so that the section containing them may be cut off with minimal loss of acceptable pipe.

13.5.5 Notches or holes should be separated such that each indication is distinct and separate from each other and from other anomalies or end effects. Equipment should provide a suitable signal-to-noise ratio.

Note: Typically, a minimum signal-to-noise ratio (S/N) of 3 to 1 for external notches and 2 to 1 for internal notches is considered suitable.

13.5.6 The longitudinal notch should be placed under each appropriate sensor of each longitudinal detector. The instrumentation should be adjusted to produce an indication having an amplitude equal to or greater than $^1/_4$ of full scale and clearly identifiable above background noise. This adjustment applies to the inside surface notch when both inside and outside surface notches are used.

13.5.7 When a transverse notch is required, it should be passed through the inspection system at production speed under a selected detector. The instrumentation should be adjusted to produce an indication having an amplitude equal to or greater than $^1/_4$ of full scale and clearly identifiable above background noise. This adjustment applies to the inside surface notch when both inside and outside surface notches are used. Each indication shall be clearly identified above background noise. The other detectors should be adjusted by repeating the above process or by another system with demonstrated capability to establish the same sensitivity for the remaining detectors.

13.5.8 The threshold alarms, if available, may be adjusted to activate based on reference notch response from each detector.

13.5.9 For the final dynamic standardization check, the standard shall be passed through the inspection system four times at production speed, once with a notch or hole at each of the following positions: 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock. The height of the principal indication from each notch or hole shall not vary more than 20 percent from its average indication level. Each indication shall be clearly identified above background noise, and no less than $^1/_4$ of full scale.

13.5.10 By agreement between the owner and agency the following standardization techniques may be used.

a. The adjustment of gain settings should be done to provide discernible imperfection signals or a suitable signal-to-noise ratio for the material being inspected.

b. For at least the first five lengths inspected, a gain should be chosen that produces background noise amplitudes of no more than $^1/_8$ of full scale.

c. If investigation of signals above the "background noise" indicates excessive gain, the gain can be reduced until minor (less than 5 percent of specified wall thickness) imperfection signals are no less than $^1/_8$ of full scale.

d. A magnetic pulser may be used for standardizing flux leakage inspection equipment. The magnetic pulser head is placed adjacent to each sensor in each detector. The overall system gain of each readout channel is then standardized to produce optimum system performance.

13.6 EQUIPMENT REQUIREMENTS AND PERIODIC CHECKS

The following periodic checks shall be made at the same frequency as stated in 11.4.1 unless otherwise specified.

13.6.1 Central Conductor (residual circular magnetization). The internal conductor (current rod) shall be completely insulated from the OCTG surface so that no arcing is possible. The connections of the conductor or current rod

shall be tight, and the rod-to-cable contactors shall be clean. The magnetizing system shall be free of internal shorts.

An ammeter indicating the magnetizing current shall be employed and observed with each application of current. Alternatively, an ammeter indicating the magnetizing current may be employed in conjunction with a low current indicator and alarm.

The magnetizing current shall not be less than the minimum value stated in the agency's standard operating procedure.

13.6.2 Active Field Type Magnetizer. The magnetizing coils should be checked to ensure that the proper current or magnetizing force is used, and that no magnetizing coils are open or shorted. The current or magnetizing force should be checked and be within 10 percent of the correct value for the equipment being used.

13.6.3 Manual and/or automatic circuit checks shall be employed to ensure sensor continuity. Continuity checks should be made with a device that produces a change in flux density or generates a current in each sensor, to provide reliable detection of an open circuit.

13.6.4 Periodic checks shall be made throughout the inspection job to ensure that the detectors carrying the EMI sensors are riding smoothly on the surface, since substantial impairment of imperfection sensitivity accompanies lift-off of these detectors.

13.6.5 All electronic inspection equipment systems shall be standardized, calibrated, or adjusted to proper sensitivity levels as described in 13.4 and 13.5 of this recommended practice.

13.7 INSPECTION PROCEDURE

13.7.1 Pass each length through the EMI inspection unit. The sequence of inspecting the OCTG by the various scanners is not specified, but each one must perform its respective function effectively and without detrimental interaction with other scanners.

13.7.2 A threshold should be established in accordance with the agency's standard operating procedure and should not be greater than the reference level, if reference indicators are used.

13.7.3 Electronic readout indications established in 13.7.2 should be located and marked on the outside surface for the full extent of each indication. Evaluate all marked indications in accordance with Section 18 of this recommended practice.

13.7.4 A readout of imperfection indications detected and a record of the inspection is made and identified. These documents should be retained by the agency for a minimum of 6 months.

13.7.5 The first length inspected and one of each 25 lengths thereafter shall be verified as being demagnetized in accordance with Section 14 of this recommended practice.

14 Residual Magnetism and Demagnetization

14.1 GENERAL

This section describes the equipment and methods used for the measurement and reduction of residual longitudinal magnetic fields.

Magnetic particle inspection (MPI) and electromagnetic inspection (EMI) are accomplished by inducing a magnetic field into the OCTG. Care must be taken that the residual longitudinal magnetic field is less than the defined acceptance level after inspection.

14.2 APPLICATION

API Specifications 5CT and 5D do not contain references or criteria for the measurement or reduction of residual magnetism. Restrictions regarding residual magnetism normally are applied only to OCTG that have been subjected to MPI or EMI. The reduction of residual longitudinal magnetism is required to prevent difficulty during subsequent processing, handling, and removal of magnetic particles. Circumferential magnetic fields do not cause difficulty and are not addressed in this recommended practice.

14.3 SERVICES

This service is performed on OCTG to reduce the longitudinal magnetic field to 30 gauss or less.

14.3.1 Measuring Flux Density

Measurements are made on the ends using a magnetometer in contact with the end. The OCTG being checked should be separated from other OCTG in all directions. A residual longitudinal field of more than 30 gauss, measured with an electronic magnetometer (gauss meter), should be reduced. A mechanical magnetometer may be used so long as the user has established the equivalence to the electronic gauss meter. In case of dispute, the electronic magnetometer shall govern.

14.3.2 Flux Density Measuring Equipment, Including Calibration

Electronic magnetometers (gauss meters) shall be calibrated at least once a year and after repair. The calibration is to be recorded on the instrument and in a log book and should specify the date of the calibration, the due date, and the initials of the person performing the calibration.

If a reference magnet is used to adjust gauss meters, the reference magnet shall be calibrated at least once a year. The

calibration is to be recorded on the reference magnet and in a log book and should specify the date of the calibration, the due date, and the initials of the person performing the calibration.

Mechanical magnetometers shall be checked for accuracy at least once every 4 months and after repair. They should be repaired when the zero position deviates more than 10 percent of maximum scale value. The accuracy should be within 10 percent of a calibrated variable reference magnetizing force over the entire range of the readout. The accuracy check is to be recorded on the instrument and in a log book and should specify the date of the calibration, the due date and the initials of the person performing the calibration.

14.3.3 Methods for Reducing Residual Longitudinal Magnetism

The residual longitudinal field may be reduced to acceptable limits by inducing a circular magnetic field. This is done with an internal conductor system meeting the requirements of 12.3.1 of this recommended practice.

The residual longitudinal field may also be reduced to acceptable limits by passing it through a circular coil energized with alternating current (AC) or direct current (DC). The larger the diameter and the thicker the wall, the more current required. Approximately 6,000 to 10,000 ampere-turns should reduce the longitudinal field to acceptable limits for OCTG up to 10 in diameter. Larger sizes may require more current, depending on the system.

Many EMI systems contain a demagnetizing DC coil as part of the inspection system. If the OCTG is to be EMI inspected, proper adjustment and monitoring of the demagnetizing unit can reduce the residual longitudinal field to the acceptable level. If this system is used, the gauss level should be measured for compliance with 14.3.1 after every 25 lengths inspected.

15 Gamma Ray Wall Thickness Inspection

15.1 GENERAL

This section describes the gamma ray equipment and procedures used for the inspection of pipe wall thickness. When available, this equipment typically is an integral component of an EMI inspection system and may not be available as a separate, stand-alone inspection. Other nondestructive methods may also be available for automated wall thickness inspection.

15.2 APPLICATION

API Specifications 5CT and 5D contain provision for the verification of seamless pipe body wall thickness, excluding end areas. The gamma ray wall thickness measurement meets that requirement.

15.2.1 Wall thickness measurement of EW pipe performed in accordance with this recommended practice is beyond the inspection requirements of API Specification 5CT.

15.2.2 Wall measurement systems may be used for the inspection of all sizes of pipe within the size range of the equipment.

15.3 EQUIPMENT

The equipment typically consists of a gamma ray source, a sensor, and a readout. Measurements are normally made on a helical path along the length. Surface coverage is typically not 100 percent. Rotation of the pipe, the source, the sensor, or any combination thereof may be used to accomplish this scan.

15.4 CALIBRATION AND STANDARDIZATION

This section includes the minimum requirements necessary to ensure that inspection equipment is operating to its intended capability. Practices should be stipulated by agreement between the owner and agency prior to commencement of the inspection service.

15.4.1 Periodic Checks

General standardization of inspection equipment shall be performed at the beginning of each job. Periodic checks on standardization shall be performed as follows:

a. At the beginning of each inspection shift and after meal breaks.
b. At least once every 4 hours of continuous operation or every 50 lengths inspected, whichever occurs first.
c. After any power interruption.
d. Prior to equipment shutdown during a job.
e. Prior to resuming operation after repair or change to a system component that would affect system performance.
f. All pipe inspected between an unacceptable check and the most recent acceptable check should be reinspected.

15.4.2 Standardization Procedure

The standardization of the gamma ray system shall be accomplished using one or more of the following methods:

a. The gain of the system is adjusted so that the readout corresponds with two known thicknesses of a reference standard.
b. The gain of the system is adjusted so that the readout corresponds with the measured thickness values on a selected circumferential ring of a reference standard having the same specified diameter and specified wall thickness as the pipe being inspected. On the ring, a minimum and maximum thickness shall be determined using a micrometer or properly

standardized ultrasonic thickness gauge. The readout of the wall thickness measuring system should be standardized to a specific scale. The readout's minimum thickness value should be adjusted to be within ±0.010 inch of the minimum thickness selected on the reference standard. The maximum thickness of the standard should be clearly distinguishable on the readout.

c. If the standard is not available, a minimum wall thickness reading for at least one of every 50 lengths inspected should be verified with a micrometer or a properly standardized ultrasonic gauge.

15.5 INSPECTION PROCEDURE

Each length of pipe shall be passed through the system and a threshold should be established in accordance with the agency's standard operating procedure.

15.5.1 To confirm the readout indications, mark the area of the suspected wall variation on the pipe surface. Evaluate all marked indications in accordance with Section 18 of this recommended practice.

15.5.2 A readout of indications detected and a record of the inspection is made and identified. These documents should be retained by the agency for a minimum of 6 months.

16 Electromagnetic Grade Comparison

16.1 GENERAL

This section describes grade comparison equipment and procedures using principles based on differences in the electromagnetic characteristics of grades of OCTG. When available, this equipment typically is an integral component of an EMI inspection system and may not be available as a separate stand-alone inspection.

Note: Grade comparators may not be capable of distinguishing between OCTG grades that have similar properties.

16.2 APPLICATION

API Specifications 5CT and 5D do not provide for grade comparison based on OCTG electromagnetic characteristics. This method is applicable to all types and diameters of OCTG within the size range of the inspection equipment.

16.3 EQUIPMENT

Grade comparators that categorize based on electromagnetic characteristics are either comparator bridge or transformer type systems.

A grade comparator, when used, should be equipped with a visible or audible alarm or otherwise signal the operator when a coil circuit opens.

16.4 CALIBRATION AND STANDARDIZATION

With either type equipment, there is no absolute calibration possible. A comparison may be made between a known standard and each length inspected.

16.4.1 Periodic Checks

General standardization of inspection equipment shall be performed at the beginning of each job. Periodic checks on standardization shall be performed as follows:

a. At the beginning of each inspection shift, and after meal break.

b. At least once every 4 hours of continuous operation or every 50 lengths inspected, whichever occurs first.

c. After any power interruption.

d. Prior to equipment shutdown during a job.

e. Prior to resuming operation after repair or change to a system component that would affect system performance.

Mill grade markings should be verified on all OCTG inspected between an unacceptable check and the most recent acceptable check.

