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QC Welding Inspector Interview Question & Answers

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QC Welding Inspector

Interview Question & Answers

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- **What does QC mean?**

  Quality control (QC) is a process through which a business seeks to ensure that product quality is maintained or improved. Quality control requires the business to create an environment in which both management and employees strive for perfection. This is done by training personnel, creating benchmarks for product quality and testing products to check for statistically significant variations.

- **Question 1: What is the difference between QA and QC?**

  Quality control can be defined as "part of quality management focused on fulfilling quality requirements." While quality assurance relates to how a process is performed or how a product is made, quality control is more the inspection aspect of quality management.

- **Four Types of Quality Control?**

  Which type of quality control focuses on making sure the processes are functioning correctly? Acceptance sampling. Process protocol. Process control. Control charts.

  Setting up an inspection plan is what type of quality control? Process control. Acceptance sampling. Control charts. Inspection.

- **What is QAP?**

  A Quality Assurance Plan (QAP) is used to define the criteria and processes that will ensure and verify that data meet specific data-quality objectives throughout the Data Lifecycle.

- **What is an ITP plan?**

  An Inspection & Test Plan (ITP) is a document which describes the plan for managing the quality control and assurance of a particular element of the construction works providing information on the requirements, overview of the method(s) to be used, responsibilities of relevant parties, and documentary evidence to be provided to verify compliance.

- **What is the meaning of hold point in ITP?**

  A Hold Point is a mandatory verification point beyond which work cannot proceed without approval by the designated authority, typically the Engineer or Consultant or 3rd Party Inspector. Work cannot proceed until receipt of a Hold Point Release issued by the person(s) who inspected the work.

- **What is a quality checklist?**

  A quality control checklist is basically a written guide for your products' contents, packaging, color, barcodes, appearance, possible defects, functions and special requirements. It's also sometimes called an “inspection criteria sheet” or inspection checklist.

- **What is the difference between QCP and ITP?**

  While both Construction Quality Control Plans and Inspection and Test Plans are intended to control construction quality, your construction QC plan will focus on a wide-range of elements. Whereas, your inspection and test plan (ITP) will only focus on inspections and tests as a means of quality control.

- **What is a quality control plan?**

  Quality Control Plan (QCP) is a written set of procedures and activities aimed at delivering products that meet quality objectives for a project as stated in contract documents and other procedures, manuals, and guidance.

- **What is piping material specification?**

  The Piping Specification (abbreviated: PIPE SPEC) is a document prepared during the design phase of any project. It provides the appropriate selection, specification and material grade of pipe and piping components for a given service.

  For all subsequent maintenance and repair on a section of pipe, the piping specification remains as the key to correct material selection

- **What are ASTM Grades?**

  ASTM standards define the specific manufacturing process of the material and determine the exact chemical composition of pipes, fittings and flanges, through percentages of the permitted quantities of carbon, magnesium, nickel, etc., and are indicated by "Grade".

  For example, a carbon steel pipe can be identified with Grade A or B, a stainless-steel pipe with Grade TP304 or Grade TP321, a carbon steel fitting with Grade WPB etc..

  Below you will find as an example 3 tables with chemical requirements for:

1. Flanges ASTM A182 Grade F304, F304L F316L
2. Pipes ASTM A312 Grade TP304, TP304L, TP3016L

3. Fittings ASTM A403 Grade WP304, WP304L, WP316L

Furthermore, a table with frequently used ASTM Grades, arranged on Pipes, Fittings, Flanges, Valves, Bolts and Nuts, which belong together as a group.

As you may have noted, in the table below, ASTM A105 has no Grade. Sometimes ASTM A105N is described;

N stands not for Grade, but for normalized. Normalizing is a type of heat treatment, applicable to ferrous metals only. The purpose of normalizing is to remove the internal stresses induced by heat treating, casting, forming etc..

CHEMICAL REQUIREMENTS COMPOSITION, %

Flanges ASTM A182								
Grade	C	Mn	P	S	Si	Ni	Cr	Mo
F304	0.08	2	0.045	0.03	1	8 - 11	18 - 20	
F304L	0.03	2	0.045	0.03	1	8 - 13	18 - 20	
F316L	0.03	2	0.045	0.03	1	10 - 15	16 - 18	2 - 3

Note:

Grades F304, F304L, and F316L shall have a maximum Nitrogen content of 0.10%.

Pipes ASTM A312								
Grade	C	Mn	P	S	Si	Cr	Ni	Mo
TP 304	0.08	2	0.045	0.03	1	18 - 20	8 - 11	
TP 304L	0.035	2	0.045	0.03	1	18 - 20	8 - 13	
TP 316L	0.035	2	0.045	0.03	1	16 - 18	10 - 14	2 - 3

Note:

For small diameter or thin walls or both, where many drawing passes are required, a Carbon maximum of 0.040% is necessary in grades TP304L and TP316L. Small outside diameter tubes are defined as those less than 0.50 in. [12.7 mm] in outside diameter and light wall tubes as those less than 0.049 in. [1.20 mm] in average wall thickness (0.044 in. [1.10 mm] in minimum wall thickness).

Fittings ASTM A403								
Grade	C (1)	Mn (1)	P (1)	S (1)	Si (1)	Ni	Cr	Mo
WP 304	0.08	2	0.045	0.03	1	8 - 11	18 - 20	
WP 304L	0.03 (2)	2	0.045	0.03	1	8 - 12	18 - 20	
WP 316L	0.03 (2)	2	0.045	0.03	1	10 - 14 (3)	16 - 18	2 - 3

Notes:

(1) Maximum, unless otherwise indicated.

(2) For small diameter or thin walls or both, where many drawing passes are required, a Carbon maximum of 0.040% is necessary in grades TP304L and TP316L. Small outside diameter tubes are defined as those less than 0.50 in. [12.7 mm] in outside diameter and light wall tubes as those less than 0.049 in. [1.20 mm] in average wall thickness (0.044 in. [1.10 mm] in minimum wall thickness).

(3) On pierced tubing, the Nickel may be 11.0-16.0%.

FREQUENTLY USED ASTM GRADES

Material	Pipes	Fttg	Flg	Valves	Bolts and Nuts
Carbon Steel	A106 Gr A	A234 Gr WPA	A105	A216 Gr WCB	A193 Gr B7 A194 Gr 2H
	A106 Gr B	A234 Gr WPB	A105	A216 Gr WCB	
	A106 Gr C	A234 Gr WPC	A105	A216 Gr WCB	
Carbon Steel Alloy High-Temp	A335 Gr P1	A234 Gr WP1	A182 Gr F1	A217 Gr WC1	A193 Gr B7 A194 Gr 2H
	A335 Gr P11	A234 Gr WP11	A182 Gr F11	A217 Gr WC6	
	A335 Gr P12	A234 Gr WP12	A182 Gr F12	A217 Gr WC6	
	A335 Gr P22	A234 Gr WP22	A182 Gr F22	A217 Gr WC9	
	A335 Gr P5	A234 Gr WP5	A182 Gr F5	A217 Gr C5	
	A335 Gr P9	A234 Gr WP9	A182 Gr F9	A217 Gr C12	
Carbon Steel Alloy Low-Temp	A333 Gr 6	A420 Gr WPL6	A350 Gr LF2	A352 Gr LCB	A320 Gr L7 A194 Gr 7
	A333 Gr 3	A420 Gr WPL3	A350 Gr LF3	A352 Gr LC3	

Austenitic Stainless Steel	A312 Gr TP304	A403 Gr WP304	A182 Gr F304	A182 Gr F304	A193 Gr B8 A194 Gr 8
	A312 Gr TP316	A403 Gr WP316	A182 Gr F316	A182 Gr F316	
	A312 Gr TP321	A403 Gr WP321	A182 Gr F321	A182 Gr F321	
	A312 Gr TP347	A403 Gr WP347	A182 Gr F347	A182 Gr F347	
Material	Pipes	Fttg	Flg	Valves	Bolts and Nuts

ASTM Materials

PIPES

- **A106** = This specification covers carbon steel pipe for high-temperature service.
- **A335** = This specification covers seamless ferritic alloy-steel pipe for high-temperature service.
- **A333** = This specification covers wall seamless and welded carbon and alloy steel pipe intended for use at low temperatures.
- **A312** = Standard specification for seamless, straight-seam welded, and cold worked welded austenitic stainless steel pipe intended for high-temperature and general corrosive service.

FITTINGS

- **A234** = This specification covers wrought carbon steel and alloy steel fittings of seamless and welded construction.
- **A420** = Standard specification for piping fittings of wrought carbon steel and alloy steel for low-temperature service.

- **A403** = Standard specification for wrought austenitic stainless steel piping fittings.

FLANGES

- **A105** = This specification covers standards for forged carbon steel piping components, that is, flanges, fittings, Valves, and similar parts, for use in pressure systems at ambient and higher-temperature service conditions.
- **A182** = This specification covers forged or rolled alloy and stainless steel pipe flanges, forged fittings, and Valves and parts for high-temperature service.
- **A350** = This specification covers several grades of carbon and low alloy steel forged or ring-rolled flanges, forged fittings and Valves for low-temperature service.

VALVES

- **A216** = This specification covers carbon steel castings for Valves, flanges, fittings, or other pressure-containing parts for high-temperature service and of quality suitable for assembly with other castings or wrought-steel parts by fusion welding.
- **A217** = This specification covers steel castings, martensitic stainless steel and alloys steel castings for Valves, flanges, fittings, and other pressure-containing parts intended primarily for high-temperature and corrosive service.
- **A352** = This specification covers steel castings for Valves, flanges, fittings, and other pressure-containing parts intended primarily for low-temperature service.

- **A182** = This specification covers forged or rolled alloy and stainless steel pipe flanges, forged fittings, and Valves and parts for high-temperature service.

BOLTS AND NUTS

- **A193** = This specification covers alloy and stainless steel bolting material for pressure vessels, Valves, flanges, and fittings for high temperature or high pressure service, or other special purpose applications.
- **A320** = Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
- **A194** = Standard specification for nuts in many different material types.
- **What is ASME Code for piping?**

  ASME B31 was earlier known as ANSI B31. The B31 Code for Pressure Piping, covers Power Piping, Fuel Gas Piping, Process Piping, Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids, Refrigeration Piping and Heat Transfer Components and Building Services Piping.

- **What is Process Piping?**

  Simply put, process piping is used to convert liquids, chemicals, fuels, gases or other raw materials into a usable product. Pipes directing water through an industrial factory to cool processes wouldn't be considered process piping, but if the piping moves the water into processes to be converted into cleaning chemicals, soft drinks, or combined with other materials to make an end product, they would then be process piping.

  So, technically, process piping is any pipe and components that are not part of the building's mechanical systems. Pipe systems for liquids and gases used for

heating and cooling processes, or pipework that leads to plumbing fixtures or waste-water systems, would not be considered process piping systems. Instead, these are considered part of plumbing systems. Process piping is also not used for power processing systems.

Process piping can consist of interconnected piping systems such as tubing, pipes, pressure hoses, valves, separators, traps, flanges, fittings, gaskets, strainers and other components. These piping components can be placed together to move, mix, separate, stop, distribute or control the flow of fluids. Process piping is commonly used in the semiconductor, chemical, paper processing, petroleum refinery, pharmaceutical and textile industries.

- **What is meant by welding?**

  Welding is a fabrication process whereby two or more parts are fused together by means of heat, pressure or both forming a join as the parts cool.

- **What are the 4 types of welding?**

  1. Gas Metal Arc **Welding** (GMAW/MIG) This style of **welding** is also referred to as Metal Inert Gas (MIG).
  2. Gas Tungsten Arc Gas **Welding** (GTAW/TIG)
  3. Shielded Metal Arc **Welding** (SMAW)
  4. Flux Cored Arc **Welding** (FCAW)

- **What are the basics of welding?**

  Welding is done by creating an arc between the base metal (the metal being welded) and the filler metal. The arc melts the base metal and filler metal, combining them into one material to join the base metals. The filler metal is consumed in the process.

- **What is the purpose of welding?**

  The basic purpose of welding is to join two elements together with a firm connection. Welders typically work with metal or thermoplastic and use durable filler material to bind them together.

- **What is WPS WPQ and PQR?**

  WPS – Welding Procedure Specifications.

  PQR – Procedure Qualification Records, and.

  WQT / WPQ – Welder Qualification Test / Welder Performance Qualifications

- **Why PQR is required?**

  A PQR is required when it is necessary to demonstrate that your company has the ability to produce welds possessing the correct mechanical and metallurgical properties. The details of the test such as the welding current, pre-heat etc., must be recorded during the test.

- **What is the purpose of WPS in welding?**

  A Welding Procedure Specification, or WPS, is a document that serves as a guide for the effective creation of a weld that meets all applicable code requirements and production standards. Think of a WPS as a recipe for welders

- **What is a WPQ?**

  A Welder Performance Qualification (WPQ) is a test certificate that shows whether a welder possesses the necessary experience and knowledge to perform the specifications of a particular weld procedure.

- **Which comes first WPS or PQR?**

  The WPS is written from the PQR. A PQR comes before a WPS. A PQR is needed to do a WPS. The PQR is specific while the WPS is generic.

- **What is ASME Section 9?**

  The ASME code is the American Society of Mechanical Engineers (ASME) standard that regulates the design, development and construction of boilers and pressure vessels. ASME Section IX specifies the requirements for the qualification of welders and the welding procedure specifications.

- **How do you qualify for PQR?**

  The PQR must include all essential variables (such as P number, F number, A number, PWHT) and supplementary essential variables (such as Group Number). The nonessential variables are not code requirements for PQR.

- **What does AWS stand for in welding?**

  ## American Welding Society

  The American Welding Society (AWS) was founded in 1919, as a nonprofit organization with a global mission to advance the science, technology and

application of welding and allied joining and cutting processes, including brazing, soldering and thermal spraying.

- **What does WPQR stand for?**

  Welding Procedure Qualification Record

  Welding Procedure Qualification Record (WPQR) A record of welding variables used to produce an acceptable test weldment and the results of tests con-ducted on the weldment to qualify a welding procedure specification.

- **What are variables in welding?**

  There are so many welding variables that influence a weld's quality; the variables are amps, volts, travel speed, filler metal, shielding gas, base material, etc.

- **What is an essential variable in WPS?**

  This is defined as a change in a welding condition that will affect the mechanical properties (other than notch toughness) of the weldment (for example, change in P-number, welding process, filler metal, electrode, preheat or post-weld heat treatment, etc.)

- **What is a Non-essential variable in WPS?**

  Nonessential variables are those that do not have a significant influence on tensile strength or ductility of the completed weld. Arc Voltage, Amperage, Travel Speed are Non-essential variables.

- **What are the supplementary essential variables in WPS?**

The code defines it as "Supplementary essential variables are conditions in which a change will affect the toughness properties of the joint, heat-affected zone, or base material". The supplementary essential variable becomes an essential variable when welding procedure qualification requires impact testing.

- **What is the F number in welding?**

  “The grouping of electrodes and welding rods in Table QW-432 is based essentially on their usability characteristics, which fundamentally determine the ability of welders to make satisfactory welds with a given filler metal.

- **What is A number in WPS?**

  A number gives a similar chemical composition in a “as weld” condition. The A number is an essential variable in most welding processes in ASME Code Section IX.

  Please note the A number in WPS does not refer to the filler wire or electrode chemical composition; it refers to the deposited weld metal chemical composition.

- **What is the P number?**

  To reduce the number of welding procedure qualifications that are required, P-Numbers (shortened to P-No) are assigned to base metals according to the characteristics of the material, such as composition, weldability, brazeability and mechanical properties.

- **What is the difference between P number and group number?**

  P numbers are groupings of base metals with similar welding characteristics that have been approved for pressure boundaries when constructing pressure vessels or piping systems. Group numbers are sub-groupings within a P number that further subdivides the P number.

- **What is SFA no in welding?**

  SFA is a universal classification system for filler materials. 5.1 is for carbon steel electrodes for SMAW, hence the designation E-6013

- **What is backing in welding?**

  Backing is defined as material placed at the root of a weld joint for the purpose of supporting molten weld metal.

- **How do you calculate metal filler consumption?**

  Calculating Filler Metal Consumption The number of pounds of welding electrodes or welding wire necessary to complete a given weld joint may be calculated by the formula: P = WL E Where: P = Pounds of electrode or wire required W = Weight per foot of weld metal L = Length of weld (feet) E = Deposition efficiency

- **Why do you carry out purging in GTAW of stainless steel pipe joints?**

  Preventing oxidation and thus avoiding discolouration and welding underbead discontinuities in tubes and pipes can be achieved readily by purging the inside with inert gas.

- **What does E6013 stand for?**

  The first character “E” in E6013 stands for flux covered electrode as used in Metal Manual Arc Welding. E60XX: The next two characters indicate the minimum tensile strength, 1 for position & 3 for coating type.

- **How do I choose a welding consumable?**

  As a rule, when welding materials that have different tensile strengths, the consumable you choose should match the material with the lower tensile strength. The preheat temperature you use should match what is required for the material with the higher tensile strength.

- **How to Store and redry welding consumables?**

  Electrodes for Shielded Metal Arc Welding (SMAW) or stick electrodes must be properly stored in order to deposit quality welds. When stick electrodes absorb moisture from the atmosphere, they must be dried in order to restore their ability to deposit quality welds. Electrodes with too much moisture may lead to cracking or porosity. Operational characteristics may be affected as well. If you've experienced unexplained weld cracking problems, or if the stick electrode arc performance has deteriorated, it may be due to your storage methods or re-drying procedures.

  Follow these simple storage, exposure and redrying techniques to ensure the highest quality welds, as well as the best operational characteristics from your stick electrodes.

Storing Low Hydrogen Stick Electrodes

Low hydrogen stick electrodes must be dry to perform properly. Unopened Lincoln hermetically sealed containers provide excellent protection in good storage conditions. Opened cans should be stored in a cabinet at 250 to 300°F (120 to 150°C). Low hydrogen stick electrode coatings that have picked up moisture may result in hydrogen induced cracking, particularly in steels with a yield strength of 80,000 psi (550 MPa) and higher.

Moisture resistant electrodes with an "R" suffix in their AWS classification have a high resistance to moisture pickup coating and, if properly stored, will be less susceptible to this problem, regardless of the yield strength of the steel being welded. Specific code requirements may indicate exposure limits different from these guidelines.

All low hydrogen stick electrodes should be stored properly, even those with an "R" suffix. Standard EXX18 electrodes should be supplied to welders twice per shift. Moisture resistant types may be exposed for up to 9 hours.

When containers are punctured or opened, low hydrogen electrodes may pick up moisture. Depending upon the amount of moisture, it will damage weld quality in the following ways:

1. A greater amount of moisture in low hydrogen electrodes may cause porosity. Detection of this condition requires x-ray inspection or destructive testing. If the base metal or weld metal exceeds 80,000 psi (550 MPa) yield strength, this moisture may contribute to under-bead or weld cracking.

2. A relatively high amount of moisture in low hydrogen electrodes causes visible external porosity in addition to internal porosity. It also may cause excessive slag fluidity, a rough weld surface, difficult slag removal, and cracking.

3. Severe moisture pickup can cause weld cracks in addition to under-bead cracking, severe porosity, poor appearance and slag problems.

Redrying Low Hydrogen Stick Electrodes

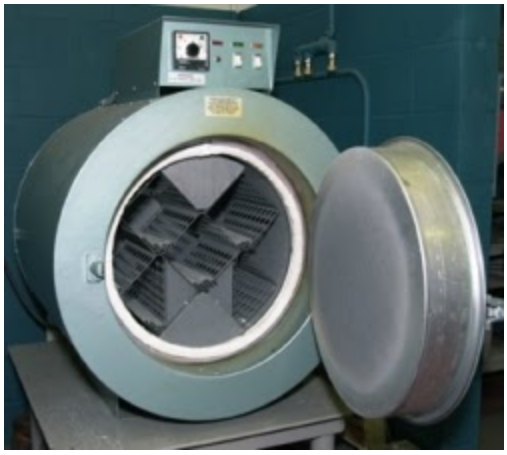
Redrying, when done correctly, restores the electrodes' ability to deposit quality welds. Proper redrying temperature depends upon the electrode type and its condition.

One hour at the listed final temperature is satisfactory. DO NOT dry electrodes at higher temperatures. Several hours at lower temperatures is not equivalent to using the specified requirements.

Electrodes of the E8018 and higher strength classifications should be given no more than three one-hour re-dries in the 700 to 800°F (370 to 430°C) range. This minimizes the possibility of oxidation of alloys in the coating resulting in lower than normal tensile or impact properties.

Any low hydrogen electrode should be discarded if excessive redrying causes the coating to become fragile and flake or break off while welding, or if there is a noticeable difference in handling or arc characteristics, such as insufficient arc force.

Electrodes to be redried should be removed from the can and spread out in the oven because each electrode must reach the drying temperature.



Redrying Conditions - Low Hydrogen Stick Electrodes

		Final Redrying Temperature	
Condition	Pre-drying Temperature(1)	E7018, E7028	E8018, E9018, E10018, E11018
Electrodes exposed to air for less than one week; no direct contact with water.	N/A	650 to 750°F (340 to 400°C)	700 to 800°F (370 to 430°C)
Electrodes which have come in direct contact with water or which have been exposed to high humidity.	180 to 220°F (80 to 105°C)	650 to 750°F (340 to 400°C)	700 to 800°F (370 to 430°C)

(1) Pre-dry for 1 to 2 hours. This will minimize the tendency for coating cracks or oxidation of the alloys in the coating.

Storing and Redrying Non-Low Hydrogen Electrodes

Electrodes in unopened Lincoln cans or cartons retain the proper moisture content indefinitely when stored in good condition.

If exposed to humid air for long periods of time, stick electrodes from opened containers may pick up enough moisture to affect operating characteristics or weld quality. If moisture appears to be a problem, store electrodes from the opened containers in heated cabinets at 100 to 120°F (40 to 50°C). DO NOT use higher temperatures, particularly for electrodes from the "Fast Freeze" group.

Some electrodes from wet containers or long exposure to high humidity can be re-dried. Adhere to the procedures in the following table for each type.

Redrying Conditions - Non-Low Hydrogen Stick Electrodes

Stick Electrode	Electrode Group	Final Redrying Temperature	Time
E6010: Fleetweld 5P, 5P+ E6011: Fleetweld 35, 35LS, 180 E7010-A1: SA-85(1) E7010-G: SA-HYP+(1) E8010-G: SA-70+(1), SA-80(1) E9010-G: SA-90(1)	Fast Freeze - excessive moisture is indicated by a noisy arc and high spatter, rusty core wire at the holder end or objectionable coating blisters while welding. Re-baking of this group of stick electrodes is not recommended.	Not Recommended	N/A
E7024: Jetweld 1, 3 E6027: Jetweld 2	Fast Fill - excessive moisture is indicated by a noisy or "digging" arc, high spatter, tight slag, or undercut. Pre-dry unusually damp electrodes for 30 - 45 minutes at 200°F to 230°F (90 - 110°C) before final drying to minimize cracking of the coating.	400 to 500°F (200to 260°C)	30 - 45 minutes
E6012: Fleetweld 7 E6013: Fleetweld 37 E7014: Fleetweld 47 E6022: Fleetweld 22	Fill Freeze - Excessive moisture is indicated by a noisy or "digging" arc, high spatter, tight slag or undercut. Pre-dry unusually damp electrodes for 30 - 45 minutes at 200° - 230°F (90° - 110°C) before final drying to minimize cracking of the coating	300 to 350°F (150 to 180°C)	20 - 30 minutes

(1) Pre-dry for 1 to 2 hours. This will minimize the tendency for coating cracks or oxidation of the alloys in the coating.

Using longer drying times or higher temperatures can easily damage the electrodes. For drying, remove the electrodes from the container and spread them out in the furnace because each stick electrode must reach the drying temperature.

- **What welding rod do I use to weld stainless to carbon steel?**

  Use 309L (including ER309LSi) when joining mild steel or low alloy steel to stainless steels, for joining dissimilar stainless steels such as 409 to itself or to 304L stainless, as well as for joining 309 base metal. CG-12 is the cast equivalent of 309

- **What is oxidation in welding?**

  Oxidation is the reaction of metal and oxygen. If the oxide formed is continuous and effective in separating the alloy from the atmosphere, the oxide is protective. However, if the oxide fails to act as a separator, problems with corrosion occur.

- **What are the welding defects?**

  Welding Defects can be defined as the irregularities formed in the given weld metal due to wrong welding process or incorrect welding patterns, etc. The defect may differ from the desired weld bead shape, size, and intended quality. Welding defects may occur either outside or inside the weld metal.

- **What are the types of welding defects?**

  Weld Crack, Porosity, Undercut, Incomplete Fusion, Incomplete Penetration, Slag Inclusion, Spatter etc.

- **What are the welding defects of fillet weld?**

  Root or face undercut, Excess convexity, Excess weld metal (excess cap height), Incomplete fill (face concavity or missed edge). Insufficient throat in fillet welds etc.

- **How do you prevent welding defects?**

  Use low hydrogen filler metals when possible

  Most filler metal manufacturers offer a variety of products, particularly flux-cored wires and stick electrodes that produce low levels of diffusible hydrogen. When welding ferritic (or iron-based) steels, the use of these filler metals can be a particularly good defense against weld failures caused by hydrogen-induced cracking, also referred to as cold cracking. This type of weld failure typically occurs within hours to days after the weld has cooled, and is the result of residual stress from the base material being restrained along the weld, along with the presence of hydrogen in the weld. Thicker materials are more prone to the failure, since they tend to create areas of high restraint and can serve as a heat sink that leads to fast cooling rates — the ideal condition for hydrogen to coalesce and add to the residual stresses in the weld. High-strength steels and applications with constrained joints are also prone to weld failures via cold cracking.

  Filler metals with an H4 or H8 designator are a good choice to prevent weld failures associated with cold cracking, as they minimize the amount of hydrogen going into the weld in the first place, and with it, the opportunity to cause cracking upon the weld cooling. These filler metals contain less than 4 or 8 ml of hydrogen per 100 g weld metal, respectively.

  In certain cases, using filler metals with a basic slag system can also help reduce the risk of weld failures from cold cracking. These filler metals typically

contain high levels of hydrogen scavengers, including fluoride, sodium and calcium that can combine with hydrogen to remove it from a cooling weld.

Take care with fit-up and joint design

Proper part fit-up and good joint design are both key in preventing weld failures, particularly those associated with hot cracking. When presented with either of these conditions, it is not uncommon for a welding operator to try to compensate by creating a wider weld bead to fuse the metal together. The danger in doing so, however, is that the resulting weld may have too thin of a throat, causing it to be weak and create stress on the center of the weld. The result is quite often a condition called bead-shape cracking, which is a specific type of hot cracking, and it appears immediately upon the weld cooling.

A good rule of thumb, when possible, is to design the joint so that the welding operator has easy access to the root. Doing so ensures a proper bead depth to width ratio. A good range for that ratio is to make the depth 5:1 to 2:1 the size of the width.

Pre- and post-weld materials correctly

Some materials are particularly susceptible to weld failures due to cracking, including high-strength steels, which have high carbon and/or high alloy levels. Because these materials are less ductile, they tend to generate residual stresses along the base metal and the finished weld during the cooling process.

It is important to always preheat such materials for the recommended time and temperature according to the welding procedure, and to ensure that adequate and uniform heat soak has occurred throughout. Preheating prevents rapid cooling and with it helps maintain a more ductile internal grain structure (pearlitic) in the heat-affect zone. It also limits shrinkage stresses in the

material and helps reduce instances of martensite formation in the grain structure — areas where hydrogen can dwell and ultimately cause cracking.

Similarly, when called for by a given welding procedure, post-weld heat treatment (PWHT) should be implemented as directed. PWHT relieves residual stresses and drives diffusible hydrogen from the weld to prevent weld failures by way of cold cracking.

Properly match filler metal and base material strengths

Selecting the appropriate filler metal strength can also help minimize the risk of weld failures. Most applications require matching the filler metal tensile or yield strength to that of the base material. The strengths should be as close as possible and selected as applicable to the design requirements of the application. If welding a lower strength material to a higher strength one, always match the filler metal to the lower strength one, as it will allow for greater ductility and help mitigate the risk of cracking. When making certain fillet welds or when welding on an application requiring only partial joint penetration (PJP), it may be desirable to undermatch the strength of the filler metal to the base material. Doing so can sometimes minimize the residual stresses in the finished weld.

Implement proper filler metal storage and handling procedures

To prevent filler metals from picking up moisture, dust, debris or oil that could lead to contamination — and ultimately weld failure — it is critical to follow proper storage procedures. Store filler metals in a dry area in their original packaging until ready for use. Ideally, keep the storage area the same temperature as the welding cell to avoid the condensation that occurs when moving from a cold area to a warm area, which could lead to moisture being absorbed by the filler metal. Allowing the filler metal to acclimate to the

temperature of the welding prior to opening the package can also protect against hydrogen pickup that could lead to cracking and weld failure.

Welding operators should always wear gloves when handling filler metals to protect it from moisture from their hands, and they should cover any open spools with a plastic bag when not in use. Doing so protects that filler metal from accumulating contaminants from the air that may lead to poor weld quality and/or failure. Too, companies should never place grinding stations near an area where filler metal spools are present, as particles can settle on the wire, causing potential inclusions in the weld. If using stick electrodes, always follow proper storage and reconditioning procedures prior to welding.

Undergo the appropriate training

The importance of training as a first defense against weld failures cannot be emphasized enough. Proper education helps instill good welding techniques, as well as the ability to make sound decisions that positively affect the welding operation. Welding operators should be trained to always follow the prescribed welding procedure and to troubleshoot the common causes of weld defects, such as undercutting, slag inclusions or porosity that may lead to weld failures. They also need to be trained to attend to the special requirements of the alloys they may encounter. Check with a local welding distributor or welding (or filler metal) manufacturer for training opportunities. They can often assist with initial welding operator training and also assist with their continuing education. If the resources allow, companies may consider implementing their own training programs as well.

In the end, welding operators who know to follow procedure and also adjust properly to the various facets of the welding operation stand a good chance of achieving the desired weld quality and preventing weld failures.

- **What causes lack of fusion in welding?**

  The principal causes are too narrow a joint preparation, incorrect welding parameter settings, poor welder technique and magnetic arc blow. Insufficient cleaning of oily or scaled surfaces can also contribute to lack of fusion**.**

- **What causes crater cracks in welding?**

  Crater cracking occurs when the welding operator stops welding prior to finishing a pass on a weld joint, leaving a wide, thin depression at the end. It can also appear in areas that have been tack welded when the corresponding weld passes does not meet fully against the tacks

- **What are inclusions in welding?**

  Slag inclusions are nonmetallic particles trapped in the weld metal or at the weld interface. Slag inclusions result from faulty welding technique, improper access to the joint, or both. Tungsten inclusions are tungsten particles trapped in weld metal deposited with the gas tungsten arc welding process.

- **How do you test for lack of fusion in welding?**

  The pure lack of fusion can be detected only by the visual inspection during welding. The other types of lack of fusion may be detected by ultrasonic testing methods. The lack of fusion reaching the surface may be detected by the liquid penetrant or magnetic particle testing methods.

- **How do you prevent lack of fusion in welding?**

  use a sufficiently wide joint preparation

select welding parameters (high current level, short arc length, not too high a welding speed) to promote penetration into the joint side wall without causing flooding

ensure the electrode/gun angle and manipulation technique will give adequate side wall fusion

use weaving and dwell to improve side wall fusion providing there are no heat input restrictions

if arc blow occurs, reposition the current return, use AC (in MMA [SMA] welding) or demagnetise the steel

- **What are inclusions in welding?**

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- **What is incomplete fusion in welding?**

  Incomplete fusion is a weld discontinuity in which fusion did not occur between weld metal and fusion faces or adjoining weld beads. This absence of fusion may occur at any location within the weld joint and may be present in fillet welds and/or groove welds.

- **What causes tungsten inclusion?**

  A tungsten inclusion is most often caused by dipping the tungsten electrode into the weld pool or touching the filler metal rod to the tungsten while welding. It

can also occur when the tungsten is accidentally “stuck” to base metal and broken off.

- **What is padding in welding?**

  A padding (weld) is a process of overlapping weld beads merging to produce even surfaces. It is mainly used to build-up broken and worn-out round surfaces as all types of shaft, pinions, round-bars, etc. Before depositing a padding weld, the surface should be thoroughly cleaned with a steel wire brush.

- **What causes slag inclusions?**

  Slag inclusions are nonmetallic particles trapped in the weld metal or at the weld interface. Slag inclusions result from faulty welding technique, improper access to the joint, or both.

- **What causes lack of fusion in welding?**

  The principal causes are too narrow a joint preparation, incorrect welding parameter settings, poor welder technique and magnetic arc blow. Insufficient cleaning of oily or scaled surfaces can also contribute to lack of fusion.

- **What is the most common type of incomplete fusion during a weld?**

  A frequent cause of incomplete fusion is improper gun position. It mostly occurs in shielded metal arc welding (SMAW) with a covered electrode and in semi-automatic gas metal arc welding (GMAW)

- **What causes porosity in welding?**

Porosity is caused by the absorption of nitrogen, oxygen and hydrogen in the molten weld pool which is then released on solidification to become trapped in the weld metal. Leaks in the gas line, too high a gas flow rate, draughts and excessive turbulence in the weld pool are frequent causes of porosity.

- **What is the temperature of an electric welding arc?**

  Arc welding is a fusion welding process used to join metals. An electric arc from an AC or DC power supply creates an intense heat of around 6500°F which melts the metal at the join between two work pieces.

- **What is undercutting in welding?**

  Undercutting is a groove or crater that occurs near the toe of the weld. When this weld flaw occurs, the weld metal fails to fill in that grooved area, resulting in a weak weld that is prone to cracking along the toes.

- **How do you prevent undercutting?**

  To eliminate undercut, reduce current and slow travel speed, or simply reduce size until you have a puddle size you can handle. Then change the electrode angle so the arc force holds the metal in the corners. Use a uniform travel speed and avoid excessive weaving.

- **What are the advantages and disadvantages of TIG welding?**

  Advantages of TIG welding: detailed precision, various applications and positions, extremely complex metal welding, non-consumable electrodes. Disadvantages of TIG welding: time-consuming process, complicated appliances, safety issues, cost of inert gas.

- **What causes hot cracking in welding?**

  Cracking occurs when the available supply of liquid weld metal is insufficient to fill the spaces between solidifying weld metal, which are opened by shrinkage strains. Thus, the principal causes of cracking are: Strain on the weld pool is too high.

- **How much undercut is allowed?**

  Depth of undercut that is not more than 1/32 in. is acceptable, period! Also, undercut greater than 1/32 in. deep that does not exceed 1/16 in. deep and its accumulated length comes to 2 in. or less is also acceptable.

- **What is root concavity in welding?**

  Root concavity is caused by shrinkage of the weld pool in the through-thickness direction of the weld. Melting of the root pass by the second pass can also produce root concavity. Excessively high welding speeds make the formation of root concavity more likely.

- **What is the maximum root opening?**

  The maximum permissible root opening is 1/32-in. unless the joint is backed sufficiently to prevent the welding composition from flowing through the root opening. With such support greater root openings can be used.

- **What is distortion in welding?**

  Distortion in a weld results from the expansion and contraction of the weld metal and adjacent base metal during the heating and cooling cycle of the

welding process. Doing all welding on one side of a part will cause much more distortion than if the welds are alternated from one side to the other.

- **What is cold cracking in welding?**

  A cold crack is generally referred to as a spontaneous crack that occurs at temperatures below 200°C after solidification is complete in welding. Cold cracks are caused by the combined effects of low ductility of the weld, residual stress and diffusible hydrogen in the weld**.**

- **What causes hydrogen cracking?**

  Cracking usually occurs at temperatures at or near normal ambient. It is caused by the diffusion of hydrogen to the highly stressed, hardened part of the weldment.

- **What are hot cracks?**

  Hot crack can be defined as cracking formed at high temperatures near the solidus of the metal, where the metal has coherence but is completely brittle. It can occur in weld metals and the heat-affected zone.

- **Why must the ends of the pipe be beveled before being welded?**

  When the wall thickness exceeds 3 mm, the weld puddle will become too large for controlling its geometrical behavior. In this case a J bevel is necessary in order to obtain wall thicknesses that can be welded easily.

- **What is bevelling in welding?**

  Bevelling is the process of preparing metal to be welded, usually by cutting an angled slope on the edge of the metal. In pipe welding bevelling is an integral part of the engineering process. Two pipe ends due to be welded together have their shapes altered by removing some of the metal from each end

- **How do you calculate root gap in welding?**

  The area of the excess weld metal is approximated by the formula (W x h)/2. The area provided by the root gap by g x t. The bevel angles, b, most often used are 10° = (tan 0.176), 15° = (tan 0.268), 22.5° = (tan 0.414) 32.5° = (tan 0.637) and 45° = (tan 1.00).

- **How is welding thickness calculated?**

  The active height (thickness) of a fillet weld is specified by the height of the biggest isosceles triangle inscribed into the weld section without penetration. The size of fillet weld height approximately specifies the = 0.7 formula, where z is the fillet weld width.

- **What is the largest Weld in a single pass?**

  For GMAW and FCAW, the largest single pass fillet weld in the horizontal position, for prequalified WPSs, is one size larger — 3/8”. All of the above has led to the general rule-of-thumb that 5/16” is a reasonable maximum weld size for single pass welds, made in the horizontal position.

- **What is the maximum size of fillet weld?**

  Why is a fillet weld size generally limited to 1/16-in. less than the material thickness when placed along the edge of a connected part.

- **Why are the ends of tack welds ground to a Featheredge?**

  Why are the ends of tack welds ground to a feather edge? To make it easier to have 100% penetration at the ending and beginning of the root weld.

- **What is the most commonly used method of weld inspection?**

  Radiographic and ultrasonic weld inspection are the two most common methods of NDT used to detect discontinuities within the internal structure of welds. The obvious advantage of both methods is their ability to help establish the weld's internal integrity without destroying the welded component.

- **What is the NDT method?**

  NDT stands for Non-Destructive Testing. It refers to an array of inspection methods that allow inspectors to evaluate and collect data about a material, system, or component without permanently altering it. NDT may also be called: NDE (non-destructive examination or evaluation) NDI (non-destructive inspection)

- **Why NDT is required?**

  The purpose of NDT is to inspect a component in a safe, reliable, and cost effective manner without causing damage to the equipment or shutting down

plant operations. This is in contrast to destructive testing where the part being tested is damaged or destroyed during the inspection process.

- **What is NDT and its types?**

  Many different NDT methods are available in the industry, each of them having their own advantages and limitations, but six of them are most frequently used: ultrasonic testing (UT), radiographic testing (RT), electromagnetic testing (ET), magnetic particle testing (MT), liquid penetrant testing (PT) and visual testing.

- **Which NDT method is best?**

  While many methods of nondestructive testing can detect failure-predictive flaws in welds, the most efficient, effective method is phased array ultrasonic testing.

  What is DPT test in welding?

  Dye Penetrant Test (DPT) is one of the most inexpensive non-destructive test methods, used to check the surface irregularities of any component. This test method is popular by many names, which are as follows; Liquid Penetrant Inspection (LPI) Liquid Penetrant testing or Liquid Penetrant test (LPT)

- **What is the purpose of PWHT?**

  Post Weld Heat Treatment (PWHT), or stress relief as it is sometimes known, is a method for reducing and redistributing the residual stresses in the material that have been introduced by welding.

- **Where is PWHT required?**

Current design codes in the pressure vessel and piping industries, such as the BSI and ASME codes, specify that PWHT is required if the thickness of the parts being welded exceeds a specified value, that limit usually depending on the Charpy test properties of the material and the minimum service temperature required.

- **Is PWHT required for carbon steel?**

In particular, PWHT is no longer a mandatory requirement for any wall thickness provided that multi-pass welding is employed for wall thicknesses greater than 5 mm (3/16 of an inch) and a minimum preheat of 95°C (200°F) is implemented for wall thicknesses greater than 25 mm (1 inch).

- **Can we do PWHT in stainless steel?**

PWHT of SS would normally only be used to homogenize the microstructure (solution annealing). If you aren't using a low carbon grade of stainless forget about it though. It won't be stainless (i.e. it will be sensitized) after a stress relief PWHT. Solution annealing and quenching is the only option.

What is the soaking temperature in PWHT?

Experiments were conducted for PWHT at **760°C** for different soaking time such as 2, 4 and 6 hours to get the desired mechanical properties. The investigated results suggest that PWHT of 2 hours at **760°C** is optimal to regain the strength of Grade 91 steel after welding.

How is PWHT done?

Post weld heat treatment (PWHT) is a controlled process in which a material that has been welded is reheated to a temperature below its lower critical transformation temperature, and then it is held at that temperature for a

specified amount of time. It is often referred to as being any heat treatment performed after welding; however, within the oil, gas, petrochemical and nuclear industries, it has a specific meaning. Industry codes, such as the ASME Pressure Vessel and Piping Codes, often require mandatory performance of PWHT on certain materials to ensure a safe design with optimal mechanical and metallurgical properties.

The need for PWHT is mostly due to the residual stresses and micro-structural changes that occur after welding has been completed.[2] During the welding process, a high temperature gradient is experienced between the weld metal and the parent material. As the weld cools, residual stress is formed.[2] For thicker materials, these stresses can reach an unacceptable level and exceed design stresses. Therefore, the part is heated to a specified temperature for a given amount of time to reduce these stresses to an acceptable level.[1] In addition to residual stresses, microstructural changes occur due to the high temperatures induced by the welding process.[1] These changes can increase hardness of the material and reduce toughness and ductility. The use of PWHT can help reduce any increased hardness levels and improve toughness and ductility to levels acceptable for design.[1]

The requirements specified within various pressure vessels and piping codes are mostly due to the chemical makeup and thickness of the material.[1] Codes such as ASME Section VIII and ASME B31.3 will require that a specified material be post weld heat treated if it is over a given thickness.[1] Codes also require PWHT based solely on the micro-structural make-up of the material.[1] A final consideration in deciding the need for PWHT is based on the components' intended service, such as one with a susceptibility to stress corrosion cracking. In such cases, PWHT is mandatory regardless of thickness.[4]

Rate of heating, hold times and temperatures, and rate of cooling are all important variables that need to be controlled and monitored precisely, or the desired effects may not be achieved.[3] When PWHT is mandatory by a given industry code, requirements for these variables will be specified.[3][4][5]

Heating

The rate of heating when PWHT is performed is typically based on the component's thickness and is specified by the governing codes.[1][6] If the rate of heating is not performed properly, either by heating too quickly or unevenly, temperature gradients within the component can become detrimental to the component. As a result, stress cracks may occur and residual stresses not previously created can form when the component is cooled to ambient temperatures.[4]

Holding temperature and time

Holding temperature and time are governed by the material and thickness respectively.[4][6] Regarding material thickness, longer holding times are needed for thicker materials.[4] This is to allow the material to reach a stable condition where the distribution and levels of stresses become more uniform and decrease.[2][6] The specified holding temperature is one that is at a high enough temperature to relieve high residual stress levels, yet is still below the lower transformation temperature.[1][2] In addition to the reduction of stress, high hold temperatures below the transformation temperature allow for microstructural transformations, therein reducing hardness and improving ductility.[6] Great care should be taken as to not heat the component above the lower transformation temperature, as detrimental metallurgical effects and impaired mechanical properties can result.[6] In addition, the holding temperature should not be greater than the original tempering temperature unless later mechanical testing is performed. Holding above the original

tempering temperature can reduce the strength of the material to below ASME required minimums.[4]

Cooling

As with the heating rate, the cooling rate must be controlled, as to avoid any detrimental temperature gradients that could cause cracking or introduce new stresses during cooling.[4] In addition to this, rapid cooling rates can increase hardness, which may increase the susceptibility of a brittle fracture.[7]

Monitoring technique

Thermocouples are typically attached to the component undergoing PWHT to check and ensure that heating rates, hold temperatures, and cooling rates meet code specification. Computer software is typically used in conjunction with the thermocouples to monitor the fore-mentioned variables and provide documentation that the PWHT was performed properly.[5]

Why do we preheat before welding?

Preheating is the process applied to raise the temperature of the parent steel before welding. It is used for the following main reasons:

The slower cooling rate encourages hydrogen diffusion from the weld area by extending the time period over which it is at elevated temperature (particularly the time at temperatures above approximately 100°C) at which temperatures hydrogen diffusion rates are significantly higher than at ambient temperature. The reduction in hydrogen reduces the risk of cracking.

To slow the cooling rate of the weld and the base material, potentially resulting in softer weld metal and heat affected zone microstructures with a greater resistance to fabrication hydrogen cracking.

Preheat can be applied through various means. The choice of method of applying preheat will depend on the material thickness, weldment size and the heating equipment available at the time of welding. The methods can include furnace heating for small production assemblies or, for large structural components, arrays of torches, electrical strip heaters, induction heaters or radiation heaters.

It is important to apply preheat correctly, with appropriate monitors and controls, and also to monitor the interpass temperature (the temperature of the workpiece between welding the first and subsequent passes), to ensure that it does not fall below the preheat temperature. (See FAQ: Which is important - Preheat or interpass?).

Common techniques for monitoring preheat are temperature indicating crayons (see FAQ: What is a Tempil stick?) and thermocouples or contact thermometers. Preheat should be monitored at a distance of 4t (where t is the thickness of the material to be joined) away from the longitudinal edge of the groove for t<50mm [1] or at a minimum distance of 75mm from the joint preparation for t>50mm and on the reverse side of the plate to the heat source [1,2].

How many thermocouples are required during PWHT?

For pipes up to and including 10 inches, one thermocouple attached to the 6 o'clock position in horizontal pipes is sufficient. For pipes 12 inches and larger, two thermocouples, one on the 6 o'clock and the other one on the 12 o'clock positions are necessary. Never attach them on the 3 o'clock nor on the 9 o'clock positions. In vertical pipes, of course, you can attach them in any position.

The thermocouples leads must run along the pipe surface for at least 8 inches before bending outwards. The leads should be insulated by means of insulating ceramic beads.

The thermocouple end should be attached at a distance of 1/2 inch from the weld centerline. One way to do this is to tack a weld on a small piece of tube to the pipe, insert the thermocouple end into the tube and flatten it with a hammer.

How do you calculate heat in PWHT?

Due to the advancement of metallurgy a lot many different materials are now used in the mechanical construction industry. In this a few are heat treated to improve mechanical properties.

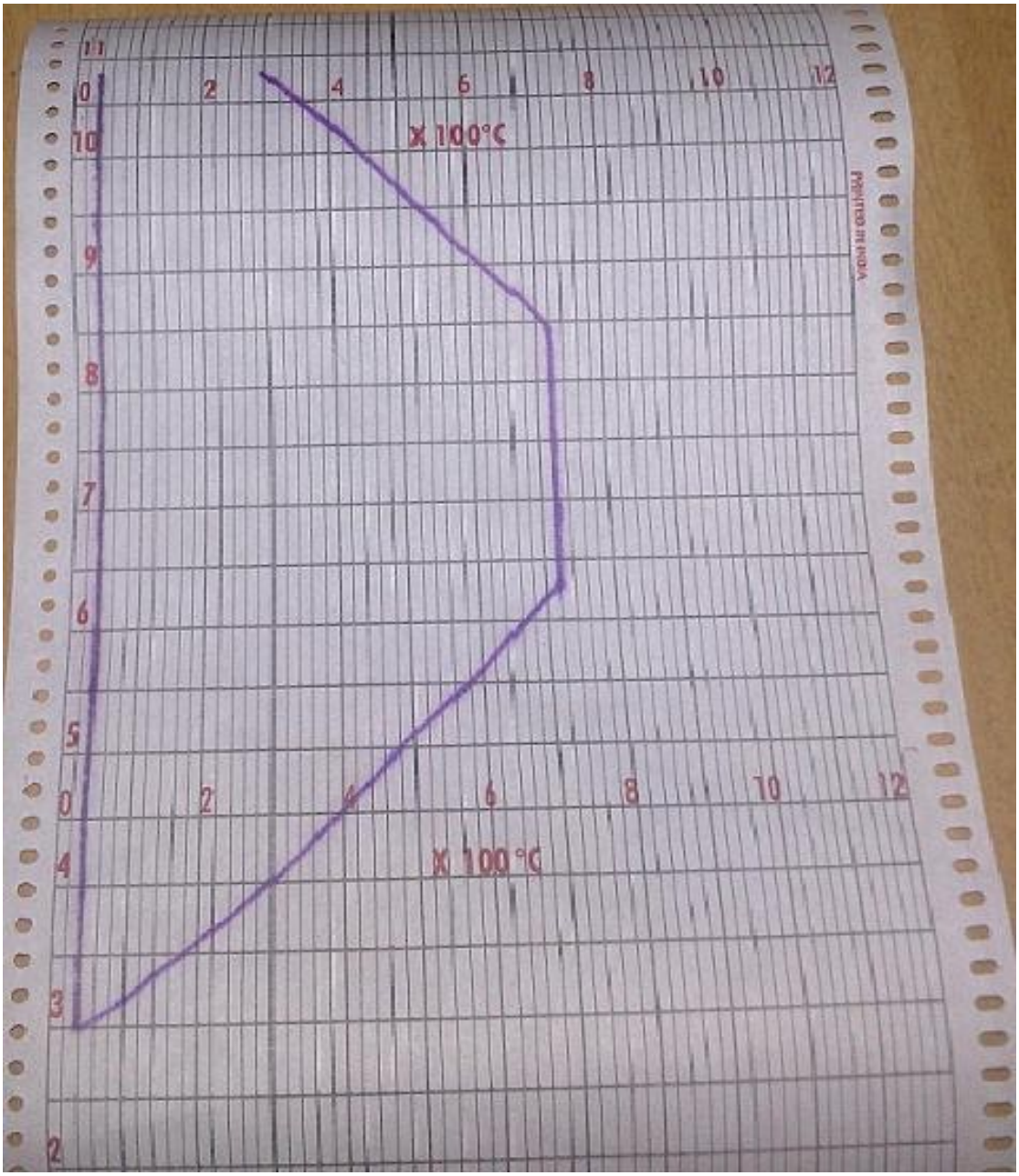
Heat treatment is done because of two reasons

1) Process requirement 2) Material Requirement

Heat treatment can be done in many ways. Furnace heating, Oil fired heating, Electric resistance heating etc. There are different types of heat treatments like normalizing, annealing etc.

Here we are going to discuss the graph which is generated in electric resistance heating for PWHT (Post Weld Heat Treatment).

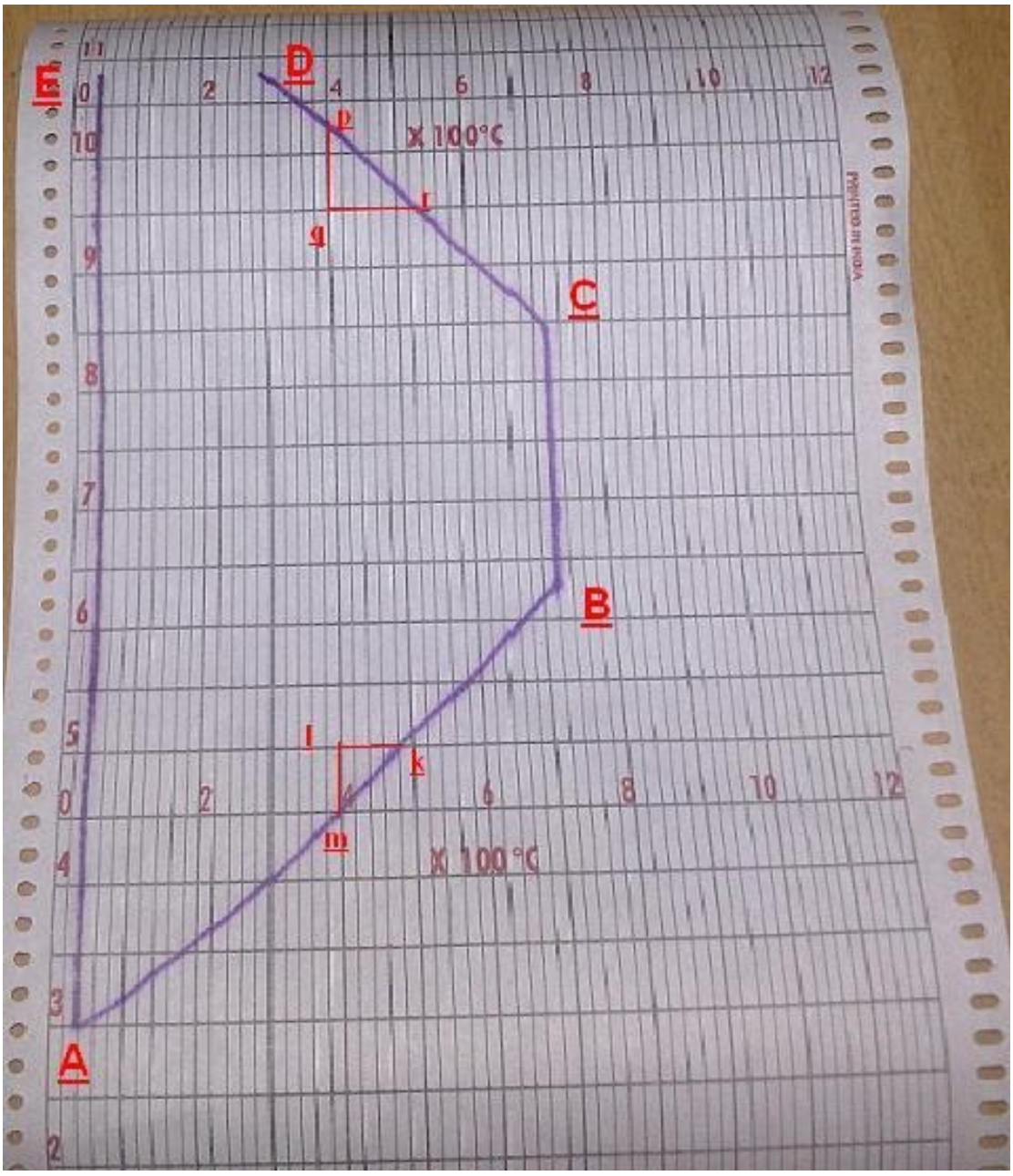
Below is the graph of a pwht process. Let's start reading it



In this chart, X-axis represents temperature and Y-axis represents Time. In the X-axis each line to line distance represents 10Deg C (See it is written as X 100°C, that means in X axis, 2 means 2 X 100°C= 200°C, 3 means 3 X 100°C= 300°C etc.)

In the Y-axis each line to line distance represents half an hour. That means the time between 2 and 3 represents one hour.

These are the basics.



The graph contains several lines, AB, BC, CD, AE

1) AB is RATE OF HEATING curve

2) BC is SOAKING TEMPERATURE

3) CD is RATE OF COOLING curve

4) AE is ROOM TEMPERATURE curve

When you check the WPS you can see the required values for each of these.

1) AB: Rate of heating: In WPS it is mentioned as a maximum value. In the graph the rate of heating is the slope of the curve AB. So the value of the slope should not be more than the value in WPS.

How to calculate the slope:

Slope = kl/lm

Now in the graph given above, for AB line, kl=80DegC and lm=1/2 hr

slope = 80 / (1/2) = 160DegC/hr ; So in this graph the rate of heating is 160DegC/hr.

2) BC: Soaking Temperature: In WPS it is mentioned as a single value with some plus/minus allowance along with time it is to be steady(mentioned as minimum)

Here in this graph it is 720Deg (Reading in X-axis) and for approximate 2hr and 10minute(this is an approximation-Reading in Y-axis)

3) CD: Rate of cooling: In WPS it is mentioned as a maximum value. In the graph the rate of heating is the slope of the curve CD. So the value of the slope should not be more than the value in WPS.

How to calculate the slope:

Slope = qr/pq

Now in the graph given above, for the CD line, qr=130DegC and pq=45 Min(this is taken as an approximation from the graph.)

slope = 130 / 45 = 2.89DegC/Min ; So in this graph the rate of heating is 173DegC/hr.

4) AE: Room Temperature: This is the room temperature, here it is 40 deg C.

Loading Temperature: Loading temperature is the temperature at which controlled heating (maintaining the rate of heating in the WPS) starts, up to which there is no need for controlled heating.

Unloading Temperature: Unloading temperature is the temperature up to which controlled cooling (maintaining the rate of cooling in the WPS) occurs, below which there is no need for controlled cooling.Normally the power connection is disconnected below the temperature, keeping the insulation. After getting cooled to the atmospheric temperature the insulation is removed.

NB: Please check the speed of the chart movement in the PWHT machine, Normally it is 25mm/hr.

Why is stainless steel not heat treated?

With sufficient quantities of nickel, stainless steel remains austenite at room temperature, creating the austenitic steels. They are nonmagnetic and cannot be heat treated through hardening like carbon steels because the phase transformation to martensite does not occur in these alloys.

- **Question 1. What Are The Main Duties Of The Piping Inspector?**
  Answer :
    - Material receiving inspection

- Storage & preservation
- Cutting, assembly & fit-up
- Pre-welding inspection
- Visual inspection of socket & threaded joints
- Pneumatic test for reinforcing pad
- Pickling & passivation
- Database reporting
- Visual inspection of completed spools
- Piping pre-inspection & spool erection
- orifice flange inspection
- Pipe support inspection
- Verification of slope
- Internal cleanliness
- Valve installation
- Piping flange joint inspection
- Pre-test punch listing
- Hydro testing
- pre-commissioning

- **Question 2. How Many Types Of Gaskets Do You Know?**

  Answer :

  - Full face (Asbestos)

- Spiral wound metallic
- Ring type
- Metal jacketed
- Inside bolt circle

- **Question 3. What Are The Different Types Of Mating Flanges? Name The 4 Most Common?**

  Answer :

  Flat face

  Raised face

  RTJ (Ring type Joint)

  Tongue & groove

  Male & female

- **Question 4. What Type Of Information Do You Get From Isometric Drawings?**

  Answer :

  - Line routing
  - Line orientation
  - Northing
  - Easting & elevation
  - Bill of mat'l
  - Insulation type
  - NDT requirement
  - Revision status
  - Material class'n

- Design
- Operating & testing temp/pressure
- Paint system
- P&ID
- Slope
- Service details
- Flow direction
- Support details
- Notes

- **Question 5. What Type Of Codes And Standards Do You Use As A Piping Inspector?**
  Answer :

  - ASME B31.3
  - ASME B31.1
  - ASME B31.5
  - ASME B31.9
  - JERES-A-004
  - JERES-A-007
  - JERES-A-206
  - JERES-A-301
  - JERES-L-105
  - JERES-L-108

- JERES-L-110
- JERES-L-150
- JERES-L-130
- JERES-L-310
- JERES-L-350
- JERES-L-351
- JERES-W-011
- JERES-W-016

- **Question 6. What Are The Types Of Valves?**

  Answer :

  - Gate valve
  - Globe valve
  - Butterfly valve
  - Needle valve
  - Check valve
  - Control valve
  - Knife gate valve

- **Based on function:-**

  - non-return valve
  - isolation valve
  - regulation valve

- special purpose valve

- **Question 7. What Are The Main Things You Will Check Before Bolt Torquing?**
  Answer :

  - Size of bolt
  - Calibration of torque wrench
  - Manual /hydraulic require
  - Lubricant
  - Friction factor for threaded lubricant
  - Torque value
  - JERES-L-109 / 351

- **Question 8. Write 3 Saudi Aramco Piping Standards (l-series)?**
  Answer :

  - SAES-L-105
  - SAES-L-108
  - SAES-L-110
  - SAES-L-150
  - SAES-L-130
  - SAES-L-310
  - SAES-L-350
  - SAES-L-351

- **Question 9. Write Minimum Ten Hydrostatic Test Punch List Items Prior To Commence Hydro Test At Site? Indicate Which Is Yes Item & No Item?**

  Answer :

  - All hot work shall be completed
  - Strainers shall be removed
  - All NDT & DT completion
  - PWHT completion
  - Adequate attachment
  - Coating on the weld joint shall be removed.
  - Calibration of equipment used. Test blind MTC.
  - Test certificates of testing fluid
  - Components in new piping systems which interfere with filling, venting, draining or flushing shall not be installed.(orifice plates, flow nozzles, sight glasses)
  - All joints (flange, threaded, welded or mechanical seals) are left exposed for visual leak detection during the strength test.
  - All permanent flange joints were inspected, gasket mat'l verified & properly torque.
  - Drains shall be provided at all low points of the piping system.
  - Vents and drain valves, both temporary and permanent, conform with the piping class or rating.
  - Supports are installed. Additional temporary support may be installed as required.

- Expansion joints and spring hangers or spring supports are provided with temporary restraints.
- Arc strikes, gouges, and other indications of careless workmanship (such as surface porosity, uneven weld profiles, and undercut) shall be removed by grinding and inspected by magnetic particle or liquid penetrant method.
- Drains are provided immediately above check valves (vertical lines)
- All threaded joints up to the first block valve of the hydrocarbon pipeline are sealed welded. Thread engagement has been verified & accepted.
- The pressure testing manifold is separately pressure tested to at least 1.2 times the system test pressure but not less than the discharge pressure of the pump used for the pressure testing.

- **Line compliance with Isometrics:**
  - Correct Materials utilized grade/schedule (Bill of Mat'ls)
  - Correct flange and fittings rating
  - Construction tolerances per SAES-L-350

- **Question 10. Weep Hole Size Shall Be Drilled For Dummy Pipe Support Will Be _____mm?**

  Answer :

  Weep hole shall be located near the base plate for all vertical dummy pipe support & near run pipe at 6 O'clock position for the horizontal dummy.(SAES-L-350 13.2.3 & L-310 14.7.2)

- **Question 11. What Is Dead Leg And Explain?**

  Answer :

  Dead Legs: Piping sections that are potential for internal corrosion due to flow stagnation.

- Dead legs are created mainly by flow stagnation enhanced with presence of settled water and solid deposits.
- When the length of the section or branch , for 2 inch pipes and larger, is longer than three times its pipe diameter, or 1.22 m (4 ft) in length, the length of the dead leg is the distance measured from the outside diameter of the header (or run) to the near end of the branch valve.
- For branch connections of 1-½ inch NPS and smaller, the length of the dead leg is the distance measured from the end of the boss to the near end of the valve.

- **Question 12. Write Any 2 Types Of Piping Supports?**

  Answer :

  - Shoe
  - spring loaded
  - resting
  - wear pad

- **Question 13. What Type Of Connection Is Acceptable For A 24" Header, 12" Branch?**

  Answer :

  Weldolet or welded branch with reinforcement pad as per JERES-L-110 app: A

- **Question 14. How Many Minimum Pressure Gauges To Be Installed During Hydro Test?**

  Answer :

  Two (JERES-A-004, Para 7.1.5)

- **Question 15. What Is A PIP?**

  Answer :

  Process industry practices.

- **Question 16. Name The Different Types Of Service Conditions?**

  Answer :

  NFS:- Normal services, Category M, Category D, High pressure fluid services (ASME-B31.3).

- **Question 17. How Do You Verify (name Several Items To Check) That The Correct Piping Material Is Used?**

  Answer :

    - Material specification
    - Pipe size
    - Schedule
    - Length
    - Flange face rating
    - Olet size rating
    - Threaded/socket weld type
    - MTC
    - PMI report

- **Question 18. How Do You Identify Fittings And Flanges?**

  Answer :

    - By material classification
    - Size

- Rating
- Joint type (lap, socket, threaded, butt), face;

- **Question 19. How Do You Check Piping For The Correct Schedule?**

  Answer :

  Verify pipe material thickness by Vernier at the end or UT on surface or stenciling done by the manufacturer (visual) or heat number, traceability by MTC of product.

- **Question 20. What Is The Standard Mill Tolerance For Piping 2'' & Less?**

  Answer :

  12% of nominal wall thickness.

Question 21. What Is The Tolerance For Ovality Of Piping?

Answer :

5% of nominal diameter at any cross section other than weld end & 3% at weld end (JERES-L-350 Para 9.2).

- **Question 22. What Is The Difference Between Torquing Cs And Ss Bolting?**

  Answer :

  CS:- Yield strength High; Torque value High.

  SS:- Yield strength low; Torque value low.

- **Question 23. What Are Jack Screws And When Are They Required?**

  Answer :

  Used in flange joint assemblies which often require frequent separation includes orifice plate, spectacle plates, spacers, screens, and drop out spools shall be provided with jack screw to facility separation and opening for the maintenance. When flange separations are used, jackscrews are not required. Jackscrews shall be installed to be accessible from both sides of the pipe. For orifice flanges, jack screws shall be installed at 3 & 9 o' clock positions.(JERES-L-310 Para 17.7).

- **Question 24. What Is Often Overlooked During Orifice Flange Fabrication?**

  Answer :

- Inside the surface of welded joints at @ orifice flanges shall be ground & machined smooth (JERES-L-350 Para 10.4.2).
- Orientation of taps is as per JERES-J-0001.
- All parallel pipelines with adjacent orifice fittings shall have a min spacing of 300 mm (12 in) between flanges outside diameters if horizontal taps are required. Where this spacing is not practical follow JERSEY-J-0001.

- Orifice flanges in adjacent lines shall be staggered so that no two pairs of orifice flanges are less than 1 m (3ft) apart.

- **Question 25. What Is The Maximum Diameter Piping Allowed In Hazardous Service?**

  Answer :

  Socket weld: - 2" for maintenance & minor modification & 1-½" for new construction.

  Threaded:- 1-½" for standard fitting & valve, and 2" maximum when required for maintenance, minor field minor modification of existing piping system(JERES-L-110 Para 7.2).

- **Question 26. Can Teflon Tape Be Used Prior To Seal Welding?**

  Answer :

  No, (JERES-L-110 Para 8.5).

- **Question 27. How Many Threads Can Be Visible After Seal Welding Threaded Joints?**

  Answer :

  No, should cover all exposed threads (JEREZ-W-011 Para 12.15.3).

- **Question 28. What Is The Gap Requirement For Socket Welds For New Construction?**

  Answer :

  1.5mm-3mm (ASME B31.3 fig 328.5.2C).

- **Question 29. Give Examples Of Unique Support Details That Allow Piping Freedom Of Movement For Thermal Expansion?**

  Answer :

  - Guide support
  - Moving saddle support
  - Expansion balloons
  - Shoe support
  - Spring loaded

- **Question 30. When You Will Apply 24 Hours Recorded Hydro Test?**

  Answer :

  If for justifiable safety reasons the UG line must be backfilled, then the joints shall remain exposed during testing, otherwise the test shall be a 24 hour recorded test.(JERES-L-150 Para 7.4.2).

- **Question 31. Difference Between Carbon Steel And Stainless Steel?**

  Answer :

  CS:- Low cost, no chromium content, suitable for non-corrosive service upto 350 degree C, max carbon 0.3%.

  SS:- Contains more than 12% Cr, 0.08% C, Suitable for corrosive, cryogenic, High temp services, costly.

- **Question 32. Difference Between Rt & Ut?**

  Answer :

  RT:- Uses X-ray or Gamma ray to detect discontinuities, reveals mostly volumetric. Planar defects & subsurface defects not detectable easily.

  UT:- Uses ultrasonic beam to detect discontinuities reveals both planar & volumetric defects, but size & exact location of defects are not easily identifiable. Possible only on materials that do not refract AT waves.

- **Question 33. Difference Between Pt & Mt?**

  Answer :

  MT:- Only Applicable for ferromagnetic materials & able to detect both surface & subsurface discontinuities, compared to PT examination it takes less time for testing & inspection; Applicable for large temp range.

  PT:- Applicable for both ferromagnetic & non ferromagnetic materials & able to detect only surface discontinuities, It requires more time; Applicable for small temp range.

- **Question 34. How Do You Control Material In a Fabrication Shop?**

  Answer :

  - All materials shall have material spec and grade stamped or stenciled & clearly marked with permanent marker.
  - All materials, heat no. will be made traceable to MTC from approved vendors & no material substitution will be done without proper approval from the company.
  - All materials shall be stored & stacked separately as per material grade.
  - Heat no. shall be transferred before cutting into pipes that have to be cut.
  - All materials shall be color coded as per traceability procedure.

- **Question 35. Write Inspection Items During Valve Installation?**

  Answer :

  - Valve type corrects at the location
  - Valve test certificate
  - Valve tag as per P&ID
  - Valve direction of flow as per P&ID

- Gasket bolts as per isometric & type
- Handle direction
- Chain wheel installed
- Valve flange face condition

-The End-

1 LIQUID PENETRANT TESTING (PT)

1.1 Liquid Penetrant Testing Level 1 (PT-1)

1.1.1 Liquid Penetrant Testing Level 1 (PT-1) General Examination

1. Liquid penetrant testing is based on the principle of:

    (a) Polarized sound waves in a liquid

    (b) Magnetic domains

    (c) Absorption of X rays

    (d) Capillary action

2. When a small diameter tube is placed in a glass of water, water rises in the tube to a level above the adjacent surface. This is called:

    (a) Viscosity

    (b) Capillary action

    (c) Surface tension

    (d) Barometric testing

3. How is the size of a liquid penetrant indication usually related to the discontinuity it represents:

    (a) Larger than

    (b) Smaller than

    (c) Equal to

    (d) Not related to

4. A penetrant that is self-emulsifying is called:

    (a) Solvent removable

    (b) Water washable

    (c) Post-emulsified

    (d) Dual sensitivity method

5. A penetrant process which employs an emulsifier as a separate step in the penetrant removal process is called:

   (a) Solvent removable

   (b) Water washable

   (c) Post-emulsified

   (d) Dual sensitivity method

6. A penetrant process in which excess penetrant is removed with an organic solvent is called:

   (a) Solvent removable

   (b) Water washable

   (c) Post-emulsified

   (d) Dual method

7. Which of the following statements accurately describes the capabilities of liquid penetrant testing?

   (a) Liquid penetrant testing is useful for locating subsurface discontinuities in a test piece

   (b) Liquid penetrant testing is useful for locating discontinuities in porous materials

   (c) Liquid penetrant testing is useful for locating discontinuities which are open to the surface in non-porous materials

   (d) none of the above

8. Which of the following discontinuity types could typically be found with a liquid penetrant test?

   (a) Internal slag in a weld

   (b) Internal slag in a casting

   (c) Sensitization in austenitic stainless steel

   (d) Fatigue cracks

9. Which of the following chemical elements are normally held to a minimum in liquid penetrant materials, when testing stainless steel and titanium?

    (a) Hydrogen

    (b) Chlorine

    (c) Carbon

    (d) Oil

10. Which of the following chemical elements are normally held to a minimum in liquid penetrant materials when testing nickel based alloys?

    (a) Sulphur

    (b) Oxygen

    (c) Carbon

    (d) Nitrogen

11. Which of the following is the most desirable method of pre-cleaning a test piece prior to penetrant testing?

    (a) Sand blasting

    (b) Vapour degreasing

    (c) Emery cloth

    (d) Wire brushing

12. Which of the following pre-cleaning processes is not recommended?

    (a) Detergent cleaning

    (b) Vapour degreasing

    (c) Shot blasting

    (d) Ultrasonic cleaning

13. A wire brush should be used for pre-cleaning:

    (a) When grease and oil must be removed

    (b) Only as a last resort

    (c) When rust is to be removed

    (d) When grinding burrs must be removed

14. A hydrometer is used to measure:

    (a) Penetrant viscosity

    (b) Specific gravity of water based wet developers

    (c) Penetrant specific gravity

    (d) Cleaner specific gravity

15. Visible, solvent removable penetrants are most advantageous for:

    (a) Inspecting parts with rough surfaces

    (b) Inspecting batches of small parts

    (c) Inspecting parts at remote locations

    (d) Inspecting parts with porous surfaces

16. For adequate test results, the black light used in fluorescent penetrant examination should provide what minimum black light intensity at the test surface?

    (a) 100 foot candles per square centimetre

    (b) 1000 microwatts per square centimetre

    (c) 800 foot candles

    (d) 35 microwatts per square centimetre

17. What minimum warm-up time is required for acceptable performance of a mercury Vapour arc black light?

    (a) None

    (b) 2 minutes

    (c) 5 minutes

    (d) 10 minutes

18. Which of the following penetrants contains an emulsifying agent?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Fluorescent

19. Which of the following penetrants must be treated with an emulsifier prior to water removal?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Fluorescent

20. What is the function of an emulsifier?

    (a) To remove the excess penetrant

    (b) To develop indications with a post emulsifiable penetrant system

    (c) To assist penetration with a post emulsifiable penetrant system

    (d) To make a post emulsifiable penetrant water washable

21. An oil based emulsifier is called:

    (a) Hydrophilic

    (b) Hydrophobic

    (c) Lipophilic

    (d) Fluoroscopic

22. A water based emulsifier is called:

    (a) Hydrophilic

    (b) Hydrophobic

    (c) Lipophilic

    (d) Fluoroscopic

23. Methylene chloride, isopropyl, alcohol, naptha and mineral spirits are examples of:

    (a) Emulsifiers

    (b) Developers

    (c) Solvent removers

    (d) None of the above

24. What type of solvent removers may be used with a solvent removable penetrant?

    (a) Any organic solvent

    (b) Only the cleaner recommended by the manufacturer of the penetrant

    (c) Any alcohol based solvents

    (d) Only chlorinated hydrocarbons

25. Which of the following is a prerequisite for a penetrant test?

    (a) Developer must be applied in a thin, even coat

    (b) Any surface coatings or soils must be completely removed

    (c) All traces of penetrant materials should be removed after testing is complete

    (d) The test object must be non-magnetic

26. Which of the following types of pre-cleaning processes may be used for liquid penetrant testing?

    (a) Wire brushing only

    (b) Detergent and water only

    (c) Vapour degreasing only

    (d) Any process that leaves the part clean and dry, does not harm the part and is compatible with the penetrant materials

27. What is the likely result of incomplete removal of all excess penetrant from the test piece surface?

    (a) Formation of false indications

    (b) Formation of relevant indications

    (c) Exaggeration of the size of relevant indications

    (d) None of the above

28. What is the preferred pre-cleaning process for removal of oil and grease :

    (a) Steam cleaning with a added acid

    (b) Vapour degreasing

    (c) Steam cleaning

    (d) Ultrasonic cleaning

29. Which pre-cleaning method may be used with either a solvent or a detergent solution?

    (a) Ultrasonic cleaning

    (b) Steam cleaning

    (c) Detergent wash

    (d) Vapour degreasing

30. What is the danger associated with using a wire brush during pre-cleaning?

    (a) Bristles from the wire brush may cause false indications

    (b) Contaminants from the wire brush may cause delayed hydrogen cracking of high carbon steels

    (c) The wire brush may not adequately remove organic soils

    (d) The wire brush may close or smear metal over

31. What is the preferred method of removing paint prior to performing a penetrant testing?

    (a) Sand blast

    (b) Chemical removers

    (c) Power wire brush

    (d) Shot blast

32. What additional surface preparation or cleaning must be performed on a machined or ground aluminium casting prior to penetrant testing?