16.4.2 Standardization Procedure

The standardization procedure depends on the type of system being used, as follows:

a. Comparator Bridge System. The grade of the first length of OCTG to be inspected is confirmed by visual examination of the markings and placed in the comparator coil in the inspection line. The bridge is balanced and the gain control set at a selected position. After several lengths are inspected, the gain control is readjusted to an optimum level based on the normal variations in the OCTG being inspected.

b. Transformer System. The first 5 lengths of OCTG to be inspected are confirmed to be the same grade by visual examination of the markings. Each of the first 5 lengths is run through the inspection line and the readout voltage is recorded. An average voltage is determined and upper and lower warning limits are set.

c. Supplementary Performance Test. A reference signal from a secondary reference standard of different magnetic or conductive properties than the material being inspected may be used to verify the sorting capability of the system.

16.5 INSPECTION PROCEDURE

Each length of OCTG shall be passed through the inspection system.

16.5.1 The readout of the grade comparison equipment shall provide a distinct indication, level, or threshold, to indicate OCTG with properties dissimilar to that being inspected.

16.5.2 When a significant grade comparator indication is detected, the proper weight, grade, and manufacturer of the length of OCTG should be investigated prior to its disposition. This investigation should include a review of the mill markings and dimensions.

17 Ultrasonic Inspection

17.1 GENERAL

This section describes the equipment and procedures used to perform ultrasonic inspection five categories. These categories are as follows:

a. Inspection of the pipe body for longitudinal and transverse imperfections. Additionally, inspection for oblique imperfections may be performed.
b. Inspection of the pipe body for wall thickness.
c. Inspection of the longitudinal weld.
d. Manual ultrasonic thickness gauging.
e. Manual ultrasonic shear wave inspection.

17.2 APPLICATION

17.2.1 For grades E-75 (Q&T), N-80 (Q&T), L-80, and C-95, API Specifications 5CT and 5D designate UT as one of the pipe body inspection methods to detect longitudinal imperfections and for seamless pipe to verify wall thickness.

17.2.2 For grades X-95, G-105, P-110, and S-135, API Specifications 5CT and 5D designate UT as one of the pipe body inspection methods to detect longitudinal and transverse imperfections and for seamless pipe to verify wall thickness.

17.2.3 For grades C-90, T-95, and Q-125, API Specification 5CT requires UT for pipe body inspection to detect longitudinal and transverse imperfections and for seamless pipe to verify wall thickness.

17.2.4 API Specifications 5CT and 5D do not require 100 percent coverage for wall thickness verification.

17.2.5 All other UT inspections performed in accordance with this recommended practice are beyond the inspection requirements of API Specifications 5CT and 5D.

17.2.6 In principle, ultrasonic inspection in all five categories can be performed using either manual or mechanized equipment.

17.2.7 In practice, inspection of the body (see 17.1.a and 17.1.b) typically is performed only using mechanized equipment and therefore is limited to the size range that can be processed through the equipment.

17.2.8 Full body UT systems as defined in this recommended practice normally are not capable of full coverage inspection to the ends of the pipe. Full coverage inspection of the end areas requires use of magnetic particle inspection, manual ultrasonic inspection or other inspection method(s) with demonstrated capability of detecting defects as defined in API Specifications 5CT and 5D.

17.3 GENERAL PROCEDURES FOR CALIBRATION, STANDARDIZATION, AND INSPECTION

The following recommendations apply to all categories of ultrasonic inspection except as noted.

17.3.1 The horizontal and vertical linearity of the CRT display should be calibrated after any repairs to related circuitry or at least once every 6 months. The vertical and horizontal linearity between 25 percent and 75 percent of full scale of either display should be within ±5 percent of its full scale value. If a recorder display is used, the linearity of its scale should also be calibrated once every 6 months. Instrument readouts for determining rotational speed and linear or inspection mechanism speed should also be calibrated once every 6 months. The calibration should be recorded on the CRT instrument or recorder and in a log book and should specify the date of calibration, the due date, and the initials of the person performing the calibration.

17.3.2 Standardization of ultrasonic inspection equipment shall be performed at the beginning of each job. A reference standard of the same specified thickness and curvature as the material being inspected should be used, except as noted in 17.7.4. The standard's material should have ultrasonic velocity and attenuation properties that are similar to those of the pipe being inspected. If the standard is to be a piece of the material to be inspected, it should be provided by the owner. Additional checks of standardization shall be performed as follows:

a. At the beginning of each inspection shift.
b. At least once every 4 hours of continuous operation or every 50 lengths inspected, whichever occurs first for mechanized units; or for manual methods, at least every 25 areas measured or inspected in a continuous operation.
c. After any power interruption or change in power supply (battery to charger).
d. For manual methods, whenever there is a change of operator (inspector).
e. Prior to equipment shutdown during a job.
f. Prior to resuming operation after repair or change to a system component that would affect system performance.
g. Whenever the transducer, cable, wedge or type of couplant is changed.
h. All OCTG inspected between an unacceptable check and the most recent acceptable check should be reinspected.

17.3.3 All OCTG surfaces shall be clean and free of loose scale, dirt, grease, or any other material that may interfere

with the sensitivity of the inspection or the interpretation of the readout.

17.3.4 A liquid couplant shall be used to wet the surface of the pipe and provide transmission of ultrasound from the transducers into the pipe being tested. It shall be free of contaminants that may interfere with the sensitivity of the inspection or the interpretation of the readout. Rust inhibitors, water softeners, glycerine, antifreeze, or wetting agents may be added to the couplant provided they are not detrimental to the pipe surface.

17.3.5 Mechanized ultrasonic inspection systems may be configured to perform more than one category of inspection in the same operation.

17.4 INSPECTION FOR LONGITUDINAL, TRANSVERSE, AND OBLIQUE IMPERFECTIONS

The entire surface shall be scanned. Separate sound beams shall be used for the detection of transverse, longitudinal, and oblique imperfections. The combination of linear and rotational speed of the material and/or scanner shall produce 100 percent full body coverage based upon the effective beam width (EBW) of the transducer and the distance between successive pulses (pulse density [PD]) for each instrument channel. The material may be pre-wet or submerged in part or totally for scanning. Couplant shall provide an effective acoustic contact between the transducer beams and the pipe surface.

Note: The EBW and PD should be defined by the agency.

17.4.1 Inspection for Longitudinal Imperfections

Shear wave sound beams are propagated clockwise and counterclockwise by two or more transducers. The sensitivity of the system shall enable it to detect, display, and record imperfections oriented parallel to the major axis such as, but not limited to, seams, laps, and cracks.

Note: The angle of sound beam chosen for OCTG inspection must ensure intersection with material inside surface.

17.4.2 Inspection for Transverse Imperfections

Shear wave sound beams are propagated in each longitudinal direction to provide for the detection of imperfections oriented transverse to the major axis. The sensitivity of the system shall enable it to detect, display, and record transversely oriented and three dimensional imperfections such as, but not limited to, cracks, cuts, rolled-in slugs, and pits.

17.4.3 Optional Inspection for Oblique or Angular Imperfections

Shear wave sound beams propagating at one or more designated angles to the longitudinal axis may be used to detect imperfections oriented oblique to the major axis. The sensitivity of the system shall enable it to detect, display, and record obliquely oriented imperfections.

Note: The angle of sound beam chosen for OCTG inspection must ensure intersection with material inside surface.

17.4.4 Standardization

17.4.4.1 A reference standard should be of a length sufficient for dynamic periodic checks and should be provided by the owner.

17.4.4.2 For the inspection standardization, reference notch length, width, and location shall be in accordance with the requirements of Section 9 of API Specification 5CT or Section 8 of API Specification 5D. Notch depth shall not exceed the depth required by Section 9 of API Specification 5CT or Section 8 of API Specification 5D. Notches, including those having depths less than the requirements of API, are used to establish equipment sensitivity. Reference signal amplitude shall not be used to determine acceptance or rejection. See Section 18 of this recommended practice for evaluation procedures.

Note: Notch widths used in field inspection are typically 0.020 inch or less. Notch depths for field inspection to $12^1/_2$ percent acceptance criteria are typically 10 percent of the specified wall thickness. Notch depths for field inspection to 5 percent acceptance criteria are as specified by API Specification 5CT or 5D.

17.4.4.3 As an alternate to the above notches, with the owner's permission, a drilled hole may be used. The hole diameter shall be in accordance with the requirements of Section 9 of API Specification 5CT or Section 8 of API Specification 5D. Reference signal amplitude shall not be used to determine acceptance or rejection. See Section 18 of this recommended practice for evaluation procedures.

17.4.4.4 Reference notches should be placed so they can be removed without reducing the wall thickness to less than the minimum allowable thickness. A reference standard that contains a drilled hole shall be clearly identified as a reject. Drilled holes should be placed so that the section containing them may be cut off with minimal loss of acceptable pipe.

17.4.4.5 Notches or holes should be separated such that the indication from each is distinct and separate from each other and from other anomalies or end effects. Equipment gain and threshold adjustments should be set for a minimum signal-to-noise ratio (S/N) of 3 to 1.

17.4.4.6 Instrumentation should be adjusted to produce reference signal amplitudes of at least 50 percent of full scale of the readout for each transducer. A threshold should be established in accordance with the agencies standard operating procedures and shall not be greater than the reference level. A dynamic standardization check should be performed to ensure repeatability at the intervals defined in 17.3.2 by

inspecting the reference standard at production speeds two consecutive times.

17.4.4.7 *Supplementary Practice:* By agreement between the owner and the agency, the effect of the shape and radial direction of a reference reflector (on signal amplitude) may be verified. This is done by comparing the peak amplitudes from both sides of the reflector. If one amplitude is less than 80 percent of the other (2 dB), the use of the reference reflector for standardization sensitivity is questionable.

17.4.5 Procedure for the Detection of Longitudinal, Transverse, and Oblique Imperfections

Inspect each length with the ultrasonic inspection system. The sequence of inspecting the OCTG by the various scanners is not specified, but each one must perform its respective function effectively and without detrimental interaction with other scanners.

Electronic readout indications established in accordance with 17.4.4.6 should be located and marked on the outside surface for the full extent of each indication. Evaluate all marked indications in accordance with Section 18 of this recommended practice.

A readout of imperfection indications detected and a record of the inspection is made and identified. These documents should be retained by the agency for a minimum of 6 months.

17.5 INSPECTION OF THE BODY WALL FOR WALL THINNING

17.5.1 Equipment

Sound beams propagated normal to the materials surface are used to measure wall thickness throughout the length of the tube covered by the automated system. The combination of linear and rotational speed of the material and/or scanner normally produces 100 percent full body coverage based upon the effective beam width (EBW) of the transducer and the distance between successive pulses (pulse density [PD]) for each instrument channel. The material may be pre-wet or submerged in part or totally for scanning. Couplant shall provide an effective acoustic contact between the transducer beams and the pipe surface. A means of monitoring effective acoustic coupling should also be used.

Note 1: Ultrasonic wall thickness verification coverage may not be 100 percent when used in conjunction with EMI units.

Note 2: The EBW and PD should be defined by the agency.

17.5.2 Standardization

17.5.2.1 The standard should contain at least two thicknesses that will allow adjustment of the readout over an appropriate range of thickness values for the material being inspected. The reference thicknesses should be verified by measurement with a micrometer or standardized ultrasonic thickness gauge (see 17.7). One thickness shall be equal to or greater than the specified wall thickness of the OCTG being inspected. The other thickness shall be less than the specified thickness. The difference in the thicknesses shall be equal to or greater than 10 percent of the specified wall thickness for seamless material.

17.5.2.2 The equipment's readout of wall thickness should be adjusted to read the reference thickness nearest the minimum allowable thickness of the material being inspected within 0.010 inch or 2 percent of the specified wall thickness, whichever is the smaller. These adjustments are to be done for each transducer used for wall thickness measurements.

17.5.2.3 *Supplementary Practice:* By agreement between the owner and the agency, the thinnest reference thickness used in 17.5.2.1 may be equal to or less than the minimum allowable thickness for the pipe being inspected. This standard is to be provided by the owner. Equipment adjustment is the same as described in 17.5.2.2.

17.5.3 Procedure for Measurement of Wall Thickness

Inspect each length with the ultrasonic inspection system.

A minimum wall thickness reading for at least one length out of every 50 inspected should be verified using a precision deep-throated caliper or a properly standardized manual ultrasonic thickness gauge.

Electronic readout indications established in accordance with 17.5.2.2 should be located and marked on the outside surface for the full extent of each indication. Evaluate all marked indications in accordance with Section 18 of this recommended practice.