    (a) Vapour degreasing

    (b) Etching

    (c) Detergent wash

    (d) Nothing

33. Acceptable methods of penetrant application are:

    (a) Spraying

    (b) Dipping

    (c) Brushing

    (d) All of the above

34. The time period during which penetrant remains on the surface of the test piece is called:

    (a) Dwell time

    (b) Soaking time

    (c) Fixing time

    (d) Development time

35. Excess penetrant removal is a two step process with which of the following penetrant methods?

    (a) Water washable

    (b) Post emulsifiable

    (c) Solvent removable

    (d) Liquid oxygen applications

36. A developer aids penetrant bleed out because of:

    (a) Adequate removal of the excess penetrant

    (b) Providing a contrasting background for visible dye indications

    (c) Capillary action

    (d) Proper emulsifier action

37. In the solvent removable penetrant process, excess penetrant is removed with:

    (a) A water spray

    (b) A hydrophilic scrubber

    (c) A solvent spray

    (d) Clean, lint free towels slightly moistened with solvent

38. Water based wet developer is applied:

    (a) Immediately before removal of excess penetrant

    (b) Immediately after removal of excess penetrant

    (c) After a drying period following removal of excess penetrant

    (d) For maximum sensitivity results

39. Non-aqueous wet developer is applied:

(a) Immediately before removal of excess penetrant

(b) Immediately after removal of excess penetrant

(c) After the excess penetrant is removed and part surface is dried

(d) For maximum sensitivity results

40. Dry developer is applied:

(a) Immediately before removal of excess penetrant

(b) Immediately after removal of excess penetrant

(c) After drying of the part

(d) For maximum sensitivity results

41. Typical ranges of emulsifier dwell times are:

(a) 5 to 10 minutes

(b) 30 seconds to 1 minute

(c) 1 to 3 minutes

(d) 5 to 10 minutes

42. Actual emulsification times are determined by:

(a) Experiment, during technique qualification

(b) Manufacturer's recommendations

(c) Code requirements

(d) None of the above

43. The colour of fluorescent penetrant under the presence of a UV light is:

(a) Yellow-green

(b) Red

(c) Blue

(d) Green

44. What action is necessary if the penetrant is inadvertently allowed to dry on the test piece?

    (a) Repeat the test, beginning with the pre-cleaning operation

    (b) Re-wet the penetrant, begin dwell time again and continue

    (c) Clean the penetrant off the surface and develop normally

    (d) Clean the penetrant off the surface, wait 5 minutes and develop normally

45. What maximum water rinse pressure is considered safe for removal of excess penetrant in the water washable penetrant process?

    (a) As low a pressure as possible, 50 PSI maximum

    (b) to 200 PSI

    (c) PSI maximum

    (d) to 500 PSI

46. During the water rinse step of the water washable penetrant process, what is the desired angle of the spray to the surface?

    (a) Normal

    (b) 30 degrees

    (c) 45 degrees

    (d) 75 degrees

47. Which type of emulsifier is designed to be used as a ‘scrubber’?

    (a) Hydrophilic

    (b) Hydrophobic

    (c) Lipophilic

    (d) Fluoroscopic

48. Post cleaning is especially important when:

    (a) Post emulsified penetrants are used

    (b) Phosphate containing detergents are used

    (c) Chlorinated hydrocarbons are used

    (d) The test object will be used in a liquid oxygen environment

49. When using a hydrophilic emulsifier, the amount of penetrant removed is most affected by:

    (a) Solution strength and time of spray

    (b) Penetrant dwell time

    (c) Emulsifier dwell time

    (d) Adequacy of pre-clean

50. If a mercury vapour arc black light is inadvertently turned off, how soon may it be restarted?

    (a) Immediately

    (b) 5 minutes

    (c) 10 minutes

    (d) 15 minutes

51. Which of the following is normally prohibited as a method of removing excess penetrant when using the solvent removable penetrant process?

    (a) A water spray

    (b) A hydrophilic scrubber

    (c) A solvent spray

    (d) Clean with lint free towels moistened with solvent

52. When performing a fluorescent penetrant examination, excess penetrant is normally removed:

    (a) By a hydrophilic scrubber

    (b) Under UV light

    (c) By solvent spray

    (d) By vapour degreasing

53. During a visible, solvent removable penetrant test, complete penetrant removal is indicated by:

    (a) Absence of red indications on the test piece surface

    (b) Clean rinse water

    (c) Completion of the rinse cycle

    (d) Absence of red dye on the cleaning towels

54. Which of the following is a function of a developer

(a) Providing a contrasting background for visible dye indications

(b) Making the penetrant water washable

(c) Penetrating into discontinuities open to the surface

(d) Dissolve organic soils on the test piece surface

55. Which of the following is a function of a developer?

(a) Providing a contrasting background for visible dye indications

(b) Accentuates presence of discontinuities by causing a penetrant indication to spread out over a larger area

(c) Provides capillary paths to aid the bleed out process

(d) All of the above

56. Which of the following developers is applied before the drying operation?

(a) Dry

(b) Non-aqueous wet

(c) Water based wet

(d) None of the above

57. The most sensitive type of developer for the detection of fine discontinuities is:

(a) Water soluble

(b) Non-aqueous wet

(c) Dry

(d) Water suspendable

58. Which of the following is the most sensitive developer in descending order?

(a) Dry, water soluble, water suspendable

(b) Non-aqueous wet, water soluble, water suspendable ,dry

(c) Non-aqueous wet, dry, water soluble

(d) Water suspendable, water soluble, non-aqueous wet

59. Low sulphur and chlorine penetrant materials would be used for testing:

(a) Aluminium, steel and plastics

(b) Tool steels, chrome vanadium steel and ferritic stainless steels

(c) Austenitic stainless steels, nickel alloys and titanium

(d) Magnetic materials

60. Which type of developer may be either in suspension or a solution?

(a) Dry

(b) Non-aqueous wet

(c) Water based wet

(d) None of the above

61. The temperature of water rinse used in the water washable penetrant process should be:

(a) 60 to 110^{o}C

(b) 40 to 100^{o}C

(c) 16 to 43^{o}C

(d) 70 to 140^{o}C

62. The danger of over washing during a water washable penetrant test is that:

(a) Excess penetrant will be removed from the test piece

(b) Penetrant will be removed from discontinuities

(c) The waste water will contain too high a concentration of penetrants

(d) A protective oxide coating on the test piece is formed

63. Which penetrant process is best suited to high production rates of many small parts?

(a) Solvent removable

(b) Water washable

(c) Post emulsifiable

(d) Fluorescent

64. Which penetrant process is best suited to detect shallow discontinuities?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Fluorescent

65. Which penetrant process is best suited to the detection of discontinuities in a test piece having threads and keyways?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Fluorescent

66. Which penetrant process is the most sensitive to detect fine discontinuities?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable fluorescent

    (d) Water washable fluorescent

67. Which penetrant process is best suited for portable application in the field?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Fluorescent

68. Which penetrant process should be used if repeated examinations are anticipated?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Fluorescent

69. What is a disadvantage of using the fluorescent penetrant process?

(a) Lower visibility of indications

(b) Must be performed in a darkened area with aid of a UV lamp

(c) Easily washed with water

(d) High visibility of indications

70. Which of the following developers is applied by brush, spraying or dipping?

(a) Non-aqueous wet

(b) Water based wet

(c) Dry

(d) Dual sensitivity

71. Which of the following developers is applied by spray only?

(a) Non-aqueous wet

(b) Water based wet

(c) Dry

(d) Dual sensitivity

72. Which of the following developers is applied by immersion or flow on only?

(a) Non-aqueous wet

(b) Water based wet

(c) Dry

(d) Dual sensitivity

73. What is the minimum time considered necessary for dark adaptation of the eyes prior to evaluating the results of a fluorescent penetrant test?

(a) 1 minute

(b) 2 minutes

(c) 5 minutes

(d) 10 minutes

74. What is the likely result of looking directly into a black light?

    (a) Burning of the retina of the eye

    (b) Temporary inflammation of the cornea

    (c) Long term tendency toward formation of cataracts

    (d) Fluorescence of the fluid in the eye

75. Which type of penetrant process would be best suited to the detection of wide, shallow discontinuities?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Fluorescent

76. Which type of penetrant process affords most control of test sensitivity level?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Fluorescent

77. Which type of penetrant process is least susceptible to over washing?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Fluorescent

78. What is a disadvantage of the solvent removable penetrant process?

    (a) It is the least sensitive of the penetrant processes

    (b) It is not well suited for use on rough surfaces

    (c) It is highly portable

    (d) No water is required for its use

79. Which of the following is the proper first step in removal of excess penetrant when using the solvent removable penetrant process?

    (a) Immerse the test piece in solvent

    (b) Spray the test piece with water

    (c) Wipe the test piece surface with clean, lint free towels slightly moistened

    (d) All of the above is correct

1.1.2 Liquid Penetrant Testing Level 1 (PT-1) Specific Examination

1. Which of the following types of penetrants, developers, solvents are used when conducting a liquid penetrant test on a part that is exposed to a liquid oxygen environment.

    (a) Water based penetrants

    (b) Water based developers

    (c) Water based solvents

    (d) All of the above

2. The causes of non relevant indications are:

    (a) Insufficient removal of excess surface penetrant

    (b) Penetrant on operators hands

    (c) Threads, keyways, splines, sharp corners, press fits, blind holes, rough surfaces

    (d) Contaminated work surfaces

3. Which of the following metals must be tested with low halogen sulphur free penetrant materials:

    (a) Copper, silver, gold

    (b) Nickel based alloys, certain stainless steel materials

    (c) Steel, iron, aluminium

    (d) Plastic, wood, paper

4. List two main advantages of ‘wet’ developers.

    (a) _____

    (b) _____

5. Penetrant testing is limited by its inability to test which of the following materials:

    (a) Aluminium

    (b) Ceramics

    (c) Porous materials

    (d) Moulded rubber

6. List four cleaning processes that are to be avoided

    (a) _____

    (b) _____

    (c) _____

    (d) _____

7. Liquid penetrants can be further categorised by the removal method of excess surface penetrant:

    (a) Water washable

    (b) Solvent removable

    (c) Post emulsified

    (d) All of the above

8. The typical temperature ranges for conducting a liquid penetrant test is:

    (a) 60 to 100ºC

    (b) 10 to 60ºF

    (c) 16 to 52ºC

    (d) 10 to 20ºK

9. Surface breaking porosity will show what type of relevant indications when a welded aluminium plate is tested with the liquid penetrant method:

    (a) Linear indications

    (b) Square indications

    (c) Triangular indications

    (d) Rounded indications

10. Cracks, lack of penetration, lack of fusion which are surface breaking on a welded aluminium plate which has been liquid penetrant tested will show as:

    (a) Linear indications

    (b) Rounded indications

    (c) Square indications

    (d) Triangular indications

11. List two ways of recording relevant indications for record purposes.

    (a) _____

    (b) _____

12. Explain what is meant by LOX compatible penetrant materials.

    (a) _____

    (b) _____

13. Which of the following methods is not recommended for pre-cleaning prior to a liquid penetrant test:

    (a) Steam cleaning, etching, rust and paint removal

    (b) Solvent wipe, vapour degreasing, ultrasonic bath cleaning

    (c) Blasting, grinding, filing, honing, machining

    (d) All of the listed methods are not recommended

14. The purpose of using a developer is:

    (a) To create a contrasting background for the penetrants to ensure better visibility of indications

    (b) Assists in reverse capillary action due to absorption ability of developers

    (c) Prevent the part from corroding after the liquid penetrant test

    (d) To ensure that the part has been correctly heat treated

    (e) Both a and b are correct

15. The typical sequence of conducting a visible solvent removable penetrant is:

    (a) Pre-clean with a solvent wipe method

    (b) Apply visible penetrant, keep wet, dwell time of 2 minutes

    (c) Pour solvent on surface of part and wipe with waste cloth

    (d) Spray on a thick layer of developer

    (e) Inspect and report

    (f) Post-clean

    (g) The above listed methods are not correct for various reasons

16. Explain why low halogen, sulphur-free penetrant materials should be used on stainless steel, titanium and nickel-based alloys.

    (a) _____

    (b) _____

17. The principle on which liquid penetrant testing is based on is:

    (a) Capillary action of the penetrant

    (b) Capillary action of cleaner/solvent

    (c) Capillary action of developer

    (d) None of the listed is correct

18. The limitation of a liquid penetrant test is:

    (a) Only surface breaking discontinuities can be detected if chemically and physically clean and dry

    (b) Porous materials cannot be tested

    (c) There is cleaning problem following penetrant inspection in some cases

    (d) All of the listed limitations are correct

19. Name the six basic steps in the correct sequence of how to conduct a typical liquid penetrant test.

    (a) _____

    (b) _____

    (c) _____

    (d) _____

(e) _____

(f) _____

20. Penetrants may be applied to the surface of part by :

    (a) Spraying

    (b) Dipping

    (c) Pouring

    (d) All of the above methods are acceptable

21. List four properties of a good penetrant.

    (a) _____

    (b) _____

    (c) _____

    (d) _____

22. Which of the following is a reason to post clean a part after a liquid penetrant test:

    (a) The part might be further processed

    (b) If repairs are necessary

    (c) Developers absorb moisture and may result in part being corroded

    (d) All of the reasons are correct

23. Which of the following penetrant has a built-in emulsifier

    (a) Water washable

    (b) Solvent removable

    (c) Post emulsified

    (d) All of the listed above

24. What is the main function of the emulsifier used in post-emulsification penetrant process:

    (a) _____

    (b) _____

25. Liquid penetrants can be classified into the types of dyes they contain:
    (a) Visible/colour contrast
    (b) Fluorescent
    (c) Dual sensitivity
    (d) All of the listed is correct

26. Explain why an emulsifier is used prior to the removal of excess surface penetrant when a post emulsified penetrant is used.
    (a) _____
    (b) _____

27. Explain what will happen when the excess surface penetrant of a solvent removable penetrant is removed by means of solvent sprayed directly onto the surface of a part.
    (a) _____
    (b) _____

28. The advantages of using a visible solvent removable penetrant versus a post emulsified fluorescent penetrant is:
    (a) No UV light is needed
    (b) The technique is well suitable for site tests or spot checks
    (c) No water or emulsifiers are needed
    (d) No extra equipment is needed
    (e) All of the advantages listed above are correct

29. Describe two important functions of a developer.
    (a) _____
    (b) _____

30. List four common surface breaking weld discontinuities that can be detected on welded aluminium, stainless steel materials when conducting a liquid penetrant test.
    (a) _____
    (b) _____
    (c) _____
    (d) _____

31. The following precautions must be observed when removing the excess surface penetrant with a water wash method using a hose pipe:
    (a) The wash angle should be at 45^{o}
    (b) A coarse droplet spray
    (c) Temperature of water 16 to $43^{o}C$
    (d) Pressure as low as possible not to exceed 50 psi
    (e) All of the precautions listed above are correct

32. List four possible causes for false indications that can be observed during a liquid penetrant test.

    (a) _____

    (b) _____

    (c) _____

    (d) _____

33. The typical causes for false indications are:

    (a) Threads, keyways, splines, rough surfaces

    (b) Sharp corners, pop rivets

    (c) Insufficient removal of excess surface penetrant, penetrant on operators' hands, using cloth/paper towels which are not lint free, dirty work surfaces

    (d) Over washing with high pressure hose pipes

34. Name four methods of pre-cleaning the surface of a part prior to conducting a liquid penetrant test.

    (a) _____

    (b) _____

    (c) _____

    (d) _____

35. Liquid penetrants can be further categorised by the removal method of excess surface penetrant:

    (a) Water washable

    (b) Solvent removable

    (c) Post emulsified

    (d) All of the above

36. The advantages of using a visible solvent removable penetrant versus a post emulsified fluorescent penetrant is:

    (a) No UV light is needed

    (b) The technique is well suitable for site tests or spot checks

    (c) No water or emulsifiers are needed

    (d) No extra equipment is needed

    (e) All of the listed is correct

37. Match the type of penetrant to the list of advantages and disadvantages as listed below:

Advantages	Disadvantages
Portable	Penetrant removal is time consuming
No UV light needed	Difficult to remove from rough surfaces
Suited for spot checks	Materials are flammable
Good sensitivity	Cannot be used in open tanks

(a) Visible water wash

(b) Visible solvent removable

(c) Visible post emulsified

(d) Fluorescent water wash

38. How will the excess surface penetrant be removed if a post emulsified penetrant was used:

(a) Dip or spray emulsifier onto part

(b) Wait correct dwell time

(c) Water wash part observing correct recommended rules

(d) Dry part and apply developer

(e) All of the listed steps are correct

39. List four basic safety rules to be followed when conducting a liquid penetrant test.

(a) _____

(b) _____

(c) _____

(d) _____

40. The six basic steps on how to conduct a typical liquid penetrant test is:

(a) Pre-clean surface to be tested

(b) Apply penetrant, keep wet, observe dwell time

(c) Remove excess surface penetrant

(d) Apply developer in a thin even layer

(e) Inspect and report

(f) Post-clean

(g) All of the listed steps are correct

1.1.3 Liquid Penetrant Testing Level 1 (PT-1) Answers to Questions

Liquid Penetrant Testing Level 1 Answers to Questions															
General Examination								Specific Examination							
1	d	35	b	69	b			1	a	35	d				
2	b	36	c	70	b			2	c	36	e				
3	a	37	d	71	a			3	d	37	b				
4	b	38	b	72	b			4	c	38	c				
5	c	39	c	73	c			5	d	39	*				
6	a	40	c	74	d			6	a	40	g				
7	c	41	c	75	c			7	a						
8	d	42	a	76	c			8	b						
9	b	43	a	77	c			9	b						
10	a	44	a	78	b			10	c						
11	b	45	a	79	c			11	d						
12	c	46	c					12	a						
13	c	47	a					13	d						
14	b	48	d					14	b						
15	c	49	a					15	d						
16	b	50	c					16	c						
17	c	51	c					17	a						
18	b	52	b					18	b						
19	c	53	d					19	c						
20	d	54	a					20	b						
21	c	55	d					21	b						
22	a	56	c					22	c						
23	c	57	b					23	a						
24	b	58	b					24	d						
25	b	59	c					25	d						
26	d	60	c					26	c						
27	a	61	c					27	a						
28	b	62	b					28	d						
29	a	63	b					29	c						
30	d	64	c					30	d						
31	b	65	b					31	b						
32	b	66	c					32	b						
33	d	67	a					33	b						
34	a	68	a					34	d						

1.2 Liquid Penetrant Testing Level 2 (PT-2)

1.2.1 Liquid Penetrant Testing Level 2 (PT-2) General Examination

1. A common application of an aluminium block containing quench cracks is to:

    (a) Determine penetrant test sensitivity

    (b) Compare performance of penetrant materials or processes

    (c) Determine effects of mechanical cleaning methods on penetrant test results

    (d) Determine effectiveness of cleaning techniques

2. Which of the following is not (!) an advantage of a water washable fluorescent penetrant process?

    (a) Excess penetrant is easily removed with a water wash

    (b) It is well suited to testing large quantities of small parts

    (c) It is readily removed from shallow discontinuities

    (d) It has low cost, low processing time compared to the post emulsified penetrant process

3. When using a water washable penetrant testing process, why should the water rinse temperature remain constant?

    (a) To avoid changes in rinse efficiency

    (b) To maintain the temperature of the part

    (c) To avoid over washing

    (d) To avoid under washing

4. What is the proper technique for removal of excess penetrant from a part when using a water washable penetrant process?

    (a) Fine spray normal to the surface

    (b) Coarse spray normal to the surface

    (c) Fine spray at 45 degrees to the surface

    (d) Coarse spray at 45 degrees to the surface

5. Which type of developer would you use to obtain the highest sensitivity test results?

    (a) Dry

    (b) Non-aqueous wet

    (c) Aqueous wet

    (d) Lipophilic

6. What type of penetrant process would be best suited to an application at near freezing temperatures?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) None of the above

7. Which type of developer does not (!) provide a contrasting background against which to view penetrant indications?

    (a) Dry

    (b) Non-aqueous wet

    (c) Water soluble

    (d) Water suspendable

8. Which type of developer should not be used with a visible dye penetrant process?

    (a) Dry

    (b) Non-aqueous wet

    (c) Water soluble

    (d) Water suspendable

9. Why might steel parts have a greater tendency towards rusting after penetrant testing?

    (a) Penetrant materials are normally corrosive

    (b) Penetrant materials residues are hydroscopic

    (c) Any protective oils are removed during penetrant testing

    (d) This is true only if the developer and penetrant residues are not removed after testing

10. The most significant advantage of the visible solvent removable penetrant process is?

    (a) Its suitability for penetrant testing of article with rough surfaces

    (b) Portability

    (c) Its non-corrosive properties

    (d) Ability to allow retest

11. Correct developer coating thickness is indicated by:

    (a) An even, snowy white appearance

    (b) A slightly pinkish background

    (c) A fine, misting spray

    (d) A thin, translucent layer

12. Which penetrant test processes commonly use the same penetrants?

    (a) Water washable

    (b) Water washable and solvent removable

    (c) Solvent removable and post emulsifier

    (d) None of the above

13. Mercury vapour black lights may be extinguished if the supply voltage drops below about:

    (a) 120 volts

    (b) 90 volts

    (c) 220 volts

    (d) 200 volts

14. The output of a mercury vapour black light depends on:

    (a) Cleanliness of its filter

    (b) Age of the bulb

    (c) Both a and b

    (d) None of the above

15. When a mercury vapour black light is first turned on, what minimum warm-up time is normally required?

    (a) None

    (b) 2 to 3 minutes

    (c) 5 minutes

    (d) 10 minutes

16. When a mercury vapour black light is inadvertently cut off, approximately how long should it be allowed to cool before attempting to restart?

    (a) Not required

    (b) 2 to 3 minutes

    (c) 5 minutes

    (d) 10 minutes

17. A soft aluminium test piece is to be penetrant tested. The piece has previously been sand blasted to remove tightly adhering soils. What additional surface preparation should be performed?

    (a) Etching

    (b) Solvent cleaning

    (c) Ultrasonic cleaning

    (d) Grinding

18. Dried, non-aqueous developers are best removed after penetrant testing by:

    (a) Solvent cleaning

    (b) Wiping with a water dampened cloth

    (c) Wiping with a dry towel

    (d) Any of the above

19. The most important penetrant test processing time to control is:

    (a) Penetrant dwell time

    (b) Emulsifier dwell time

    (c) Water rinse time

    (d) Development time

20. A penetrant which contains an emulsifier is called:

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Solvent suspended

21. A penetrant which requires a separate emulsification step prior to removal from the surface of the test piece is called?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Solvent suspended

22. The chief advantage of using a water washable penetrant process is:

    (a) Sensitivity

    (b) Safety

    (c) Water tolerance

    (d) Economics

23. While performing a fluorescent water washable penetrant test, which of the following steps should be performed under black light?

    (a) Penetrant application

    (b) Excess penetrant removal

    (c) Emulsification

    (d) Developer application

24. What are the two most important properties in determining the penetrating ability of a penetrant?

    (a) Viscosity and surface tension

    (b) Viscosity and contact angle

    (c) Surface tension and wetting ability

    (d) None of the above

25. The human eye is most sensitive to which of the following types of light?

    (a) Yellow-green

    (b) Red

    (c) Blue-violet

    (d) Orange

26. What amount of time is normally considered necessary for dark adaption of the eyes prior to performing a fluorescent penetrant test?

    (a) None required

    (b) 1 to 2 minutes

    (c) 3 to 5 minutes

    (d) 5 to 10 minutes

27. Which of the following is not normally recommended?

    (a) Performing a fluorescent penetrant test following a visible penetrant test?

    (b) Performing a visible penetrant test following a fluorescent test

    (c) Removing excess penetrant with a water spray

    (d) Removing excess penetrant with towels moistened with solvent

28. What is the most common source of penetrant bath contamination?

    (a) Emulsifier

    (b) Water

    (c) Developer

    (d) Solvent

29. Which of the following is normally considered acceptable practice?

    (a) Sand blasting a soft aluminium part during pre-cleaning

    (b) Performing a fluorescent penetrant test following a visible penetrant test

    (c) performing a re-test on a part tested with a water washable penetrant process

    (d) Removing excess penetrant with a water spray

30. A penetrant testing method in which an emulsifier, separate from the penetrant, is used is called:

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifying

    (d) Self emulsifying

31. A penetrant testing method in which the degree of washability can be controlled by the operator is called:

    (a) Self emulsifying

    (b) Post emulsifiable

    (c) Water washable

    (d) Solvent removable

32. Open, shallow discontinuities are best detected by which penetrant testing method?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) None of the above

33. An advantage of the post emulsifiable penetrant testing process is that:

    (a) Test pieces can be re-processed several times with little loss of sensitivity

    (b) It is the most economical penetrant testing process

    (c) It is highly susceptible to over washing

    (d) It is not self emulsifying

34. A disadvantage of the post emulsifiable penetrant process is that:

    (a) Test pieces can be re-processed several times with little loss of sensitivity

    (b) It is not very sensitive to open, shallow discontinuities

    (c) It is less sensitive to degradation in the presence of acids and chromates

    (d) Emulsifier application is an extra processing step

35. Acceptable methods to apply emulsifier are:

    (a) Dipping

    (b) Flowing

    (c) Spraying

    (d) All of the above

36. An advantage of emulsifier application by dipping is:

    (a) Excess penetrant is recovered in the emulsifier tank and reprocessed

    (b) All of the test object is coated at approximately the same time

    (c) Excess emulsifier drains back into the emulsifier tank for re-use

    (d) Hydrophilic scrubbing is then easier to perform

37. Emulsification time is less critical for the detection of:

    (a) Fine, tight cracks

    (b) Wide, shallow discontinuities

    (c) Internal porosity

    (d) None of the above

38. Over washing during excess penetrant removal is less likely with which penetrant testing process?

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Self emuslifying

39. The fluorescent dyes used in the liquid penetrant testing process are most active when energised with black light of what wavelengths? (Å stands for angstrom units)

    (a) 2.0×10^{-7}m (2000 Å)

    (b) 2.5×10^{-7}m (2500 Å)

    (c) 3.25×10^{-7}m (3250 Å)

    (d) 3.65×10^{-7}m (3650 Å)

40. Application of penetrant to a test piece may be by:

    (a) Dipping, brushing or spraying

    (b) Spraying only

    (c) Bushing or spraying only

    (d) Dipping or spraying only

41. The penetrant process best suited to use on parts with rough surfaces is:

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Magnetic particle

42. The penetrant process best suited for the detection of very fine discontinuities is:

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Magnetic particle

43. The penetrant process best suited for use on parts with keyways and threads is:

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) None of the above

44. Indications which are caused by design or construction of the test piece are called?

    (a) Relevant

    (b) Non-relevant

    (c) False

    (d) Real

45. Indications which are caused by something other than a discontinuity are called:

    (a) Relevant

    (b) Non-relevant

    (c) False

    (d) Real

46. Which of the following discontinuities would you not expect to find in a casting?

(a) Shrinkage cracks

(b) Incomplete penetration

(c) Cold shuts

(d) Porosity

47. Which type of casting is made in a metal mould?

(a) Investment casting

(b) Sand casting

(c) Die casting

(d) Lost wax process

48. The act of determining the cause of an indication is called

(a) Interpretation

(b) Inspection

(c) Evaluation

(d) Determination

49. The act of determining the effect of a discontinuity of the usefulness of a part is called:

(a) Interpretation

(b) Inspection

(c) Evaluation

(d) Determination

50. Contaminants which are commonly limited in penetrant materials are:

(a) Hydrogen and chlorine

(b) Carbon and sulphur

(c) Hydrogen and carbon

(d) Chlorine and sulphur

1.2.2 Liquid Penetrant Testing Level 2 (PT-2) Specific Examination

1. The most likely result of a too short dwell time of an emulsifier is:

    (a) A tendency to remove the penetrant from fine discontinuities

    (b) Incomplete removal of excess surface penetrant

    (c) An overactive emulsifier

    (d) All of the above

2. Diffusion of a lipophilic emulsifier penetrant into the test piece surface is stopped by:

    (a) The conclusion of the emulsifier dwell time

    (b) The penetrant

    (c) Application of developer

    (d) The water rinse step

3. When using a post emulsifiable penetrant process, it is important to drain as much excess penetrant as possible from the surface of a test piece which has been immersed in the penetrant because:

    (a) Too much penetrant on the part surface may lead to more rapid penetration and over-sensitivity

    (b) A thinner layer of penetrant is likely to have higher capillary action and, thus, be more sensitive to fine discontinuities

    (c) A thinner layer of penetrant will result in less penetrant contamination in the emulsifier tank

    (d) None of the above

4. When a drain-dwell technique is used during emulsification, what two mechanisms are responsible for combining the emulsifier and penetrant?

    (a) Diffusion and turbulent mixing

    (b) Osmosis and agitation

    (c) Turbulent mixing and osmosis

    (d) Agitation and turbulent mixing

5. When performing a post emulsifiable penetrant test, the test piece does not rinse acceptable clean during normal processing. What should be done?

    (a) Return the test piece to the emulsifier and repeat the step

    (b) Increase water temperature and pressure

    (c) Remove the excess penetrant with solvent remover and process the remainder of the test normally

    (d) Clean the test piece and re-process through the complete penetrant test process

6. The adequacy of excess penetrant removal, using water washable penetrant process, is judged and controlled by:

    (a) Water rinse time

    (b) Fluorescent brightness measurement

    (c) Visual observation

    (d) Cleanliness of cloths used for removal

7. Another name for a self-emulsifying penetrant process is:

    (a) Solvent removable

    (b) Water washable

    (c) Post emulsifiable

    (d) Solvent emulsifiable

8. Which of the following is a function of an emulsifier?

    (a) To draw penetrant out of a discontinuity and form a visible indication

    (b) To increase the size of an indication through capillary action

    (c) To provide contrasting background for viewing penetrant indications

    (d) None of the above

9. When viewed under black light, developer appears:

    (a) Yellow-green

    (b) Blue-black

    (c) White

    (d) Pinkish white

10. Penetrant developers are used in which of the following forms?

    (a) Water washable

    (b) Water suspendable

    (c) Solvent suspendable

    (d) All of the above

11. Which of the following developers requires the test piece to be dried prior to its application?

    (a) Water washable

    (b) Water suspendable

    (c) Non-aqueous suspendable

    (d) All of the above

12. An effect of a thick developer coating might be:

    (a) To obscure discontinuity indications

    (b) To enhance discontinuity indications

    (c) To increase penetrant test sensitivity by providing more capillary paths

    (d) None of the above

13. Why is it important to view the test piece shortly after developer application and periodically through the development time?

    (a) To make sure the developer dries evenly

    (b) To guard against pooling of developer in low areas

    (c) To avoid missing small flaw indications adjacent to areas of high bleed-out

    (d) To avoid missing transient indications against an otherwise clean background

14. Which of the following is an advantage of a dry developer?

    (a) Ease of handling

    (b) Non-corrosive

    (c) No hazardous vapours

    (d) All of the above

15. Why is the need for a dry surface prior to developer application more of a disadvantage with a dry developer than with a non-aqueous wet developer?

    (a) Because the dry developer only forms a thin film on the surface of the test piece

    (b) Because the solvent in a non-aqueous wet developer penetrates deeper into discontinuities to contact entrapped penetrant and draw it back out

    (c) Because the warm test piece causes evaporation of the solvent in the non-aqueous developer

    (d) All of the above

16. The preferred method of application of aqueous wet developer is:

    (a) Dipping

    (b) Spraying

    (c) Brushing

    (d) All of the above

17. It is easier to control developer coating thickness with a soluble developer than a water suspendable one because:

    (a) Less developer can be dissolved that suspended in water

    (b) It dries more rapidly on the test piece

    (c) Evaporation deposits a thin, even coating on the test piece

    (d) All of the above

18. Which of the following is not an advantage of an aqueous wet developer?

    (a) It may be applied to a dry surface

    (b) It has no hazardous vapours

    (c) There is visible evidence of developer coverage

    (d) During drying, only water evaporates, not costly solvents

19. A disadvantage of water soluble developers is:

    (a) Agitation of the developer is not required

    (b) A uniform developer film is obtained

    (c) The dried developer is difficult to remove during post cleaning

    (d) None of the above

20. Fluorescent penetrant indications are more visible than colour contrast penetrant indications because:

    (a) They reflect more light

    (b) They emit rather than reflect light

    (c) They contain a higher concentration of dye particles

    (d) Yellow and green contrast more than red and white

21. The tendency of a liquid to be drawn into small discontinuities is called:

    (a) Viscosity

    (b) Barometric

    (c) Capillary action

    (d) Surface tension

22. A liquid which reacts with a penetrant to render it water washable is called:

    (a) Developer

    (b) Emulsifier

    (c) Aqueous scrubber

    (d) Non-aqueous cleaner

23. A water tolerance test would be performed on:

    (a) Solvent removable penetrants

    (b) Water washable and post emulsifiable penetrant

    (c) Solvent removable penetrants and hydrophilic emulsifiers

    (d) Water washable penetrants and lipophilic emulsifiers

24. A problem which could be caused by a penetrant with abnormally high water content is:

    (a) Hydrogen assisted cracking

    (b) Rusting of steel parts

    (c) Water contamination

    (d) Blurring of indications

25. Deterioration of penetrant material performance may be caused by which of the following?

    (a) Water contamination

    (b) Heat

    (c) Cleaning solvents

    (d) All of the above

26. When adding water to a penetrant, the water tolerance limit is indicated when:

    (a) Opacity reaches 2% of International optical transmission standard

    (b) The penetrant material and dye separate into their constituent parts

    (c) Permanent cloudiness occurs

    (d) None of the above

27. Possible degradation of penetrant materials performance is often checked by:

    (a) Performing penetrant testing of comparator blocks using samples of new and used penetrant materials

    (b) Water tolerance test

    (c) Using a penetrant test penetrameter

    (d) Judgment of a qualified inspector during production testing

28. The most common biological effect of penetrant materials on personnel is:

    (a) Burns to the retina of the eye from over exposure to ultraviolet light

    (b) Skin irritation caused by removal of natural oils from the skin

    (c) Acute chlorine poisoning

    (d) No effect

29. Hydrophilic emulsifiers may be applied by:

    (a) Dipping

    (b) Immersion

    (c) Spraying

    (d) All of the above

30. The term ‘drag out losses’ refers to:

    (a) Loss of penetrant materials that are carried from one processing station to another on the test piece

    (b) Penetrant which is removed from discontinuities during the water washable process

    (c) Penetrant which is removed from discontinuities because of over-emulsification prior to water removal

    (d) Both b and c

31. The diffusion mechanism is used in the operation of:

    (a) Solvent removable penetrant

    (b) Lipophilic emulsifiers

    (c) Hydrophilic emulsifiers

    (d) Both b and c

32. The concentration of a hydrophilic emulsifier may be measured by:

    (a) Specific gravity

    (b) Fluorescent brightness

    (c) An optical refraction meter

    (d) A comparator block

33. When applied by immersion, an optimum concentration for a hydrophilic emulsifier is about:

    (a) 0.5–2%

    (b) 80–100%

    (c) 2.5–20%

    (d) 50–80%

34. Hydrophilic emulsifier contact time depends on which of the following?

    (a) Surface finish of test piece

    (b) Emulsifier concentration

    (c) Method of application

    (d) All of the above

35. How is the correct emulsifier contact time determined?

    (a) Manufacturer's recommendations

    (b) One half penetrant dwell time

    (c) Experiment

    (d) Same as penetrant dwell time

36. Which of the following is used in connection with hydrophilic emulsifier applied by immersion?

    (a) Brushing

    (b) Agitation

    (c) Drain-dwell

    (d) All of the above

37. Which of the following is a disadvantage of a hydrophilic emulsifier?

    (a) Greater penetrant tolerance than lipophilic emulsifiers

    (b) Economical

    (c) Low drag-out losses compared to lipophilic emulsifiers

    a. Versatile application

38. During excess penetrant removal, a water spray pre-rinse might be used with:

    (a) A lipophilic emulsifier

    (b) A hydrophilic emulsifier

    (c) A hydrophobic emulsifier

    (d) None of the above

39. Re-cycling of penetrant and rinse water is facilitated with which of the following emulsifier types?

    (a) Hydrophobic

    (b) Hydrophilic

    (c) Lipophilic

    (d) Hygroscopic

40. Which type of emulsifier is intended for use without dilution?
    (a) Hydrophobic
    (b) Hydrophilic
    (c) Lipophilic
    (d) Hygroscopic

41. Halogen content of penetrant materials is limited because of the possibility of stress corrosion cracking in which of the following materials?
    (a) High tensile steel
    (b) Austenitic stainless steel
    (c) Titanium alloys
    (d) All of the above

42. The most likely cause of loss of performance in a lipophilic emulsifier is:
    (a) High viscosity
    (b) Water contamination
    (c) Phase separation
    (d) Improper concentration

43. In performing a water content test of a lipophilic emulsifier per ASTM D-95, what solvent is used?
    (a) Naptha
    (b) Trichloroethane
    (c) Benzene
    (d) Xylene

44. Which of the following developers would you expect to be the least sensitive?
    (a) Water suspendable wet (immersion)
    (b) Water suspendable wet (spray)
    (c) Dry immersion (dip)
    (d) Non-aqueous wet (solvent spray)

45. Which of the following developers would you expect to be the most sensitive?
    (a) Water suspendable wet (immersion)
    (b) Water suspendable wet (spray)
    (c) Dry immersion (dip)
    (d) Non-aqueous wet (solvent spray)

46. Which of the following developers would you expect to be the least sensitive?

(a) Water suspendable wet (immersion)

(b) Water suspendable wet (spray)

(c) Water soluble (spray)

(d) Water soluble (immersion)

47. Which of the following developers would you expect to be the most sensitive?

(a) Water suspendable wet (immersion)

(b) Water suspendable wet (spray)

(c) Water soluble (spray)

(d) Water soluble (immersion)

48. Dual purpose penetrants are viewed under what type of light?

(a) White light

(b) Black light

(c) Both a and b

(d) None of the above

49. When is it possible to detect slightly sub-surface defects using penetrant testing?

(a) Only if you are using fluorescent penetrant

(b) When using post-emulsifiable penetrant

(c) It is not possible to detect slightly sub-surface defects using penetrant testing

(d) When using dual sensitivity penetrants

50. Which of the following would be classed as an in-service fault?

(a) A shrinkage crack

(b) A fatigue crack

(c) A grinding crack

(d) All could be in-service faults

1.2.3 Liquid Penetrant Testing Level 2 (PT-2) Answers to Questions

Liquid Penetrant Testing Level 2 Answers to questions															
General Examination								Specific Examination							
1	a	35	d					1	b	35	c				
2	c	36	b					2	d	36	b				
3	c	37	a					3	d	37	b				
4	d	38	b					4	a	38	b				
5	b	39	d					5	d	39	b				
6	d	40	a					6	c	40	c				
7	a	41	b					7	b	41	d				
8	a	42	c					8	d	42	b				
9	c	43	b					9	b	43	d				
10	b	44	b					10	d	44	c				
11		45	b					11	c	45	d				
12	c	46	c					12	a	46	b				
13	d	47	c					13	c	47	d				
14	c	48	a					14	d	48	c				
15	c	49	c					15	a	49	c				
16	c	50	d					16	d	50	b				
17	c							17	d						
18	d							18	a						
19	a							19	d						
20	b							20	b						
21	c							21	c						
22	b							22	b						
23	b							23	d						
24	c							24	b						
25	c							25	d						
26	c							26	c						
27	a							27	a						
28	b							28	b						
29	d							29	d						
30	c							30	a						
31	c							31	b						
32	c							32	c						
33	a							33	c						
34	d							34	dd						

2 MAGNETIC PARTICLES TESTING (MT)

2.1 Magnetic Particles Testing Level 1 (MT-1)

2.1.1 Magnetic Particles Testing Level 1 (MT-1) General Examination

1. Magnetic particles testing is most likely to find subsurface discontinuities in:

    (a) Soft steels with high permeability

    (b) Soft steels with low permeability

    (c) Hardened steels with low permeability

    (d) Hardened steels with high permeability

2. Which of the following is not an advantage of magnetic particles testing?

    (a) Fast and simple to perform

    (b) Can detect discontinuities filled with foreign material

    (c) Most reliable for finding surface cracks in all types of material

    (d) Works well through a thin coat of paint

3. Which of the following does not represent a limitation of magnetic particle testing?

    (a) The type of materials which may be effectively tested

    (b) The directionality of the magnetic field

    (c) The need for demagnetization

    (d) The ability to detect discontinuities filled with foreign material

4. The most effective NDT method for locating surface cracks in ferromagnetic materials is:

    (a) Ultrasonic testing

    (b) Radiographic testing

    (c) Magnetic particle testing

    (d) Liquid penetrant testing

5. Which of the following may cause magnetic particle test indications?

    (a) A joint between two ferromagnetic materials of different permeability

    (b) A shrink fit joint in ferromagnetic materials

    (c) A brazed joint in ferromagnetic materials

    (d) All of the above

6. A discontinuity which is produced during solidification of the molten metal is called:

    (a) Inherent

    (b) Processing

    (c) Service

    (d) None of the above

7. Pipe would be classified as what type of discontinuity?

    (a) Inherent

    (b) Processing

    (c) Service

    (d) None of the above

8. A seam would be classified as what type of discontinuity?

    (a) Inherent

    (b) Processing

    (c) Service

    (d) None of the above

9. A lamination in steel plate would be classified as what type of discontinuity?

    (a) Inherent

    (b) Processing

    (c) Service

    (d) None of the above

10. An internal rupture caused by working steel at improper temperatures is called a:

    (a) Lap

    (b) Cold shut

    (c) Forging burst

    (d) Slag inclusion

11. Cracks which are caused by alternating stresses above a critical level are called:

    (a) Stress corrosion cracks

    (b) Cycling cracks

    (c) Critical cracks

    (d) Fatigue cracks

12. Cracks which are caused by a combination of tensile stress and corrosion are called:

    (a) Stress corrosion cracks

    (b) Cycling cracks

    (c) Critical cracks

    (d) Fatigue cracks

13. Which of the following are ferromagnetic materials?

    (a) Aluminium, iron, copper

    (b) Iron, copper, nickel

    (c) Copper, aluminium, silver

    (d) Iron, cobalt, nickel

14. The reverse magnetising force necessary to remove a residual magnetic field from a test piece after it has been magnetically saturated is called:

    (a) Hysteresis

    (b) Coercive force

    (c) Demagnetising flux

    (d) Reverse saturation

15. Magnetic lines of force enter and leave a magnet at:

    (a) Saturation

    (b) L/D ratios of greater than 4 to 1

    (c) Flux concentration points

    (d) Poles

16. The ease with which a magnetic field can be established in a test piece is called:

    (a) Reluctance

    (b) Retentivity

    (c) Permeability

    (d) Electromagnetism

17. Opposition to establishment of a magnetic field is called:

    (a) Reluctance

    (b) Retentivity

    (c) Permeability

    (d) Electromagnetism

18. The ability of a material to remain magnetic after the magnetising force is removed is called:

    (a) Reluctance

    (b) Retentivity

    (c) Permeability

    (d) Electromagnetism

19. A magnetic field which is contained completely within the test piece is called a:

    (a) Confined field

    (b) Longitudinal field

    (c) Circular field

    (d) Saturated field

20. Which of the following produces a circular field?

    (a) Coil

    (b) Head shot

    (c) Yoke

    (d) All of the above

21. A technique used to find transverse discontinuities at the ends of longitudinally magnetised bars by the use of transient currents is called:

    (a) A coil technique

    (b) A fast break technique

    (c) A yoke technique

    (d) A head shot

22. A leakage field is strongest when a discontinuity interrupts the magnetic flux lines at an angle of:

    (a) Zero degrees

    (b) 45 degrees

    (c) 90 degrees

    (d) 180 degrees

23. The best method of inducing a circular field in a tube is by a:

    (a) Central conductor

    (b) Head shot

    (c) Coil

    (d) Prod technique

24. Magnetic flux density is zero at:

    (a) The inside surface of a tube magnetised with a central conductor

    (b) The outside surface of a tube magnetised with a central conductor

    (c) The outside surface of a bar magnetised with a head shot

    (d) The centre of a bar magnetised with a head shot

25. Magnetic flux density is highest at:

    (a) The outside surface of a non-ferromagnetic tube magnetised with a central conductor

    (b) The inside surface of a non-ferromagnetic tube magnetised with a central conductor

    (c) The outside surface of a ferromagnetic tube magnetised with a central conductor

    (d) The inside surface of a ferromagnetic tube magnetised with a central conductor

26. An important consideration when using a direct contact method is:

    (a) Lifting power of the yoke

    (b) Coil diameter

    (c) Preventing arc burns

    (d) Field strength adjacent to the coil inside diameter

27. A prod method would be most sensitive to cracks:

    (a) Parallel to a line connecting the prod contact points

    (b) Tangential to a radius from each prod contact point

    (c) Perpendicular to a line connecting the prod contact points

    (d) Perpendicular to the long axis of the coil

28. When using prods, arc burns may be caused by which of the following?

    (a) Dirty contact tips

    (b) Inadequate pressure

    (c) Too large a magnetic current

    (d) All of the above

29. The important difference between AC and DC current for magnetic particle testing purposes is:

    (a) The skin effect caused by DC adds mobility to the magnetic particles

    (b) The resulting AC magnetic fields are more difficult to demagnetize

    (c) The DC magnetic fields are more penetrating

    (d) The AC magnetic fields are stronger

30. The ‘skin’ effect would be most noticeable in which of the following?

    (a) A magnetic conductor carrying a DC current

    (b) A nonmagnetic conductor carrying a DC current

    (c) A magnetic conductor carrying a 50 Hz AC current

    (d) A nonmagnetic conductor carrying a 50 Hz AC current

31. The most common source of DC current for magnetic particle testing is:

    (a) Motor generators

    (b) Rectified AC

    (c) Storage batteries

    (d) None of the above

32. Fields generated in ferromagnetic material with AC current are useful for locating:

    (a) All discontinuities

    (b) Surface cracks

    (c) Subsurface discontinuities

    (d) Internal porosity

33. A common rule of thumb to use for current required in circular magnetisation:

    (a) 1000 amps/25mm of diameter

    (b) 1000 ampere turns/25mm of diameter

    (c) 1000 amps/25mm of prod spacing

    (d) None of the above

34. The formula, NI = 45000/(L/D), is used to calculate the proper magnetising current for:

    (a) Prod magnetization

    (b) A head shot

    (c) A central conductor

    (d) Coil magnetisation

35. The formula, NI = 45000/(L/D), gives proper magnetising current for a coil, regardless of coil size as long as:

    (a) The test piece is not larger than 1/10 the cross sectional area of the coil

    (b) AC current only is used

    (c) The test piece essentially fills the coil

    (d) The test piece is held tightly against the coil

36. For direct contact magnetising methods, the magnetic field is oriented in what direction relative to the current direction?

    (a) Parallel

    (b) At 45 degrees

    (c) At 90 degrees

    (d) At 180 degrees

37. For direct contact magnetising methods, current should be flowing in what direction relative to expected discontinuities?

    (a) Parallel

    (b) At 45 degrees

    (c) At 90 degrees

    (d) At 180 degrees

38. What is the magnetic field strength at the surface of a 100 mm diameter bar as compared to that at the surface of a 50 mm diameter bar, each carrying 1000 amps of current?

    (a) Twice

    (b) One half

    (c) One quarter

    (d) Four times

39. What is the magnetic field strength at the surface of a 25mm diameter bar as compared to that at the surface of a 50mm diameter bar, each carrying 1000 amps of current?

    (a) Twice

    (b) One half

    (c) One quarter

    (d) Four times

40. The magnetic field outside a conductor decreases:

    (a) Exponentially

    (b) In a linear manner

    (c) Inversely with distance

    (d) Inversely with the square of distance

41. How is the magnetic field strength at the surface of a magnetic conductor having permeability, μ, related to the magnetic field strength, F, at the surface of a nonmagnetic conductor carrying the same current?

    (a) F × μ

    (b) Same

    (c) F/μ

    (d) Not related

42. Compared to the magnetic field strength at the outer surface, the magnetic field strength, at the centre of a hollow, nonmagnetic conductor carrying DC current is:

    (a) I/D

    (b) The same

    (c) Zero

    (d) Need more information to determine

43. How is the magnetic field strength, F, just outside a magnetic conductor having permeability, μ, related to that just outside a nonmagnetic conductor of the same size, carrying the same current?

    (a) F × μ

    (b) Same

    (c) (F)/μ

    (d) Not related

44. Which of the following describes the shape of particles used for dry magnetic particle testing?

    (a) Spherical

    (b) Angular

    (c) Elongated

    (d) Mixture of elongated and globular

45. Which of the following *particles* would be most sensitive?

    (a) Wet

    (b) Dry

    (c) Depends on the test piece permeability

    (d) None of the above

46. Which of the following colours is readily available for magnetic particle test powder?

    (a) Red

    (b) Gray

    (c) Black

    (d) All of the above

47. A magnetic particle testing technique in which the test piece is magnetised and magnetic particles applied after the magnetising force has been removed is called the:

    (a) Magnetic method

    (b) Continuous method

    (c) Residual method

    (d) Discontinuous method

48. Which of the following characteristics would be most important in a test piece which is to be tested using the residual method?

    (a) High rententivity

    (b) High permeability

    (c) Low reluctance

    (d) Low permeability

49. The wet method is superior to dry particles for detecting:

    (a) Subsurface discontinuities

    (b) Fine surface cracks

    (c) Open surface cracks

    (d) None of the above

50. Selection of magnetic particle colour is based on:

    (a) Optimum performance of magnetic particle/developer

    (b) Colour of inspection light available

    (c) Obtaining maximum contrast with the test piece background

    (d) Optimum colour response of the human eye

51. The residual method is applicable to:

    (a) Surface discontinuities only

    (b) Subsurface discontinuities only

    (c) Either surface or subsurface discontinuities

    (d) All but tight surface cracks

52. Highest sensitivity to fine surface cracks would be obtained by which of the following techniques?

    (a) Residual field, wet method

    (b) Residual field, dry method

    (c) Continuous field, wet method

    (d) Continuous field, dry method

53. A residual field is always less than a continuous field because?

    (a) The magnetic field, as shown by a hysteresis curve, is zero when there is no magnetising force

    (b) The magnetic field, as shown by a hysteresis curve, is less when there is no magnetising force

    (c) The magnetic field, as shown by a hysteresis curve, is greater when there is no magnetising force

    (d) None of the above

54. Where possible, circular magnetisation is preferable to longitudinal magnetization because:

    (a) Less current is required

    (b) Stronger fields are obtained

    (c) Fewer confusing secondary poles are produced

    (d) None of the above is true

55. Which of the following is a disadvantage of the dry method?

    (a) Ease of application with portable equipment

    (b) Superior sensitivity for fine surface cracks

    (c) Good particle mobility with AC and HWDC

    (d) Good sensitivity for subsurface discontinuities

56. Which of the following is an advantage of the dry method

(a) Good sensitivity for subsurface discontinuities

(b) Faster than wet method for quantities of small test pieces

(c) Easily applied in an automated system

(d) Easy coverage of surfaces of irregularly shaped test pieces

57. Loss of fine particle sizes due to re-use of dry particles would probably lead to:

(a) Loss of sensitivity to larger discontinuities

(b) Loss of sensitivity to finer discontinuities

(c) Unpredictable results

(d) Slower inspection speeds

58. Which of the following is a disadvantage of the wet method?

(a) It is the most sensitive method for detection of very fine surface cracks

(b) Rapid testing of large quantities of small test pieces

(c) Readily adaptable to mechanised equipment

(d) Excellent detection of completely subsurface discontinuities

59. Which of the following is an advantage of the wet method?

(a) Excellent detection of completely subsurface discontinuities

(b) Ease of bath recovery and re-use

(c) Low flash point ensures freedom from fire hazards

(d) Relatively clean and easy to work with

60. The primary reason for using water rather than oil as a suspension medium for wet method baths is that:

(a) Water is more chemically inert than oil

(b) Bath flammability hazards are eliminated

(c) Water has the capability to dissolve the needed rust inhibitors

(d) Water baths may be used at lower temperatures than oil baths

61. A disadvantage of fluorescent magnetic particles is:

    (a) Darkened area and black light are required

    (b) Abnormally high sensitivity

    (c) Only dry particles are available

    (d) Only wet concentrate is available

62. A common physiological effect of black light inspection on the inspector is:

    (a) Burned retinas of the eyes

    (b) Rejected cornea syndrome

    (c) Eye fatigue

    (d) Retarded iris control

63. A common physiological effect of black light inspection on the inspector is:

    (a) Burned retinas of the eyes

    (b) Rejected cornea syndrome

    (c) Eyeball fluorescence

    (d) Retarded iris control

64. Which of the following represents ultraviolet light of wavelengths which are potentially injurious (1 Å = 10^{-10}m)

    (a) 2000 to 3200 Å

    (b) 3200 to 4000 Å

    (c) 4000 to 4600 Å

    (d) 4600 to 5200 Å

65. Dyes which receive light at one wavelength and re-emit light of another wavelength are called:

    (a) L.E.Ds

    (b) Phosphorescent

    (c) Luminescent

    (d) Fluorescent

66. Most fluorescent dyes used for magnetic particle testing fluoresce what colour?

    (a) Blue green

    (b) Yellow green

    (c) Blue black

    (d) Red orange

67. The best available source of black light for inspection is:

    (a) The mercury vapour lamp

    (b) The fluorescent tube

    (c) The incandescent bulb

    (d) Sunlight

68. Which of the following would be likely to cause variations in the output of an inspection black light?

    (a) Voltage fluctuations

    (b) Aged bulb

    (c) Dirty filter

    (d) All of the above

69. The temperature above which steels become nonmagnetic is called the:

    (a) Zero retentivity

    (b) Curie point

    (c) Demagnetisation temperature

    (d) Random polar point

70. The temperature above which most soft steels become nonmagnetic is about:

    (a) 440ºC (770ºF)

    (b) 523ºC (975ºF)

    (c) 626ºC (1160ºF)

    (d) 754ºC (1390ºF)

71. The most common method of demagnetising small test pieces is:

    (a) Heat treatment

    (b) Shot peening

    (c) Passing through an AC coil

    (d) Direct contact with AC current

72. Demagnetisation with reversing DC is more effective than AC because:

    (a) DC is more penetrating

    (b) Demagnetisation is assisted by the skin effect

    (c) DC is more direct

    (d) Not true - AC is more effective

73. The type of discontinuity which magnetic particle testing most effectively locates is:

    (a) Slag inclusions

    (b) Magnetic writing

    (c) Porosity

    (d) Surface cracks

74. An indication which is formed when two pieces of magnetised steel come in contact with each other is called:

    (a) A metallurgical discontinuity

    (b) Magnetic writing

    (c) Magnetic transfer

    (d) A ferromagnetic notch

75. Magnetic particle test indications which are due to cold work can best be removed by:

    (a) Demagnetisation

    (b) Using a lower current

    (c) Re-crystallisation

    (d) Heat treating

76. Which of the following might cause non-relevant indications?

    (a) Over magnetisation

    (b) Indications at the edges of a braze joint

    (c) A joint between hard and soft steels

    (d) All of the above

77. An inspection for surface and subsurface discontinuities in ferromagnetic welds would best be accomplished by which of the following techniques?

    (a) Prods

    (b) AC yoke

    (c) Half wave DC yoke

    (d) None of the above

78. A continuous linear indication along the centre of a fillet weld would most likely be a:

    (a) Crater crack

    (b) Overlap

    (c) Root indication

    (d) None of the above

79. Wet magnetic particle bath strength is checked by which of the following?

    (a) Specific gravity

    (b) Optical density

    (c) Settling test

    (d) None of the above

80. Which of the following describes the best technique for applying dry magnetic particles to a test piece?

    (a) Dip the test piece in a tank of dry particles while current is flowing

    (b) Apply with an electrostatic spray gun at approximately 30 PSIG

    (c) Gently pour the powder onto the test piece

    (d) Shake or dust the powder onto the test piece with minimum velocity

81. An advantage of AC equipment over DC is:

(a) AC is more penetrating

(b) AC is less hazardous

(c) AC makes the magnetic particles more mobile on the test surface

(d) AC equipment is heavier than DC

82. When the orientation of likely discontinuities is unknown, what is the minimum number of magnetising operations required to perform an adequate test?

(a) 1

(b) 2

(c) 3

(d) None of the above

83. Maximum practical prod spacing is about:

(a) 100 mm

(b) 200 mm

(c) 300 mm

(d) 450 mm

84. Magnetic lines of flux which are parallel to a discontinuity produce:

(a) Strong indications

(b) Weak indications

(c) No indications

(d) Fuzzy indications

85. The area of maximum induced field strength using a yoke is:

(a) At the north pole of the yoke

(b) At the south pole of the yoke

(c) The area directly between the poles

(d) On the outside of the pole pieces

86. A minimum of external poles are produced by what type of magnetisation?

(a) Continuous

(b) Residual

(c) Circular

(d) Longitudinal

87. A split coil would most likely be used with a:

(a) DC yoke

(b) Split phase AC yoke

(c) Stationary magnetic particle unit

(d) Portable magnetic particle unit

88. The most common harmful effect of exposure to black light is:

(a) Eyeball fluorescence

(b) Burned retinas

(c) Skin burns

(d) None of the above

89. Which of the following types of magnetic fields may be present without any external evidence?

(a) Circular

(b) Longitudinal

(c) Secondary

(d) Tertiary

90. A residual circular field may be objectionable because:

(a) Grinding may produce cracks

(b) Machining may create external poles

(c) Heat treating may lead to tight surface cracks

(d) All of the above

91. Which of the following is a disadvantage of magnetic particle testing?

    (a) Fast and simple to perform

    (b) Can detect discontinuities filled with foreign material

    (c) Most reliable for finding surface cracks in all types of metals

    (d) Works well through a thin coat of paint

2.1.2 Magnetic Particles Testing Level 1 (MT-1) Specific Examination

1. The primary reason for using water rather than oil as a suspension medium for wet method baths is that

    (a) Water is more chemically inert than oil

    (b) Bath flammability hazards are eliminated

    (c) Water has the capability to dissolve the needed rust inhibitors

    (d) Water baths may be used at a lower temperature than oil baths

2. Wet magnetic particle strength is checked by which of the following?

    (a) Specific gravity

    (b) Optical density

    (c) Settling test

    (d) None of the above

3. A residual circular field may be objectionable because:

    (a) Grinding may produce heat cracks

    (b) Machining may create external poles

    (c) Heat treating may lead to tight surface cracks\

    (d) All of the above

4. A prod method would be most sensitive to cracks:

    (a) Parallel to a line connecting the prod contract points

    (b) Tangential to a radius from each prod contact point

    (c) Perpendicular to a line connecting the prod contact points

    (d) Perpendicular to the long axis

5. Highest sensitivity to fine surface cracks would be obtained by which of the following techniques?

    (a) Residual field, wet method

    (b) Residual field, dry method

    (c) Continuous field, wet method

    (d) Continuous field, dry method

6. Maximum practical prod spacing for a 2000 amp unit is about:

    (a) 100 mm

    (b) 200 mm

    (c) 300 mm

    (d) 450 mm

7. Demagnetisation with reversing DC is more effective than AC because:

    (a) DC is more penetrating

    (b) Demagnetisation is assisted by the skin effect

    (c) DC is more direct

    (d) Not true-AC is more effective

8. Fluorescent magnetic particle indications should be inspected under

    (a) Fluorescent light

    (b) Any light

    (c) Black light

    (d) Red light

9. A discontinuity which is produced during solidification of the molten metal is called:

    (a) Inherent

    (b) Processing

    (c) Service

    (d) None of the above

10. Cracks which are caused by a combination of tensile stress and corrosion are called:

    (a) Intergranular stress corrosion cracking

    (b) Cycling cracks

    (c) Stress corrosion cracking

    (d) Fatigue cracks

11. The type of discontinuity potentially most harmful to the useful life of a part is:

    (a) Slag inclusions

    (b) Magnetic writing

    (c) Porosity

    (d) Surface cracks

12. Magnetic particle test indications which are due to cold work can best be removed by:

    (a) Demagnetisation

    (b) Using a lower current

    (c) Using penetrant testing

    (d) Re-heat treating

13. Which of the following might cause non relevant indications?

    (a) Magnetic writing

    (b) Indications at the edges of a braze joint

    (c) A joint between hard and soft steels

    (d) All of the above

14. A continuous linear indication along the edge of a new fillet weld would most likely be a:

    (a) Crater crack

    (b) Fatigue crack

    (c) Stress corrosion crack

    (d) Heat affected zone hydrogen crack

15. Ferromagnetic material is:

    (a) Strongly attracted by a magnet

    (b) Capable of being magnetized

    (c) Both (a) and (b)

    (d) Not capable of being magnetized

16. The retentivity of a material describes:

    (a) The ease with which it can be magnetized

    (b) The depth of the magnetic field in the part

    (c) The length of time required to demagnetise it

    (d) The ability to retain the magnetic field

17. Which of the following can be magnetised?

    (a) Iron

    (b) Nickel

    (c) Cobalt

    (d) All of the above

18. The magnetic field is strongest when:

    (a) The magnetising voltage is flowing

    (b) The magnetising current is flowing

    (c) The material exhibits high coercive forces

    (d) The magnetising current is not flowing

19. The unit usually used to denote flux density is the:

    (a) Gauss

    (b) Henry

    (c) Farad

    (d) Ampere

20. Which statement is true when related to magnetic lines of force?

    (a) They never cross

    (b) They are most dense at the poles of a magnet

    (c) They seek the path of least resistance

    (d) All of the above

21. Magnetic lines of force:

    (a) Travel in straight lines

    (b) Form a closed loop

    (c) Are randomly oriented

    (d) Overlay in highly ferromagnetic materials

22. The areas on a magnetised part from which the magnetic field is leaving or returning into the part are called:

    (a) Salient points

    (b) Defects

    (c) Magnetic poles

    (d) Nodes

23. The magnetism which remains in a piece of magnetisable material after the magnetising force has been removed is called the:

    (a) Tramp field

    (b) Residual field

    (c) Damped field

    (d) Permanent field

24. Which technique is the most sensitive?

    (a) Continuous

    (b) Residual

    (c) Interrupted

    (d) Counter current

25. The point at which the magnetism in a material cannot be increased even though the magnetising force continues to increase is known as the:

    (a) Salient pole

    (b) Saturation point

    (c) Residual point

    (d) Remnant point

26. An electric current through a copper wire:

    (a) Creates a magnetic field around the wire

    (b) Creates magnetic poles in the wire

    (c) Magnetises the wire

    (d) Does not create a magnetic field

27. A longitudinal surface crack in a circularly magnetised part will cause:

    (a) The magnetic field to die out

    (b) A decrease in permeability

    (c) A magnetic leakage field

    (d) A current to flow

28. The type of current that is best suited to detect surface discontinuities is:

    (a) DC

    (b) AC

    (c) Pulsating DC

    (d) Half wave

29. Retentivity:

    (a) Represents the ability to induce magnetism in a ferromagnetic body by an outside magnetising force

    (b) Represents the ability of a material to resist the establishment of magnetic flux within it

    (c) Represents the ability of a material to retain a portion of the magnetic field set up in it after the magnetising force has been removed

    (d) Is not a term used in magnetic particle testing

30. Demagnetisation:

    (a) May be easy or difficult depending on the type of material

    (b) Is easy for materials having a high coercive force

    (c) Is always most difficult in materials retaining a high residual field

    (d) All of the above answers are correct

31. What rule describes the direction of current flow (+ to -) when lines of magnetic force surround a conductor?

    (a) Left hand rule

    (b) Right hand rule

    (c) Flux rule

    (d) Reluctance rule

32. The proper number of ampere-turns for a given test specimen is determined by:

    (a) Its length

    (b) The material and its diameter

    (c) Both the length and the material

    (d) Its diameter and length

33. An electrical yoke produces:

    (a) A longitudinal field

    (b) A circular field

    (c) Alternating fields

    (d) A swinging field

34. In longitudinal magnetisation the proper term for calculating magnetising force is:

    (a) Amperes

    (b) Ampere-turns

    (c) Watts

    (d) Ohms

35. The amount of amperage used for magnetic particle inspection using the prod method is determined from the:

    (a) Type of material

    (b) Distance between the prods

    (c) Diameter of the part

    (d) Total length of the part

36. Which of the following is the most effective method for the detection of extremely deep-lying defects:

    (a) Dry residual method using DC surge

    (b) Wet continuous method using half wave rectified current

    (c) Wet residual method

    (d) Dry continuous method using half wave rectified current with prods

37. What method provides greater sensitivity, particularly in locating subsurface discontinuities?:

    (a) Continuous

    (b) Residual

    (c) Circular

    (d) Longitudinal

38. Which type of current has a ‘skin effect’:

    (a) AC

    (b) DC

    (c) Half wave rectified

    (d) Full wave rectified

39. When using the wet continuous method, the flow of suspension from the hose should be shut off:

    (a) Immediately after applying the current

    (b) Immediately before applying the current

    (c) While the current is flowing

    (d) Thirty seconds before applying the current

40. The area of maximum induced field strength using a yoke is:

    (a) At the north pole of the yoke

    (b) At the south pole of the yoke

    (c) The area directly between the poles

    (d) on the outside of pole pieces

41. The strongest magnetic field in a coil is at the:

    (a) Outside edge

    (b) Inside edge

    (c) Centre

    (d) End

42. What equipment is used to determine if a part has been demagnetised?

    (a) A magnet on the part

    (b) A field meter

    (c) A survey meter

    (d) Careful observation for clinging magnetic particles

43. Which of the following will best define surface cracks?

    (a) Half wave rectified AC

    (b) DC

    (c) AC

    (d) Surge current

44. Applying the theory of the ‘Right Hand Rule’, a longitudinal surface defect in a round bar is detected by ‘current passing in a direction parallel to the direction of expected defects’ because:

    (a) The current direction is in line with the defect

    (b) The magnetic field is at right angles to the defect

    (c) It makes no difference

    (d) The magnetic field is parallel to the defect

45. Why are magnetic particles available in different colours?

    (a) For colour contrast with the part surface

    (b) To enhance the detection of indications

    (c) For both a and b

    (d) Different colours are used with different magnetic flux values

46. A magnetic particle build-up from a discontinuity is strongest when the discontinuity is oriented:

    (a) 180^{o} to the magnetic field

    (b) 45^{o} to the magnetic field

    (c) 90^{o} to the magnetic field

    (d) 90^{o} to the current flow

47. Why is it preferable to disassemble parts before magnetic particle inspection?

    (a) Disassembly makes all surface areas visible

    (b) Interfaces will create leakage fields which may confuse the inspection

    (c) It is usually easier to handle the disassembled parts

    (d) All of the above

48. Fluorescent magnetic particle indications should be inspected under

    (a) Fluorescent light

    (b) Any light

    (c) Black light

    (d) Neon light

49. Why should one avoid using a high velocity flow of a wet testing media over the test area

    (a) It may wash away a fine or lightly held indication

    (b) This is not a problem

    (c) It may splash particle into eyes

    (d) None of the above are correct

50. What are the three causes of non-relevant indications?

(a) Lack of fusion, change of section thickness, grinding cracks

(b) Change of section thickness, very high amperage, drilled hole near surface

(c) Very high amperage, drilled hole near surface, blow holes

(d) Drilled hole near surface, very high amperage, lack of fusion

51. Magnetic particle inspection is not a reliable method of detecting

(a) Laps

(b) Deep seated cavities

(c) Cracks

(d) Seams

52. A defect open to the surface produces an indication which is

(a) Sharp and distinct

(b) Wide and indefinite

(c) Criss-cross

(d) High and fuzzy

53. Wet magnetic bath strength is checked by which of the following

(a) Specific gravity

(b) Optical density

(c) Settling test

(d) None of the above

54. When preparing a bath it is important to have the bath strength at a proper level, as too many particles can result in:

(a) Lowering the test amperage

(b) Having to increase the magnetising current

(c) Masking the indications

(d) None of the above

55. Magnetic particle is a non-destructive examination method used for:

    (a) Locating surface discontinuities

    (b) Near surface discontinuities

    (c) Both a and b

    (d) Material separation

56. A part is adaptable to magnetic particle inspection if

    (a) It is attached to an electrostatic field

    (b) The material is ferromagnetic

    (c) The material is non-ferrous

    (d) The material is an electric conductor

57. The permeability of a material describes:

    (a) The ease with which it can be magnetized

    (b) The depth of the magnetic field in the part

    (c) The length of time required to demagnetise it

    (d) The ability to retain the magnetic field

58. If a crack exists in a circular magnet, the attraction of magnetic particles to the crack is caused by:

    (a) A coercive force

    (b) A leakage field

    (c) A Doppler effect

    (d) A high reluctance at the crack

59. The flux within and surrounding a magnetised part or around a conductor carrying a current is known as:

    (a) Saturation point

    (b) Magnetic field

    (c) Ferromagnetic

    (d) Paramagnetic

60. A metal that is difficult to magnetise is said to have:

(a) High permeability

(b) Low permeability

(c) High reluctance

(d) Low retentivity

61. Which residual field is most difficult to demagnetise?

(a) Longitudinal

(b) Circular

(c) Vector

(d) Binodal

62. Which brings out surface indications most clearly?

(a) AC

(b) DC

(c) Pulsed DC

(d) DC with surge

63. To detect lengthwise defects on the inside diameter of hollow parts, you should:

(a) Pass current through it

(b) Magnetise with a coil

(c) Pass current through a central conductor

(d) Increase the amperage used

64. Which of the following is most often used for dry magnetic particle inspection:

(a) Full cycle direct current

(b) Half wave rectified alternating current

(c) High voltage, low amperage current

(d) Direct current from electrolytic cells

65. When a magnetic field is induced in a part with prods spaced 150mm apart, the field is:

    (a) Solenoidal

    (b) Circular

    (c) Longitudinal

    (d) Distorted trapezoidal

66. With current flowing from + to - in a coil, a longitudinal field is created. Which of the following may be used to establish the direction of the magnetic field?

    (a) Left hand rule

    (b) Right hand rule

    (c) Ohms law

    (d) There is no relevant law

67. Which form of magnetisation is easiest to control in most parts?

    (a) Longitudinal magnetisation

    (b) Permanent magnetism

    (c) Circular magnetization

    (d) Parallel magnetization

68. The strength of a magnetic field within a coil is determined by:

    (a) The current in the coil

    (b) The number of turns in the coil\

    (c) The diameter of the coil

    (d) All of the above factors

69. The field in a section of pipe being magnetised by means of a central conductor is stronger at:

    (a) The ends of the pipe

    (b) The outer surface of the pipe

    (c) The inside surface of the pipe

    (d) The middle of the pipe wall

70. The space within and surrounding a magnetized part of a conductor carrying a current is known as:

    (a) Saturation point

    (b) Magnetic field

    (c) Ferromagnetic

    (d) Paramagnetic

71. Subjecting the part to a magnetic field that is constantly reversing in polarity and gradually diminishing in strength accomplishes which of the following:

    (a) Magnetises the part

    (b) Removes residual field from the part

    (c) Soaks in the flux density

    (d) Helps find deep lying defects

72. The type of method most frequently used with mobile equipment is the:

    (a) Indirect induction method

    (b) Wet method with auxiliary tank

    (c) Yoke method

    (d) Dry magnetic particle powder method

73. Which of the following is NOT a liquid vehicle in which particles are suspended in magnetic particle testing:

    (a) Water treated with a wetting agent

    (b) Kerosene

    (c) Gasoline

    (d) Water treated with antifoam

74. The most common cause of non relevant indications in MT is:

    (a) Over magnetisation

    (b) Low amperage

    (c) High flux density

    (d) Under magnetisation

75. When a ferromagnetic material is in an unmagnetized state, the domains are:

    (a) Aligned in a North and South direction

    (b) Aligned in an East West direction

    (c) Randomly organized

    (d) Balanced to produce a gauss rating of 2

76. Paramagnetic materials:

(a) Are commonly inspected using magnetic particle testing

(b) Are affected by magnetic fields

(c) Cannot be magnetized

(d) Have low reluctance to establishment of magnetic flux

77. What type of magnetization uses the formula:
I = 45000/(L/D)N where I is the current in Amperes, N the number of turns of the magnetizing coil, L the length of the cylindrical test piece and D its diameter.

(a) Circular

(b) Longitudinal

(c) Swinging field

(d) Central conductor

78. The magnetic field is the strongest when:

(a) The magnetising current is flowing

(b) The magnetising voltage is applied

(c) The leakage field is flowing

(d) The magnetising current is off

79. The retentivity of a material describes:

(a) The length of time required to demagnetise it

(b) The depth of the magnetic field in the part

(c) The ability to retain the magnetic field

(d) The ease with which it can be demagnetized

80. A material with a wider hysteresis loop has:

(a) Lower reluctance

(b) Lower residual magnetism

(c) Higher residual magnetism

(d) Higher permeability

81. The unit usually used to denote flux density is the:

(a) Henry

(b) Angstrom

(c) Gauss

(d) Ampere

82. Which technique is the most sensitive?

(a) Residual

(b) Continuous

(c) Permanent

(d) Interrupted

83. An electric current through a copper wire:

(a) Creates a magnetic field around the wire

(b) Creates magnetic poles in the wire

(c) Magnetises the wire

(d) Does not create a magnetic field

84. What rule describes the direction of current flow (+ to -) when lines of magnetic force surround a conductor?

(a) Left hand rule

(b) Right hand rule

(c) Flux density rule

(d) Reluctance rule

85. The areas on a magnetised part from which the magnetic field is leaving or returning into the part are called:

(a) Salient points

(b) Defects

(c) Magnetic poles

(d) Nodes

86. The opposition that a ferromagnetic material shows to the establishment of a magnetic field is called:

(a) Retentivity

(b) Reluctance

(c) Coercive force

(d) Permeability

87. The magnetism which remains in a piece of magnetisable material after the magnetising force has been removed is called the:

    (a) Tramp field

    (b) Residual field

    (c) Damped field

    (d) Permanent field

88. A material with a narrower hysteresis loop has:

    (a) Higher permeability

    (b) Lower retentivity

    (c) Lower coercive force

    (d) All of the above

89. The correct number of ampere-turns for a given test specimen is determined by:

    (a) Its length

    (b) The material and its diameter

    (c) Both the length and the material

    (d) Its diameter and length

2.1.3 Magnetic Particle Testing Level 1 (MT-1) Answers to Questions

Magnetic Particle Testing Level 1 Answers to Questions																
General Examination								Specific Examination								
1	a	35	a	69	b			1	b	35	b	69	c		
2	c	36	c	70	d			2	c	36	d	70	b		
3	d	37	a	71	c			3	b	37	a	71	b		
4	c	38	b	72	a			4	a	38	a	72	d		
5	d	39	a	73	d			5	c	39	c	73	c		
6	a	40	b	74	b			6	b	40	c	74	a		
7	a	41	b	75	d			7	a	41	b	75	c		
8	b	42	c	76	d			8	c	42	b	76	b		
9	b	43	b	77	a			9	a	43	c	77	b		
10	c	44	d	78	c			10	c	44	b	78	a		
11	d	45	b	79	c			11	d	45	c	79	c		
12	a	46	d	80	d			12	d	46	c	80	c		
13	d	47	c	81	c			13	d	47	d	81	c		
14	b	48	a	82	b			14	d	48	c	82	b		
15	d	49	b	83	b			15	c	49	a	83	a		
16	c	50	c	84	c			16	d	50	b	84	b		
17	a	51	a	85	c			17	d	51	b	85	c		
18	b	52	c	86	c			18	b	52	a	86	b		
19	c	53	b	87	d			19	a	53	c	87	b		
20	b	54	d	88	a			20	d	54	c	88	d		
21	b	55	b	89	a			21	b	55	c	89	d		
22	c	56	a					22	c	56	b				
23	a	57	b					23	b	57	a				
24	d	58	d					24	a	58	b				
25	d	59	b					25	b	59	b				
26	c	60	b					26	a	60	b				
27	a	61	a					27	c	61	b				
28	d	62	c					28	b	62	a				
29	c	63	c					29	c	63	c				
30	d	64	a					30	a	64	b				
31	b	65	d					31	b	65	b				
32	b	66	b					32	d	66	b				
33	b	67	a					33	a	67	a				
34	d	68	d					34	b	68	d				

2.2 Magnetic Particles Testing Level 2 (MT-2)

2.2.1 Magnetic Particles Testing Level 2 (MT-2) General Examination

1. Which of the following is not a property of magnetic lines of force?
   (a) They form closed loops which do not cross
   (b) The density increases with distance from the poles of a permanent magnet
   (c) Hey are considered to have direction
   (d) They seek paths of least magnetic resistance or least reluctance
2. Surrounding an electromagnet, the magnetic field is strongest:
   (a) Immediately after the current ceases to flow
   (b) While the magnetizing current ceases to flow
   (c) At the time the magnetic particles are applied to the part
   (d) Just prior to current reversal
3. The value of permeability is:
   (a) A fixed value depending upon the type of material
   (b) Between 1 and 100 for all ferromagnetic materials
   (c) Between 0 and 10 for all ferromagnetic materials
   (d) Dependent upon the amount of magnetizing force necessary to overcome saturation
4. The flux density of the magnetism induced by a coil is affected by:
   (a) The coil size
   (b) The current in the coil
   (c) The number of turns in the coil
   (d) All of the above
5. How many turns of a coil will be needed to establish a longitudinal field in a steel shaft that is 22.86 cm (9 inches) long and 7.62 cm (3 inches) in diameter? 3000 amperes magnetizing current is available, it is desired to magnetize the part in accordance with the formula NI = 45,000/(L/D):
   (a) 1
   (b) 3
   (c) 5
   (d) 7

6. How many ampere-turns are required to magnetize a part that is 40.6 cm (16 inches) long and 5 cm (2 inches) in diameter?