A readout of imperfection indications detected and a record of the inspection is made and identified. These documents should be retained by the agency for a minimum of 6 months.

17.6 ULTRASONIC INSPECTION OF LONGITUDINAL WELDS

17.6.1 Equipment

The longitudinal weld area is automatically or manually scanned along its entire length for imperfections. Shear wave sound beams are propagated through the weld in opposing circumferential directions for detection of weld imperfections such as, but not limited to, lack of fusion, pin holes, lack of penetration, longitudinal cracks, porosity, and inclusions. Equipment should be capable of inspecting $^1/_{16}$ inch on either side of weld line throughout the entire thickness of the weld.

17.6.2 Standardization for Weld Inspection

Longitudinal notches shall be placed on the outside and inside surfaces of the reference standard. Normal practice includes the use of a reference notch meeting requirements for N-10 or N-5 notches described in Section 9 of API Specification 5CT. As an alternate, an API Specification 5CT drilled hole may be used.

Notches or holes should be separated such that the indication from each is distinct and separate from each other and from other anomalies or end effects. Equipment gain and threshold adjustments should be set for a minimum signal-to-noise ratio (S/N) of 3 to 1.

Distance amplitude compensation may be used when it is required to detect and gauge reflectors over a significant distance.

Note: The angle of sound beam chosen for OCTG inspection must ensure intersection with material inside surface.

Reference signal amplitudes should be produced by simulation of the scanning method on the pipe to be inspected. Reference reflector signal amplitude should be adjusted to at least 50 percent of full scale of the readout for each transducer. A threshold should be established in accordance with the agencies standard operating procedures and shall not be greater than the reference level. A dynamic standardization check should be performed to ensure repeatability at the intervals defined in 17.3.2 by inspecting the reference standard at production speeds two consecutive times. Coverage of scanning on both sides of the center line of the weld may be verified by demonstrating signal amplitude from a reflector positioned offset from the reference line for the weld.

Supplementary Practice A: By agreement between the owner and the agency, specific reference standards and reference reflectors may be used to:

a. Check each transducer angle.

b. Check proper adjustment of gates and inspection coverage by the equipment. This includes the use of multiple internal and external surface reflectors and a longitudinally drilled hole at mid-wall of the material. Longitudinal notches for radial holes are separated by a minimum transverse distance of $^1/_{16}$ inch on both sides of the reference line, and the longitudinal hole is placed along a line midway between them. In addition, a radial hole through the reference line may be used for setting the reference signal amplitude (see Figure 2). The offset reflectors, as well as the longitudinal hole, are used to verify sensitivity of coverage on both sides of the center line of the weld and through the thickness of the weld. By agreement between the owner and the agency, the reference line may coincide with the weld line. Signal repeatability should be the same as stated in 17.6.2 above.

Supplementary Practice B: By agreement between the owner and the agency, the effect of the shape and radial direction of a reference reflector (on signal amplitude) may be verified. This is done by comparing the peak amplitudes from both sides of the reflector. If one amplitude is less than 80 percent of the other (2 dB), the use of the reference reflector for standardization sensitivity is questionable.

17.6.3 Procedure for Ultrasonic Inspection of Longitudinal Welds

The inspection shall cover the entire length of the weld excluding upsets and threads. A method of tracking the weld in a consistent manner shall be employed. The inspection for thin wall and planar imperfections may be included by agreement between the owner and agency. Then, the operation of the equipment would include a normal beam inspection along the edge of the weld in accordance with 17.5. Proceed as follows:

a. Propel the transducer assembly along the weld at the scanning speed used in 17.6.2.

b. Electronic readout indications established in accordance with 17.6.2 should be located and marked on the outside surface for the full extent of each indication. Evaluate all marked indications in accordance with Section 18 of this recommended practice.

c. A readout of imperfection indications detected, and a record of the inspection is made and identified. These documents should be retained by the agency for a minimum of six months.

17.7 MANUAL ULTRASONIC THICKNESS GAUGING

17.7.1 Equipment

The ultrasonic thickness gauge is used to measure wall thickness from the outside surface. The gauge typically consists of an ultrasonic transducer, a connecting cable, and a battery powered instrument package with a digital, scope, or meter readout. The transducer element diameter should not exceed $^3/_8$ inch (0.375 inch). It shall be capable of reading the thickness of a parallel surface test block within ±0.001 inch of the actual thickness.

17.7.2 Surface Conditions

Surface roughness may cause an ultrasonic thickness reading to be different from a mechanical caliper reading at the same spot. Generally, ultrasonic readings are a response to the average thickness between the peaks and valleys of surface roughness. Therefore, ultrasonics will give a slightly thinner reading than a mechanical caliper (as specified in 9.5.1 of the latest edition of API Specification 5CT), which measures on the peaks of surfaces.

Slightly nonparallel surfaces may cause differences between ultrasonic measurements and mechanical measure-

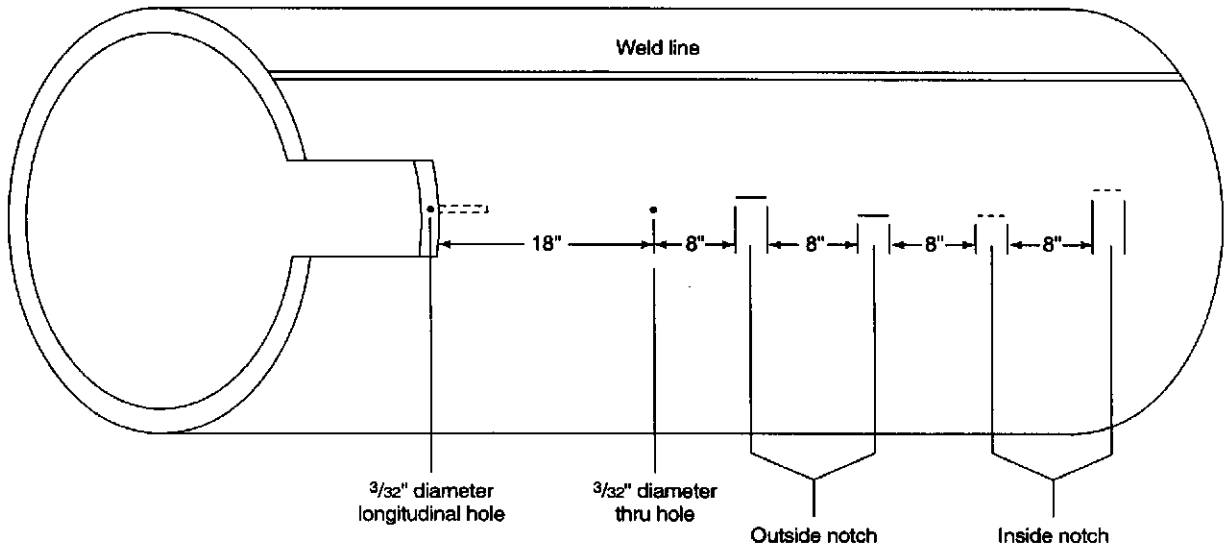


Figure 2—Ultrasonic Reference Standard Example for Supplementary Practice A

ments. The type of difference depends mainly on the type of transducer used and the application of the mechanical caliper.

17.7.3 Calibration

17.7.3.1 Gauge Linearity

The linearity of the gauge's readout should be calibrated over an interval of 0.100 inch to 2.000 inches after any repair of the instrument or at least once every 6 months.

17.7.3.2 Sensitivity Check

If the UT gauge is used to evaluate an imperfection on the inside surface of the pipe, it should be able to detect a $^{1}/_{32}$-inch flat bottom hole at least $^{3}/_{8}$ inch from the front surface of a parallel surface test block. The remaining wall thickness measurement accuracy should be ±0.010 inch and should be checked after any repair of the instrument and at least once every 6 months.

The calibration is to be recorded on the instrument and in a log book and should specify the date of the calibration, due date, and the initials of the person performing the calibration.

17.7.4 Standardization

All standards used for standardization should have velocity and attenuation properties similar to the material being inspected. Prior to use, to minimize error due to temperature differences the standard(s) should be exposed to the same ambient temperature as the material for 30 minutes or more. Placement of the standard on the pipe surface and maximizing its contact area may shorten the exposure time to 10 minutes.

Standardize the gauge according to the gauge manufacturer's instructions on a standard thickness that is at least 0.050 inch thinner than the specified wall thickness and on a second standard thickness that is at least 0.050 inch greater than the specified wall thickness of the material being inspected. The thickness should be verified by micrometer measurement. The gauge accuracy should be within ±0.001 inch of the standard's thickness.

The standards specified above should have the same outside surface curvature as the outside diameter of the material being measured. A flat standard may be used for specified diameters larger than 3 $^{1}/_{2}$ inches.

17.7.4.1 Primary Reference Standard Standardization

When practical, a micrometer measurement of a properly prepared area of the material to be inspected should be used for final standardization of the gauge. If the reading of the standardized gauge is not the same thickness (±0.002 inch) as the micrometer, the source of the error shall be determined. If the error is due to transducer curvature, adjust the zero control. If the error is due to material velocity, adjust the velocity control. A properly prepared external surface includes removal of varnish, paint, and loose material. A prepared internal surface, at the same point, includes removal of loose material, scale, and varnish to allow proper contact of the micrometer anvil.

17.7.4.2 Frequency of Standardization Checks

In addition to the requirements stated in 17.3.2 of this recommended practice, the following should be done:

a. Verify standardization whenever a reject reading is encountered or whenever a reading is within 0.005 inch of the minimum permissible thickness is encountered.

b. The gauge reading during a standardization check should be readjusted when there is a variance of more than 0.002 inch from the original setup value.

17.7.5 Procedure

17.7.5.1 When the UT gauge is turned ON (if battery powered) and the instrument indicates that the battery is low, the battery shall be recharged or replaced before proceeding. The appropriate scale is then selected for the wall thickness to be measured, and the UT gauge shall be standardized as described in 17.7.4.

17.7.5.2 When measuring the wall thickness, remove all dirt and loose material from the external surface and apply a couplant to the area to be gauged. This couplant shall be noninjurious to the material being inspected. Place the transducer firmly onto the surface. When measuring the wall thickness after contour grinding, allow the OCTG surface to cool to the same ambient temperature as the surrounding material surface.

17.7.5.3 When a dual element transducer is employed, the parting line between the transmitting and receiving transducer shall be perpendicular to the pipe axis. When the parting line of a dual element transducer is applied at less than perpendicular with the longitudinal axis, the resulting ultrasonic readings may be greater than the actual pipe thickness. The smaller the pipe diameter the larger the error.

17.7.5.4 Allow the reading to stabilize, then compare the reading with the minimum allowable wall thickness. A stable reading is one that maintains the same value (±0.001 inch) for at least 3 seconds.

17.7.5.5 When a reading is made that would classify the material as a reject, scrape all surface coating and loose scale to clean the surface without removing any base metal. Verify the gauge standardization and recheck the thickness measurement.

17.7.5.6 When using a highly sensitive gauge, care must be taken to ensure that detection of an inclusion or lamination is not interpreted as a reduction in wall thickness. Refer to Section 18 for imperfection evaluation details.

17.7.5.7 Ultrasonic Transducer Wear. After a significant amount of use, examine the ultrasonic transducer face for wear. When a worn transducer face results in inaccurate readings, it should be replaced. A concave transducer face causes pipe wall to appear thinner than actual when the ultrasonic gauge is standardized on a thickness with a greater radius of curvature than the material being inspected.

17.7.5.8 Gauge Function. If the readout does not remain stable when the transducer is being held securely on the test block, the gauge may be malfunctioning. It should be repaired or replaced.

Note: Gauge accuracy: Achieving the accuracy on standardization thicknesses as described in 17.7.4 does not necessarily assure the same accuracy for wall thickness measurements. The material's surface condition (both entry and back wall reflection surfaces) is not necessarily the same as a test block. Digital readouts normally round off the least significant digit, causing a small amount of error.

17.8 MANUAL ULTRASONIC SHEAR WAVE INSPECTION

17.8.1 Equipment

The ultrasonic instrumentation shall be the pulse-echo type with an A-scan presentation. For the amplitude-based inspection technique, a transducer frequency between 2.25 and 10.0 MHz should be used. Wedges shall be used to generate shear waves in the material to be inspected. Reject, if available, shall not be used.

Note: The use of a 45 degree refracted angle is typical. Refracted angles must ensure intersection with the material inside surface.