    (a) 9000 ampere-turns

    (b) 5625 ampere-turns

    (c) 2812 ampere-turns

    (d) None of the above

7. The lines of flux or force in a circularly magnetized ferromagnetic bar:

    (a) Are aligned through the piece from the south to the north pole

    (b) Are aligned through the piece from the north to the south pole

    (c) Leave the south pole and enter the north pole

    (d) Are contained within and around the part

8. In which magnetizing method is the current passed directly through the part, thereby setting up a magnetic field at right angles to the current flow?

    (a) Longitudinal magnetization

    (b) Coil magnetization

    (c) Central conductor magnetization

    (d) None of the above

9. Which of the following is false concerning a magnetic field in and around a hollow conductor as compared to that of a solid conductor of the same outside diameter when both are of the same magnetic material, and when the applied current is the same?

    (a) The field immediately outside the outer surface of the hollow conductor is greater

    (b) The field gradient inside the hollow conductor is steeper

    (c) The fields outside the conductors are the same

    (d) The fields are the same at the centre

10. The field in a section of ferromagnetic pipe being magnetized by means of a central conductor is strongest at the:

    (a) Ends of the pipe

    (b) Outer surface of the pipe

    (c) Inner surface of the pipe

    (d) The field is uniform at all places

11. For a 7.6 cm (3 inches) diameter bar how much current is needed to magnetize the bar for the detection of longitudinal discontinuities:

    (a) 5500 amperes

    (b) 16500 amperes

    (c) 1000 amperes

    (d) 3000 amperes

12. For detection of longitudinal discontinuities a 7.6 cm (3 inches) diameter bar is magnetized in:

    (a) The longitudinal direction

    (b) The circular direction

    (c) The clockwise direction

    (d) None of the above directions

13. A bar that is 5 cm (2 inches) by 10 cm (4 inches) by 30.5 cm (12 inches) is being magnetized in the circular direction. About how many amperes are required using the perimeter approach?

    (a) 2200

    (b) 4500

    (c) 3800

    (d) None of the above

14. An advantage of AC is that:

    (a) It is most readily available

    (b) Equipment can be made lighter

    (c) It leaves the part demagnetized

    (d) All of the above

15. When a magnetic field cuts across a crack:

    (a) Electrons begin jumping back and forth across the crack

    (b) The crack begins to heat up

    (c) Magnetic poles form at the edges of the crack

    (d) All of the above

16. A disadvantage of AC current is that it:

    (a) Cannot be used with dry powder

    (b) Has poor penetrating power

    (c) Can only provide low flux densities

    (d) Cannot be used for residual magnetic particle testing

17. What causes a leakage field in a steel bar?

    (a) A crack

    (b) Reversal of the magnetic field

    (c) Paint on the surface

    (d) All of the above

18. An indication is a defect under which of the following conditions?

    (a) If it is greater than 3.8 cm (1.5 inches) long

    (b) If it exceeds the limits of a standard or specification

    (c) If it is deep

    (d) Under all of the above indications

19. Paint will not affect the detection of a crack if:

    (a) The paint is thick and the defect is subsurface

    (b) The paint is thin and the crack is parallel to the direction of flux lines

    (c) The crack is sharp and the paint is thin

    (d) All of the above

20. A magnetic particle indication is sharp and very fine; this suggests that the discontinuity is:

    (a) Subsurface seam

    (b) A shallow, tight surface crack

    (c) Porosity

    (d) A deep crack

21. Among the following, the best type of current for the detection of fatigue cracks is:

    (a) Half-wave direct current

    (b) Alternating current

    (c) Direct current

    (d) Half-wave alternating current

22. Continuous magnetization provides the most sensitivity because:

    (a) The magnetic particles are present while the part is being magnetized

    (b) The magnetic field is greatest while the magnetizing current is on

    (c) All of the above

    (d) Neither of the above

23. The sensitivity of magnetic particle testing is greatest when the discontinuity is:

    (a) Parallel to the direction of the magnetic flux lines

    (b) Perpendicular to the flow of the magnetizing current

    (c) Perpendicular to the direction of the magnetic flux

    (d) Perpendicular to the line between prods

24. To provide reliability and reproducibility in magnetic particle testing, written procedures should include:

    (a) Location of the coil and current for each magnetization

    (b) Requirements for ammeter calibration

    (c) Type and concentration of the particles

    (d) All of the above

25. The magnetic particles are noticed to bunch in some fillet areas and stand on end on the edge of a part being magnetized. These observations indicate that the:

    (a) Particle concentration is too low

    (b) Flux density is excessive

    (c) Flux density is too low

    (d) Magnetizing current should be changed form AC to DC

26. Flux density is a measure of the number of magnetic flux lines perpendicular to an area of cross-section. If a discontinuity is in the plane of the unit area, the strongest magnetic article indication will be formed when the discontinuity is:

    (a) Inclined at 45º to the flux lines

    (b) Parallel to the flux lines

    (c) 90º to the flux lines

    (d) 135º to the flux lines

27. Prods are being used to magnetize a weld area. When dry powder is dusted on the surface, it is observed that there is no mobility of the particles. What is the most probable reason for this observation?

    (a) The magnetizing current is not high enough

    (b) The flux density is too low

    (c) DC is being used

    (d) All of the above are possible reasons

28. The current from portable high amperage units can be applied to the object using:

    (a) Prods

    (b) Cable coils

    (c) Pre-wrapped coils

    (d) All of the above

29. How can parts be tested to determine if they have been adequately demagnetized?

    (a) By bringing a suspended paper clip near the middle of the part

    (b) By using a small horseshoe permanent magnet

    (c) By using a small magnetometer held at a corner of the part

    (d) By sprinkling some magnetic particles on the part

30. The statement ‘magnetic particle testing can be applied to plated and painted parts’.

    (a) May be true depending upon the thickness of the coating

    (b) May be true if flux densities are increased to compensate for the coating thickness

    (c) Is true only for circular circumstances

    (d) Both (a) and (b)

31. A group of indications, some sharp and some broad and fuzzy, were found on an area of a small forging. Demagnetization and re-inspection eliminated these indications. What was the probable cause?

    (a) Forging lap

    (b) Magnetic writing

    (c) Change in permeability

    (d) Subsurface variation

32. Magnetic particle testing is most likely to find subsurface discontinuities in:

    (a) Soft steels with high permeability

    (b) Soft steels with low permeability

    (c) Hardened steels with low permeability

    (d) Hardened steels with high permeability

33. Which of the following is not an advantage of Magnetic Particle testing?

    (a) Fast and simple to perform

    (b) Can detect discontinuities filled with foreign material

    (c) Most reliable for finding surface cracks in all types of material

    (d) Works well through a thin coat of paint

34. Which of the following does not represent a limitation of Magnetic Particle testing?

    (a) The type of materials which may be effectively tested

    (b) The directionality of the magnetic field

    (c) The need for demagnetization

    (d) The ability to detect discontinuities filled with foreign material

35. The most effective NDT method for locating surface cracks in ferromagnetic materials is:

    (a) Ultrasonic testing

    (b) Radiographic testing

    (c) Magnetic particles testing

    (d) Liquid penetrant testing

36. A discontinuity which is produced during solidification of the molten metal is called:

(a) Inherent

(b) Processing

(c) Service

(d) None of the above

37. Pipe would be classified as what type of discontinuity?

(a) Inherent

(b) Processing

(c) Service

(d) None of the above

38. A seam would be classified as what type of discontinuity?

(a) Inherent

(b) Processing

(c) Service

(d) None of the above

39. A lamination in steel plate would be classified as what type of discontinuity?

(a) Inherent

(b) Processing

(c) Service

(d) None of the above

40. An internal rupture caused by working steel at improper temperatures is called a:

(a) Lap

(b) Cold shut

(c) Forging burst

(d) Slag inclusion

41. Cracks which are caused by alternating stresses above a critical level are called:

    (a) Stress corrosion cracks

    (b) Cycling cracks

    (c) Critical cracks

    (d) Fatigue cracks

42. Cracks which are caused by a combination of tensile stress and corrosion are called:

    (a) Stress corrosion cracks

    (b) Cycling cracks

    (c) Critical cracks

    (d) Fatigue cracks

43. Which of the following are ferromagnetic materials?

    (a) Aluminium, iron, copper

    (b) Iron, copper, nickel

    (c) Copper, aluminium, silver

    (d) Iron, cobalt, nickel

44. The reverse magnetising force necessary to remove a residual magnetic field from a test piece after it has been magnetically saturated is called:

    (a) Hysteresis

    (b) Coercive force

    (c) Demagnetising flux

    (d) Reverse saturation

45. Magnetic lines of force enter and leave a magnet at:

    (a) Saturation

    (b) L/D ratios of greater than 4 to 1

    (c) Flux concentration points

    (d) Poles

46. The ease with which a magnetic field can be established in a test piece is called:

    (a) Reluctance

    (b) Retentivity

    (c) Permeability

    (d) Electromagnetism

47. Opposition to establishment of a magnetic field in a test piece is called:

    (a) Reluctance

    (b) Retentivity

    (c) Permeability

    (d) Electromagnetism

48. The ability of a material to remain magnetic after the magnetising force is removed is called:

    (a) Reluctance

    (b) Retentivity

    (c) Permeability

    (d) Electromagnetism

49. A magnetic field which is contained completely within the test piece is called a:

    (a) Confined field

    (b) Longitudinal field

    (c) Circular field

    (d) Saturated field

50. Which of the following produces a circular field?

    (a) Coil

    (b) Head shot

    (c) Yoke

    (d) All of the above

51. A technique used to find transverse discontinuities at the ends of longitudinally magnetised bars by the use of transient currents is called:

    (a) A coil technique

    (b) A fast break technique

    (c) A yoke technique

    (d) A head shot

52. A leakage field is strongest when a discontinuity interrupts the magnetic flux lines at an angle of:

    (a) 0^{o}

    (b) 45^{o}

    (c) 90^{o}

    (d) 180^{o}

53. The best method of inducing a circular field in a tube is by a:

    (a) Central conductor

    (b) Head shot

    (c) Coil

    (d) Prod technique

54. Magnetic flux density is zero at:

    (a) The inside surface of a tube magnetised with a central conductor

    (b) The outside surface of a tube magnetised with a central conductor

    (c) The outside surface of a bar magnetised with a head shot

    (d) The centre of a bar magnetised with a head shot

55. Magnetic flux density is highest at:

    (a) The outside surface of a non-ferromagnetic tube magnetised with a central conductor

    (b) The inside surface of a non-ferromagnetic tube magnetised with a central conductor

    (c) The outside surface of a ferromagnetic tube magnetised with a central conductor

    (d) The inside surface of a ferromagnetic tube magnetised with a central conductor

56. An important consideration when using a direct contact method is:

(a) Lifting power of the yoke

(b) Coil diameter

(c) Preventing arc burns

(d) Field strength adjacent to the coil inside diameter

57. A prod method would be most sensitive to cracks:

(a) Parallel to a line connecting the prod contact points

(b) Tangential to a radius from each prod contact point

(c) Perpendicular to a line connecting the prod contact points

(d) Perpendicular to the long axis of the coil

58. When using prods, arc burns may be caused by which of the following?

(a) Dirty contact tips

(b) Inadequate pressure

(c) Too large a magnetic current

(d) All of the above

59. The most common source of DC current for magnetic particle testing is:

(a) Motor generators

(b) Rectified AC

(c) Storage batteries

(d) None of the above

60. Fields generated in ferromagnetic material with AC current are useful for locating:

(a) All discontinuities

(b) Surface cracks

(c) Subsurface discontinuities

(d) Internal porosity

61. A common rule of thumb to use for current required in circular magnetisation:

    (a) 1000 amps/25 mm of diameter

    (b) 1000 ampere-turns/25 mm of diameter

    (c) 1000 amps/25 mm of prod spacing

    (d) None of the above

62. The formula, NI = 45000/(L/D), is used to calculate the proper magnetising current for:

    (a) Prod magnetisation

    (b) A head shot

    (c) A central conductor

    (d) Coil magnetization

63. The formula, NI = 45000/(L/D), gives proper magnetising current for a coil, regardless of coil size as long as:

    (a) The test piece is not larger than 1/10 the cross sectional area of the coil

    (b) AC current only is used

    (c) The test piece essentially fills the coil

    (d) The test piece is held tightly against the coil

64. For direct contact magnetising methods, the magnetic field is oriented in what direction relative to the current direction?

    (a) Parallel

    (b) At 45^{o}

    (c) At 90^{o}

    (d) At 180^{o}

65. For direct contact magnetising methods, current should be flowing in what direction relative to expected discontinuities?

    (a) Parallel

    (b) At 45^{o}

    (c) At 90^{o}

    (d) At 180^{o}

66. What is the magnetic field strength at the surface of a 100 mm diameter bar as compared to that at the surface of a 50 mm diameter bar, each carrying 1000 amps of current?

    (a) Twice

    (b) One half

    (c) One quarter

    (d) Four times

67. What is the magnetic field strength at the surface of a 25 mm diameter bar as compared to that at the surface of a 50 mm diameter bar, each carrying 1000 amps of current?

    (a) Twice

    (b) One half

    (c) One quarter

    (d) Four times

2.2.2 Magnetic Particles Testing Level 2 (MT-2) Specific Examination

1. Demagnetization, ASTM E709-95 recommends a coil of ampere-turns:

    (a) 1000 to 3000

    (b) 3000 to 5000

    (c) 5000 to 10000

    (d) 10000 to 15000

2. According to ASTM E709-95 when dry particles are used magnetic particle testing shall not be performed on the surface of parts whose temperature exceeds:

    (a) 57ºC

    (b) 79ºC

    (c) 158ºC

    (d) 136ºC

3. According to ASTM E709-95 in using prod technique, prod spacing shall not exceed:

    (a) 50 mm

    (b) 100 mm

    (c) 150 mm

    (d) 200 mm

4. According to ASTM E709-95, the UV intensity shall not be less than:

    (a) 600 $\mu W/cm^2$

    (b) 700 $\mu W/cm^2$

    (c) 800 $\mu W/cm^2$

    (d) 900 $\mu W/cm^2$

5. According to ASTM E709-95 in using prod technique on a 50 mm thickness plate with a prod spacing of 101 mm (4 inches), current shall be selected in the following range:

    (a) 300-450 A

    (b) 400-500 A

    (c) 500-625 A

    (d) 550-700 A

6. According to ASMT E709-95 alternating current electromagnetic yokes should give a lifting force of at least:

    (a) 1.5 kg

    (b) 2.5 kg

    (c) 3.5 kg

    (d) 4.5 kg

7. According to ASTM E709-95 direct current electromagnetic yokes should have a lifting force of at least:

    (a) 15 kg

    (b) 16 kg

    (c) 17 kg

    (d) 18 kg

8. According to ASTM E709-95 the UV light shall be centred on (1 Å = 10^{-10}m):

   (a) 3000 Å

   (b) 3250 Å

   (c) 3400 Å

   (d) 3650 Å

9. According to ASTM E709-95 when fluorescent particles are used, the UV light intensity shall be above:

   (a) 700 μW/cm^2

   (b) 800 μW/cm^2

   (c) 900 μW/cm^2

   (d) 1000 μW/cm^2

10. According to ASTM E709-95 when fluorescent particles are used, the bulb shall be warmed up prior to use for at least:

    (a) 1 min

    (b) 2 min

    (c) 3 min

    (d) 4 min

    (e) 5 min

11. According to ASTM E709-95 with prod technique, the prods shall be tipped if the open circuit voltage is over:

    (a) 10 V

    (b) 15 V

    (c) 20 V

    (d) 25 V

12. According to ASME Section VIII, a linear indication is defined as an indication in which the length is equal to or greater than the width by a factor of:

    (a) 1

    (b) 2

    (c) 3

    (d) 4

13. According to ASTM E709-95 the viscosity limit (measured in centi Stokes) of the wet medium (conditioned water) should not exceed:

    (a) 1 cSt

    (b) 3 cSt

    (c) 6 cSt

    (d) 4 cSt

14. According to ASTM E709-95 when applying fluorescent magnetic particles technique, the operator shall be in darkness area at least …… prior to examination:

    (a) 2 min

    (b) 3 min

    (c) 4 min

    (d) 5 min

15. According to ASTM E709-95 the alkalinity of conditioned water shall not exceed:

    (a) 10.0 pH

    (b) 10.5 pH

    (c) 11.0 pH

    (d) 11.5 pH

16. According to ASTM E709-95, with wet continuous magnetization technique, the duration of magnetization current is of the order of:

    (a) 0.5 sec

    (b) 1.0 sec

    (c) 1.5 sec

    (d) 2.0 sec

17. According to ASTM E709-95 in using prods having a spacing of 19 mm (3/4 inches) and above, the magnetizing current shall be:

    (a) From 90 to 110 A/25 mm (1 inch)

    (b) From 100 to 125 A/25 mm (1 inch)

    (c) From 90 to 120 A/ 25 mm (1 inch)

    (d) From 100 to 200 A/25 mm (1 inch)

18. According to ASTM E709-95 powder shall be applied upon the part to be tested in such a manner that:

    (a) A light uniform coating is formed

    (b) In excess coating

    (c) All of the above

    (d) None of the above

19. According to ASTM E709-95 before turning off current and examination, dry powder in excess shall be:

    (a) Removed by a dry-air current

    (b) Kept in place

    (c) All of the above

    (d) None of the above

20. According to ASTM E709-95 demagnetization can be performed by:

    (a) Decreasing alternating current

    (b) Reversing direct current

    (c) All of the above

    (d) None of the above

21. According to ASTM E709-95, Table 3., alternating current electromagnetic yokes must have a lifting force of at least:

    (a) 3.0 kg (7 lb)

    (b) 3.5 kg (8 lb)

    (c) 4.0 kg (9 lb)

    (d) 4.5 kg (10 lb)

22. According to ASTM E709-95, Table 3., direct current electromagnetic yokes must have a lifting force of at least:

    (a) 15 kg (33 lb)

    (b) 16 kg (36 lb)

    (c) 17 kg (38 lb)

    (d) 18 kg (40 lb)

23. According to API, the acceptable particle concentration of wet particle solution for fluorescent particles is:

    (a) 0.1 to 0.4 mL by volume

    (b) 0.1 to 0.5 mL by volume

    (c) 0.1 to 0.6 mL by volume

    (d) 0.1 to 0.7 mL by volume

24. According to API, the particle concentration of wet particle solution must be checked:

    (a) Prior to each shift

    (b) Only after each shift

    (c) Only each week

    (d) Only each two weeks

25. According to ASTM E709-95 and API, the UV intensity measured at a minimum of 38 cm (15 inches) at least shall not be less than:

    (a) 700 $\mu W/cm^2$

    (b) 800 $\mu W/cm^2$

    (c) 900 $\mu W/cm^2$

    (d) 1000 $\mu W/cm^2$

26. According to ASTME 709-95 and API, in order to eliminate all contaminants, an appropriate cleaning shall be performed on all the surfaces to be examined and on a minimum of adjacent material:

    (a) 25.4 mm (1 inch)

    (b) 31.7 mm (5/4 inches)

    (c) 38.1 mm (1.5 inches)

    (d) 44.5 mm (7/4 inches)

27. According to ASTM E709-95 and API, the temperature of the dry particles can be usable up to:

    (a) 38ºC

    (b) 2000ºC

    (c) 49ºC

    (d) 315ºC

28. According to ASTM E709-95 and API, the thickness of non conductive coatings will not exceed:

    (a) 1-10 mm

    (b) 2-5 mm

    (c) 0.02-0.05 mm

    (d) 0.001-0.004 mm

29. According to ASTM E709-95 and API, relevant indications are produced by:

    (a) Greasy surfaces

    (b) Excessive background

    (c) Leakage fields

    (d) Rotating Eddy currents

30. According to ASTM E709-95 and API, when fluorescent particles are used, the UV bulb shall warm up prior to use for at least:

    (a) 1 minute

    (b) 2 minutes

    (c) 3 minutes

    (d) 5 minutes

31. According to AST M E709-95 and API, after removing magnetization of parts after examination, the residual magnetism shall not exceed (1 gauss = 0.0001 tesla):

    (a) 3×10^{-4}T (3 gauss)

    (b) 4×10^{-4}T (4 gauss)

    (c) 6×10^{-4}T (6 gauss)

    (d) 8×10^{-4}T (8 gauss)

32. According to ASTM E709-95 and API, a linear indication is defined as an indication in which the length is equal to or greater than the width by a factor of:

    (a) 1

    (b) 2

    (c) 3

    (d) 4

33. According to API, a non- relevant indication is defined as an indication which in the major dimension is equal to, or less than:

    (a) 1.59 mm (1/16 inches)

    (b) 2.4 mm (3/32 inches)

    (c) 3.2 mm (1/18 inches)

    (d) 4 mm (5/32 inches)

34. According to ASME Section V, with fluorescent magnetic particles technique, the operator shall be in darkness area at least ……. prior to examination:

    (a) 2 min

    (b) 3 min

    (c) 4 min

    (d) 5 min

35. According to ASME Section VIII Div 1, Appendix 6, on pressure containing welds whose depth is greater than 15.8 mm (5/8 inches), which of the following indications is unacceptable:

    (a) Rounded relevant indication with a major dimension less than 3.2 mm (1/8 inches)

    (b) Rounded relevant indication with a major dimension less than 3.2 mm (1/8 inches)

    (c) Rounded relevant indication with a major dimension greater than 4.8 mm (3/16 inches)

    (d) None of the above

2.2.3 Magnetic Particle Testing Level 2 (MT-2) Answers to Questions

Magnetic Particle Testing Level 2 Answers to Questions															
General Examination								Specific Examination							
1	b	35	c					1	c	35	c				
2	d	36	a					2	a						
3	a	37	a					3	d						
4	d	38	b					4	c						
5	c	39	b					5	a						
6	b	40	c					6	d						
7	d	41	d					7	d						
8	d	42	a					8	d						
9	c	43	d					9	d						
10	c	44	b					10	d						
11	d	45	d					11	d						
12	b	46	c					12	c						
13	c	47	a					13	c						
14	d	48	b					14	b						
15	c	49	c					15	b						
16	b	50	b					16	a						
17	a	51	b					17	b						
18	b	52	c					18	a						
19	c	53	a					19	d						
20	b	54	d					20	c						
21	b	55	d					21	d						
22	c	56	c					22	d						
23	c	57	a					23	a						
24	d	58	d					24	a						
25	b	59	b					25	d						
26	c	60	b					26	a						
27	d	61	a					27	d						
28	d	62	d					28	c						
29	c	63	a					29	c						
30	a	64	c					30	d						
31	b	65	a					31	a						
32	a	66	b					32	c						
33	c	67	a					33	a						
34	d							34	b						

3 RADIOGRAPHIC TESTING (RT)

3.1 Radiographic Testing Level 1 (RT-1)

3.1.1 Radiographic Testing Level 1 (RT-1) General Examination

1. Which of the following types of intensifying screens are not used in industrial radiography?

    (a) Lead

    (b) Fluorescent

    (c) Silver halide

    (d) All of the above

2. Betatrons are used to produce X rays in what range?

    (a) Several MeV

    (b) 50-500 keV

    (c) 500-1000 keV

    (d) 0-50 keV

3. Which of the following is an isotope not artificially produced for industrial use:

    (a) Ir-192

    (b) Ra-226

    (c) Co-60

    (d) All of the above

4. One half value layer of lead for Iridium-192 is approximately:

    (a) 12 mm

    (b) 4 mm

    (c) 2 mm

    (d) 25 mm

5. One half value layer of lead for Cobalt-60 is approximately:

    (a) 12 mm

    (b) 6 mm

    (c) 2 mm

    (d) 25 mm

6. The film processing step in which the undeveloped silver bromide is removed from the film emulsion is called:

    (a) Development

    (b) Stop bath

    (c) Fixing

    (d) Rinsing

7. A radiation producing device which emits radiation of one or a few discreet wavelengths is:

    (a) An X ray machine

    (b) A linear accelerator

    (c) A gamma ray source

    (d) A betatron

8. The intensifying action of lead screens is caused by:

    (a) Secondary X ray emission

    (b) Secondary gamma ray emissions

    (c) Fluorescence of lead screens

    (d) Electron emission

9. Most of the energy applied to an X ray tube is converted into:

    (a) X rays

    (b) Light

    (c) Heat

    (d) Ultraviolet radiation

10. Radiography of tubular sections using a double wall, double viewing technique is mainly applicable to sections:

    (a) Over 38 mm in diameter

    (b) 88 mm in diameter or less

    (c) 125 mm in diameter and less

    (d) Under 25 mm in diameter

11. Which of the following is the most common method of packaging film?

    (a) Individual sheets for use in cassettes

    (b) Rolls

    (c) Pre-packaged (‘day-pack’)

    (d) All of the above

12. Which of the following types of radiation is particulate?

    (a) X

    (b) Gamma

    (c) Alpha

    (d) None of the above

13. Most scattered radiation which adversely affects the radiographic image quality originates:

    (a) From floors and walls adjacent to the test piece

    (b) From other nearby objects

    (c) From the test piece itself

    (d) From the lead intensifying screens

14. An effect of scattered radiation is to:

    (a) Decrease required exposure time

    (b) Diminish contrast, detail and clarity of radiographic image

    (c) Decrease film density

    (d) All of the above

15. What is the most important factor in determining the archival quality of radiographic film?

    (a) Film density

    (b) Image quality

    (c) Degree of removal of fixer residues during washing

    (d) Degree of removal of developer residues during washing

16. Radiographic enlargement to distinguish small defects is possible:

    (a) Only with a very small source or focal spot size radiation source

    (b) Routinely

    (c) With most sources

    (d) Never

17. A detrimental effect of fluorescent screens might be:

    (a) High definition

    (b) Screen mottle

    (c) Non-linear attenuation

    (d) Displaced core effect

18. The penetrating power of an X ray machine is indicated by:

    (a) Milliamperage

    (b) Tube voltage

    (c) Filament current

    (d) Anode current

19. Reticulation may be the result of:

    (a) Inadequate agitation of the film during development

    (b) Inadequate water rinse during processing

    (c) Using exhausted stop bath solution

    (d) Developing solutions not maintained at the same temperatures.

20. The main advantage of having small focal spot on an X ray tube is:

    (a) Heat is conducted away more efficiently than with a large focal spot

    (b) A smaller focal spot is unlikely to be damaged from the required tube currents

    (c) Longer tube life

    (d) A smaller focal spot allows sharper radiographic images than does a larger focal spot

21. Cobalt-60 is produced by:

    (a) Fission of Uranium-235

    (b) Neutron capture by Cobalt-59

    (c) Radioactive decay

    (d) None of the above

22. For a particular isotope, gamma radiation intensity is determined by:

    (a) Type of isotope used

    (b) Energy level of gamma rays in source

    (c) Source strength in curies

    (d) None of the above

23. Which of the following statements should be true to achieve the highest level of radiographic sharpness (definition)?

    (a) The focal spot should be as small as practicable

    (b) The focal spot to test piece distance should be as large as practicable

    (c) The film to test piece distance should be as small as practicable

    (d) All of the above

24. Which of the following correctly expresses the inverse square law if I_1=dose rate nearest source, I_2=dose rate furthest from the source, D_1=distance nearest to source and D_2=distance furthest from the source:

    (a) $I_1/I_2 = D_1^2/D_2^2$

    (b) $I_1^2/I_2^2 = D_1/D_2$

    (c) $I_1/I_2 = D_2^2/D_1^2$

    (d) $I_1^2/I_2^2 = D_2/D_1$

25. Thicker materials would normally be inspected using:

(a) Lower kV X rays

(b) Higher mA X rays

(c) Higher kV X rays

(d) Lower mA X rays

26. Another name for a penetrameter is:

(a) Radiographic shim

(b) Image quality indicator

(c) Density standard

(d) Acceptance standard

27. The silver nitrate spot test can be used to:

(a) Check the film for film quality

(b) Check for under developed films

(c) Check for film artifacts

(d) All the above answers are correct

28. The difference in densities seen on a radiograph due to section changes in an item is:

(a) Film contrast

(b) Radiographic contrast

(c) Subject contrast

(d) Radiographic sensitivity

29. Which type of film would exhibit the coarsest grain?

(a) Slow

(b) Medium

(c) Fast

(d) No difference in the grain sizes

30. An advantage of a gamma ray source is:

    (a) Radiation may be turned on or off at will

    (b) Outside power is normally not required

    (c) Less shielding is required than for X ray

    (d) All of the above

31. Higher X ray tube voltages result in:

    (a) Shorter wavelengths X rays

    (b) Less penetrating X rays

    (c) Fewer X rays in the primary beam

    (d) All of the above

32. A casting flaw which is formed when two masses of molten metal flowing from different directions flow together, but fail to fuse, is called:

    (a) A hot tear

    (b) Shrinkage

    (c) A cold crack

    (d) A cold shut

33. X rays are produced by:

    (a) Radioactive isotopes

    (b) The rapid deceleration of electrons

    (c) Ultraviolet radiation of unstable atoms

    (d) All of the above

34. Which of the following is a function of lead screens?

    (a) To reduce geometric unsharpness

    (b) To increase scatter

    (c) To reduce exposure time

    (d) All of the above

35. A silver nitrate spot test might be used to:

    (a) Check for archival film quality

    (b) Check for out of date film

    (c) Check for single versus double emulsion film

    (d) Any of the above

36. A linear accelerator is used to produce X rays having energy in the range of:

    (a) Several MeV

    (b) 50-500 keV

    (c) 500-1000 keV

    (d) 0-50 keV

37. How is the wavelength of scattered radiation compared to the primary beam?

    (a) Longer than the wavelength of the primary beam

    (b) Shorter than the wavelength of the primary beam

    (c) Same as the wavelength of the primary beam

    (d) Not related

38. Which of the following viewing conditions is most desirable for interpreting radiographic film?

    (a) Brightness of surroundings approximately the same as the area of interest on the radiograph

    (b) Totally dark viewing room

    (c) Well lit viewing room

    (d) None of the above

39. Pinhole radiography would be used to:

    (a) Make high quality radiographs for critical inspection

    (b) Determine focal spot size

    (c) Construct exposure charts

    (d) None of the above

40. A straight, dark line in the centre of the film of a weld cap would probably be:

    (a) Porosity

    (b) Undercut

    (c) Tungsten inclusions

    (d) A linear crack

41. Which one of the following steps is necessary to dissolve the undarkened silver salt crystals in the film emulsion:

    (a) Developing

    (b) Fixing

    (c) Washing

    (d) None of the above

42. Approximately what energy X ray machine would be required to have penetrating power equivalent to a Cobalt-60 source:

    (a) 600 keV

    (b) 1.2 MeV

    (c) 2 MeV

    (d) None of the above

43. The normal range of steel that is radiographed using Ir-192 is:

    (a) 5 mm–20 mm

    (b) 25 mm – 75 mm

    (c) 0.5 mm – 5 mm

    (d) 75 mm – 150 mm

44. The focal spot size of an X ray machine must be known in order to determine:

    (a) The geometric unsharpness

    (b) Kilovoltage peak output

    (c) Required mA setting

    (d) Exposure time

45. X ray intensity is a function of :

(a) Cathode current

(b) Step down ratio of the filament transformer

(c) The distance from the test piece

(d) Size of the anode (target)

46. What is the minimum age in years at which a person may perform radiography :

(a) 15

(b) 18

(c) 21

(d) 30

47. A densitometer is an instrument that measures:

(a) Radiographic contrast

(b) Radiographic sensitivity

(c) Radiographic density

(d) Radiographic resolution

48. Which of the following is the correct formula to use for calculating geometric unsharpness if F=source size, T=specimen thickness, D=source to object distance and U_g=geometric unsharpness:

(a) $U_g = FD/T$

(b) $U_g = DT/F$

(c) $U_g = FT/D$

(d) $U_g = FTD$

49. A wetting agent is used in film processing to:

(a) More closely control development

(b) Prevent formation of water marks during the drying stage

(c) Reduce formation of air bubbles in the developer solution

(d) Reduce formation of air bubbles in the fixer

50. Film intensifying screens are normally used to:

(a) Decrease exposure time

(b) Increase grain size

(c) Shield film from stray light

(d) All of the above

51. A radiation producing device which emits a broad spectrum of wavelengths is:

(a) A gamma ray source

(b) An X ray machine

(c) A Geiger-Müeller tube

(d) A curie tube

52. Which of the following represent types of radiation stemming from radioactive decay :

(a) Alpha, beta, gamma

(b) Alpha, gamma, delta

(c) X, rho, sigma

(d) Sigma, gamma, beta

53. Explain the difference between X and gamma rays:

(a) They are both types of electromagnetic radiation

(b) X rays are naturally occurring; gamma rays are man made

(c) X rays are produced electrically; gamma rays are emitted by disintegrating atomic nuclei

(d) There is no difference

54. Most industrial X ray machines contain targets made of:

(a) Beryllium

(b) Magnesium

(c) Lead

(d) Tungsten

55. The effects of scattered radiation may be lessened by:

    (a) Using a lead mask around the test piece

    (b) Using a lead or copper filter between the X ray tube and the test piece

    (c) Using lead screens

    (d) All of the above

56. A reaction which occurs when a radiation beam of 500 keV is partially absorbed by a test piece would probably be:

    (a) The Compton effect

    (b) The photoelectric effect

    (c) Pair production

    (d) Any of the above

57. The term used to describe the reaction of human cells, other than reproductive cells, to ionizing radiation is:

    (a) Genetic effects

    (b) Somatic effects

    (c) Corpuscular effects

    (d) Hematological effects

58. A low density image of the letter ‘B’ on a radiographic film would probably be caused by:

    (a) Under exposure

    (b) Excessive exposure

    (c) Excessive backscatter

    (d) Insufficient backscatter

59. A term which refers to the sharpness of the radiographic image is:

    (a) Sensitivity

    (b) Halo effect

    (c) Shadow effect

    (d) Definition

60. A dark, irregular indication which is located adjacent to the toe of the weld would probably be:

    (a) Undercut

    (b) Incomplete penetration

    (c) Porosity

    (d) Tungsten inclusions

61. A term which refers to the smallest detail visible in a radiograph is called:

    (a) Radiographic sensitivity

    (b) Radiographic contrast

    (c) Subject contrast

    (d) Film contrast

62. Which type of gamma ray source would be used to radiograph a weld in 150 mm thick steel plate?

    (a) Ir-192

    (b) Co-60

    (c) Tm-170

    (d) Cs-137

63. The radiation quality of a gamma ray source is determined by:

    (a) The size of the source

    (b) The type of isotope to be used

    (c) Can be varied by the operator

    (d) Ci strength of the source

64. Generally, X ray output is changed by changing the:

    (a) Atomic number of the anode

    (b) Tube current of the unit

    (c) Supply voltage to the unit

    (d) Atomic weight of the cathode

65. Deep scratches on lead intensifying screens will cause?

    (a) Selective image enhancement

    (b) Irregular light lines on the film

    (c) Dark lines on the film

    (d) Unacceptable blockage of the primary radiation beam

66. Which of the following is classified as electromagnetic radiation?

    (a) Visible light

    (b) X rays

    (c) Infrared radiation

    (d) All of the above

67. The main disadvantage of having a small focal spot on an X ray tube is:

    (a) Heat is conducted away too fast

    (b) Sharper radiographic images may be achieved with a larger focal spot

    (c) A smaller focal spot is limited to lower tube currents because of the potential damage from overheating

    (d) None of the above

68. Exposure of whole body to moderate radiation doses of 500 – 2000 mSv (50 to 200 rem) would probably cause which of the following effects?