17.8.2 Inspection for Longitudinal Imperfections

A shear wave sound beam is propagated clockwise and counterclockwise in the inspection area. The sensitivity of the system shall enable it to detect and display imperfections oriented parallel to the major axis such as, but not limited to seams, laps, and cracks. Wedges should be machine contoured to fit the external curvature of the material and maintain the refracted sound path angle. Manually contoured wedges will not give reproducible results.

17.8.3 Inspection for Transverse Imperfections

A shear wave sound beam is propagated in each longitudinal direction in the inspection area. The sensitivity of the system shall enable it to detect and display transversely oriented and three dimensional imperfections such as, but not limited to, cracks, cuts, rolled-in slugs, and pits.

17.8.4 Optional Inspection for Oblique or Angular Imperfections

A shear wave sound beam is propagated clockwise and counterclockwise at the anticipated angle to the longitudinal axis in the inspection area. The sensitivity of the system shall enable it to detect and display obliquely oriented imperfections.

17.8.5 Standardization

17.8.5.1 A reference standard should contain internal and external, longitudinal and transverse notches that meet the requirements of 17.4.4.2 and 17.4.4.5.

17.8.5.2 The effect of the shape and radial direction of a reference notch(es) (on signal amplitude) should be verified. This is done by comparing the peak amplitudes from both sides of the reflector. If one amplitude is less than 89 percent of the other (1 dB), the use of the reference reflector for standardization sensitivity is questionable. For oblique notches, 17.4.4.7 may apply.

17.8.5.3 When applicable, to eliminate parallax error during standardization and inspection, the A-scan presentation shall be viewed perpendicular at all times.

17.8.5.4 To locate imperfections accurately, a distance standardization is recommended. Typically a DSC, miniature angle beam, or DC block is used to perform a distance standardization of the A-scan presentation. The distance used should be established in the agencies standard operating procedures but shall not be less than the shear wave metal path distance equivalent of one-and-one-half skips. When applicable, the digital sound path display should also be standardized for distance.

17.8.5.5 Instrumentation should be adjusted to produce reference signal amplitudes of at least 50 percent of full scale of the readout.

Note: For amplitude-based methods, standardization should be performed beyond the near-field.

17.8.6 Frequency of Standardization Checks

In addition to 17.3.2, standardization checks shall be performed as follows:

a. Whenever an indication is within ±20 percent of the reference amplitude.
b. Before accepting a shear wave indication as rejectable.

17.8.7 Unacceptable Standardization Checks

The following conditions constitute an unacceptable check:

a. If a standardization check indicates a ±10 percent FSH change in reference level.
b. If a standardization check shows that any reference point has moved more than 5 percent of its sweep reading.

All material evaluated since the last acceptable standardization check shall be re-evaluated.

17.8.8 Procedure for Inspection of Longitudinal, Transverse, and Oblique Imperfections

To aid in locating imperfections, scanning may be performed with additional gain.

Inspect required areas in the appropriate orientation with the ultrasonic equipment.

Indications noted on the readout should be located and marked on the outside surface for the full extent of each indication. Evaluate all marked indications in accordance with Section 18 of this recommended practice.

18 Evaluation of Imperfections and Deviations

18.1 GENERAL

This section describes the procedures for the evaluation of imperfections and deviations detected using the methods contained in this recommended practice. Acceptance and rejection principles are contained in Section 9 of this recommended practice.

18.2 APPLICATION

The evaluation procedures contained in this section are applicable to all OCTG except those classified as prime as the result of inspection in accordance with this recommended practice.

18.3 EQUIPMENT

Equipment used in conjunction with evaluation procedures includes, but is not limited to, the following:

a. Depth gauges.
b. Wall thickness calipers.
c. Straight edges.
d. Rules, rigid and flexible.
e. Thread profile gauges.
f. Portable ultrasonic inspection equipment.
g. Magnetic particle inspection equipment.

18.4 CALIBRATION AND STANDARDIZATION PROCEDURES

All equipment and materials used to evaluate imperfections shall be calibrated on a regular basis in accordance with the provisions of the agency's quality assurance program. In addition, the following standardizations shall be performed:

a. Hardness Testing. Refer to 11.5 of this recommended practice for the standardization procedure.
b. Ultrasonic Thickness Measurement. Refer to 17.7.4 of this recommended practice for the standardization procedure.
c. Shear Wave Ultrasonic Equipment. Refer to 17.8.5 of this recommended practice for the standardization procedure.
d. MPI Equipment and Materials. Refer to 12.6 of this recommended practice for the standardization procedure.

18.5 PROCEDURE FOR EVALUATING OUTSIDE SURFACE PIPE BODY IMPERFECTIONS

This procedure is to be used when inspecting pipe to imperfection and wall thickness tolerances stated in 7.3 of the latest edition of API Specification 5CT or 6.3 of the latest edition of API Specification 5D.

Note 1: If an imperfection of any size in the pipe or upset extends under the coupling where it is inaccessible for exploration, the imperfection shall be classified as a defect.

An *imperfection* is a discontinuity or irregularity in the product detected by methods outlined in the applicable specification.

A *defect* is an imperfection of sufficient magnitude to warrant rejection of the product based on the stipulations of the applicable specifications.

Note 2: Grinds that run under the coupling are not defects, provided the grind is well contoured with the circumference of the pipe and displays a high degree of workmanship. Because of the difficulty in defining acceptable contours and a high degree of workmanship, owner discretion shall govern. Owner discretion applies only to the contour of the grind.

Note 3: Quench cracks detected by methods outlined in this recommended practice shall be considered defects.

18.5.1 Exploration

When imperfections such as seams, laps, or cracks are found in a length of pipe, the following procedure applies. Explore the imperfection with a file or grinder. Exploratory grinding should be round bottomed. To avoid over grinding, a good practice, though not required, is to leave some trace of the imperfection across the bottom of the grind. If a length is determined to be rejectable, a trace of the defect shall be left for verification by the manufacturer or the manufacturer's representative. Pits, cuts, and gouges usually do not require probe grinding for depth measurement.

18.5.2 Measurement of Imperfection Depth

Adjust the depth gauge to zero on a flat surface. Measure the depth of the imperfection using a depth gauge. Verify the measurement before rejection by scraping away the varnish and loose scale and removing metal protrusions using a flat file. Read the depth of the imperfection directly from the dial. The "zero point" of the gauge will be reconfirmed after a reading is made that results in rejection. If the normal pipe contour is irregular or has a dent, the depth gauge should be zeroed adjacent to the imperfection.

18.5.3 Determination of Remaining Wall Thickness

18.5.3.1 For radial imperfections penetrating the wall approximately vertically, measure the wall thickness on each side of the imperfection adjacent to its deepest penetration. Subtract the depth of the imperfection from the average of these wall thickness readings.

18.5.3.2 For imperfections penetrating the wall at an angle (for example a lap or hook crack), measure the wall thickness on each side of the exploratory grind at the point of maximum penetration of the imperfection. Subtract the depth of the imperfection from the average of these wall thickness readings.

18.5.3.3 Caliper measurement should be used to determine wall thickness when practical near the ends of the OCTG.

18.5.4 Further Exploration

When an electromagnetic or ultrasonic inspection indication is displayed and a magnetic particle buildup exists but no imperfection is readily identifiable, refer to 18.6.3 for further exploration procedure.

18.5.5 Linear Defects—Group 1 and 2 (Except C-90 and T-95)

Note: Linear imperfections include, but are not limited to, cracks, seams, laps, plus scores, cuts, and gouges.

Any linear imperfection that is deeper than $12^1/_2$ percent of the specified wall thickness, as measured from the surface, or that reduces the wall thickness remaining at the root of the imperfection to less than $87^1/_2$ percent of the specified wall thickness shall be considered a defect.

18.5.6 Linear Defects—Group 3 and 4, C-90, and T-95

Any linear imperfection that is deeper than 5 percent of the specified wall thickness, as measured from the surface, or that reduces the wall thickness remaining at the root of the imperfection to less than $87^1/_2$ percent of the specified wall thickness shall be considered a defect.

18.5.7 Nonlinear Defects—All Grades

Any nonlinear imperfection, such as a pit, that results in a wall thickness above or below the imperfection with a value less than $87^1/_2$ percent of specified wall thickness shall be considered a defect.

18.5.8 Disposition

Pipe containing defects shall be given one of the following dispositions:

a. Disposition A. The defect may be removed by grinding, providing the remaining wall thickness is not less than $87^1/_2$ percent of the specified wall thickness. When the depth of a grind exceeds 10 percent of the specified wall thickness, the remaining wall thickness should be verified. Removal of

defects by grinding is performed only by agreement between the owner and the agency.

b. Disposition B. Reject the length. The defect should not be contoured or removed but should be left in the pipe for confirmation by the manufacturer or processor representative.

c. Disposition C. The section of pipe containing the defect may be cut off within the limits of requirements on length if agreed upon between the owner and the manufacturer or processor.

18.5.9 Radius Grinds

Contour all exploratory grinds and file marks with generous radii in acceptable pipe. All outside surface grinds in acceptable pipe should be coated with a rust inhibitor.

18.6 PROCEDURE FOR EVALUATING INSIDE SURFACE BREAKING PIPE BODY IMPERFECTIONS

When the inside surface breaking imperfection is near the end of the pipe, but not in the threads, an attempt shall be made to explore and measure the imperfection when the diameter permits. See 18.5.1 through 18.5.4.

18.6.1 Ultrasonic Evaluation

When the inside surface imperfection is not accessible from the pipe end, it shall be evaluated using shear and/or compression wave ultrasonics in accordance with the following procedure:

Note: The guidelines provided in this section are considered minimum requirements related to the amplitude-based evaluation technique. It is recommended that this procedure not rely on signal amplitude alone to classify an imperfection as a defect. Time-based or other flaw-sizing techniques may prove acceptable and should be by agreement between the owner and the agency. An evaluation procedure should be developed and agreed upon between the owner and the agency.

a. The area to be evaluated should have been marked by the method that originally detected the indication.

b. Manual ultrasonic thickness gauging may also be used to aid in locating the imperfection. Manual ultrasonic thickness gauges shall be standardized prior to use in accordance with 17.7.4.

c. Manual ultrasonic shear wave equipment shall be standardized prior to use in accordance with 17.8.5.

d. Manipulate the transducer with respect to the material such that the ultrasonic beam interrogates the entire area of interest. The A-scan display should be continuously monitored noting the largest amplitude responses from both sides of the imperfection. Once the largest indication has been identified, return the instrument to the reference gain.

e. If the maximum amplitude obtained equals or exceeds the reference level, the imperfection may be considered a defect, but further evaluation is recommended using additional shear wave techniques.

f. An ultrasonic thickness gauge may be used to measure the wall thickness above the imperfection to determine if $87^1/_2$ percent of the specified wall thickness is present, provided it can be demonstrated that the imperfection breaks the inside surface.

18.6.2 Defects and Disposition

Refer to 18.5.5 through 18.5.8.

18.6.3 Further Exploration

When an electromagnetic or ultrasonic inspection indication is displayed and/or a magnetic powder buildup exists but no imperfection is readily identifiable, supplementary tools and techniques shall be used to evaluate these imperfections as either acceptable or rejectable. The following tools and techniques are used:

a. Inspecting the inside surface using a high intensity light source or a borescope.

b. Perform an internal MPI in the area of interest in accordance with 12.10.2 of this recommended practice.

18.6.4 Defects and Disposition

Refer to 18.5.5 through 18.5.8.

18.6.5 Radius Grinds

Contour all exploratory grinds and file marks with generous radii in acceptable pipe.

18.7 PROCEDURE FOR EVALUATING WELDS

These guidelines are to be used when evaluating surface imperfections or dimensional variations detected in the weld area of OCTG manufactured by a welding process.

18.7.1 Surface Penetrating Imperfections

Evaluate in accordance with 18.5 or 18.6.

18.7.2 Nonsurface Breaking Imperfections

Nonsurface breaking imperfections should be evaluated by the procedure in 18.6.1. Any weld seam imperfection within $^1/_{16}$ inch of either side of the weld line, not on the inside or outside surface, that is proven to reduce the net effective wall thickness below $87^1/_2$ percent of the specified wall thickness shall be considered a defect.

18.7.3 Flash Height

Flash in electric welded OCTG is considered a defect if its height exceeds the limits described in 7.7 of API Specification 5CT.

18.7.4 Excessive Trim

Excessive trim in electric welded pipe is considered a defect if the depth of the groove exceeds the limits described in 7.7 of API Specification 5CT. The depth of the groove is determined by the difference between wall thickness measurements taken approximately one inch away from the groove and in the groove in the same transverse plane.

18.7.5 Disposition

The disposition of pipe containing defects shall be according to 18.5.8.

18.7.6 Radius Grinds

Contour all exploratory grinds and file marks with generous radii in acceptable pipe. Also, all grinds on the outside surface of acceptable pipe should be coated with a rust inhibitor.

18.8 PROCEDURE FOR EVALUATING GRIND

When evidence of defect removal (grind) by the manufacturer or processor is found, the following paragraphs apply:

18.8.1 Inspection

Inspect the area using MPI to ensure complete removal of the imperfection. If the imperfection is not completely removed, use the procedure in 18.5 or 18.6 to evaluate the imperfection.

18.8.2 Wall Thickness Measurement

If no further imperfection is found, measure the wall thickness in several places in the grind area to ensure that a wall thickness of $87^1/_2$ percent or greater of the specified wall thickness remains. If not, the length shall be rejected. Refer to 18.9 for procedures related to determining rejection.

18.8.3 Defects and Disposition

Refer to 18.5.5 through 18.5.8.c.

18.9 PROCEDURE FOR EVALUATING LARGE AREA WALL REDUCTION

When a wall reduction, or thinning, is evident due to eccentricity or other conditions, the procedure in 18.9.1 and 18.9.2 applies:

18.9.1 Wall Thickness Measurement

Determine the wall thickness using an acceptable measuring device such as an ultrasonic wall thickness gauge or mechanical caliper.

When using a mechanical caliper, it should meet the construction requirements in 9.5.1 of the latest edition of API Specification 5CT or 5.4.b of the latest edition of API Specification 5D.

When using an ultrasonic thickness gauge, if the minimum reading is borderline on $87^1/_2$ percent of the specified wall thickness, multiple readings should be taken to determine the lowest measured wall thickness. The "measured" wall thickness is defined as the average of at least three ultrasonic readings within approximately $^1/_4$ inch diameter surface area. Each reading should be no closer than $^1/_8$ inch to another. Readings that do not differ by more than 0.010 inch shall be used for averaging. No single reading shall be basis for rejection.

18.9.2 Disposition

If the "measured" wall thickness is less than $87^1/_2$ percent of the specified wall thickness, it is considered a defect and dispositioned according to 18.5.8.

Note: In case of disputed wall thickness measurements, direct measurement by mechanical caliper shall govern as stated in 9.5.1 of the latest edition of API Specification 5CT or 5.4.b of the latest edition of API Specification 5D.

18.10 PROCEDURE FOR EVALUATING UPSET IMPERFECTIONS

18.10.1 Surface Penetrating Imperfections

The maximum permissible depth of imperfections measured from the surface of the upset portion of the pipe shall be in accordance with Table 29 of API Specification 5CT or 8.4 of API Specification 5D.

Note 1: The internal upset configuration on all upset products shall exhibit no sharp corners or drastic changes of sections and shall permit a 90 degree hook-type tool to be pulled through without hang-up.

Note 2: If an imperfection in the upset extends under the coupling, where it is inaccessible for exploration, the imperfection shall be classified as a defect. Grinds that run under the coupling are not defects provided the grind is well contoured with the circumference of the pipe and displays a high degree of workmanship. Because of the difficulty in defining acceptable contours and a high degree of workmanship, owner discretion shall govern. Owner discretion applies only to the contour of the grind.

When practical, evaluation should be done in accordance with 18.5.1. and 18.5.2.

18.10.2 Internal Inaccessible Imperfections

When the imperfection is inaccessible for direct depth measurements, a substantial effort should be made to determine its depth using a mechanical caliper and/or ultrasonic thickness measurements.

The following procedures should be used:

a. Measure the wall thickness on each side of the imperfection adjacent to its deepest penetration.

b. Measure the remaining wall thickness at the deepest penetration of the imperfection. Subtract the value from the average of the adjacent wall thickness measurements.

c. Evaluate with ultrasonics in accordance with 18.6.1.

18.10.3 Additional Requirements for Plain End Drill Pipe

The maximum permissible depth of a visible imperfection in the L_{eu} or L_{iu} areas of the upsets of plain-end drill pipe is determined from respective API diameter allowances. The minimum allowable value of D_{ou} is used for outside surface imperfections. The maximum allowable value of d_{ou} is used for inside surface imperfections.

18.10.4 Disposition

An imperfection that has a depth exceeding the maximum API allowable depth shall be considered a defect. A wall thickness that is less than the API allowable minimum shall be considered a defect. In the case of disputed wall thickness measurements, direct measurement by mechanical caliper shall govern as stated in 9.5.1 of API Specification 5CT or 5.4.b of API Specification 5D.

Pipe containing a defect in the upset portion shall be rejected, unless the defect can be removed by grinding. Grinding shall not be done where wall thickness or diameter tolerances are not specified. Removal of defects by grinding is performed only by agreement between the owner and the agency. Grinding shall not produce any of the following:

a. A wall thickness less than $87^1/_2$ percent of the specified body wall thickness in the upset runout intervals.

b. An outside diameter less than the applicable API minimum allowable.

c. An inside diameter greater than the applicable API maximum allowable.

18.11 PROCEDURE FOR EVALUATION OF OUTSIDE SURFACE IMPERFECTIONS ON COUPLINGS

18.11.1 Pits, round-bottom gouges, and similar imperfections are not defects unless the depth of the imperfection exceeds that listed in Table 15.

18.11.2 Grip marks, sharp-bottom gouges, and similar imperfections are not defects unless the depth of the imperfection exceeds that listed in Table 15. If a gouge has an adjacent metal protrusion, the protrusion shall be removed prior to making a depth measurement.

18.11.3 Group 1, Grades J-55 and K-55 impact tested above 32°F and Grade H-40: Finished couplings shall be free of all visible seams, cracks, and porosity as specified in API Specification 5CT.

Note: Visible seams or cracks are those that can be seen without the aid of magnetic particle inspection or other nondestructive methods of inspection on uncoated couplings or if the coating is removed.

18.11.4 Group 1, Grades J-55 and K-55 couplings that comply with the requirements of 8.13.2.2 of API Specification 5CT and are marked as required in Table 58 of API Specification 5CT. Linear imperfections, such as seams or cracks on the outside surface are not defects unless their depth exceeds that listed in Table 16.

18.11.5 Group 1 (N-80) and Groups 2, 3, and 4: Linear imperfections such as seams or cracks on the outside surface are not defects unless their depth exceeds that listed in Table 16. Indications of nonmetallic inclusions are not defects unless their depth exceeds 0.035 inch.

18.11.6 The depth of the imperfection shall be measured from the normal surface or contour of the coupling extended over the imperfection. All depth measurements should be done in accordance with 18.5.2. Evaluation of linear imperfections such as seams or cracks should be done in accordance with 18.5.1.

18.11.7 All seams, cracks, or pits may be removed, and all other defects or imperfections may be removed or reduced to acceptable limits by machining or grinding on the outer surface, provided that the resulting diameter is within the toler-

Table 15—Permissible Depth of Imperfections (Inches)

	Group 1, 2 (L-80 and C-95) and Group 3		Group 2 (C-90 and T-95) and Group 4
Coupling for Pipe Sizes	Pits and Round Bottom Gouges	Grip Marks and Sharp Bottom Gouges	All
Tubing:			
Smaller than $3^1/_2$	0.030	0.025	0.030
$3^1/_2$ and larger	0.045	0.030	0.035
Casing:			
Smaller than $6^5/_8$	0.035	0.030	0.030
$6^5/_8$ to $7^5/_8$, incl.	0.045	0.040	0.035
Larger than $7^5/_8$	0.060	0.040	0.035

Table 16—Linear Imperfections on the Outside Surface of Couplings (All Groups Except Grades J-55 and K-55 Impact Tested Above 32 and H-40)

	Permissible Depth in Inches[a]						
Size[b]	NEU	EUE	EUE[c]	BTC[c]	BTC	LTC	STC
1.050	0.009	0.011	—	—	—	—	—
1.315	0.011	0.013	—	—	—	—	—
1.660	0.012	0.012	—	—	—	—	—
1.900	0.010	0.013	—	—	—	—	—
2 3/8	0.015	0.015	0.011	—	—	—	—
2 7/8	0.019	0.018	0.013	—	—	—	—
3 1/2	0.023	0.023	0.015	—	—	—	—
4	0.023	0.023	—	—	—	—	—
4 1/2	0.022	0.025	—	0.013	0.016	0.017	0.017
5	—	—	—	0.013	0.018	0.020	0.019
5 1/2	—	—	—	0.013	0.018	0.020	0.019
6 5/8	—	—	—	0.014	0.023	0.026	0.024
7	—	—	—	0.014	0.021	0.023	0.022
7 5/8	—	—	—	0.017	0.027	0.029	0.027
8 5/8	—	—	—	0.018	0.030	0.032	0.031
9 5/8	—	—	—	0.018	0.030	0.033	0.031
10 3/4	—	—	—	0.018	0.030	—	0.031
11 3/4	—	—	—	—	0.030	—	0.031
13 3/8	—	—	—	—	0.030	—	0.031
16	—	—	—	—	0.033	—	0.032
18 5/8	—	—	—	—	0.043	—	0.041
20	—	—	—	—	0.033	0.034	0.032

[a]Five percent of the critical thickness defined in Table 6 of API Specification 5CT.
[b]The size of the coupling is the same as the corresponding pipe size.
[c]Special clearance only.

Table 17—Casing Coupling Outside Diameters and Tolerances[a]

	1	2	3	4	5	6	7	8	9
	Round Thread			Buttress Thread Outside Diameter					
	Outside Diameter, W			Regular, W			Special Clearance, W_c		
Size[b]	Minimum[c]	Specified	Maximum	Minimum[c]	Specified	Maximum	Minimum[c]	Specified	Maximum
4 1/2	4.950	5.000	5.050	4.950	5.000	5.050	4.859	4.875	4.906
5	5.507	5.563	5.619	5.507	5.563	5.619	5.359	5.375	5.406
5 1/2	5.989	6.050	6.111	5.989	6.050	6.111	5.859	5.875	5.906
6 5/8	7.316	7.390	7.464	7.316	7.390	7.464	6.984	7.000	7.031
7	7.579	7.656	7.733	7.579	7.656	7.733	7.359	7.375	7.406
7 5/8	8.415	8.500	8.585	8.415	8.500	8.585	8.109	8.125	8.156
8 5/8	9.529	9.625	9.721	9.529	9.625	9.721	9.109	9.125	9.156
9 5/8	10.519	10.625	10.731	10.519	10.625	10.731	10.109	10.125	10.156
10 3/4	11.632	11.750	11.868	11.632	11.750	11.868	11.234	11.250	11.281
11 3/4	12.625	12.750	12.875	12.625	12.750	12.875	—	—	—
13 3/8	14.250	14.375	14.500	14.250	14.375	14.500	—	—	—
16	16.875	17.000	17.125	16.875	17.000	17.125	—	—	—
18 5/8	19.875	20.000	20.125	19.875	20.000	20.125	—	—	—
20	20.875	21.000	21.125	20.875	21.000	21.125	—	—	—

[a]From Tables 31 and 32 of API Specification 5CT.
[b]The size of the coupling is the same as the corresponding pipe size.
[c]Does not apply to Q-125 casing sizes 6 and larger. For Q-125 pipe, 6 and larger, use $W - 1/16$ inch for the minimum.

Table 18—Tubing Coupling Outside Diameters and Tolerances[a]

	1	2	3	4	5	6	7	8	9
	Nonupset Outside Diameter			External Upset Outside Diameter					
	Regular, W			Regular and Special Bevel, W			Special Clearance, W_c		
Size[b]	Minimum	Specified	Maximum	Minimum	Specified	Maximum	Minimum	Specified	Maximum
1.050	1.300	1.313	1.326	1.643	1.660	1.677	—	—	—
1.315	1.643	1.660	1.677	1.881	1.900	1.919	—	—	—
1.660	2.033	2.054	2.075	2.178	2.200	2.222	—	—	—
1.900	2.178	2.200	2.222	2.475	2.500	2.525	—	—	—
$2^3/_8$	2.846	2.875	2.904	3.032	3.063	3.094	2.895	2.910	2.925
$2^7/_8$	3.465	3.500	3.535	3.631	3.668	3.705	3.445	3.460	3.475
$3^1/_2$	4.207	4.250	4.293	4.455	4.500	4.545	4.165	4.180	4.195
4	4.702	4.750	4.798	4.950	5.000	5.050	—	—	—
$4^1/_2$	5.148	5.200	5.252	5.507	5.563	5.619	—	—	—

[a]From Tables 33 and 34 of API Specification 5CT.
[b]The size of the coupling is the same as the corresponding pipe size.

ances specified in Table 17. The outside diameter of the finished coupling shall be measured across the finished surface or contour of the coupling (i.e., initial surface or grind contour resulting from the removal of a defect or imperfection). The outside diameter shall not be measured at the base of an acceptable imperfection. Grinding or machining should not be performed by the agency except at the specific direction of the owner. The grinding shall be approximately faired into the outer contour of the coupling. The minimum OD.