    (a) Blood cell changes

    (b) Swelling

    (c) Possible nausea

    (d) All of the above

69. A reaction which occurs when a radiation beam of 90 keV is totally absorbed by a test piece would probably be:

    (a) The Compton effect

    (b) The photoelectric effect

    (c) Pair production

    (d) Any of the above

70. The term used to describe the reaction of human reproductive cells, to ionizing radiation is:

    (a) Genetic effects

    (b) Somatic effects

    (c) Corpuscular effects

    (d) Hematological effects

71. Explain the difference between X and gamma rays:

    (a) They are both types of electromagnetic radiation

    (b) X rays are naturally occurring; gamma rays are man made

    (c) X rays are produced electrically; gamma rays are emitted by disintegrating atomic nuclei

    (d) There is no difference

72. Which of the following is classified as electromagnetic radiation?

    (a) Visible light

    (b) X rays

    (c) Infrared radiation

    (d) All of the above

73. The intensifying action of lead screens is caused by:

    (a) Secondary X ray emission

    (b) Secondary gamma ray emissions

    (c) Fluorescence of lead screens

    (d) Electron emission

74. How is the wavelength of scattered radiation related to the primary beam?

    (a) Longer

    (b) Shorter

    (c) Same

    (d) Not related

75. X rays are produced by:

    (a) Radioactive isotopes

    (b) The rapid deceleration of electrons

    (c) Ultraviolet radiation of unstable atoms

    (d) All of the above

76. Most of the energy applied to an X ray tube is converted into:

    (a) X rays

    (b) Light

    (c) Heat

    (d) Ultraviolet radiation

77. Higher X ray tube voltages result in:

    (a) Shorter wavelengths X rays

    (b) More penetrating X rays

    (c) Higher intensity X ray beam

    (d) All of the above

78. Betatrons are used to produce X rays having energy in the range of:

    (a) Several MeV

    (b) 50-500 keV

    (c) 500-1000 keV

    (d) 0-50 keV

79. A linear accelerator is used to produce X rays in what range?

    (a) Several MeV

    (b) 50-500 keV

    (c) 500-1000 keV

    (d) 0-50 keV

80. For a particular isotope, gamma radiation intensity is determined by:

(a) Type isotope used

(b) Energy level of gamma rays in source

(c) Source strength in curies

(d) None of the above

81. A term used to describe the range of radiation intensities falling on the film during exposure is:

(a) Film contrast

(b) Radiographic contrast

(c) Subject contrast

(d) Radiographic sensitivity

82. An expression which is used to describe the slope of a film characteristic curve is:

(b) Film latitude

(c) Film contrast

(d) Film sensitivity

(e) Film gradient

83. Which of the following factors affect film graininess?

(a) Wavelengths of radiation

(b) Film processing conditions

(c) Film speed

(d) All of the above

84. The amount of radioactivity which corresponds to 3.7×10^{10} disintegrations per second is called:

(a) 0.01 gray (1 rad)

(b) 1 Farad

(c) 37 GBq (1 curie)

(d) 10 mSv (1 roentgen)

85. The result of filtering the X rays is to produce:

(a) More geometric unsharpness

(b) Less geometric unsharpness

(c) Softer radiation

(d) Harder radiation

86. Which of the following actions is performed by lead screens?

(a) Absorbs a portion of the primary radiation beam

(b) Preferentially absorbs soft X rays

(c) Emits electrons under gamma and X ray fields

(d) All of the above

87. The total radiation dose received equals:

(a) The radiation intensity

(b) The source size in curies

(c) Radiation intensity times time of exposure

(d) Radiation intensity divided by the square of the distance from the source

88. Which of the following is the most common type of X ray tube?

(a) Bipolar

(b) Unipolar

(c) Long anode

(d) None of the above

89. A reaction which occurs when a radiation beam of 15 MeV is partially absorbed by a test piece would probably be:

(a) The Compton effect

(b) The photoelectric effect

(c) Pair production

(d) Any of the above

90. A reaction which occurs when a radiation beam of 50 keV is partially absorbed by a test piece would probably be:

(a) The Compton effect

(b) The photoelectric effect

(c) Pair production

(d) Any of the above

91. A lethal dose of complete body radiation is normally considered to be:

(a) 1-2 Sv (100-200 rem)

(b) 250-500 mSv (25-50 rem)

(c) 6-8 Sv (600-800 rem)

(d) 500 mSv (50000 mrem)

3.1.2 Radiographic Testing Level 1 (RT-1) Specific Examination

1. Almost all gamma radiography today is done with artificially activated:

(a) Particles

(b) Isotopes

(c) Radium

(d) X ray machines

2. A Curie (37 gigabecquerel)of radioactive material will disintegrate at the rate of:

(a) 37 million (3.7×10^7) disintegrations per second

(b) 37 billion (3.7×10^{10}) disintegrations per second

(c) 37 trillion (3.7×10^{13}) disintegrations per second

(d) None of the above

3. The specific activity of radioactive isotopes is measured in:

(a) MeV (million electron volts)

(b) R/h (roentgens per hour) or gray per hour

(c) Ci/g (curies per gram) or Becquerel per gram

(d) Counts per minute (c/min)

4. What is the primary difference between X rays and gamma rays of the same energy?
    (a) Wavelength
    (b) Frequency
    (c) Velocity
    (d) Origin
5. Screens should be:
    (a) Separated from the film by a sheet of clean white paper
    (b) Separated from the film by at least 3.125 mm
    (c) In direct contact with the film
    (d) Separated from the film by its cardboard backing
6. Lead foil in direct contact with the film in a cassette absorbs:
    (a) All radiation to protect the film from exposure
    (b) Light rays that might otherwise expose the film
    (c) Long wave length radiation more than short wavelength
    (d) Short wavelength radiation more than long wavelength
7. Lead screens improve mainly the _____ of the final radiograph:
    (a) Density
    (b) Contrast
    (c) Exposure
    (d) Definition
8. Lead foil is placed behind the films to:
    (a) Absorb as much side scatter as possible
    (b) Reduce non image forming back-scatter
    (c) Reduce the quality of image-forming primary rays
    (d) Limit the amount of light striking the film.

9. A filter will reduce the amount of _____ in the primary radiation beam:

    (a) Scatter

    (b) Electrons

    (c) High energy radiation

    (d) Low energy radiation

10. A filter is placed:

    (a) Between the source and the specimen

    (b) Between the specimen and the film

    (c) Around the specimen

    (d) Behind the film

11. The tube current in milliamps multiplied by the time in seconds or minutes equals:

    (a) Density

    (b) Intensity

    (c) Exposure

    (d) Kilovoltage

12. If we were to maintain the same exposure but decrease the source to film distance, we must _____ the time of exposure:

    (a) Increase

    (b) Decrease

13. Lead screens act as intensifiers at voltage above:

    (a) 1000 kV

    (b) 150 kV

    (c) 325 kV

    (d) 2000 kV`

14. Use of a slower speed film improves the definition of the radiograph because the slower film:

    (a) Requires more exposure

    (b) Is more sensitive to X rays

    (c) Requires less voltage

    (d) Has finer grains

15. The penetrameter is a tool used to check the _____ of a radiograph:

    (a) Contrast

    (b) Definition

    (c) Sensitivity

    (d) Emulsion

16. When using a radioactive isotope in making a radiograph, we can express the equation for exposure as Ci × T. In this equation , Ci stands for:

    (a) Current through tube

    (b) Intensity in curies or becquerels

    (c) Degree of contrast

    (d) Coarseness of the film

17. In the radiographic analysis procedure that is used to prepare an exposure chart, the first step is to:

    (a) Make a series of radiographs of a step wedge

    (b) Radiograph several objects of known thickness

    (c) Convert the densities read from the radiographs to a standard density

    (d) Plot the exposures on a graph

18. Which exposure factors are recorded in the process of making a step wedge analysis?

    (a) Voltage and exposure

    (b) Source-to-film distance and film

    (c) Film density and materials

    (d) All of the above

19. After the step wedge radiographs have been made, the _____ of the image of each step is recorded on chart:

    (a) Sharpness

    (b) Contrast

    (c) Density

    (d) Length

20. The process of loading more than one film into a cassette is known as the _____ technique:

    (a) Single film technique

    (b) Multiple film technique

21. Which of the following isotopes are commonly used for radiographic purposes?

    (a) Iridium-192

    (b) Osmium-188

    (c) Cobalt-87

    (d) Rubidium

22. The process of being radioactive is called (Choose one):

    (a) Heating

    (b) Decaying

    (c) Bremsstrahlung

    (d) Rectification

23. Which of the following types of radiation is commonly used in radiographic testing? (Choose one):

    (a) Alpha particles

    (b) Neutrons

    (c) gamma rays

    (d) Beta rays

24. The amount of X radiation or gamma radiation is often spoken of as the _____ of the radiation:

    (a) Wavelength

    (b) Energy

    (c) Intensity

    (d) Frequency

25. The speed at which X and gamma rays travel is: (choose one)

    (a) The speed of light

    (b) The speed of sound

    (c) It varies with the wavelength

    (d) Depends on the source

26. A beam of radiation consisting of a single wavelength is known as: (choose one)

    (a) Microscopic radiation

    (b) Monochromatic radiation

    (c) Heterogeneous radiation

    (d) Fluoroscopic radiation

27. What governs the penetrating ability of an X ray beam?

    (a) Kilovoltage

    (b) Time

    (c) Activity

    (d) Milliamperage

28. The shorter the wavelength of X or gamma rays:

    (a) The higher their energy

    (b) The faster they travel

    (c) The greater their intensity

    (d) The closer they are to becoming radio waves

29. ‘Photoelectric effect’ refers to:

(a) An electric camera

(b) Complete absorption of a photon

(c) The visible electromagnetic spectrum

(d) Scatter of neutrons

30. When a tissue cell in human body is damaged by radiation:

(a) The cell may lose its ability to reproduce

(b) The cell may die

(c) Damage is caused by knocking an electron out of the orbit of its parent atom.

(d) All of the above

31. Lead intensifying screens are used to:

(a) Decrease exposure time

(b) Increase grain size

(c) Shield film from stray light

(d) All of the above

32. An effect of scattered radiation is to:

(a) Decrease required exposure time

(b) Diminish contrast, detail and clarity of radiographic image

(c) Decrease film density

(d) All of the above

33. The effects of scattered radiation may be lessened by:

(a) Using a lead mask around the test piece

(b) Using a lead or copper filter between the X ray tube and the test piece

(c) Using lead screens

(d) All of the above

34. Radiographic film speed can be increased by using:

    (a) A higher mA setting

    (b) A lower mA setting

    (c) A double emulsion versus a single emulsion film

    (d) Lead screens versus fluorescent screens

35. An advantage of a gamma ray source is:

    (a) Radiation may be turned on or off at will

    (b) Outside power is normally not required

    (c) Less shielding is required than for X ray

    (d) All of the above

36. A radiation producing device which emits radiation of one or a few discreet wavelengths is:

    (a) An X ray machine

    (b) A linear accelerator

    (c) A gamma ray source

    (d) A betatron

37. A radiation producing device which emits a broad spectrum of wavelengths is:

    (a) A gamma ray source

    (b) An X ray machine

    (c) A Geiger Mueller tube

    (d) A curie tube

38. The primary effect of an increase in the milliamperage at which a X ray tube is being operated would be to:

    (a) Increase the radiation intensity

    (b) Increase penetrating power

    (c) Increase primary beam wavelengths

    (d) All of the above

39. The primary effect of an increase in the kilovoltage at which a X ray tube is being operated would be to:

(a) Increase the radiation intensity

(b) Increase penetrating power

(c) Increase penetrating power and radiation intensity

(d) Increase primary beam wavelength

40. Which of the following types of intensifying screens are used in industrial radiography?

(a) Lead

(b) Fluorescent

(c) Lead oxide

(d) All of the above

41. Which of the following expressions correctly describe the relation between milliamperage (M) and focus-to-film distance (D)?

(a) $M_1/M_2 = (D_1^2)/(D_2^2)$

(b) $M_2/M_1 = (D_1^2)/(D_2^2)$

(c) $M_1/M_2 = D_1/D_2$

(d) $M_1/M_2 = D_2/D_1$

42. Which of the following expressions correctly describes the relation between exposure time (T) and focus-film distance (D)?

(a) $T_1/T_2 = (D_1^2)/(D_2^2)$

(b) $T_2/T_1 = (D_1^2)/(D_2^2)$

(c) $T_1/T_2 = D_1/D_2$

(d) $T_1/M_2 = D_2/D_1$

43. Which of the following expressions correctly describes the relation between milliamperage (M) and exposure time (T)?

(a) $M_1/M_2 = T_1/T_2$

(b) $M_2/M_1 = T_1^2/T_2^2$

(c) $M_1/M_2 = T_2^2/T1^2$

(d) $M_1/M_2 = T_2/ T_1$

44. A change in which of the following parameters would necessitate the construction of a new X ray exposure chart?

(a) X ray machine used

(b) Film type

(c) Focal spot to film distance

(d) Any of the above

45. The ASTM penetrameter for a 25 mm thick test piece contains holes of what sizes?

(a) T, 2T, 3T

(b) 2T, 3T, 4T

(c) T, 2T, 4T

(d) T, 3T, 4T

46. The minimum size hole in an ASTM penetrameter is:

(a) 0.127 mm (0.005 inches)

(b) 0.254 mm (0.010 inches)

(c) 0.508 mm (0.020 inches)

(d) 0.762 mm (0.030 inches)

47. A radiographic sensitivity level of 2-2T means that:

(a) The #2 hole in a #2 penetrameter must be visible on the film

(b) The 2T hole in a penetrameter which is 2% of the test piece thickness must be visible on the film

(c) The 2T hole in a #2 penetrameter must be visible on the film

(d) Two penetrameters which are each 2% of the test piece thickness must be used

48. What is the most desirable temperature for manual developer solutions?

(a) 15.5^{o}C (60^{o}F)

(b) 20^{o}C (68^{o}F)

(c) 22.2^{o}C (72^{o}F)

(d) 26.6^{o}C (80^{o}F)

49. What is the longest period of time which should elapse between complete changes of developer solution?

(a) 1 week

(b) 2 weeks

(c) 1 month

(d) 3 months

50. A possible result of failing to use a stop bath during manual development is:

(a) Streaking of the film

(b) Underdevelopment of the film

(c) Contamination of the developer solution

(d) Developer solution drag-out

51. Mottled film may result from:

(a) Inadequate agitation of the film during development

(b) Inadequate water rinse during processing

(c) Using exhausted stop bath solution

(d) Any of the above

52. Radiography of tubular sections using a double wall, double viewing technique is mainly applicable to sections:

(a) Over 38 mm in diameter

(b) 88 mm in diameter or less

(c) 125 mm in diameter and less

(d) Under 25 mm in diameter

53. A thin, white line within the film image of a weld crown might be:

(a) A hair between the lead screen and the film

(b) Incomplete penetration

(c) A crack

(d) Undercut

3.1.3 Radiographic Testing Level 1 (RT-1) Answers to questions

Radiographic Testing Level 1 Answers to Questions															
General Examination								Specific Examination							
1	c	35	a	69	b			1	b	35	b				
2	a	36	a	70	a			2	b	36	c				
3	b	37	a	71	c			3	c	37	b				
4	c	38	a	72	d			4	d	38	a				
5	a	39	b	73	d			5	c	39	b				
6	a	40	d	74	a			6	c	40	a				
7	c	41	b	75	b			7	b	41	a				
8	d	42	b	76	c			8	b	42	b				
9	c	43	b	77	d			9	d	43	d				
10	b	44	a	78	a			10	a	44	a				
11	d	45	a	79	a			11	c	45	c				
12	c	46	b	80	c			12	b	46	b				
13	a	47	c	81	b			13	b	47	b				
14	b	48	c	82	d			14	d	48	b				
15	c	49	b	83	d			15	c	49	d				
16	a	50	a	84	c			16	b	50	a				
17	b	51	b	85	d			17	a	51	d				
18	b	52	a	86	d			18	d	52	c				
19	d	53	c	87	c			19	c	53	a				
20	d	54	d	88	a			20	b						
21	b	55	d	89	c			21	a						
22	c	56	a	90	b			22	b						
23	d	57	b	91	c			23	c						
24	c	58	c					24	c						
25	c	59	d					25	a						
26	b	60	a					26	b						
27	a	61	a					27	a						
28	c	62	b					28	a						
29	c	63						29	b						
30	b	64	b					30	d						
31	a	65	b					31	a						
32	d	66	d					32	b						
33	b	67	c					33	d						
34	c	68	d					34	d						

3.2 Radiographic Testing Level 2 (RT-2)

3.2.1 Radiographic Testing Level 2 (RT-2) General Examination

1. Increasing the kV setting on an X ray machine increases the:

    (a) Penetrating power

    (b) Short wavelength components of the X ray beam

    (c) Radiation intensity

    (d) All of the above

2. During the manufacturing of a casting, the purpose of a riser is:

    (a) To introduce molten metal into the mould

    (b) To provide additional molten metal to allow for shrinkage during solidification

    (c) To allow excess heat to escape during solidification

    (d) To provide a vent for excess steam to escape

3. An effective method of recognising a film artifact is:

    (a) Viewing a film in daylight

    (b) Viewing film in reflected light from a viewer

    (c) Comparing both film shot with a double film technique

    (d) All of the above

4. The main reason for using a casting is that:

    (a) Castings are stronger than other metal product forms

    (b) Castings are normally of higher quality than other metal product forms

    (c) Complex shapes of minimum weight are easily manufactured

    (d) None of the above

5. A change in which of the following parameters would require a new X ray exposure chart?

    (a) kV

    (b) Required film density

    (c) Test piece thickness

    (d) All of the above

6. Static marks on radiographic film are caused by:

    (a) An improperly grounded X ray tube

    (b) Scratches on the lead screens

    (c) Poor film handling technique

    (d) Old film

7. Of the following radiographic sources, which emits the most penetrating radiation?

    (a) Co-60

    (b) Ra-226

    (c) Cs-137

    (d) Ir-192

8. Which of the following techniques would probably reduce the amount of back scattered radiation reaching the film during a radiographic exposure?

    (a) Using a finer grained film

    (b) Backing the cassette with a sheet of lead

    (c) Removing lead screens

    (d) All of the above

9. Radiographic contrast is dependant on:

    (a) Density

    (b) Processing

    (c) Radiation energy

    (d) All of the above

10. A plot of film density versus log of relative exposure is called:

    (a) An H&D curve

    (b) A sensitometric curve

    (c) A characteristic curve

    (d) All of the above

11. The most common material used for targets in X ray tubes is:

    (a) Tungsten

    (b) Copper

    (c) Silver

    (d) Beryllium

12. A dark crescent shaped spot, clearly in the base metal adjacent to a weld would probably be:

    (a) Burn through

    (b) Film crimp mark

    (c) A crack

    (d) A water spot on the film

13. Which of the following are potential sources of scattered radiation?

    (a) Test piece

    (b) Cassette

    (c) Floor

    (d) All of the above

14. If the required exposure time for a 2220 GBq (60 curie) Ir-192 source is 2 minutes, what exposure time would be required at 1110 GBq (30 curie) source:

    (a) 2/3 minutes

    (b) 60 minutes

    (c) 2 minutes

    (d) 4 minutes

15. An advantage of a larger grain film is:

    (a) It has higher speed

    (b) It has better definition

    (c) It has lower speed

    (d) None of the above

16. How does radiation intensity change with increasing distance from the source?

    (a) Inversely with distance

    (b) Inversely with the square of distance

    (c) Directly with distance

    (d) Directly with the square of distance

17. A weld discontinuity which consists of unmelted joint surfaces at the root, and which may be caused by poor fit- up, is called:

    (a) Hot short cracking

    (b) A slag inclusion

    (c) Incomplete penetration

    (d) Burn through

18. Mottling due to X ray diffraction can be identified by:

    (a) Noting a large change between two successive exposures with the test piece rotated slightly about the beam axis

    (b) Noting a slight change between two successive exposures with the test piece rotated slightly about the beam axis

    (c) Noting a characteristic pattern corresponding to the lattice spacing

    (d) None of the above

19. Which of the following welding discontinuities would be considered the most serious?

    (a) Porosity

    (b) Incomplete penetration

    (c) Crack

    (d) Slag inclusions

20. A depression at the edge of a weld where the base metal has been melted during welding is called:

    (a) Burn through

    (b) Undercut

    (c) Root concavity

    (d) Root convexity

21. Which of the following would not be considered a film artifact?

    (a) Sugar

    (b) Chemical streaks

    (c) PI lines

    (d) Pressure marks

22. Gamma ray or high voltage X ray radiography, using film without lead screens, is likely to result in:

    (a) Mottling of the film

    (b) Increased geometric unsharpness

    (c) No apparent difference, but increased exposure time

    (d) No apparent difference, but decreased exposure time

23. Which of the following would be detrimental to radiographic image sharpness?

    (a) Small focal spot

    (b) Small film focal distance

    (c) Small object to film distance

    (d) None of the above

24. A change in which the following parameters would require a new X ray exposure chart?

    (a) kV

    (b) X ray machine

    (c) Test piece thickness

    (d) All of the above

25. If the required exposure time for a 1850 GBq (50 curie) Ir-192 source is 4 minutes, what exposure time would be required for 925 GBq (25 curie) source:

    (a) 4 minutes

    (b) 8 minutes

    (c) 2 minutes

    (d) 16 minutes

26. A radiograph is made using film X with an exposure of 10 mA-min. Film density obtained in the area of interest is 1.0. If it is desired to achieve a density of 2.0 in the area of interest, what exposure is required? (Log relative exposure = 1.1 for a density of 1.0 and 1.62 for a density of 2.0)

    (a) 41.67 mA-min

    (b) 10 mA-min

    (c) 12.6 mA-min

    (d) 33.1 mA-min

27. The least offensive of the following welding discontinuities would probably be:

    (a) Incomplete penetration

    (b) Lack of fusion

    (c) Slag inclusions

    (d) Porosity

28. A quantity calculated by the formula, 0.693/(decay constant), is called:

    (a) Half value layer

    (b) Mass attenuation constant

    (c) Half-life

    (d) Specific activity

29. The density difference displayed from one area of a film radiograph to another is called:

    (a) Subject contrast

    (b) Radiographic contrast

    (c) Film contrast

    (d) Film latitude

30. The half-life of Co-60 is approximately:

    (a) 74 days

    (b) 129 days

    (c) 5.3 years

    (d) 30.1 years

31. Increasing the mA setting on an X ray machine:

    (a) Decreases exposure time

    (b) Increases exposure time

    (c) Increases the short wavelength components of the X ray beam

    (d) Decreases the short wavelength components of the X ray beam

32. Which of the following would be considered a film artifact?

    (a) Excessive film density

    (b) Light leaks

    (c) Inadequate penetration

    (d) Sugar

33. Which of the following would be detrimental to radiographic image sharpness?

    (a) Small focal spot

    (b) Large film focal distance

    (c) Small object to film distance

    (d) None of the above

34. The half-life of Ir-192 is approximately:

    (a) 74 days

    (b) 129 days

    (c) 5.3 years

    (d) 30.1 years

35. A dark crescent shaped mark in the centre of a weld bead radiographic image would probably be:

    (a) A film artifact

    (b) Porosity

    (c) A tungsten inclusion

    (d) Root concavity

36. A photon-nuclear interaction in which energy is converted into sub-atomic particles is called:

    (a) The photoelectric effect

    (b) The Compton effect

    (c) Pair production

    (d) Bremsstrahlung

37. An interaction in which radiation is produced by the rapid deceleration of an electron is called:

    (a) The photoelectric effect

    (b) The Compton effect

    (c) Pair production

    (d) Bremsstrahlung

38. The gamma factor of Tm-170 is:

    (a) 1.37 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

    (b) 0.59 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

    (c) 0.0062 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

    (d) 0.38 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

39. An exposed radiographic film which transmits 1% of the light incident on it has what density:

    (a) 1.0

    (b) 2.0

    (c) 99.0

    (d) 0.5

40. If the radiation intensity is 5 Gy/h (500 R/h) at a distance of 152.4 cm (5 feet) from a source, what is the intensity at 1524 cm (50 feet)?

    (a) 0.5 Gy/h (50 R/h)

    (b) 1.0 Gy/h (100 R/h)

    (c) 0.1 Gy/h (10 R/h)

    (d) 0.05 Gy/h (5 R/h)

41. The average energy of a Cs-137 source is approximately:

    (a) 60-80 keV

    (b) 660 keV

    (c) 400 keV

    (d) 1.2 MeV

42. Which of the following is an advantage of X ray over gamma ray sources for radiography?

    (a) Portability

    (b) Required maintenance

    (c) Variable radiation energy

    (d) All of the above

43. The basic purpose of a penetrameter is to:

    (a) Indicate quality of the radiographic technique

    (b) Indicate the smallest discontinuity which can be shown by the radiographic technique being used

    (c) Serve as a comparison standard for evaluating discontinuity size

    (d) All of the above

44. When a casting is being non destructively examined for critical service, and the possibility of cracks exists, which of the following techniques would be best?

    (a) X ray radiography at 200 kV or less

    (b) Magnetic Particle or Liquid Penetrant testing

    (c) Radiography (X or gamma ray, depending on the thickness)

    (d) Radiography and either Magnetic Particle or liquid Penetrant testing

45. Which of the following is an advantage of X ray over gamma ray sources for radiography?

    (a) Safety

    (b) Variable radiation intensity

    (c) Variable radiation energy

    (d) All of the above

46. The average energy of a T3-170 source is approximately:

(a) 60-80 keV

(b) 660 keV

(c) 400 keV

(d) 1.2 MeV

47. The gamma factor of Co-60 is:

(a) 1.37 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

(b) 0.59 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

(c) 0.0062 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

(d) 0.38 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

48. The intensifying effect of lead screens is mainly caused by:

(a) X ray generated by the lead screens

(b) Fluorescence of the lead screens

(c) Excited electrons

(d) The Maxwell effect

49. Which of the following expressions correctly determines radiographic density?

(a) I_o/I_t

(b) Log (I_o/I_t)

(c) Log (I_o-I_t)

(d) I_o-I_t

50. The most significant difference in two X ray beams produced at different kV settings is:

(a) Beam intensity

(b) Exposure

(c) Wavelength distribution

(d) Beam divergence

51. Most significant difference in two X ray beams produced at different mA settings is:

    (a) Penetrating power

    (b) Wavelength distribution

    (c) X ray quality

    (d) Beam intensity

52. Which of the following would be considered a film artifact?

    (a) Excessive film density

    (b) Insufficient film density

    (c) Insufficient definition (penetrameter holes)

    (d) Static marks

53. Natural discontinuities comparable in size to the penetrameter holes shown on a radiograph may not be detected because:

    (a) Natural discontinuities may contain less dense material than the penetrameter holes

    (b) Natural discontinuities may be thicker than the penetrameter holes

    (c) Natural discontinuities do not necessarily have as sharp edges as the penetrameter holes

    (d) All of the above

54. If the radiation intensity is 1 Gy/h (100 R/h) at a distance of 152.4 cm (5 feet) from a source, what is the intensity at 610 cm (20 feet)?

    (a) 0.0625 Gy/h (6.25 R/h)

    (b) 0.25 Gy/h (25 R/h)

    (c) 16 Gy/h (1600 R/h)

    (d) 4 Gy/h (400 R/h)

55. Fluorescent screens are seldom used in industrial radiography because:

    (a) Light leaks degrade the film image

    (b) Film fogging can result if used in the vicinity of fluorescent lights

    (c) Poor definition and screen mottle can result

    (d) None of the above

56. Calculate geometric unsharpness for the following conditions: Source size = 2 mm × 2 mm; SFD = 700 mm; test piece thickness = 25 mm

    (a) 0.6 mm

    (b) 0.06 mm

    (c) 6,0 mm

    (d) 0.15 mm

57. The gamma factor of Ir-192 is:

    (a) 1.37 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

    (b) 0.59 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

    (c) 0.0062 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

    (d) 0.38 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

58. A test piece with large differences in thickness would have:

    (a) High film contrast

    (b) High subject contrast

    (c) Low subject contrast

    (d) Low film contrast

59. A quantity expressed by the formula, 0.693/(absorption co-efficient) is called:

    (a) Half value layer

    (b) Mass attenuation constant

    (c) Half-life

    (d) Specific activity

60. Which of the following techniques would probably reduce the amount of scattered radiation reaching the film during a radiographic exposure?

    (a) Using a finer grained film

    (b) Using a filtered X ray beam

    (c) Removing lead screens

    (d) All of the above

61. A radiographic indication in a weld, characterised by two parallel dark lines in the film image, would probably be caused by:

    (a) Incomplete penetration

    (b) Lack of fusion

    (c) Slag inclusions

    (d) Tungsten inclusions

62. To produce the sharpest image, which of the following should be true?

    (a) The radiographic source should be small

    (b) The radiographic source should be as close as possible to the test piece

    (c) The planes of the test piece and the film should be at oblique angles to each other

    (d) All of the above

63. 'Undercut' or 'burned out' edges of the test piece film image are caused by:

    (a) Geometric unsharpness

    (b) Scattered radiation

    (c) Inadequate source to film distance

    (d) Old film

64. Which of the following is an advantage of gamma ray over X ray sources for radiography?

    (a) Portability

    (b) No external power supply needed

    (c) Ruggedness

    (d) All of the above

65. The intensifying effects of fluorescent screens are caused by:

    (a) Electron emission

    (b) Light emission

    (c) Secondary X rays

    (d) All of the above

66. If the required X ray exposure time for a 225 kV, 5 mA exposure is 3 minutes, approximately what exposure time would be required at 10 mA?

    (a) 1/2 minute

    (b) 1 minute

    (c) 1.5 minutes

    (d) 3 minutes

67. The half-life of Cs-137 is approximately:

    (a) 74 days

    (b) 129 days

    (c) 5.3 years

    (d) 30.1 years

68. Unacceptable radiographic film quality would be indicated by:

    (a) Artifacts of known origin in the film's area of interest

    (b) Use of a smaller penetrameter than required

    (c) H & D density less than 2.0

    (d) All of the above

69. Which of the following welding discontinuities would be most difficult to image radiographically:

    (a) Porosity

    (b) Lack of side wall fusion

    (c) Undercut

    (d) Slag inclusions

70. The most important factor in limiting radiation exposure is:

    (a) Time

    (b) Distance

    (c) Shielding

    (d) All of the above

71. The threshold energy below which pair production cannot occur is approximately:

    (a) 100 keV

    (b) 1 MeV

    (c) 10 MeV

    (d) 20 MeV

72. A photon-electron interaction in which a photon gives up all its energy to an electron is called:

    (a) The photoelectric effect

    (b) The Compton effect

    (c) Pair production

    (d) Bremsstrahlung

73. An acceptable quality radiograph should include:

    (a) Proper identification

    (b) Correct penetrameter and visible holes

    (c) Location markers

    (d) All of the above

74. For gamma ray sources, radiographic intensity is proportional to source activity in gigabecquerels or curies for:

    (a) All sources

    (b) Large sources

    (c) Small sources

    (d) None of the above

75. Poor contact between lead screens and film is likely to cause:

    (a) An indistinct or ‘fuzzy’ image

    (b) A mottled appearance on the film

    (c) ‘Undercut’ of the test piece image

    (d) Increased geometric unsharpness

76. Which of the following conditions might cause mottling of a radiographic film?

    (a) Test piece with thickness equal to an integral multiple of the primary beam wavelength

    (b) Back scatter from aged fluorescent screens

    (c) Test piece with thickness of the same order of magnitude as the grain size

    (d) Test piece with thickness equal to an integral multiple of the average grain size

77. A photon-electron interaction in which a photon gives up a portion of its energy to an electron is called:

    (a) The photoelectric effect

    (b) The Compton effect

    (c) Pair production

    (d) Bremsstrahlung

78. If the radiation intensity is 5.9 Gy/h (590 R/h) at a distance of 30.5 cm (1 foot) from a source, how far is it to the point where the radiation intensity is 0.02 Gy/h (2 R/h)?

    (a) 518 cm (17 feet)

    (b) 16551 cm (543 feet)

    (c) 8291 cm (272 feet)

    (d) 17983 cm (590 feet)

79. It is important to initiate the welding arc within the weld groove because:

    (a) Starting a weld bead outside the groove may overheat the base metal

    (b) Too rapid heating and cooling of the base metal can cause hard spots which are potential failure initiation sites

    (c) Starting a weld bead outside the groove results in excessively wide welds

    (d) None of the above

80. If the radiation intensity is 5 Gy/h (500 R/h) at a distance of 152.4 cm (5 feet) from a source, how far is it to the point where the radiation intensity is 0.05 Gy/h (5 R/h)?

    (a) 1676.4 cm (55 feet)

    (b) 1981 cm (65 feet)

    (c) 1524 cm (50 feet)

    (d) 762 cm (25 feet)

81. Which of the following techniques would probably reduce the amount of scattered radiation reaching the film during a radiographic exposure?

    (a) Using a finer grained film

    (b) Masking the test piece

    (c) Removing lead screens

    (d) All of the above

82. The lights in a high intensity viewer are typically:

    (a) Fluorescent

    (b) Normal incandescent bulbs

    (c) Photoflood bulbs

    (d) Mercury vapour lamps

83. The gamma factor of Cs-137 is:

    (a) 1.37 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

    (b) 0.59 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

    (c) 0.0062 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

    (d) 0.38 $R \cdot h^{-1} \cdot Ci^{-1}$ at one metre

84. If the required X ray exposure time for a 150 kV, 5 mA exposure is 2 minutes, approximately what exposure time would be required at 10 mA?

    (a) 1/2 minute

    (b) 1 minute

    (c) 2 minutes

    (d) 4 minutes

85. A thin, jagged, dark line inside the weld image on a radiographic film is probably:

    (a) Incomplete penetration

    (b) Lack of fusion

    (c) Burn through

    (d) A crack

86. A straight, dark line in the centre of a weld bead image on film would be suspected of being:

    (a) Lack of fusion

    (b) A crack

    (c) Incomplete penetration

    (d) Root concavity

87. 'Undercut' or 'burned out' edges of the test piece in film image can usually be reduced by:

    (a) Increasing source to film distance

    (b) Decreasing the thickness of the lead screens

    (c) Placing a thin sheet of lead behind the cassette

    (d) Masking the test piece

88. Which of the following would be detrimental to radiographic image sharpness?

    (a) Small focal spot

    (b) Large film focal distance

    (c) Large object to film distance

    (d) None of the above

3.2.2 Radiographic Testing Level 2 (RT-2) Specific Examination

1. Contrast and definition are the two major factors that determine the _____ of the radiograph:

    (a) Density

    (b) Sensitivity

    (c) Graininess

    (d) Intensity

2. Scatter radiation:

    (a) Is not controllable

    (b) Is controllable to some extent, but cannot be completely eliminated

    (c) Can be eliminated completely by changing the kV

    (d) Can be eliminated completely by using lead intensifying screens

3. Which of the following factors will affect the definition of the radiographic image?

    (a) Intensity of radiation

    (b) Film density

    (c) Tube current

    (d) Focal spot size

4. Slow films:

    (a) Give better definition than fast films

    (b) Are faster than fast films

    (c) Require shorter exposure times than fast films

    (d) Usually have less contrast than fast films

5. Contrast is defined as the comparison between _____ on different areas of the radiograph:

    (a) Density

    (b) Sensitivity

    (c) Sharpness

    (d) Latitude

6. Definition is defined as the measure of the _____ of the outline of the image in the radiograph.

    (a) Density

    (b) Sensitivity

    (c) Sharpness

    (d) Latitude

7. As radiation (X ray or gamma ray) energy is lowered:

    (a) Radiation of longer wavelength and better penetration is produced

    (b) Radiation of shorter wavelength and better penetration is produced

    (c) Radiation of shorter wavelength and less penetration is produced

    (d) Radiation longer wavelength and less penetration is produced

8. Dark crescent-shaped indications on a radiographic film are most likely caused by:

    (a) Crimping film after exposure

    (b) Crimping film before exposure

    (c) Sudden extreme temperature change while processing

    (d) Warm or exhausted fixer

9. Lead screen are primarily used to:

    (a) Improve the quality of the radiography by increasing the effect of scatter radiation

    (b) Intensify the primary beam

    (c) Decrease film graininess

    (d) Reduce density of film

10. Static marks are most often caused by:

    (a) Film bent when inserted in a cassette or holder

    (b) Foreign material or dirt imbedded in screens

    (c) Scratches on lead foil screens

    (d) Improper film handling techniques

11. When radiographic energy is decreased:

    (a) The subject contrast decreases

    (b) The film contrast decreases

    (c) The subject contrast increases

    (d) The film contrast decreases

12. The major cause for poor definition is:

    (a) A source-to-film distance which is too long

    (b) Screens which are too thin

    (c) Film graininess

    (d) Too small a source size

13. In order to increase latitude so that thick and thin portions may be radiographed at reasonable viewing densities simultaneously:

    (a) Fluorescent screen should be employed

    (b) Led screens should be at least 5 mm thick

    (c) The cassette may be loaded with two separate films of different speeds

    (d) Radiograph the object at low energy

14. A dark circle type indication appearing on a radiograph that is the result of the failure of a core support to completely melt is called:

    (a) A hot tear

    (b) A gas hole

    (c) An unfused chaplet

    (d) A spongy shrink

15. Dark rounded indications with rather smooth edges appear on the radiograph of casting made in sand mould. These indications would be interpreted as:

    (a) Slag inclusions

    (b) Misrun

    (c) Shrinkage

    (d) Gas holes

16. A dark, sharply defined, straight line in the centre of the weld, and running parallel with the length of the weld should be interpreted as:

    (a) Porosity

    (b) Incomplete penetration

    (c) A slag inclusion

    (d) Lack of fusion

17. A dark, jagged, linear indication appears on a radiograph of a casting. The area is a transition area between a thick and a thin section. This indication should be interpreted as:

    (a) A hot tear

    (b) A gas hole

    (c) An unfused chaplet

    (d) A spongy shrink

18. In a radiograph of a weld there is an indication appearing at the end of the weldbead. It appears as a dark rounded indication with fine small tails coming from around the rounded indication giving it some what of a star-shaped appearance. This would probably be:

    (a) A crater crack

    (b) A slag inclusion

    (c) Root concavity

    (d) A star crack

19. The density of the radiograph through the weld area is 3.2 while the density in the base metal is 2.9. This would probably indicate:

    (a) Too high a kV was used

    (b) Too low a kV was used

    (c) There is excessive weld reinforcement

    (d) Weld underfill

20. When radiographing a part which contains a crack, it will appear on the radiograph as:

    (a) A dark continuous line

    (b) A light, irregular line

    (c) Either a dark or light line

    (d) A dark linear indication which could be continuous or intermittent

21. If it were necessary to radiograph 18 cm (7 in.) thick steel product, which of the following gamma ray sources would most be used?