18.11.8 resulting from grinding or machining shall be measured with an OD micrometer or other suitable instrument capable of being read in thousandths of an inch.

18.12 PROCEDURE FOR EVALUATION OF VISUALLY LOCATED THREAD IMPERFECTIONS

18.12.1 General

Good judgment and discretion should be exercised in field examination of exposed threads on casing and tubing. Some surface irregularities will not affect the joint strength or the pressure seal performance unless they are large enough to act as a leak channel. Keep in mind that thread crests of round threads do not engage the roots of the threads of the mating piece. Therefore, minor chatter, tears, cuts, or other surface irregularities on the crests or roots of round threads may not be cause for rejection.

18.12.1.1 Some surface roughness may even be beneficial to proper makeup by holding thread compound in place as the thread is engaged during makeup.

18.12.1.2 Superficial scratches, minor dings, and surface irregularities on the threads are occasionally encountered and may not necessarily be detrimental. Because of the difficulty in defining superficial scratches, minor dings, and surface irregularities, and because of the degree to which they can affect thread performance, no blanket waiver of such imperfections can be established. The thread flanks in the L_c area of round threads are the critical sealing elements.

18.12.1.3 Minor (cosmetic) field repair of threads and other repairs stated in 18.12 shall only be performed by agreement between the owner and the agency.

18.12.1.4 Arc burns are rejectable anywhere in the threaded areas.

18.12.1.5 Refer to Tables 9 and 10 of this recommended practice to determine the length of specific thread areas (for example, L_c and PTL).

18.12.2 Reject Criteria in the Non-L_c Area

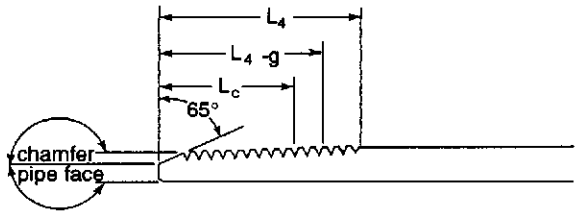
18.12.2.1 Pits, seams, laps, cuts, and other imperfections are rejectable if they penetrate through the root of the thread, or if they exceed $12^1/_2$ percent of the specified wall thickness body as measured from the projected pipe surface, whichever is greater.

18.12.2.2 Detectable protrusions on the threads are rejectable if they can peel off the protective coatings on the coupling threads or score mating surfaces.

18.12.3 Reject Criteria in the L_c Area

18.12.3.1 Threads shall be free of any visible imperfections as listed in 10.10.4.a. of this recommended practice that break the continuity of the threads.

18.12.3.2 Detectable protrusions on the threads are rejectable if they can peel off the protective coatings on the coupling threads or score mating surfaces.



Note: Eccentricity and ovality limitations are not currently specified by API.

Figure 3—External Thread Inspection Parameters

18.12.3.3 On round threads, all threads within the L_c area shall have full crests or they are rejectable.

18.12.3.4 In buttress casing, a single thread showing the original outside surface of the pipe for more than 25 percent of the circumference is cause for rejection. More than two threads showing the original outside surface of the pipe is cause for rejection.

18.12.3.5 Minor pitting and thread discoloration may also be encountered and may not necessarily be detrimental. Because of the difficulty in defining pitting and discoloration and the degree to which they affect thread performance, no blanket waiver of such imperfections can be established. As a guide to acceptance, most critical considerations are that any corrosion products protruding above the surface of the threads be removed and that no leak path exists. Filing or grinding to remove pits is not permitted.

18.12.3.6 In field inspection, heat tinting on threads from thermal cutting to remove couplings or protectors may indicate localized hardening of the threads. This may be cause for rejection by agreement between the agency and the owner.

18.12.4 Reject Criteria in Chamfer Area

18.12.4.1 Chamfer not present for a full 360 degree circumference is cause for rejection.

18.12.4.2 A thread root that runs out on the face of the pipe or produces a feather edge (and not on the chamfer) is cause for rejection. See Figure 4.

18.12.4.3 Excessive chamfer that produces a knife edge (razor edge) on the face of the pipe is cause for rejection. See Figure 5.

18.12.4.4 A burr on the starting thread within the chamfer is not cause for rejection unless the burr is loose or protrudes into the mating thread form. The burr shall be removed if any of these possibilities exist.

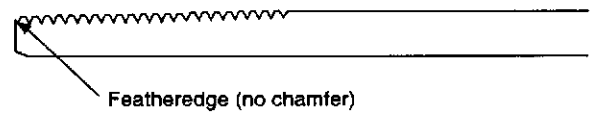


Figure 4—Featheredge (No Chamfer)

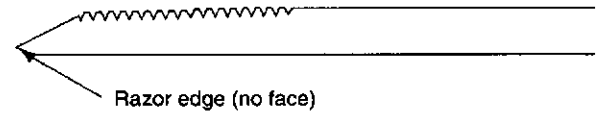


Figure 5—Razor Edge (No Face)

18.12.4.5 A false starting thread is not cause for rejection, if it does not extend into the true starting thread. An interrupted starting thread is not cause for rejection but may indicate chamfer or thread misalignment. Those conditions should be evaluated.

18.12.4.6 Dents or mashes that cause out-of-tolerance thread dimensions are cause for rejection.

18.12.5 Reject Criteria for Pipe Ends

18.12.5.1 Pipe ends with burrs or fins that cannot be removed by grinding shall be rejected.

18.12.5.2 Dents or mashes that cause out-of-tolerance thread dimensions are cause for rejection.

18.12.6 Reject Criteria for Round or Bullet Nose Tubing

18.12.6.1 Ends with sharp corners or abrupt radius changes are cause for rejection.

18.12.6.2 For other rejection criteria refer to 18.12.8.

18.12.7 Other Criteria

Other visually evident imperfections that are not specifically covered in the preceding sections, whether in the L_c area or not, that may be detrimental to the makeup, strength, or sealing capacity of the thread, or that could result in galling should be reported to the owner.

18.12.8 Reject Criteria for the PTL Area of Box or Coupling Threads

The threads in the PTL area have the same reject criteria as the L_c area (see 18.12.3). The PTL area is defined in 10.10.3.3 of this recommended practice.

18.12.9 Reject Criteria for Threads Beyond the PTL Area of Box or Coupling Threads

Threads not extending to the center of the coupling or to a distance of L_4 plus 0.500 inch from the box face of integral joint shall be cause for rejection. Threads in this area need not be full crested.

Note: Tapping machines may not produce uniform threads in the "J" area since they tap from each side using multitoothed chasers. During the tapping of the second side, the lead side of the chaser taps the threads in the "J" area of the first side that has been tapped.

18.12.10 Reject Criteria for Coupling or Box Face and Counterbore

18.12.10.1 Faces with burrs or fins that cannot be removed by grinding or filing shall be rejected.

18.12.10.2 Dents or mashes that cause counterbore diameter reduction or out-of-tolerance thread dimensions are cause for rejection.

18.12.10.3 Tool marks on the counterbore are not cause for rejection but may indicate incorrect counterbore diameter, counterbore misalignment, or thread misalignment. Those conditions should be evaluated.

18.12.11 Reject Criteria for Seal Ring Grooves

Fins, wickers, and ribbons that are loose or can become loose and fold into the thread form are cause for rejection unless removed.

18.13 PROCEDURE FOR TRIANGLE LOCATION, AND COUPLING MAKEUP POSITION

18.13.1 Buttress Thread

18.13.1.1 Triangle Location

Verify the location of the triangle stamp on the field end of each length of buttress thread casing. Using a metal scale, measure from the end of the pin to the base of triangle, holding the scale parallel to the longitudinal axis of the pipe. If the triangle cannot be located or is in the wrong position (outside A1 $\pm 1/32$ inch) it shall be cause for rejection.

18.13.1.2 Coupling Makeup

Determine the distance N – A1, where N is the measured coupling length. This is the nominal position of the end of the pin in the coupling. Measure the distance from the end of the coupling to the end of the pin inside the coupling. If the measured distance is different from the nominal distance by more than +0.200 inch or –0.375 inch, the condition shall be cause for rejection.

18.13.2 Round Thread

18.13.2.1 Triangle Location

Verify the location of the triangle stamp on the field end of each length of 16, $18\,5/8$, and 20 round thread casing. Using a metal scale, measure from the end of the pin to the base of the triangle. Hold the scale parallel to the longitudinal axis of the pipe. If the triangle stamp cannot be located or if the triangle is in the wrong position ($\pm 1/32$ inch) it shall be reported to the owner. The base of the triangle will aid in locating the vanishing point for basic power tight makeup; however, the position of the coupling with respect to the base of the triangle shall not be a basis for acceptance or rejection of the product. As a guide, makeup of the couplings should be measured as described in below.

18.13.2.2 Coupling Makeup (Not API, but Provided As a Guide)

For all sizes, determine the distance $N - L_4$, where N is the measured coupling length. This is the nominal position of the end of the pin in the coupling. Measure the distance from the end of the coupling to the end of the pin inside the coupling. If the measured distance is different from the nominal distance by more than ±0.250 inch, the condition should be reported to the owner.

18.14 PROCEDURE FOR EVALUATING STRAIGHTNESS

18.14.1 All pipe shall be reasonably straight. This judgment criteria applies to all sizes and is the only straightness requirement for sizes smaller than $4\,1/2$. If the pipe is not reasonably straight it is cause for rejection.

18.14.2 For pipe sizes $4\,1/2$ and larger, use the following procedure:

a. Chock the pipe so it cannot roll, with the major arc or bow oriented in the horizontal plane.

b. Measure and record the total length of the pipe from one end to the other. The total length shall be converted to inches prior to calculation of maximum chord height. Maximum chord height is total pipe length in inches times 0.002.

c. Stretch a taut string or wire across the arc or bow from one end to the other. The taut string or wire should be extended between couplings, upsets, or protectors; not over them. See Figure 6.

Measure and record the maximum distance (chord height) from the taut string or wire to the pipe body (see Figure 6). If the measured value exceeds the calculated maximum chord height, the pipe shall be dispositioned in accordance with 18.14.4.

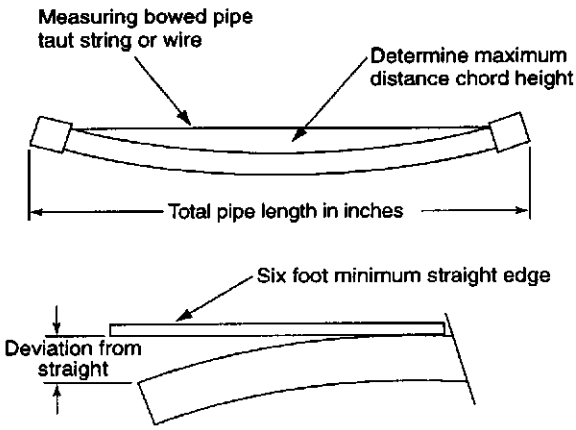


Figure 6—Measuring Hooked-End Plain-End Pipe

18.14.3 For plain-end pipe sizes $4^1/_2$ and larger, deviation from straight shall not exceed 0.125 inch in a 5-foot length at each end. See Figure 6 for method of measurement. If the measured value is greater than the above tolerance, the pipe shall be dispositioned in accordance with 18.14.4.

18.14.4 Pipe not meeting straightness requirements shall be given one of the following dispositions:

a. The pipe is rejected.

b. Hooked ends may be cut off within the limits of requirements on length if agreed upon between the owner and the manufacturer or processor.

The pipe may be straightened if agreed upon between the owner and the manufacturer or processor.

18.15 PROCEDURE FOR EVALUATING PIPE DIAMETER

When diameter is measured the procedure in 18.15.1 and 18.5.2 applies:

18.15.1 Determination of Outside Diameter

Determine either the minimum or maximum outside diameter, whichever is applicable, using a caliper or other suitable instrument at the point of interest.

18.15.2 Reject Criteria for Pipe Diameter

If the pipe has a diameter exceeding the tolerances of the latest edition of API Specification 5CT, it shall be dispositioned as follows:

a. Disposition A. The section of pipe containing an unacceptable diameter may be cut off within the limits of requirements on length if agreed between the owner and the manufacturer or processor.

b. Disposition B. Reject the length.

c. Disposition C. By agreement between the owner and the manufacturer or processor, pipe with an unacceptable diameter may be repaired.

19 Hydrostatic Pressure Testing

19.1 GENERAL

This section describes the equipment and procedures used to hydrostatically pressurize OCTG for the purpose of detecting leaks in the body, couplings, mill end connections, or pin end threads. This section applies to rack testing only.

Typically field pressure testing is conducted using a pressure that produces a fiber stress in the OCTG which is in accordance with the applicable tables and formulas listed in the latest edition of API Specification 5CT, Section 9.4.

Note: Because of environmental considerations, the use of fresh water for hydrotesting may be desirable.

19.2 APPLICATION

API Specification 5CT, Section 9.4, requires that all OCTG shall comply with the test requirements for the particular designation, grade, and end finish shown in referenced tables.

19.2.1 The OCTG body, upset, coupling, or box (excluding threads) shall be free of leakage.

19.2.2 The connection between the coupling and mating mill end shall be free of leakage.

19.2.3 API Specification 5CT contains no criteria for leakage of the threaded connections engaged by the pressure test plugs.

19.3 EQUIPMENT, SAFETY, AND GENERAL PROCEDURES

The equipment typically consists of a pressure test unit equipped with pressure and recording gauges plus test plugs.

19.3.1 Pressure Gauge

The pressure test unit shall be equipped with an indicating pressure gauge which shall directly indicate the full hydrostatic pressure being applied. The indicating pressure gauge shall have a graduated dial for the entire pressure range, and its range will exceed the test pressure by a minimum of 25 percent. The gauge should be located in a position that will be convenient for the operator to observe throughout the test. The gauge shall have sufficient accuracy, scale divisions, and damping so that it can be easily read to within 5 percent of the applied pressure throughout the pressure cycle. Gauges shall not be over-pressurized.

19.3.2 Pressure Recording

In addition to the indicating pressure gauge, each hydrostatic pressure test unit shall have a recording-type pressure gauge connected to read the full applied pressure throughout each pressure cycle. The recording gauge reading shall be compared with the indicating pressure gauge a minimum of once per hour to ensure reliability.

19.3.3 Test Plugs

Documentation shall be provided to assure the test plugs are fabricated from material sufficient to withstand the pressure to which they may be subjected. Test plugs should have effective anti-gall (see note) protection on the threads. Round thread pin end test plugs shall be manufactured so that they cover the threads to the plane L_1 plus four threads (minimum). Buttress pin end test plugs should completely cover the L_4 area (minimum).

Note: Martensitic chromium steels (9Cr and 13Cr - 5CT - Group 2 grades) are sensitive to galling. Special precautions may be necessary for thread surface treatment and/or lubrication to minimize galling during hydrostatic testing (plug application and removal).

19.3.4 Safety

19.3.4.1 Safety Precautions

The pressure testing of OCTG is a dangerous operation, and appropriate safety precautions should be taken.

19.3.4.2 Air Entrapment

Care should be taken to protect both the testing personnel and others from moving OCTG, test plugs, and test fluids in case of failure of threads, pressure plugs, lines, or connections. If air is entrapped in the OCTG, the movement may be sudden, quick, and without warning.

19.3.4.3 Control of Pressure

The pressure shall be under proper control at all times so that the required test pressure is never exceeded by more than 5 percent.

19.3.5 General Procedures

19.3.5.1 Pressure-hold Time

The pressure-hold time shall be a minimum of five seconds after the gauge indicator has reached its maximum stable pressure value.

19.3.5.2 Protection of Threads

Care shall be used in handling OCTG while the thread protectors are removed to ensure that the unprotected threads of two lengths do not strike one another, damaging the thread or sealing surfaces. Also, care shall be used in installing threaded pressure plugs onto the OCTG to ensure that no cross threading or other damage occurs to the threads.

Note: Seal rings (if supplied) must be removed prior to testing.

19.3.5.3 Temperature

The water or other liquid used for pressure testing, and the OCTG being tested, shall be approximately the same temperature during the pressure-hold cycle. If testing is done at an ambient temperature below 40°F, the temperature of the water shall be by agreement between the owner and the agency.

19.3.5.4 Test Plugs

Test plugs shall be visually inspected before each use for thread imperfections and damage that would affect the integrity of the mating product threads. Damaged test plugs shall be repaired or replaced. At regular intervals established by the responsible parties performing the testing, test plugs shall be inspected visually for wear and damage and nondestructively for cracks using the wet fluorescent magnetic particle or penetrant method of inspection. Prior to the start of each job, test plugs shall be thread gauged with all thread element (lead, height, taper) readings recorded.

19.4 EQUIPMENT CALIBRATION

19.4.1 Calibration Check

The indicating pressure gauge, recording gauge, or reference gauge should be checked for accuracy, over the entire range of the gauge, whenever:

a. There is a failure to respond smoothly and repeatably to slowly increasing pressures.
b. It is over pressurized, in which case it should also be recalibrated prior to further use.
c. Gauge repairs have been made.
d. Four (4) months or more have passed since the previous calibration check.
e. Indicating pressure gauge and recording gauge, or reference gauge, are in disagreement by more than 5 percent of the applied pressure.

19.4.2 Calibration Tag

A calibration tag shall be attached to each pressure measuring gauge. Each tag shall indicate the calibration check date, due date, accuracy, and the name of the person or organization performing the calibration.

19.4.3 Time Control

When a time delay control or indicator is used to ensure proper test time, the control should be checked once every inspection shift. A stop watch may be used.

19.5 OPERATING PROCEDURE

The following procedure is recommended for field pressure testing of OCTG.

19.5.1 After removing the thread protectors, examine the threaded areas. If the threads are dry and/or dirty, then the threads shall be cleaned of all old thread compound and/or dirt and fresh thread compound applied. If cleaned, examine the threads before reapplying compound. Lengths with damaged threads shall be repaired before testing or be rejected. Compound that is applied shall be clean and undiluted thread compound that meets the performance objectives of API Recommended Practice 5A3; however, the owner may direct a specific compound be used.

CAUTION: Solvents and other cleaning agents may contain hazardous materials. Solvents are normally volatiles and may build up pressure in containers. Material Safety Data Sheets should be read and the precautions observed when handling products of this type. Storage, transport, use and disposal of excess materials and containers should be considered. Observe appropriate regulations relative to disposal of used solvents and generated waste materials.

19.5.2 The end of the OCTG, opposite the fill end, is elevated to facilitate purging all air prior to starting the pressure cycle. Pressure test plugs are screwed on each end of the OCTG and torqued to ensure a good seal.

19.5.3 Connect the lines and begin filling the OCTG with water. Allow all air and air-water mixture to exit through the high pressure valve on the elevated end of the OCTG. When all air has been purged, the high pressure valve on the elevated end is closed.

19.5.4 Bring the OCTG up to the required pressure, then stop applying pressure, and hold so that the hydrostatic pressure can be closely observed. The cause for any observable pressure drop during the hold cycle shall be identified through observation of the OCTG, connections and plugs. If the cause of the pressure drop is not discovered, or if a leak is discovered between the pipe and pressure cap or between the coupling and the pressure test plug, clean and examine the pipe and/or coupling threads to look for a condition which might cause a leak. If no cause is found, then clean and examine the pressure test plug and/or cap. If no cause for the leak is found, re-lubricate the thread and pressure test a second time.

19.5.5 If the pressure drops perceptibly during the second test, the length shall receive one of the following dispositions:

a. If the OCTG body, upset, coupling, or box (excluding threads) bursts, leaks, seeps, or weeps, the length is unacceptable and shall be rejected.

b. If the connection between the coupling and mating mill end threads leaks, the length shall be rejected and marked for repair.

c. If the threaded connections engaged by the pressure test plugs have a large leak, exceeding 10 percent drop of test pressure in five seconds, the threads should receive additional inspection to determine acceptability.

d. If the OCTG holds pressure and the plugs seal or only leak slightly, the length is acceptable.

19.5.6 If a large leak is discovered in two successive lengths of OCTG on the same end, the pressure test plug on the leaking end of the lengths shall be removed. Clean and dry the plug threads, and carefully examine them for possible mechanical damage. If thread damage is found, replace the plug or repair it.

19.5.7 After the pressure testing of each acceptable length of OCTG, release the hydrostatic pressure, and remove the water from the length. Remove the test plugs from the OCTG. Product threads shall be examined for damage such as cuts and galls. As a minimum, clean an inspect the connections on each tenth length.

CAUTION: Solvents and other cleaning agents may contain hazardous materials. Solvents are normally volatiles and may build up pressure in containers. Material Safety Data Sheets should be read and the precautions observed when handling products of this type. Storage, transport, use and disposal of excess materials and containers should be considered. Observe appropriate regulations relative to disposal of used solvents and generated waste materials.

19.5.8 Apply thread compound and protectors in accordance with Section 8 of this recommended practice.

19.5.9 Mark all tested OCTG in accordance with Section 20 of this recommended practice.

20 Marking

20.1 GENERAL

This section sets forth the recommended practice for the uniform inspection marking of new OCTG.

20.2 AUTHORITY

The classification of each inspected length shall be performed only by a qualified inspector. However, any crew member may be directed to paint the length with appropriate descriptions and paint bands.

20.3 GENERAL GUIDELINES (SEE NOTE)

Note: Inspection markings on rejected OCTG shall be kept to a minimum to facilitate salvage.

20.3.1 Legibility

No inspection markings shall be placed over the mill markings (except the paint stripe identifying the location of

the buttress thread triangle) that reduce the legibility of the manufacturer's markings, unless an imperfection exists under such marking.

20.3.2 Paint Bands

All paint bands or stripes shall be approximately 1 inch wide and applied neatly on the OCTG. They shall be placed as close as possible to the coupling, box, or identified end of the OCTG (but not on threads).

20.3.3 Exploratory Areas

All exploratory marks and grinds except those on rejected lengths should be covered with a rust-inhibiting coating.

20.3.4 Sequence Number

Each length of inspected OCTG shall have a unique number printed in white paint in accordance with 8.3.3.

20.3.5 Marking

For $2^{3}/_{8}$ and larger OCTG, white paint markings shall be placed adjacent to the inspection paint band or stripe or following the mill markings. These markings shall identify the agency, work order number, type of inspection, and date (month and year) of the inspection. On each reject length, the type and depth (if applicable) of defect shall be printed in white paint, and the word "REJECT" shall be printed after the type of inspection in white paint. The format illustrated in Figure 7 is presented as an example only. On small diameter OCTG, it may be necessary to place the markings in a single line along the longitudinal axis. On couplings, connectors, and OCTG smaller than $2^{3}/_{8}$, an alternate marking method may be used by agreement between the owner and the agency. Inspection techniques shall be indicated using either descriptive wording or the following abbreviations. (By agreement between the owner and the agency, a trade name may be substituted for a specific inspection.)

a. FLEMI: full-length electromagnetic inspection.
b. SEA: end area inspection.
c. FLVI: full-length visual inspection.
d. FLD: full-length drifting.
e. VTI: clean and visual thread inspection.
f. FLMPI: full-length magnetic particle inspection.
g. HRC or HRB: Hardness Rockwell C (or B) test.
h. TESTED: hydrostatically tested xxx psi.
i. UTFL: ultrasonic full-length inspection.
j. UTW: ultrasonic weld inspection only.
k. ALT FLD: alternate full-length drifting.
l. API TG: API thread gauging (thread element measuring).

20.3.6 Drill Pipe Without Tool Joints

All inspection paint bands and stencils normally placed on the identified end shall be placed at least 3 feet from this end.

20.4 MARKING OF PRIME OCTG

20.4.1 Requirements

Each length of OCTG that meets the requirements in the latest edition of API Specification 5CT and Standard 5B, or Specification 5D, for the specific inspections being performed, is classified as prime.

Note: Each coupling shall carry its own classification. If the length has integral connections the length and the connections together shall be given one classification.

20.4.2 Markings

One white paint band or white stripe placed on the OCTG as close as possible to the identified end, and other markings as described in 20.3.5.