    (a) Cs–137

    (b) Tm–170

    (c) Ir–192

    (d) Co–60

22. Almost all gamma radiography is performed with:

    (a) Tm-170

    (b) Natural isotopes

    (c) Radium

    (d) Ir-192 or Co-60

23. The half value layer of lead for Co-60 is approximately 13 mm (0.5 in). If the radiation level on the source side of a 38 mm (1.5 in) lead plate is 0.64 Gy/h (64 R/h):, the radiation level on the opposite side is:

    (a) 0.08 Gy/h (8 R/h).

    (b) 0.213 Gy/h (21.33 R/h).

    (c) 0.107 Gy/h (10.67 R/h).

    (d) 0.32 Gy/h (32 R/h).

24. The degree of concentration of the radioactive material in gamma ray sources is referred to as the:

    (a) Atomic weight of the source

    (b) Half-life of the source

    (c) Quality of the source

    (d) Specific activity of the source

25. If 37 GBq (1 Ci), of Ir-92 produces dose rate of 0.59 Gy/h (59000 mR/h) at 30.5 cm (1 foot), how much dose in Gy/h (R/h) will 370 GBq (10 Ci) produce at the same distance?

    (a) 0.59 Gy/h (59000 R/h)

    (b) 0.0059 Gy/h (590 R/h)

    (c) 5.9 Gy/h (590,000 R/h)

    (d) 0.00059 Gy/h (59 R/h)

26. Co-59 becomes Co-60 when it is placed in a nuclear reactor where it captures:

    (a) A proton

    (b) Contamination

    (c) Neutron

    (d) An electron

27. Approximately how long would it take for a 370 GBq (10 Ci) Co-60 source to decay to 92.5 GBq (2.5 Ci)?

    (a) 5.3 days

    (b) 5.3 years

    (c) 10.6 days

    (d) 10.6 years

28. An NDT technician is using a 740 GBq (20 Ci) source of Ir-192, he is standing at a distance of 305 cm (10 feet). What dose rate will he receive? (Show your working)

29. In the above question, at what distance from the source the technician be to receive 20 mSv/h (2R/h)?

30. The dose rate for a technician standing 610 cm (20 ft), from a 1295 GBq (35 Ci) Ir-192 source is 5.16 mSv (516.25 mR/h). If he continues standing at his location, how much lead shielding will be required to reduce the dose rate to 0.02 mSv (2mR/h)?

31. The specific activity of radioactive isotope is expressed in:

    (a) MeV (million electron-volts)

    (b) Ci/g (Curies per gram) or Becquerel per kg

    (c) R/h (Roentgens per hour or gray per hour

    (d) Counts per minute

32. The general method of producing X rays involves the sudden deceleration of high velocity electrons in a solid body called a:

    (a) Focus cup

    (b) Filament

    (c) Target

    (d) Cathode

33. The velocity of electrons striking the target in an X ray tube is a function of:

    (a) The atomic number of the cathode material

    (b) The atomic number of the filament material

    (c) The voltage applied

    (d) The current flow in the tube

34. The primary form of energy conversion when an X ray tube is energized results in the production of:

    (a) Primary X rays

    (b) Secondary X ray

    (c) Short wavelength X ray

    (d) Heat

35. The radiation from 37 GBq (1 Ci) of Co-60 (0.145 Gy or 14.5R at 30.5 cm or 1 foot) is attenuated in air to approximately 5mR/h at a distance of approximately:

    (a) 914.5 cm (30 feet)

    (b) 1524 cm (50 feet)

    (c) 3048 cm (100 feet)

    (d) 6096 cm (200 feet)

36. The standard dose rate of a radioactive isotope is expressed in:

    (a) Roentgens per hour per curie at any standardised distance not exceeding 75 feet

    (b) Roentgens per hour per curie per foot

    (c) Roentgens per hour at a distance of one foot

    (d) Curies per hour

    (e) Distance required to 2 mR/h

37. Tick the items that are characteristic of X or gamma radiation:

_____	is a particle	_____	has mass
_____	ionizes matter	_____	travels at the speed of light
_____	harmful to humans	_____	has high frequency

38. Tick the items that are characteristic of X or gamma radiation:

_____	is electromagnetic	_____	penetrates matter
_____	has odour	_____	is visible
_____	causes fluorescence in some materials	_____	is non-destructive to humans

39. At 61 cm (two feet) from a radiation source, radiation intensity is 3 Gy/h (300 R/h). What is the Intensity at 244 cm (8 feet) from the source?

    (a) 0.12 Gy/h (12 R/h)

    (b) 1.2 Gy/h (120 R/h)

    (c) 0.1875 Gy/h (18.75 R/h)

    (d) 0.28 Gy/h (28 R/h)

40. Define the following by selecting appropriate numbers from the second column:

_____	curie	1.	Million electron volts
_____	roentgen	2.	Unit of absorbed dose of radiation
_____	Half value layer	3.	Geometric unsharpness
_____	kVp	4.	Milliampere × minute
_____	MeV	5.	Time required for a radioactive isotope to lose half of its original activity
_____	U_g	6.	Rate of disintegration of a radioactive isotope
_____	rad	7.	Curie per gram
_____	mA-min	8.	Kilovolt peak
_____	Half-life	9.	Thickness of material which reduces the radiation to half of its original intensity
_____	definition	10.	Degree of image sharpness

41. Number these radiographic film processing steps in their correct sequence:

_____	Stop Bath	_____	Fixing
_____	Wetting Agent	_____	Washing
_____	Developing	_____	Drying

42. Source to film distance for first exposure is 91.5 cm (36 inches) and is changed to 122 cm (48 inches) for the second exposure. Time #1 was 900 mA-sec. How many mA-min will the second exposure require?

Answer: _____

43. A good Cobalt-60 shot is made on a 7.6 cm (3 inches) steel casting using an exposure time of 10 minutes and a source-to-film distance of 91.5 (36 inches). If it is necessary to change the source-to-film distance to 61 cm (24 inches), what exposure time would produce a similar radiograph if all other conditions remain the same?

    (a) 1.6 minutes

    (b) 4.4 minutes

    (c) 6.4 minutes

    (d) 8.8 minutes

44. A radiographic exposure with 3700 GBq (100 Ci) source of Ir-192 using source to film distance of 60 cm results in a radiation intensity of 0.12 Gy/h (11.8 R/h) and a radiographic density of 2.5. The intensity of radiation needed to obtain the same density when the source to film distance is changed to120 cm is:

    (a) 0.472 Gy/h (47.2 R/h)

    (b) 0.118 Gy/h (11.8 R/h)

    (c) 0.029 Gy/h (2.9 R/h)

    (d) 0.236 Gy/h (23.6 R/h)

45. A 7.6 cm (3 inches) thick test specimen is radiographed with a source having size of 1.3 cm (1/2 inch), the film is placed in contact with the test specimen. The source to film distance is 40.6 cm (16 inches).The geometric unsharpness obtained is:

    (a) 0.1 cm

    (b) 0.3 cm

    (c) 0.5 cm

    (d) 1.0 cm

46. Radiographic equivalence factors for Inconel and 304 stainless steel are 1.4 and 1.0 respectively. What is the approximate equivalent thickness of Inconel requiring the same exposure as 1.27 cm (½ inch) thickness of 304 stainless steel?

    (a) 1.27 cm (0.50 inches)

    (b) 1.78 cm (0.70 inches)

    (c) 0.9 cm (0.36 inches)

    (d) 3.55 cm (1.40 inches)

47. The approximate radiographic equivalence factors for steel and copper at 220 kV are 1.0 and 1.4 respectively. If it is desirable to radiograph a 1.27 cm (0.5 inch) piece of copper, what thickness of steel would require about the same exposure characteristics?

    (a) 1.78 cm (0.7 inches)

    (b) 0.9 cm (0.35 inches)

    (c) 3.55 cm (1.4 inches)

    (d) 2.54 cm (1.0 inch)

48. If an exposure time of 60 seconds and source to film distance of 365.7 m (1200 feet) is necessary for a particular exposure, what exposure time would be needed for an equivalent exposure if the source- to-film distance is changed to 457.2 m (1500 feet)?

    (a) 75 seconds

    (b) 94 seconds

    (c) 48 seconds

    (d) 38 seconds

49. The technique requires 2500 mA-sec exposure. How long would the exposure time be in minutes using:

    (a) 5 mA Answer: _____

    (b) 10 mA Answer: _____

50. Using a 250, kV 10 mA X ray unit, the technique chart indicates an exposure time of 1200 mA-sec. Using maximum mA, how many minutes should be used?

    Answer: _____

51. Source to film distance for first exposure is 91.5 cm (36 inches) and is changed to 60.1 cm (24 inches) for the second exposure. Time #1 was 900 mA-sec. How many minutes will the second exposure require at the same mA?

    Answer: _____

52. Subject contrast and film contrast are the two factors that comprise radiographic:

    (a) Definition

    (b) Distortion

    (c) Contrast

    (d) Graininess

53. Scatter _____ radiographic contrast.

    (a) Reduces

    (b) Increases

    (c) Does not affect

54. 'Film contrast' is the inherent ability of a film to show _____ for a given change in film exposure.

    (a) No appreciable change in density

    (b) Graininess

    (c) A difference in density

    (d) No graininess

55. The range of the specimen thickness that can be adequately recorded on a radiograph is known as the _____ of the radiograph.

    (a) Sensitivity

    (b) Latitude

    (c) Accuracy

    (d) Intensity

56. Source-to-object distance, object-to-film distance, and source size are the three factors that control the _____ of the radiograph.

    (a) Density

    (b) Exposure

    (c) Film size

    (d) Unsharpness

57. The 'multi-film' technique may be used when one radiograph film does not have enough _____ to produce a satisfactory radiograph of a specimen.

    (a) Latitude

    (b) Definition

    (c) Graininess

    (d) Activity

58. When a fast film and a slow one are loaded in the same cassette (multi-film technique), the slow film can be expected to record adequately the _____ (thinner) or (thicker) sections of a specimen.

59. What governs the penetrating power of an X ray beam?

    (a) Kilovoltage

    (b) Time

    (c) Activity

    (d) Milliamperage

60. The shorter the wavelength of X or gamma rays:

    (a) The higher their energy

    (b) The faster they travel

    (c) The smaller their penetrating power

    (d) The closer they are to becoming radio waves

61. A large source size can be compensated for by:

    (a) Increasing source-to-specimen distance

    (b) Addition of lead screens

    (c) Increasing specimen-to-film distance

    (d) Increasing penumbra

62. The maximum film density to which the radiograph should be exposed is dependent upon:

    (a) The quality of the film viewer

    (b) The variation in thickness of the specimen

    (c) The speed of the film

    (d) The graininess of the film

63. The selection of the proper source-to-film distance is a primary factor in controlling:

    (a) Contrast

    (b) Unsharpness

    (c) Graininess

    (d) Scatter

64. When the penumbra on a radiograph measures less than 0.5 mm (0.020 inches), the image will appear to unaided eye of the film interpreter as:

    (a) Fuzzy

    (b) Sharp

    (c) Distorted

    (d) Dark

65. Two X ray machines operating at same nominal kilovoltage and milliamperage settings:

    (a) Will produce the same intensities and energies of radiation

    (b) Will produce the same intensities but produce different energies of radiation

    (c) Will produce the same energies but may produce different intensities of radiation

    (d) May give not only different intensities, but also different energies of radiation

66. The fact that gases, when bombarded by radiation, ionise and become electrical conductors make them useful in:

    (a) X ray transformers

    (b) X ray tubes

    (c) Masks

    (d) Radiation detection equipment

67. An acceptable quality radiograph should include:

    (a) Proper identification

    (b) Correct penetrameter and visible holes

    (c) Location markers

    (d) All of the above

68. A weld discontinuity which consists of unmelted joint surfaces at the root, and which may be caused by poor fit-up, is called:

    (a) Hot short cracking

    (b) A slag inclusion

    (c) Incomplete penetration

    (d) Burn through

69. Which of the following welding discontinuities would be most difficult to image radiographically:

(a) Planar lack of fusion

(b) Incomplete penetration

(c) Undercut

(d) Slag inclusions

70. The average energy of a Ir-192 source is approximately:

(a) 60-80 keV

(b) 660 keV

(c) 400 keV

(d) 1.2 MeV

72. The half-life of Th-170 is approximately:

(a) 74 days

(b) 129 days

(c) 5.3 years

(d) 30.1 years

73. If the required exposure time for a 50 Curie Ir-192 source is 4 minutes, what exposure time would be required at 25 Curie source:

(a) 4 minutes

(b) 8 minutes

(c) 2 minutes

(d) 16 minutes

74. Which of the following is not a function of the lead screen placed around radiographic film?

(a) Increase the photographic action on the film

(b) Selectively absorbs scattered radiation

(c) Intensifies effects of the primary radiation beam

(d) To mask the test piece

75. Which of the following is a function of the lead screen placed around radiographic film?

(a) Masks the test piece

(b) Improves geometric unsharpness

(c) Intensifies effects of the primary radiation beam

(d) None of the above

76. What is the best advantage achieved in exposure time, using front and back lead screens, as compared to exposure time without screens?

(a) About the same, but less scatter

(b) About twice as great, but less scatter

(c) 1/2 to 1/3

(d) Not related

77. Gamma ray or high voltage X ray radiography, using film without lead screens, is likely to result in:

(a) Mottling of the film

(b) Increased geometric unsharpness

(c) No apparent difference, but increased exposure time

(d) No apparent difference, but decreased exposure time

78. Fluorescent screens are seldom used in industrial radiography because:

(a) Light leaks degrade the film image

(b) Film fogging can result if used in the vicinity of fluorescent lights

(c) Poor definition and screen mottle can result

(d) None of the above

79. An advantage of a double versus a single emulsion film is:

(a) It is higher speed

(b) It is finer grained

(c) It is lower speed

(d) None of the above

80. A radiograph is made using film X with an exposure of 10 mA-min. Film density in the area of interest is 1.0. If it is desired to achieve a density of 2.0 in the area of interest, what exposure is required? (Log relative exposure = 1.1 for a density of 1.0 and 1.62 for a density of 2.0)

(a) 41.67 mA-min

(b) 10 mA-min

(c) 12.6 mA-min

(d) 33.1 mA-min

3.2.3 Radiographic Testing Level 2 (RT-2) Answers to questions

Radiographic Testing Level 2 Answers to Questions																	
General Examination								Specific Examination									
1	a	35	a	69	b			1	b	35	b	69	a		
2	b	36	c	70	d			2	b	36	c	70	d		
3	b	37	d	71	b			3	d	37	*	71	b		
4	d	38	c	72	a			4	a	38	*	72	b		
5	b	39	c	73	d			5	a	39	c	73	b		
6	c	40	d	74	a			6	c	40	*	74	b		
7	a	41	b	75	a			7	d	41	*	75	c		
8	b	42	c	76	b			8	a	42	*	76	c		
9	d	43	a	77	b			9	b	43	b	77	a		
10	d	44	b	78	a			10	d	44	c	78	c		
11	a	45	d	79	d			11	c	45	b	79	a		
12	b	46	a	80	c			12	c	46	c	80	d		
13	d	47	a	81	b			13	c	47	a				
14	d	48	c	82	c			14	c	48	b				
15	a	49	b	83	d			15	d	49	*				
16	b	50	c	84	b			16	b	50	*				
17	c	51	d	85	d			17	a	51	*				
18	b	52	d	86	c			18	d	52	c				
19	c	53	c	87	d			19	d	53	a				
20	b	54	a	88	c			20	d	54	c				
21	a	55	c					21	d	55	b				
22	a	56	d					22	d	56	d				
23	b	57	b					23	d	57	a				
24	b	58	b					24	a	58	*				
25	b	59	a					25	c	59	a				
26	a	60	b					26	c	60	a				
27	d	61	b					27	d	61	a				
28	c	62	a					28	*	62	a				
29	b	63	b					29	*	63	b				
30	c	64	d					30	*	64	b				
31	a	65	b					31	b	65	d				
32	b	66	c					32	c	66	d				
33	b	67	d					33	c	67	d				
34	a	68	d					34	c	68	c				

4 ULTRASONIC TESTING (UT)

4.1 Ultrasonic Testing Level 1 (UT-1)

4.1.1 Ultrasonic Testing Level 1 (UT-1) General Examination

1. The divergence of an ultrasonic beam is dependant on:

    (a) Transducer wavelength and diameter

    (b) Test specimen density

    (c) The sound wave's angle of incidence

    (d) The degree of damping of the ultrasonic transducer

2. When a longitudinal wave is incident upon an inclined interface between zero degrees and the first critical angle:

    (a) The sound beam is totally reflected

    (b) Only shear waves are produced in the second material

    (c) Shear waves and longitudinal waves are produced in the second material

    (d) Only longitudinal waves are produced in the second material

3. The piezoelectric material in a search unit which vibrates to produce ultrasonic waves is called:

    (a) A backing material

    (b) A lucite wedge

    (c) A transducer element or crystal

    (d) A couplant

4. When a longitudinal wave is incident upon an inclined interface and is refracted at ninety degrees, the angle of the incident longitudinal wave is called:

    (a) The Snell constant

    (b) The Snell angle

    (c) The mode conversion constant

    (d) The first critical angle

5. When a longitudinal wave sound beam passes through an acoustic interface at some angle other than zero degrees:

   (a) Surface waves are generated

   (b) Plate waves are generated

   (c) Reflection, refraction and mode conversion will occur

   (d) The first critical angle is reached

6. Which of the following can be a source of spurious ultrasonic signals?

   (a) Surface roughness of the test piece

   (b) Mode conversion within the test piece

   (c) Shape or contour of the test piece

   (d) All of the above

7. A noisy base line, or hash may result in:

   (a) Laminations in the test piece

   (b) Discontinuities at an angle to the test piece surface

   (c) Large grain size

   (d) Fatigue cracks

8. Sound waves which travel on the surface of a solid in a manner similar to waves on a water surface are called:

   (a) Rayleigh waves

   (b) Shear waves

   (c) Primary waves

   (d) Compression waves

9. Lamb waves are formed in a part which has:

   (a) A thickness greater that about ten wavelengths

   (b) A thickness approximately equal to the wavelength

   (c) Low acoustic impedance compared to the transducer crystal material

   (d) A thickness of about four wavelengths

10. Which type(s) of sound wave modes will propagate through liquids?

    (a) Longitudinal

    (b) Shear

    (c) Surface

    (d) All of the above

11. When the motion of the particles of a medium is transverse to the direction of propagation, the wave being transmitted is called a:

    (a) Longitudinal wave

    (b) Shear wave

    (c) Surface wave

    (d) Lamb wave

12. Which of the following test frequencies would generally provide the best penetration in a 12 inch thick specimen of coarse-grained steel?

    (a) 1.0 MHz

    (b) 2.25 MHz

    (c) 5.0 MHz

    (d) 10 MHz

13. An oscilloscope display in which the screen base line is adjusted to represent the one way distance in a test piece is called a:

    (a) A scan display

    (b) B scan display

    (c) C scan display

    (d) D scan display

14. A common use of ultrasonic testing is:

    (a) Cleaning

    (b) Detecting of sub-surface indications

    (c) Determination of the test piece ductility

    (d) Communications

15. Sound waves of a frequency beyond the hearing range of the human ear are referred to as ultrasonic waves or vibrations, and the term embraces all vibrational waves of frequency greater than approximately:

    (a) 20 kHz

    (b) 2 MHz

    (c) 2 kHz

    (d) 200 kHz

16. Y cut crystals produce:

    (a) Longitudinal waves

    (b) Shear waves

    (c) Lamb waves

    (d) Surface waves

17. The cable that connects the ultrasonic instrument to the search unit is specially designed so that one conductor is centred inside another. The technical name for such a cable is:

    (a) BX cable

    (b) Conduit

    (c) Coaxial cable

    (d) Ultrasonic conductor cable grade 20

18. As ultrasonic frequency increases:

    (a) Wavelength increases

    (b) Wavelength decreases

    (c) Sound velocity increases

    (d) Sound velocity decreases

19. In an A scan presentation, the amplitude of vertical indications on the screen represents the:

    (a) Amount of ultrasonic sound energy returning to the search unit

    (b) Distance travelled by the search unit

    (c) Thickness of material being tested

    (d) Elapsed time since the ultrasonic pulse was generated

20. Loss of the test piece back wall echo during scanning may be caused by:

    (a) An abnormally homogeneous material structure

    (b) A smooth entry surface on the test piece

    (c) A discontinuity which is not parallel to the entry surface

    (d) An opposite surface which is parallel to the entry surface

21. When a sound beam is reflected:

    (a) The angle of reflection is found using Snell's law

    (b) The angle of reflection equals the angle of incidence

    (c) All the sound energy is reflected unless the acoustic impedance is zero

    (d) Beam spread is decreased

22. Which of the following circuits converts electrical energy to ultrasonic energy?

    (a) The pulse generator

    (b) The transducer

    (c) The transformer

    (d) The power supply

23. An instrument display in which the horizontal base line represents elapsed time and the vertical deflection represents signal amplitudes is called:

    (a) A scan

    (b) B scan

    (c) C scan

    (d) A time line display

24. Which of the following circuits provides short duration, high energy pulses which are used to excite the transducer?

    (a) The pulse generator

    (b) The amplifier

    (c) The transducer

    (d) The clock

25. A cross section view of a test piece is produced by which of the following?

(a) A scan

(b) B scan

(c) C scan

(d) A time line display

26. Echo amplitude losses may be caused by:

(a) Entry surface roughness

(b) Coarse grain size

(c) Discontinuity orientation

(d) All of the above

27. Which of the following is an advantage of using a focused transducer?

(a) The useful range of the transducer is decreased

(b) The useful range of the transducer is increased

(c) Sensitivity to the effects of a rough surface is increased

(d) Greater sensitivity is achieved in the transducer's useable range

28. Which of the following circuits provide current to operate the ultrasonic instrument?

(a) The pulse generator

(b) The amplifier

(c) The power supply

(d) The sweep generator

29. Which of the following is a true statement?

(a) Higher frequencies produce lower sensitivity

(b) Higher frequencies produce longer wavelengths

(c) Thicker crystals produce lower frequency transducers

(d) Longer wavelengths produce higher sensitivity

30. Which type(s) of sound wave modes will propagate through solids?

    (a) Longitudinal

    (b) Shear

    (c) Surface

    (d) All of the above

31. The longitudinal wave incident angle at which the refracted shear wave angle equals ninety degrees is called:

    (a) The Snell angle

    (b) The Snell constant

    (c) The first critical angle

    (d) The second critical angle

32. The amount of beam divergence from a crystal is primarily dependent on the:

    (a) Type of test

    (b) Tightness of crystal backing in the search unit

    (c) Frequency and crystal size

    (d) Pulse length

33. In ultrasonic testing, a liquid coupling medium between the crystal surface and the part surface is necessary because :

    (a) Lubricant is required to minimize wear on the crystal surface

    (b) An air interface between the crystal surface and the part surface would almost completely reflect the ultrasonic vibrations

    (c) The crystal will not vibrate if placed directly in contact with the surface of the part being inspected

    (d) The liquid is necessary to complete the electrical circuit in the search unit

34. X cut crystals produce:

    (a) Longitudinal waves

    (b) Shear waves

    (c) Lamb waves

    (d) Surface waves

35. Lower frequency transducers are normally used:

    (a) In contact testing applications

    (b) In angle beam testing applications

    (c) In immersion testing applications

    (d) Where deeper penetration is required

36. All other factors being equal, which of the following modes of vibration has the greatest velocity?

    (a) Shear wave

    (b) Transverse wave

    (c) Surface wave

    (d) Longitudinal wave

37. In immersion testing, the position of the search unit is often varied to transmit sound into the test part at various angles to the front surface. Such a procedure is referred to as:

    (a) Angulation

    (b) Dispersion

    (c) Reflection testing

    (d) Refraction

38. The angle of a refracted shear wave generated as a sound wave passes at an angle through an acoustic interface is dependant on:

    (a) The acoustic impedances of the materials of each side of the interface

    (b) The frequency of the incident sound wave

    (c) The wavelength of the incident sound wave

    (d) The hardness of the materials on each side of the interface

39. Which of the following is a likely effect of a rough test piece surface?

    (a) An improved ultrasonic signal to noise ratio

    (b) A more penetrating sound beam

    (c) Loss of discontinuity signal amplitude

    (d) Higher test reliability

40. Wavelength is:

    (a) The distance from the crest to the next trough of a sound wave

    (b) The time required for a sound wave to propagate from a trough to the next trough of a sound wave

    (c) The distance a sound wave travels in one second

    (d) The distance from trough to trough or from peak to peak of a sound wave

41. The velocity of surface waves is approximately _____ the velocity of shear waves in the same material.

    (a) Two times

    (b) Four times

    (c) One half

    (d) Nine-tenths

42. An ultrasonic instrument control which allows moving an A scan display to the left or right without changing the distance between any echoes displayed is called:

    (a) The sweep length or range control

    (b) The damping control

    (c) The sweep delay

    (d) The pulse length control

43. A disadvantage of using natural quartz crystals in a search unit is that:

    (a) It will dissolve in water

    (b) It is the least effective generator of ultrasonic energy of all commonly used materials

    (c) It easily loses it operating characteristics as it ages

    (d) None of the above is correct

44. The formula Sin A/Sin B = V_A/V_B is known as:

    (a) The Fresnell relationship

    (b) Snell's law

    (c) The law of sines

    (d) The critical velocity ratio

45. A 25 MHz search unit would most likely be used during:

    (a) Straight beam contact testing

    (b) Immersion testing

    (c) Angle beam contact testing

    (d) Surface wave contact testing

46. A technique in which two transducers are used, one on each side of the test piece, is called:

    (a) Angle beam testing

    (b) Modified immersion testing

    (c) Through transmission testing

    (d) Twinning

47. Sound beam intensity is irregular in the area called:

    (a) The near field

    (b) The far field

    (c) The beam spread

    (d) The delay line

48. A more highly damped transducer crystal results in:

    (a) Better resolution

    (b) Better sensitivity

    (c) Lower sensitivity

    (d) Poorer resolution

49. The process of comparing an instrument or device with a standard is called:

    (a) Angulation

    (b) Calibration

    (c) Attenuation

    (d) Correlation

50. Scattering of an ultrasonic beam is most pronounced when:

    (a) Material grain size and wavelength are comparable

    (b) Low frequency transducers are used

    (c) Large wavelengths are used for ultrasonic testing

    (d) None of the above

51. Ultrasonic testing is:

    (a) Mechanical energy with a speed of propagation faster than the speed of sound

    (b) Sound which has a frequency or pitch above the range of the human ear

    (c) The science of discontinuity detection using ultrasonic sound

    (d) Mechanical vibrations below the frequency of human hearing

52. Which technique would most likely be used to examine a weld, with the weld cap still in place?

    (a) Through transmission testing

    (b) Angle beam testing

    (c) Straight beam testing

    (d) None of the above

53. The maximum frequency usually used for contact testing is:

    (a) 1 MHz

    (b) 5 MHz

    (c) 10 MHz

    (d) 25 MHz

54. Higher frequency transducers are normally used:

    (a) In contact testing applications

    (b) In angle beam testing applications

    (c) In immersion testing applications

    (d) Where deeper penetration is required

55. Typical ultrasonic testing frequencies are:

(a) 50 kHz to 1 MHz

(b) 200 kHz to 25 MHz

(c) 10 MHz to 100 MHz

(d) 1 MHz to 5 MHz

56. ‘25 million cycles per second’ can also be stated as:

(a) 25 kHz

(b) 2500 kHz

(c) 25 MHz

(d) 25 Hz

57. A disadvantage of using a high frequency ultrasonic transducer is:

(a) It provides a smaller beam angle and better resolving power

(b) It provides a larger beam angle and poorer resolving power

(c) It is scattered more by coarse grained material

(d) It is scattered less by coarse grained material

58. Which of the following circuits provides timing signals to the pulser?

(a) The clock

(b) The amplifier

(c) The pulse generator

(d) The sweep generator

59. Which of the following search units would contain the thinnest quartz crystal?

(a) A 1 MHz search unit

(b) A 5 MHz search unit

(c) A 15 MHz search unit

(d) A 25 MHz search unit

60. With longitudinal wave incident at angles between the first and second critical angles:

    (a) The sound beam is totally reflected

    (b) Only shear waves are produced in the second material

    (c) Shear waves and longitudinal waves are produced in the second material

    (d) Only longitudinal waves are produced in the second material

61. Sound velocity is described by which of the following relationships?

    (a) Wavelength times frequency

    (b) Wavelength divided by frequency

    (c) Wavelength divided acoustic impedance

    (d) Acoustic impedance divided by density

62. The relationship between the longitudinal wave incident angle and the refracted shear wave angle is defined by:

    (a) Snell's law

    (b) Snell's constant

    (c) The law of acoustics

    (d) Fraunhofer’s law

63. Acoustic impedance is defined by which of the following relations?

    (a) Material density/wavelength

    (b) Material density × velocity

    (c) Velocity/wavelength

    (d) Velocity × wavelength

64. The upper limit of human hearing is normally considered to be about:

    (a) 12 kHz

    (b) 16 kHz

    (c) 20 kHz

    (d) 30 kHz

65. Reference standards containing a series of flat bottom holes of the same diameter at different depths in each block are called?

    (a) Area-amplitude blocks

    (b) Distance-amplitude blocks

    (c) IIW blocks

    (d) Sizing blocks

66. During ultrasonic testing by the immersion method, it is frequently necessary to angulate the search unit when a discontinuity is located at an angle in order to:

    (a) Avoid a large number of back reflections that could interfere with a normal test pattern

    (b) Obtain a maximum response if the discontinuity is not originally oriented perpendicular to the ultrasonic beam

    (c) Obtain a discontinuity indication of the same height as the indication from the flat bottomed hole in a reference block

    (d) Obtain the maximum number of entry surface reflections

67. Which of the following transducer materials is the most efficient receiver of ultrasonic energy?

    (a) Lead metaniobate

    (b) Quartz

    (c) Lithium sulphate

    (d) Barium titanate

68. An ultrasonic wave in which particle displacement is 90 degrees to the direction of wave propagation is called a:

    (a) Longitudinal wave

    (b) Shear wave

    (c) Compressional wave

    (d) Plate wave

69. An advantage of using lithium sulphate in search units it that:

    (a) It is one of the most efficient generators of ultrasonic energy

    (b) It is one of the most efficient receivers of ultrasonic energy

    (c) It is insoluble

    (d) It can withstand temperatures as high as 700ºC

70. Moving a search unit over a test surface either manually or automatically is referred to as:

    (a) Scanning

    (b) Attenuating

    (c) Angulating

    (d) Resonating

4.1.2 Ultrasonic Testing Level 1 (UT-1) Specific Examination

1. Which of the following materials of the same alloy is most likely to produce the greatest amount of sound attenuation over a given distance?

    (a) A hand forging

    (b) A coarse grained casting

    (c) An extrusion

    (d) The attenuation is equal in all materials

2. The ability to separate echos from reflectors close together in depth is called:

    (a) Resolution

    (b) Attenuation

    (c) Accuracy

    (d) Sensitivity

3. Greater depth of penetration in coarse grained material may be achieved using:

    (a) More sweep delay

    (b) Higher frequencies

    (c) Less sweep delay

    (d) Lower frequencies

4. Lower frequency transducers produce:

    (a) Deeper penetration, greater attentuation and less beam spread

    (b) Deeper penetration, less attentuation and greater beam spread

    (c) Greater beam spread but higher sensitivity and resolution

    (d) Less beam spread but lower sensitivity and resolution

5. Spurious indications might be caused by which of the following?

   (a) Mode conversion from beam spread in a long specimen

   (b) Surface waves generated during straight beam testing

   (c) A test piece with a smooth machined surface

   (d) All of the above

6. The portion of a test piece which is represented by the CRT screen area from zero to the rightmost edge of the initial pulse is called:

   (a) The dead zone

   (b) The near field

   (c) The near zone

   (d) The far zone

7. The depth of penetration of surface waves is approximately:

   (a) One wavelength

   (b) Three wavelengths

   (c) 1/2 wavelength

   (d) The total part thickness

8. An ultrasonic test using a straight beam contact search unit is being conducted through the thickness of a flat part such as a plate. This test should detect:

   (a) Laminar-type flaws with major dimensions parallel to the rolled surface

   (b) Transverse-type flaws with major dimensions at right angles to the rolled surface

   (c) Radial flaws with major dimensions along length but radially oriented to the rolled surface

   (d) None of the above

9. The first critical angle is defined as the longitudinal wave incident angle which results in:

   (a) A refracted longitudinal wave of ninety degrees

   (b) A refracted shear wave of ninety degrees

   (c) Complete reflection of the shear wave

   (d) None of the above

10. The number of complete waves which pass a given point in a given period of time (usually one second) is referred to as the:

    (a) Amplitude of a wave motion

    (b) Pulse length of a wave motion

    (c) Frequency of a wave motion

    (d) Wavelength of a wave motion

11. The speed of sound in a given material depends on:

    (a) The specific acoustic impedance of the material

    (b) The acoustic impedance and density of the material

    (c) The density and elasticity of the material

    (d) The piezo-electric resistance of the material

12. A screen pattern containing a large number of low-level indications (often reffered to as ‘hash’) could be caused by:

    (a) A crack

    (b) A large inclusion

    (c) Coarse grained material

    (d) Fine grained material

13. In an A scan presentation, the horizontal base line represents the:

    (a) Amount of refracted ultrasonic sound energy

    (b) Distance traveled by the search unit

    (c) Elapsed time or distance

    (d) None of the above

14. An ultrasonic instrument control which is used to expand or contract the horizontal base line of an A scan display is called:

    (a) The sweep length or range control

    (b) The damping control

    (c) The sweep delay

    (d) The pulse length control

15. In a basic ultrasonic test pattern (A scan) for contact testing, the initial pulse (assume no sweep delay is used):

    (a) Is the high indication on the extreme left side of the screen that represents the entry surface of the inspected part

    (b) Is the first pulse that occurs near the right side of the screen and represents the opposite boundary of the inspected part

    (c) Is an indication that appears and disappears during screening

    (d) Is always the second pulse from the left on the viewing screen

16. A term used in ultrasonics to express the rate at which sound waves pass through various substances is:

    (a) Frequency

    (b) Velocity

    (c) Wave length

    (d) Pulse length

17. Transducer focal lengths are normally specified as:

    (a) Distance in steel

    (b) Distance in aluminium

    (c) Distance in air

    (d) Distance in water

18. The second critical angle is defined as the longitudinal wave incident angle which results in:

    (a) A refracted longitudinal wave of ninety degrees

    (b) A refracted shear wave of ninety degrees

    (c) Complete reflection of the sound beam

    (d) None of the above

19. Spurious or nonrelevant indications might be suspected if:

    (a) Indications are unusually consistent in amplitude and appearance

    (b) There are strong indications in localised areas

    (c) The indications are localised and repeatable

    (d) None of the above

20. A disadvantage of lithium sulfate as a transducer material is that:

    (a) It is an inefficient receiver of ultrasonic energy

    (b) It is soluble in water

    (c) It is not piezo- electric

    (d) It has extremely coarse grain structure

21. An advantage of using a ceramic transducer in search units is that:

    (a) It is one of the most efficient generators of ultrasonic energy

    (b) It is one of the most efficient receivers of ultrasonic energy

    (c) It has a very low mechanical impedance

    (d) It can withstand temperatures as high as 700^{o}C

22. The three most common modes of sound vibration are:

    (a) Longitudinal, compressional, and transverse waves

    (b) Longitudinal, transverse and rayleigh waves

    (c) Transverse, longitudinal and shear waves

    (d) Transverse, shear waves and rayleigh waves

23. A larger diameter crystal results in:

    (a) Greater beam spread

    (b) Lower penetrating power

    (c) Less beam spread

    (d) Greater penetrating power

24. Entry surface resolution is a characteristic of an ultrasonic testing system which defines its ability to:

    (a) Detect discontinuities oriented in a direction parallel to the ultrasonic beam

    (b) Detect discontinuities located in the center of a forging containing a fine metallurgical structure

    (c) Detect minute surface scratches

    (d) Detect discontinuities located just beneath the entry surface in the part being tested

25. Higher frequency transducers produce which of the following?

    (a) Greater beam spread, sensitivity and resolution

    (b) Greater sensitivity, resolution and penetration

    (c) Greater penetration, attenuation and resolution

    (d) Greater sensitivity, resolution and attenuation

26. In immersion testing, verification that the search unit is normal to a flat entry surface is indicated by:

    (a) Maximum reflection from the entry surface

    (b) Proper wavelength

    (c) Maximum amplitude of the initial pulse

    (d) Elimination of water multiples

27. Which of the following is true?

    (a) Velocity = frequency/wavelength

    (b) Frequency = velocity × wavelength

    (c) Velocity = wavelength/frequency

    (d) Wavelength=velocity/frequency

28. Most commercial ultrasonic testing is accomplished using frequencies between:

    (a) 1 and 25 kHz

    (b) 0.2 and 25 MHz

    (c) 1 and 1 000 kHz

    (d) 15 and 100 MHz

29. The longitudinal wave incident angle which results in formation of a rayleigh wave is called:

    (a) Normal incidence

    (b) The first critical angle

    (c) The second critical angle

    (d) Any angle above the first critical angle

30. An ultrasonic testing technique in which the transducer element is not parallel to the test surface is called:

    (a) Angle beam testing

    (b) Immersion testing

    (c) Contact testing

    (d) Through-transmission testing

31. In the same material, shear wave velocity is:

    (a) Approximately 1/2 longitudinal wave velocity

    (b) Approximately twice longitudinal wave velocity

    (c) Approximately 1/4 longitudinal wave velocity

    (d) Approximately four times longitudinal wave velocity

32. Another name for a compression wave is a:

    (a) Lamb wave

    (b) Shear wave

    (c) Longitudinal wave

    (d) Transverse wave

33. Under most circumstances, which of the following frequencies would result in the best resolving power?

    (a) 1 MHz

    (b) 5 MHz

    (c) 10 MHz

    (d) 25 MHz

34. The most useful range of incident longitudinal wave angles for ultrasonic testing is:

    (a) Normal incidence to the first critical angle

    (b) First critical angle to the second critical angle

    (c) Second critical angle to the third critical angle

    (d) Above the third critical angle

35. Ultrasonic testing of material where the search unit is in direct contact with the material being tested may be:

    (a) Straight beam testing

    (b) Surface wave testing

    (c) Angle beam testing

    (d) All of the above

36. The echo on the cathode ray tube (CRT) which represents the far boundary of the material being tested is called:

    (a) Hash

    (b) The initial pulse

    (c) The 'main bang'