20.5 MARKING OF NO-DRIFT OCTG

20.5.1 Requirements

Each length of OCTG that will not pass an API dimensioned drift will be classified as no-drift.

20.5.2 Markings

All of the following are required:

a. One red paint band around the OCTG as close as possible to the coupling, box, or identified end.
b. One red paint band around the OCTG on each side of the location where the drift will not pass.
c. "No Drift to xx.xxx" printed in white paint over the location where the drift mandrel will not pass.
d. Markings as described in 20.3.5.

20.6 MARKING OF CONDITIONED OCTG

20.6.1 Requirements

Each length of OCTG that has a defect requiring conditioning according to API Specification 5CT or 5D shall be classified as prime after proper conditioning.

20.6.2 Markings

After the OCTG has been properly conditioned, the length is considered prime and shall be identified as described in 20.3.5.

20.7 MARKING OF CONDITIONABLE OCTG (TO BE CONDITIONED)

Note: When a length of OCTG has integral connections, the length and the connections together shall be given one classification.

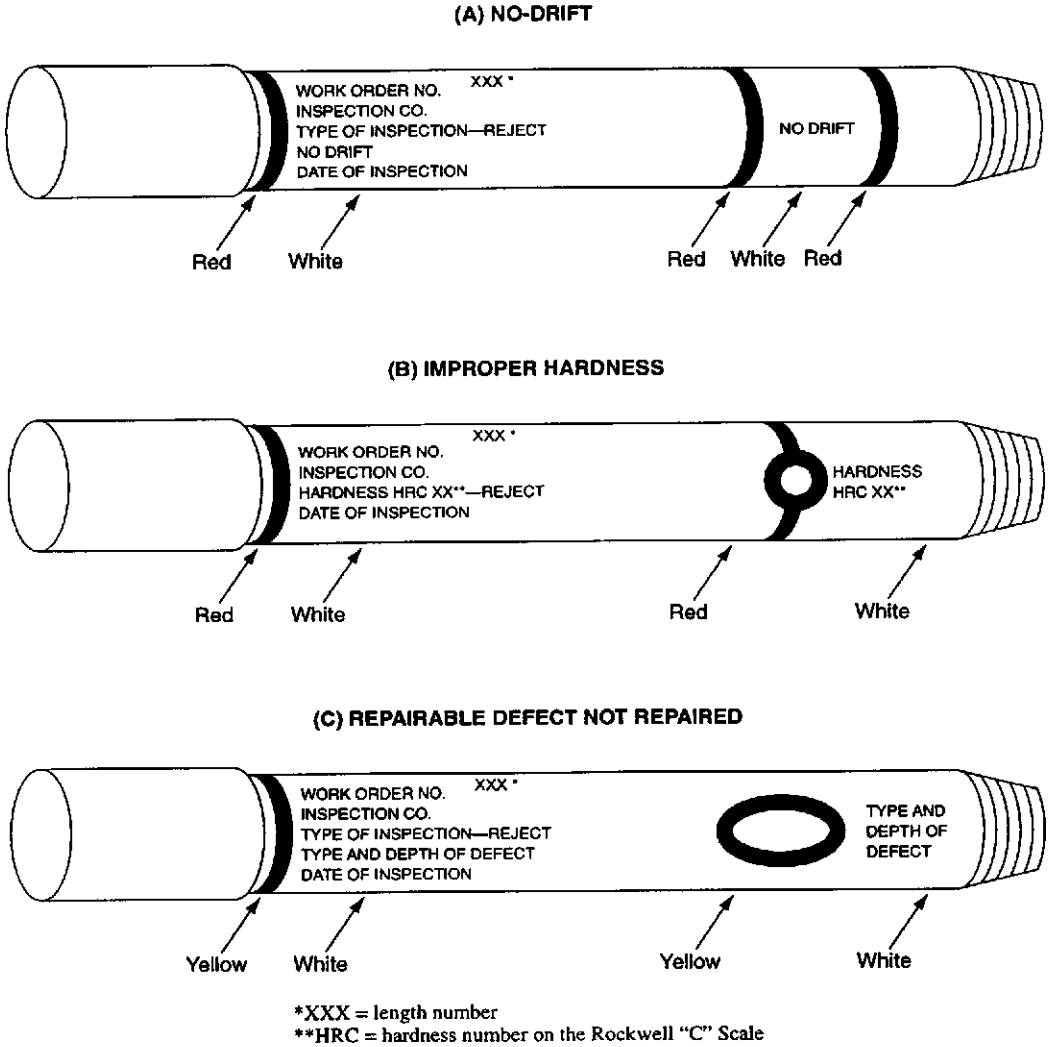
20.7.1 Requirements

Each length of OCTG that has a defect requiring conditioning according to API Specification 5CT or 5D and not conditioned shall be classified as a conditionable length.

20.7.2 Markings

All of the following are required:

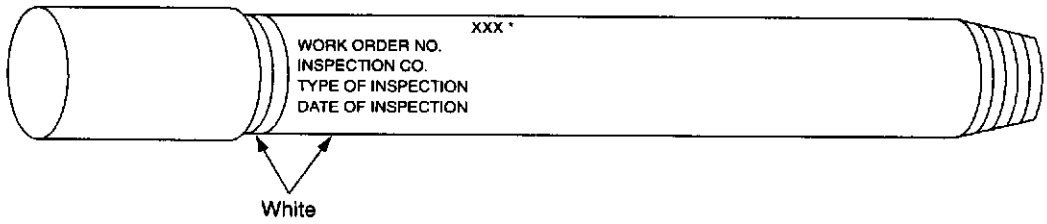
a. One yellow paint band around the OCTG as close as possible to the identified end.
b. Yellow paint outlining the total length and width of the defect on the outside surface.
c. Type and depth of the defect printed in white paint adjacent to the defect.
d. Other markings as described in 20.3.5.



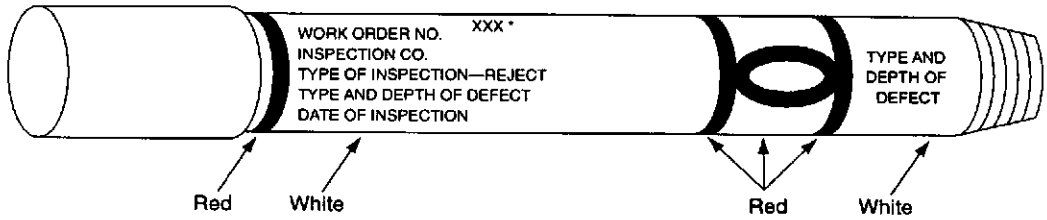
*XXX = length number
**HRC = hardness number on the Rockwell "C" Scale

Figure 7—Identification of Inspected New Tubular Goods and Couplings

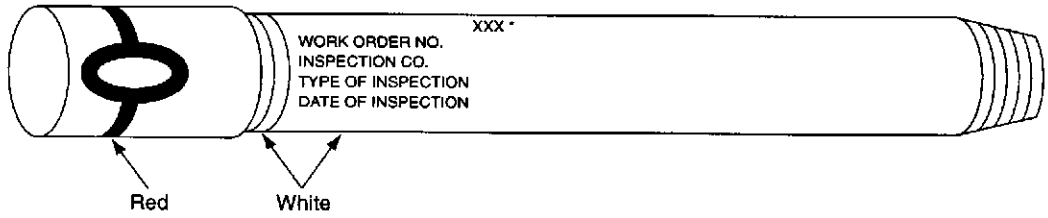
(D) PRIME LENGTH



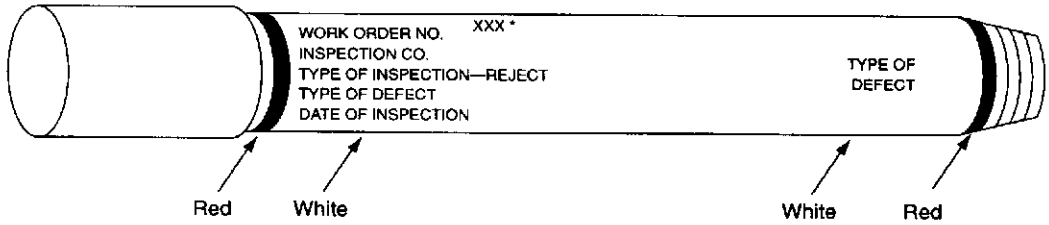
(E) DEFECTIVE LENGTH



(F) DEFECTIVE COUPLING



(G) DEFECTIVE PIN



*XXX = length number

Figure 7—Identification of Inspected New Tubular Goods and Couplings (Continued)

20.8 MARKING OF NONCONDITIONABLE (REJECT) OCTG

20.8.1 Requirements

Each length of nonconditionable OCTG containing a defect, as defined in API Specification 5CT and Standard 5B, or Specification 5D, shall be classified as a reject. When a OCTG has a defective pin connection or integral box connection, the entire length shall be rejected.

20.8.2 Markings

All of the following are required:

a. One red paint band around the OCTG as close as possible to the coupling, box, or identified end.
b. Red paint outlining the total length and width of the defect on the outside surface.
c. One red paint band around the OCTG at each end of the defect. In the case of a defective pin connection, the red paint band is placed adjacent to the last scratch of the threads (but not on the threads).
d. Type and depth of the defect printed in white paint adjacent to the defect.
e. Markings as described in 20.3.5.

Note: When more than one defect appears in a length, then by agreement between the owner and the agency, all of the defects shall be outlined in red paint, but only the deepest defect need be measured and recorded.

20.9 MARKING OF OCTG NOT MEETING API SPECIFICATIONS FOR HARDNESS

20.9.1 Requirements

Each length of OCTG that does not meet API specifications for hardness is identified with red paint.

20.9.2 Markings

All of the following are required:

a. One red paint band as close as possible to the coupling, box, or identified end.
b. One red paint circle around the test area and one red paint band around the OCTG at the test area, the ends of which connect with the paint circle.
c. The hardness value printed in white paint on the OCTG adjacent to the test area.
d. Markings as described in 20.3.5.

20.10 MARKING OF PRIME COUPLINGS AND CONNECTORS

20.10.1 Requirements

Couplings and connectors that are found to have no defects are classified as prime.

20.10.2 Markings

If the coupling is installed on OCTG, no identifying color band is required.

For couplings not installed on OCTG and connectors, one white paint band is placed around the coupling or connector at one end and the name of the agency is printed in white paint in full (if space permits) or else in abbreviated form.

20.11 MARKING OF CONDITIONED COUPLINGS AND CONNECTORS

All couplings and connectors that contain imperfections that have been conditioned and meet the requirements for couplings and connectors in the latest edition of API Specification 5CT are considered prime and shall be identified as described in 20.10.2.

20.12 MARKING OF CONDITIONABLE COUPLINGS AND CONNECTORS (TO BE CONDITIONED)

20.12.1 Requirements

When a length of OCTG has a removable coupling with imperfections that require conditioning by grinding, the coupling shall carry its own identification, independent of the pipe.

20.12.2 Markings

All of the following are required:

a. One yellow paint band around the coupling or connector.
b. Yellow paint outlining the defect on the outside surface of the coupling or connector.
c. White paint on an attached coupling that indicates the OCTG sequence number with a "C" after it and the type and depth of the defect.
d. White paint on a connector or unattached coupling that indicates a reject number and the type and depth of the defect.

20.13 MARKING OF NONCONDITIONABLE (REJECT) COUPLINGS AND CONNECTORS

20.13.1 Requirements

When a length of OCTG has a coupling with defects, the coupling shall carry its own identification, independent of the pipe.

20.13.2 Markings

All of the following are required:

a. One red paint band around the coupling or connector.
b. Red paint outlining the defect on the outside surface of the coupling or connector.

c. White paint on an installed coupling that indicates the OCTG sequence number with a "C" after it and the type and depth of the defect.

d. White paint on a connector or unattached coupling that indicates a reject number and the type and depth of the defect.

Table 19—Summary of New OCTG Inspection Identification Bands

Classification	Band Color
Prime OCTG	White
Acceptable conditioned OCTG	White
OCTG requiring conditioning	Yellow
Nonconditionable (reject) OCTG	Red
OCTG failing API drift tests	Red
OCTG failing API hardness specifications	Red
Prime connector or unattached coupling	White
Acceptable conditioned connector or unattached coupling	White
Couplings or connectors requiring conditioning	Yellow
Nonconditionable (reject) coupling or connector	Red
OCTG failing special owner specified tests	Green

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