    (d) The back wall echo

37. A standard block which can be used to calibrate an instrument for an angle beam range calibration is:

    (a) Area-amplitude blocks

    (b) Distance-amplitude blocks

    (c) V_1/A_2 block

    (d) Beam spread block

38. The ability to detect echos from small reflectors is called:

    (a) Resolution

    (b) Attenuation

    (c) Accuracy

    (d) Sensitivity

39. When the motion of the particles of a medium is parallel to the direction of propagation, the wave being transmitted is called a:

    (a) Longitudinal wave

    (b) Shear wave

    (c) Surface wave

    (d) Lamb wave

40. In contact testing, the entry surface indication is sometimes referred to as:

    (a) The initial pulse

    (b) The ‘main bang’ or transmitter pulse

    (c) Both (a) and (b)

    (d) None of the above

41. A second name for Rayleigh waves is:

    (a) Shear waves

    (b) Longitudinal waves

    (c) Transverse waves

    (d) Surface waves

42. Sound beam intensity decreases expontentially with distance in the area called:

    (a) The near field

    (b) The far field

    (c) The dead zone

    (d) The delay line

43. A test method employing two seperate search units on opposite surfaces of the material being tested is called:

    (a) Contact testing

    (b) Surface wave testing

    (c) Through-transmission testing

    (d) Lamb wave testing

44. Which of the following is not (!) a requirement of a couplant?

    (a) Easy application

    (b) Highly penetrating

    (c) Harmless both to the test piece and transducers

    (d) Excludes all air between transducer and test piece

45. A plan view representation of a test piece is produced by which of the following?

    (a) A scan

    (b) B scan

    (c) C scan

    (d) A time line display

46. A widening of the front surface indication, when testing a rough surface, is caused by:

    (a) Defects in the test piece

    (b) A coarse grain structure

    (c) A partial reflection of ultrasonic beam side lobe energy

    (d) Ultrasonic instrument malfunction

47. When a vertical indication has reached the maximum signal height which can be displayed or viewed on the CRT of an ultrasonic instrument, the indication is said to have reached its:

    (a) Distance-amplitude height

    (b) Absorption level

    (c) Vertical level

    (d) Limit of resolution

48. A material used between the face of a search unit and the test surface to permit or improve the transmission of ultrasonic vibrations from the search unit to the material being tested is called:

    (a) A wetting agent

    (b) A couplant

    (c) A acoustic transmitter

    (d) A lubricant

49. When an ultrasonic beam passes through the interface between two dissimilar materials at an angle, a new angle of sound travel is formed in the second material due to:

    (a) Attenuation of ultrasound

    (b) Transmission of ultrasound

    (c) Compression of ultrasound

    (d) Refraction

50. The velocity of sound waves is primarily dependent on:

    (a) The pulse length

    (b) The frequency

    (c) The material in which the sound is being transmitted and the mode of vibration

    (d) None of the above

51. Piezoelectric ability is the property of a material to:

    (a) Become electrically conductive when heated above its critical temperature

    (b) Generate sound when heated above its critical temperature

    (c) Vibrate at high frequency when subjected to a temperature gradient

    (d) Produce an electric current when deformed and vice versa

52. The boundary between two different materials which are in contact with each other is called:

    (a) A rarefactor

    (b) A refractor

    (c) An interface

    (d) A marker

53. An ultrasonic insrument control which is used to adjust the sharpness of the CRT screen display is called:

    (a) Astigmatism or focus

    (b) Pulse repetition rate

    (c) Pulse energy

    (d) Gain

54. A disadvantage of using a low frequency ultrasonic transducer is:

    (a) It provides better penetration in most materials

    (b) It provides poorer penetration in most materials

    (c) It provides a smaller beam angle and poorer resolving power

    (d) It provides a larger beam angle and poorer resolving power

55. As transducer crystal thickness decreases:

    (a) Transducer wavelength increases

    (b) Frequency decreases

    (c) Frequency increases

    (d) None of the above

56. On the area-amplitude ultrasonic standard test blocks, the flat-bottomed holes in the blocks are:

    (a) All of the same diameter

    (b) Different in diameter, increasing by 1/64 inch increments from the No. 1 block to the No. 8 block

    (c) Largest in the No. 1 block and smallest in the No. 8 block

    (d) Drilled to different depths from the front surface of the test block

57. An ultrasonic instrument control which is used to expand or contract the horizontal base line of an A scan display is called:

    (a) The sweep length or range control

    (b) The damping control

    (c) The sweep delay

    (d) The pulse length control

58. Greater depth of penetration in coarse grained material may be achieved using:

    (a) More sweep delay

    (b) Higher frequencies

    (c) Less sweep delay

    (d) Lower frequencies

59. A disadvantage of using a low frequency ultrasonic transducer is:

    (a) It provides better penetration in most materials

    (b) It provides poorer penetration in most materials

    (c) It provides a smaller beam angle and poorer resolving power

    (d) It provides a larger beam angle and poorer resolving power

60. A disadvantage of using a high frequency ultrasonic transducer is:

    (a) It provides a smaller beam angle and better resolving power

    (b) It provides a larger beam angle and poorer resolving power

    (c) It is scattered more by coarse grained material

    (d) It is scattered less by coarse grained material

61. When a longitudinal wave sound beam passes through an acoustic interface at some angle other than zero degrees:

    (a) Surface waves are generated

    (b) Plate waves are generated

    (c) Reflection, refraction and mode conversion occur

    (d) The first critical angle is reached

62. The angle of a refracted shear wave generated as a sound wave passes at an angle through an acoustic interface is depentant on:

    (a) The acoustic impedances of the materials on each side of the interface

    (b) The frequency of the incident sound wave

    (c) The wavelength of the incident sound wave

    (d) The hardness of the materials on each side of the interface

63. The purpose of the couplant is to:

    (a) Match impedances between the transducer and test piece

    (b) Absorb stray reflectors

    (c) Clean the test piece so a more efficient test may be continued

    (d) Lock the ultrasonic scanner into place prior to testing

64. Which of the following can be a source of spurious ultrasonic signals?

    (a) Surface roughness of the test piece

    (b) Mode conversion within the test piece

    (c) Shape or contour of the test piece

    (d) All of the above

65. When a sound beam is reflected:

    (a) The angle of reflection is found using Snell's law

    (b) The angle of reflection equals the angle of incidence

    (c) All the sound energy is reflected unless the acoustic impedanmce is zero

    (d) Beam spread is decreased

66. Sound beam intensity decreases expontentially with distance in the area called:

    (a) The near field

    (b) The far field

    (c) The dead zone

    (d) The delay line

67. The ability to detect echoes from small reflectors is called:

    (a) Resolution

    (b) Attenuation

    (c) Accuracy

    (d) Sensitivity

68. The ability to separate echoes from reflectors close together in depth is called:

    (a) Resolution

    (b) Attenuation

    (c) Accuracy

    (d) Sensitivity

69. Which of the following transducer materials is the most efficient receiver of ultrasonic energy?

    (a) Lead metaniobate

    (b) Quartz

    (c) Lithium sulfate

    (d) Barium titanate

70. A display which shows the initial pulse and the front surface echo superimposed would be considered:

    (a) An immersion test

    (b) An A scan

    (c) A contact test

    (d) A B scan

71. A display which shows the initial pulse and the front surface echo with a fairly wide space between the two would be considered:

    (a) An immersion test

    (b) An A scan

    (c) A contact test

    (d) A B scan

72. When conducting an immersion test, the water path distance must be controlled so that:

    (a) Spurious signals are not created by surface waves on the test piece

    (b) The (water path distance)/(diameter) ratio does not result in asymmetric standing waves

    (c) The test piece discontinuity indications appear between the first front and first back surface echos

    (d) The second front surface echo does not appear on the CRT screen between the first front and first back surface echos

73. Bubblers and wheel transducers are considered:

    (a) Immersion techniques

    (b) Modified immersion techniques

    (c) Contact techniques

    (d) Offset techniques

4.1.3 Ultrasonic Testing Level 1 (UT-1) Answers to Questions

Ultrasonic Testing Level 1 Answers to Questions																
General								Specific								
1	a	35	d	69	b			1	b	35	d	69	c		
2	c	36	d	70	a			2	a	36	d	70	b		
3	c	37	a					3	d	37	c	71	a		
4	d	38	a					4	b	38	d	72	c		
5	c	39	c					5	a	39	a	73	b		
6	d	40	d					6	b	40	c				
7	c	41	d					7	a	41	d				
8	a	42	c					8	a	42	b				
9	b	43	b					9	a	43	c				
10	a	44	b					10	c	44	b				
11	b	45	b					11	c	45	c				
12	a	46	c					12	c	46	c				
13	b	47	a					13	c	47	c				
14	b	48	a					14	a	48	b				
15	a	49	b					15	a	49	d				
16	b	50	a					16	b	50	c				
17	c	51	b					17	a	51	d				
18	b	52	b					18	b	52	c				
19	a	53	b					19	a	53	a				
20	c	54	c					20	b	54	d				
21	b	55	d					21	a	55	c				
22	b	56	c					22	b	56	b				
23	a	57	c					23	c	57	a				
24	a	58	a					24	d	58	d				
25	b	59	d					25	d	59	c				
26	d	60	b					26	a	60	c				
27	d	61	a					27	d	61	c				
28	c	62	a					28	b	62	a				
29	c	63	b					29	c	63	a				
30	d	64	c					30	a	64	d				
31	d	65	b					31	a	65	b				
32	c	66	b					32	c	66	b				
33	b	67	c					33	d	67	d				
34	a	68	b					34	a	68	a				

4.2 Ultrasonic Testing Level 2 (UT-2)

4.2.1 Ultrasonic Testing Level 2 (UT-2) General Examination

1. Most commercial ultrasonic testing is performed at frequencies between:

   (a) 1 MHz and 10 MHz

   (b) 1 MHz and 100 MHz

   (c) 10 MHz and 50 MHz

   (d) 1 MHz and 25 MHz

2. For a transducer with any given Q, resolution increases with:

   (a) Sensitivity

   (b) Frequency

   (c) Wavelength

   (d) Crystal thickness

3. Resolving power of a transducer is directly proportional to its:

   (a) Wavelength

   (b) Crystal thickness

   (c) Bandwidth

   (d) Q

4. The term is used to refer to the product of wave velocity and density is:

   (a) Acoustic impedance

   (b) The velocity-density ratio

   (c) Index of refraction

   (d) Reflection co-efficient

5. For an ultrasonic beam with normal incidence, the reflection coefficient is given by:

   (a) $[(Z_1+Z_2)^2]/[(Z_1-Z_2)^2]$

   (b) $(Z_1+Z_2)/(Z_1-Z_2)$

   (c) $[(4)\ (Z_1)(Z_2)]/[(Z_1+Z_2)^2]$

   (d) $[(Z_1-Z_2)^2]/[Z_1+Z_2)^2]$

6. For an ultrasonic beam with normal incidence the transmission coefficient is given by:

   (a) $[(Z_1+Z_2)^2]/[(Z_1-Z_2)^2]$

   (b) $(Z_1+Z_2)/(Z_1-Z_2)$

   (c) $[(4)\ (Z_1)(Z_2)]/[(Z_1+Z_2)^2]$

   (d) $[(Z_1-Z_2)^2]/[Z_1+Z_2)^2]$

7. Snell's law is given by which of the following:

   (a) $(\text{Sin A})/(\text{Sin B}) = V_B/V_A$

   (b) $(\text{Sin A})/(\text{Sin B}) = V_A/V_B$

   (c) $(\text{Sin A})/\ V_B = V(\text{Sin B})/V_A$

   (d) $(\text{Sin A})[V_A] = (\text{Sin B})[\ V_B]$

8. Snell's law is used to calculate:

   (a) Angle of beam divergence

   (b) Angle of diffraction

   (c) Angle of refraction

   (d) None of the above

9. Calculate the refracted shear wave angle in steel [V_S = 0.323cm/microsec] for an incident longitudinal wave of 37.9 degrees in Plexiglas [V_L = 0.267cm/microsec]

   (a) 26 degrees

   (b) 45 degrees

   (c) 48 degrees

   (d) 64 degrees

10. Calculate the refracted shear wave angle in steel [V_S = 0.323cm/microsec] for an incident longitudinal wave of 45.7 degrees in Plexiglas [V_L = 0.267cm/microsec]

    (a) 64 degrees

    (b) 45.7 degrees

    (c) 60 degrees

    (d) 70 degrees

11. Calculate the refracted shear wave angle in aluminium [V_S = 0.31cm/microsec] for an incident longitudinal wave of 43.5 degrees in Plexiglas [V_L = 0.267cm/microsec]

    (a) 53 degrees

    (b) 61 degrees

    (c) 42 degrees

    (d) 68 degrees

12. Calculate the refracted shear wave angle in aluminium [V_S = 0.31cm/microsec] for an incident longitudinal wave of 53 degrees in Plexiglas [V_L = 0.267cm/microsec]

    (a) 53 degrees

    (b) 61 degrees

    (c) 42 degrees

    (d) 68 degrees

13. Lithium sulphate, barium titanate and lead metaniobate are examples of:

    (a) Magnetostrictive elements

    (b) Piezoelectric elements

    (c) Rochelle salts

    (d) Y cut crystals

14. The particle motion for compression waves is:

    (a) Parallel to wave propagation

    (b) Transverse to wave propagation

    (c) Elliptical

    (d) Circular

15. Shear waves for ultrasonic testing are usually produced:

    (a) X cut crystals

    (b) Y cut crystals

    (c) Modulated R-F conversion

    (d) Mode converted longitudinal waves

16. Near surface resolution can be improved by:

    (a) Using a narrow band transducer

    (b) Using a focused transducer

    (c) Using a high Q transducer

    (d) None of the above

17. The most important requirement for paintbrush transducer is:

    (a) Uniform beam intensity across the transducer

    (b) A pinpoint focal spot

    (c) Good horizontal linearity characteristics

    (d) Prescribed vertical and horizontal linearity characteristics

18. Which of the following is an advantage of a focused transducer?

    (a) Extended useful range

    (b) Reduced sensitivity in localised area

    (c) Improved signal to noise ratio over an extended range

    (d) Higher resolution over a limited range

19. Which of the following is intended to be a ‘first cut’ or rough inspection device to be followed by more precise evaluation of any discontinuities found?

    (a) Wheel transducer

    (b) Focused transducer

    (c) Paintbrush transducer

    (d) Ball transducer

20. A wider entry surface indication or pulse may result from:

    (a) Side lobes of the sound beam being reflected from a rough surface

    (b) Using a lower energy pulser

    (c) Using a higher amplifier attenuation setting

    (d) Huygen's principle

21. Which of the following methods might be used to reduce attenuation losses in an ultrasonic test?

    (a) Use a shorter wavelength

    (b) Use a lower frequency transducer

    (c) Change from longitudinal waves to shear waves

    (d) Change to a coarser grained test piece

22. When comparing discontinuity echoes to equivalent flat bottom hole echoes in materials with similar impedance, surface finish and attenuation:

    (a) The flaw is never larger than the flat bottom hole

    (b) The flaw is never smaller than the flat bottom hole

    (c) The flaw is always smaller than the flat bottom hole

    (d) None of the above

23. An advantage of immersion testing is that:

    (a) Large parts are easily inspected

    (b) Most test systems are easily transported in the field

    (c) High test frequencies may be used

    (d) Most test systems are not easily transported in the field

24. An advantage of immersion testing is that:

    (a) Large parts may be easily inspected

    (b) Most test systems are easily transported in the field

    (c) Low test frequencies may be used

    (d) Irregularly shaped test pieces can be virtually completely examined

25. An ultrasonic data display which shows a plan view presentation of the data is called:

    (a) A scan

    (b) B scan

    (c) C scan

    (d) Orthogonal view

26. An ultrasonic display which shows a cross section of the test piece and any flaws which are found are called:

    (a) A scan

    (b) B scan

    (c) C scan

    (d) Orthogonal view

27. An ultrasonic display which shows echo locations and amplitude is called:

    (a) A scan

    (b) B scan

    (c) C scan

    (d) Orthogonal view

28. An advantage of using lower frequencies during ultrasonic testing is that:

    (a) Near surface resolution is improved

    (b) Sensitivity to small discontinuities is improved

    (c) Beam spread is reduced

    (d) Sensitivity to unfavourable oriented flaws is improved

29. A method of compensating for the ‘dead zone’ or near surface resolution problems is to:

    (a) Inspect all areas of the test piece twice to assure repeatability of indications

    (b) Re-inspect from the opposite side of the test piece if geometry permits

    (c) Re-inspect using a higher energy pulse

    (d) Re-inspect using a higher frequency transducer that does not have a ‘dead zone’

30. When testing a test piece with parallel front and back surfaces, no back wall echo can be obtained. Which of the following actions might enable you to obtain a back wall echo?

    (a) Use a wetter transducer

    (b) Use a lower frequency transducer

    (c) Use a transducer with a narrower bandwidth

    (d) Use a higher frequency transducer

31. Materials which can readily be inspected with frequencies of 1 to 5 MHz are:

    (a) Steel, cast iron and concrete

    (b) Titanium, wood and aluminium

    (c) Magnesium, titanium and steel

    (d) All of the above

32. When variations are noticed in the front surface reflection, the test piece should be inspected for possible near surface discontinuities by:

    (a) Using a lower frequency transducer

    (b) Using a higher pulse energy

    (c) Inspecting from the opposite side

    (d) Calibrating on a smaller diameter flat bottom hole

33. Forging bursts are most often orientated:

    (a) Parallel to the surface

    (b) Perpendicular to the surface

    (c) In a random manner

    (d) At an angle of 45 degrees to the surface

34. The purpose of adding a wetting agent to an immersion bath is:

    (a) To make sure the bath is wet

    (b) To reduce corrosive properties of the bath

    (c) To eliminate air bubbles in the bath

    (d) To prevent rust

35. During immersion testing of pipe or tubing the incident longitudinal wave angle must be limited to a narrow range. The reason for the upper limit is:

    (a) To avoid complete reflection of ultrasound from the test piece

    (b) To prevent formation of Rayleigh waves

    (c) To prevent formation of shear waves

    (d) To avoid saturating the test piece with ultrasound

36. A calibration for immersion ultrasonic testing of pipe or tubing should establish a transducer position such as:

    (a) I.D. and O.D. notches produce equal responses for equivalent metal path distances

    (b) Rayleigh waves are generated through the entire pipe or tubing wall

    (c) All ultrasound enters the test piece

    (d) Only longitudinal waves are generated in the test piece

37. One way of identifying spurious echoes in an ultrasonic test is:

    (a) Re-test the test piece to verify that the echoes are repeatable

    (b) Clean and re-test the teat piece to determine if the echoes can be eliminated

    (c) Use the reject control to eliminate unwanted echoes

    (d) Decrease the gain to see if the echoes can be eliminated

38. During immersion ultrasonic testing of pipe or tubing, spurious echoes may be caused by:

    (a) Dirt on the test piece

    (b) Grease on the test piece

    (c) Air bubbles on the test piece

    (d) All of the above

39. Typical frequencies which might be used to perform ultrasonic testing of concrete are:

    (a) 25 to 100 kHz

    (b) 200 to 5 MHz

    (c) 1 MHz to 5 MHz

    (d) 2.25 MHz to 10 MHz

40. Typical frequencies which might be used to perform ultrasonic testing of ferrous and non-ferrous welds are:

    (a) 25 to 100 kHz

    (b) 200 to 5 MHz

    (c) 1 MHz to 5 MHz

    (d) 2.25 MHz to 10 MHz

41. Which of the following materials would probably require testing at the lowest frequency?

    (a) Small grained mild steel

    (b) Mild steel castings

    (c) Mild steel forgings

    (d) Cast iron

42. Which of the following is an advantage of contact testing over immersion?

    (a) Ability to maintain uniform coupling on rough surface

    (b) Longer dead time near the front surface of the test piece

    (c) Ease of field use

    (d) Ability to continuously vary incident wave angle during test

43. Which of the following is a disadvantage of contact testing?

    (a) Ability to maintain uniform coupling on rough surface

    (b) Ease of field use

    (c) Greater penetrating power than immersion testing

    (d) Less penetrating power than immersion testing

44. A typical application for a through transmission technique is:

    (a) Flaw depth sizing

    (b) Flaw depth location

    (c) Thickness gauging

    (d) Bond/unbond testing

45. An ultrasonic technique in which two transducers are used, in a constant position relative to each other, is:

    (a) Through transmission

    (b) Contact testing

    (c) Pulse echo

    (d) Continuous wave

46. Which of the following cast materials could most likely be successfully ultrasonically tested?

    (a) Low carbon steel

    (b) Stainless steel

    (c) Iron

    (d) Pure lead

47. Which of the following product forms would probably be tested at the lowest frequency?

    (a) Forgings

    (b) Hot rolled plate

    (c) Castings

    (d) Extrusions

48. Addition of approximately 6% antimony as an alloying element could be expected to increase the ultrasonic inspectability of which of the following materials?

    (a) Low carbon steel

    (b) Stainless steel

    (c) Iron

    (d) Pure lead

49. Strong signals which travel across the horizontal time base of an A scan presentation while the transducer is motionless on the test piece are probably:

    (a) Randomly oriented flaws

    (b) Electrical interference

    (c) Grain noise

    (d) Loose wedge on transducer

50. Excessive ringing of the transducer could be caused by:

    (a) Electrical interference

    (b) Loose crystal

    (c) Test piece with large grain size

    (d) Test piece with small grain size

51. When inspecting a long bar with a longitudinal wave from one end, a series of additional echoes are seen immediately after the bottom surface reflection. these are most likely:

    (a) Refracted shear and longitudinal waves caused by beam spread

    (b) Flaw indications

    (c) Multiples of the back surface reflection

    (d) None of the above

52. One of the most apparent characteristics of a discontinuity echo, as opposed to a non-relevant indication is:

    (a) Lack of repeatability

    (b) Sharp, distinct signal

    (c) Stable position with fixed transducer position

    (d) High noise level

53. Typical immersion test frequencies for wrought aluminium are:

    (a) 10 MHz and up

    (b) 5 MHz and below

    (c) 500 MHz to 1 MHz

    (d) Above 25 MHz

54. Choice of ultrasonic test frequency depends upon which of the following?

    (a) Surface condition

    (b) Minimum size discontinuity to be detected

    (c) Level of grain noise

    (d) All of the above

55. Polished, flat surfaces are undesirable for ultrasonic testing consideration because:

    (a) Coupling losses are greater

    (b) Scan speeds tend to be too rapid

    (c) Spurious lamb waves are prevalent

    (d) The probe sticks to the surface because of suction

56. The most effective liquid ultrasonic couplant (highest acoustic impedance) is:

    (a) SAE 30 motor oil

    (b) Glycerine

    (c) Water

    (d) Grease

57. When using a straight beam technique to examine a thick test piece what change(s) would you expect to see in back wall echo size as you approach the side of the test piece? (Transducer remains completely on test piece)

    (a) No change

    (b) Increase

    (c) Decrease

    (d) Depends on material acoustic velocity

58. What useful purpose may be served by maintaining grass on the baseline?

    (a) To estimate casting grain size

    (b) To provide a reference for estimating signal to noise ratio

    (c) To verify adequate coupling to the test piece

    (d) All of the above

59. Which of the following describes the sound field propagating in a piece of steel bar stock which is being tested from one end with longitudinal waves?

    (a) Non uniform, containing maxima and minima because of the focusing effect of laterally reflected waves

    (b) Increasing to a peak, then decreasing throughout the far field

    (c) Uniformly decreasing along the length of the bar

    (d) Decreasing according to the inverse square law

60. When a probe is coupled to a solid, strong surface waves may be produced:

    (a) If a high frequency probe is used

    (b) If the probe has only incomplete contact with the surface

    (c) If the probe is large in diameter

    (d) None of the above

61. To avoid interfering surface waves, low frequencies should only be used on:

    (a) Polished surfaces

    (b) Castings

    (c) Flat surfaces

    (d) Non-polished surfaces

62. Which of the following conditions would be most likely to cause strong, interfering surface waves?

    (a) High frequency transducers

    (b) Testing on a small diameter surface

    (c) Testing on a flat surface

    (d) Testing on a curved surface with a contoured wedge and transducer

63. Flaw sizing by the 6 dB drop technique is applicable to:

    (a) Large flaws relative to the sound beam

    (b) Small flaws relative to the sound beam

    (c) Any flaws

    (d) None of the above

64. How many decibels of attenuation correspond to an ultrasonic signal loss of from 100% to 25% on full screen height?

    (a) 6

    (b) 10

    (c) 12

    (d) 14

65. An increase in gain of how many decibels corresponds to a 5:1 increase in flaw echo amplitude?

    (a) 10

    (b) 14

    (c) 6

    (d) 20

66. A focused sound beam is produced by a:

(a) Convex mirror

(b) Concave transducer

(c) Convex lens

(d) None of the above

67. A divergent sound beam is produced by:

(a) Concave mirror

(b) Convex mirror

(c) Convex lens

(d) None of the above

68. A type of cast iron which has ultrasonic properties similar to steel is:

(a) White

(b) Gray

(c) Lamellar

(d) Ductile

69. What effect does hardening have on acoustic velocity in steel?

(a) Increases

(b) Decreases

(c) No effect

(d) Any of the above

70. Variation in acoustic velocity from one type of steel to another is usually less than:

(a) 1%

(b) 2%

(c) 5%

(d) 10%

71. In general, which of the following materials would have the least ultrasonic attenuation?

    (a) Aluminium

    (b) Silver

    (c) Lead

    (d) Tungsten

72. The velocity of lamb waves depends on:

    (a) Elastic constants of test material

    (b) Plate thickness

    (c) Frequency

    (d) All of the above

73. Which of the following is the most durable piezoelectric material?

    (a) Barium titanate

    (b) Quartz

    (c) Dipotassoium tartrate

    (d) Rochelle salt

74. Which of the following methods are used to produce ultrasonic waves?

    (a) Magnetostrictive methods

    (b) Magnetoinductive methods

    (c) Piezoelectric elements

    (d) All of the above

75. Spurious indications may be caused by which of the following?

    (a) Test piece edges

    (b) Mode conversions

    (c) Multiple reflections from a single interface

    (d) All of the above

76. A reason for using a dual element search unit is:

(a) Improving near surface resolution

(b) Improving penetration

(c) Eliminating wear on the crystal faces

(d) None of the above

77. A wheel transducer is normally considered:

(a) A contact method

(b) A dynamic scanning method

(c) An immersion method

(d) A static scanning method

78. Which of the following is not an advantage of a focused transducer?

(a) High sensitivity to small flaws

(b) Deep penetration

(c) High resolving power

(d) Not much affected by surface roughness

79. What type of search unit allows the greatest resolving power with standard ultrasonic testing equipment?

(a) Delay tip

(b) Focused

(c) Highly damped

(d) High Q

80. The 50 mm diameter hole in an IIW block is used to:

(a) Determine the beam index point

(b) Check resolution

(c) Calibrate angle beam distance

(d) Check beam angle

81. The 100 mm radius in an IIW block is used to:

    (a) Calibrate sensitivity level

    (b) Check resolution

    (c) Calibrate angle beam distance

    (d) Check beam angle

82. Which of the following is a disadvantage of immersion test units?

    (a) Inspection speed

    (b) Ease of controlling sound beam direction

    (c) Portability

    (d) Application to automatic scanning techniques

4.2.2 Ultrasonic Testing Level 2 (UT-2) Specific Examination

1. Which of the following may result in a long narrow rod if the beam divergence results in a reflection from a side of the test piece before the sound wave reaches the back surface?

    (a) Multiple indications before the first back reflection

    (b) Indications from multiple surface reflections

    (c) Conversion from the longitudinal mode to shear mode

    (d) Loss of front surface indications

2. Acoustic energy propagates in different modes. Which of the following represent a mode?

    (a) Longitudinal wave

    (b) Shear wave

    (c) Surface wave

    (d) All of the above

3. Which of the following would be considered application(s) of ultrasonic testing?

    (a) Determination of a material's elastic modulus

    (b) Study of a material's metallurgical structure

    (c) Measurement of a material's thickness

    (d) All of the above

4. Waves whose particle displacement is parallel to the direction of propagation are called:

    (a) Longitudinal waves

    (b) Shear waves

    (c) Lamb waves

    (d) Rayleigh waves

5. Sound waves with particle displacement transverse to the direction of wave travel are known as:

    (a) Longitudinal waves

    (b) Shear waves

    (c) Rayleigh waves

    (d) Plate waves

6. The only sound waves which travel in liquids are:

    (a) Longitudinal waves

    (b) Shear waves

    (c) Rayleigh waves

    (d) Plate waves

7. In steel, the velocity of sound is greatest in which of the following modes of vibration?

    (a) Longitudinal

    (b) Shear

    (c) Surface wave

    (d) Sound velocity is identical in all modes, in a given material

8. The scattering of the rays of an ultrasonic beam due to reflection from a highly irregular surface is called:

    (a) Angulation

    (b) Dispersion

    (c) Refraction

    (d) Diffraction

9. Acoustic impedance is a material's:

    (a) (Density)/(velocity)

    (b) (Density) × (velocity)

    (c) Refractive index

    (d) (Density)/(refractive index)

10. When a sound beam is incident on an acoustic interface at some angle other than normal incidence, which of the following occurs?

    (a) Reflection

    (b) Refraction

    (c) Mode conversion

    (d) All of the above

11. The angle formed by an ultrasonic wave as it enters a medium of different velocity than the one from which it came and a line drawn perpendicular to the interface between the two media is called:

    (a) The angle of incidence

    (b) The angle of refraction

    (c) The angle of diffraction

    (d) The angle of reflection

12. Which of the following frequencies would probably result in the greatest ultrasonic attenuation losses?

    (a) 1 MHz

    (b) 2.25 MHz

    (c) 10 MHz

    (d) 25 MHz

13. Attenuation is made up of:

    (a) Diffusion and absorption

    (b) Scatter and reflection

    (c) Absorption and scatter

    (d) Reflection at grain boundaries

14. The most important factor required for the proper interpretation of ultrasonic test results is:

    (a) The ultrasonic signal amplitude

    (b) A knowledge of the test specimen material and its construction

    (c) A knowledge of the ultrasonic instruments operating characteristics

    (d) The ultrasonic signal location

15. A significant limitation of a lower frequency, single element transducer is:

    (a) Scatter of sound beam due to microstructure of test object

    (b) Increased grain noise or ‘hash’

    (c) Less beam spread

    (d) Impaired ability to display discontinuities just below the entry surface

16. Which of the following is the least efficient generator of ultrasonic waves:

    (a) Quartz

    (b) Lithium sulphate

    (c) Lead metaniobate

    (d) Barium titanate

17. Which of the following is the least efficient receiver of ultrasonic Energy?

    (a) Quartz

    (b) Lithium sulphate

    (c) Lead metaniobate

    (d) Barium titanate

18. The length of the zone adjacent to a transducer in which fluctuations in sound pressure occur is mostly affected by:

    (a) The frequency of the transducer

    (b) The diameter of the transducer

    (c) The length of transducer cable

    (d) Both (a) and (b)

19. An advantage of using a transducer with a large beam spread is:

    (a) Higher sensitivity to small discontinuities

    (b) Less likelihood of spurious echoes

    (c) Greater likelihood of spurious echoes

    (d) Greater likelihood of detecting randomly oriented discontinuities

20. Resolution is inversely proportional to:

    (a) Wavelength

    (b) Crystal thickness

    (c) Bandwidth

    (d) Mechanical losses

21. Of the piezoelectric materials listed below, the most efficient sound transmitter is:

    (a) Lithium sulphate

    (b) Quartz

    (c) Barium titanate

    (d) Silver oxide

22. Other factors being equal, which of the following transducers would have the greatest beam spread?

    (a) A larger diameter transducer

    (b) A smaller diameter transducer

    (c) A higher frequency transducer

    (d) None of the above has any effect

23. The fundamental frequency of a piezoelectric crystal is primarily a function of:

    (a) The length of the applied voltage pulse

    (b) The amplifying characteristics of the pulse amplifier in the instrument

    (c) The thickness of the crystal

    (d) None of the above

24. In which zone does the amplitude of an indication from a given discontinuity diminish exponentially as the distance increases?

    (a) Far field zone

    (b) Near field zone

    (c) Dead zone

    (d) Fresnel zone

25. A typical application for a through transmission technique is:

    (a) Flaw depth sizing

    (b) Flaw depth location

    (c) Thickness measuring

    (d) Bond/lack of bond testing

26. An advantage of a dual crystal search unit is that:

    (a) There is no ‘dead zone’

    (b) There is no near surface resolution

    (c) There is no near field

    (d) All of the above are true

27. Most contact testing is performed by which of the following techniques?

    (a) Through transmission

    (b) Pitch-catch

    (c) Pulse-echo

    (d) Continuous wave

28. When contouring an angle beam wedge for a convex surface, an undesirable result of a wedge which is contoured too well might be:

    (a) Production of unwanted surface waves

    (b) Greater beam divergence due to larger contact area

    (c) Lower beam divergence due to larger contact area

    (d) Overly efficient coupling of sound beam into test part

29. It is possible for a discontinuity smaller than the transducer to produce indications of fluctuating amplitude as the search unit is moved laterally if testing is being performed in the:

    (a) Fraunhofer zone

    (b) Near field

    (c) Snell field

    (d) Shadow zone

30. A smooth flat discontinuity whose major plane is not perpendicular to the direction of sound propagation may be indicated by:

    (a) An echo amplitude comparable in magnitude to the back surface reflection

    (b) A complete loss of back surface reflection

    (c) An echo amplitude larger in magnitude than the back surface reflection

    (d) All of the above

31. An effective method of testing for air bubbles in a pipe is to:

    (a) Measure pipe back wall echo amplitude

    (b) Analyze the frequency spectrum of pipe back wall echo

    (c) Transmit sound across pipe diameter and look for echo loss

    (d) Transmit sound across pipe diameter and look for echoes from air bubbles

32. The ultrasonic test method in which finger damping is most effective in locating a discontinuity is:

    (a) Shear wave

    (b) Longitudinal wave

    (c) Surface wave

    (d) Compression wave

33. Inspection of castings is often impractical because of:

    (a) Extremely small grain structure

    (b) Coarse grain structure

    (c) Uniform flow lines

    (d) Uniform velocity of sound

34. One of the most common applications of ultrasonic tests employing shear waves is the:

    (a) Detection of discontinuities in welds, tube and pipe

    (b) Determination of elastic properties of metallic products

    (c) Detection of laminar discontinuities in heavy plate

    (d) Measurement of thickness of thin plate

35. The 2 mm wide notch in the IIW block is used to:

    (a) Determine beam index point

    (b) Check resolution

    (c) Calibrate angle beam distance

    (d) Check beam angle

36. A primary purpose of a reference standard is:

    (a) To provide a guide for adjusting instrument controls to reveal discontinuities that are considered harmful to the end use of the product

    (b) To give the technician a tool for determining exact discontinuity size

    (c) To provide assurance that all discontinuities smaller than a certain specified reference reflector are capable of being detected by the test

    (d) To provide a standard reflector which exactly simulates natural discontinuities of a critical size

37. Laminations would most likely be encountered in which of the following product forms?

    (a) Forgings

    (b) Hot rolled plate

    (c) Castings

    (d) Welds

38. A 50 percent decrease in echo amplitude is equal to a loss of how many decibels?

    (a) 2

    (b) 6

    (c) 10

    (d) 14

39. Typical frequencies which might be used to perform ultrasonic testing of concrete are:

    (a) 25 to 100 kHz

    (b) 200 kHz to 5 MHz

    (c) 1 MHz to 5 MHz

    (d) 2.25 MHz to 10 MHz

40. Compared to the echo returned from a smooth reflector, the echo returned from a natural flaw of the same area and orientation is:

    (a) The same

    (b) Greater

    (c) Smaller

    (d) Not related to

41. Which of the following is least likely to be a source of false indications?

    (a) Discontinuities oriented at an angle to the entry surface

    (b) Contoured surfaces

    (c) Edge effects

    (d) Surface condition

42. Abnormally large grain size in the test material may be indicated by:

    (a) High levels of baseline noise, or hash

    (b) High amplitude reflections between front and back surface echoes

    (c) High amplitude, spurious echoes which are not repeatable

    (d) Abnormally high back surface echo

43. The coated inside surface of the large end of a cathode ray tube which becomes luminous when struck by an electron beam is called:

    (a) An electron gun

    (b) An electron amplifier

    (c) A CRT screen

    (d) An electron counter

44. In a basic pulse-echo ultrasonic instrument, the component that produces the time base line is called a:

    (a) Sweep circuit

    (b) Receiver

    (c) Pulser

    (d) Synchroniser

45. Gas discontinuities are reduced to flat discs or other shapes parallel to the surface by:

    (a) Rolling

    (b) Machining

    (c) Casting

    (d) Welding

46. Reflection indications from a weld area being inspection by the angle beam technique may represent:

    (a) Porosity

    (b) Cracks

    (c) Weld bead

    (d) All of the above