FUNDAMENTAL MANUFACTURING PROCESSES

Mechanical & Non-Destructive Testing

SCENE 1.

MND01A, CGS: FBI warning

white text centered on black to blue

SCENE 2.

MND02A, CGS: disclaimer

white text centered on black to blue

gradient

SCENE 3.

MND03A, CGS: MMR/SME screen

white text centered on black to blue

gradient

SCENE 4.

MND04A, SME logo open, with music

SCENE 5.

MND05A, FMP open, with music

MND05B, peter carey narration

MND05C, blue background

room tone, audio only

WARNING

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Society of Manufacturing Engineers

Always read the operating manual and safety

information provided by the manufacturer

before operating any mechanical or

non-destructive testing equipment.

Make sure all machine guards are in place,

and follow all safety procedures when working with or near mechanical or

non-destructive testing equipment.

This program was produced using the technical

resources of the Machining & Material Removal

Community of SME.

For more information on mechanical &

non-destructive testing,

please visit our website at:

www.sme.org

MUSIC UP AND UNDER

NARRATION (VO):

MND05D, tape MND14, 14:23:00-14:24:00 THE FUNDAMENTAL MANUFACTURING PROCESSES VIDEO

SERIES, EXAMINING THE TOOLS AND TECHNIQUES OF

PRECISION MANUFACTURING.

SCENE 6.

MND06A, CGS: Mechanical & Non-Destructive Testing white text centered on black

SCENE 7.

MND07A, tape MND01, 01:02:52-01:03:02
metal material being hardness tested
MND07B, tape 670, 02:12:43-02:12:58
metal part design on screen
MND07C, tape 451, 18:17:03-18:17:33
zoom out, casting metal flowing into
mold, up in risers

SCENE 8.

MND08A, tape 114, 01:18:22-01:18:38 produced bolts coming off of conveyor MND08B, tape MND15, 15:34:01-15:34:20 zoom out, bolt being tested MND08C, tape MND01, 01:39:50-01:39:59 bolt being hardness tested

SCENE 9.

MND09A, tape MND15, 15:13:45-15:14:04
bolt being sheared
MND09B, tape MND06, 06:54:17-06:54:25
c.u., shear tensile test
MND09C, tape MND04, 04:43:50-04:44:11
zoom in, magnetic particle part
viewed under black light
MND09D, CGS: Mechanical Testing
Non-Destructive Testing

NARRATION (VO):

THIS PROGRAM EXPLORES THE FUNDAMENTAL METHODS

OF MECHANICAL AND NON-DESTRUCTIVE TESTING.

NARRATION (VO):

BEFORE BEING MANUFACTURED, MANY MATERIAL...,
PRODUCT DESIGN...,

AND PRODUCTION DECISIONS ARE MADE TO ENSURE

THAT A PART IS PRODUCED WITHOUT DEFECTS THAT

COULD LEAD TO POOR PERFORMANCE ISSUES OR

PREMATURE PART FAILURE.

NARRATION (VO):

ONCE A PART IS PRODUCED, IT'S COMMONLY TESTED

TO EVALUATE PRODUCT QUALITY AND TO IDENTIFY

THE EXISTENCE, OR VERIFY THE ABSENCE, OF ANY

PERFORMANCE-IMPAIRING FLAWS. THIS ENSURES THAT

PARTS MEET RELEVANT CODE AND SPECIFICATION

REQUIREMENTS.

NARRATION (VO):

THERE ARE A VARIETY OF TESTS USED TO GAGE THE QUALITY OF MATERIALS AND PARTS THROUGHOUT THE MANUFACTURING PROCESS. THESE TESTS ARE GROUPED INTO TWO MAJOR CATEGORIES:

MECHANICAL TESTING,

AND NON-DESTRUCTIVE TESTING.

THIS PROGRAM FOCUSES ON THE PRINCIPAL METHODS AND TYPES OF TESTS IN THESE CATEGORIES.

SCENE 10.

MND10A, CGS: Mechanical Testing white text centered on black

SCENE 11.

MND11A, peter carey narration

wide, impact test

MND11C, tape 397, 01:18:08-01:18:21

plastic tensile test

SCENE 12.

MND12A, tape MND06, 06:08:00-06:08:12 zoom out, shear specimen

MND12B, tape MND05, 05:12:13-05:12:22 zoom out, specimen for impact test

MND12C, tape MND14, 14:25:36-14:26:00 zoom out, working with sheet metal

specimens

SCENE 13.

MND13A, tape MND07, 07:30:15-07:30:29 zoom in, testing at room temperature MND13B, tape MND07, 07:26:30-07:26:43

zoom in, testing at elevated temperature

MND13C, tape MND05, 05:02:03-05:02:10 zoom out, cold part ready for impact test

SCENE 14.

 $\mbox{\bf MND14A, 'astm' standards page 01}$

MND14B, 'astm' standards page 02

MND14C, 'astm' standards page 03

MND14D, scroll down, 'ansi' website

NARRATION (VO):

MND11B, tape MND14, 14:21:01-14:21:21 MECHANICAL TESTING, WHICH IS ALSO KNOWN AS DESTRUCTIVE TESTING, IS USED TO GATHER SPECIFIC PERFORMANCE OR PROPERTY VALUES OF MATERIALS FOR PART DESIGN PURPOSES AND QUALITY CONTROL. THIS IS DONE BY FORCING MATERIALS TO FAIL USING VARIOUS TESTING LOAD APPLICATIONS.

NARRATION (VO):

THE MATERIAL PROPERTY EVALUATED IS BASED ON TESTING SPECIMENS OR SAMPLES WITH RESPECT TO THE SPECIFIC TYPE OF MECHANICAL TEST BEING ADMINISTERED. ALTHOUGH SPECIMEN CONFIGURATIONS HAVE BEEN STANDARDIZED FOR PARTICULAR TESTS, THEIR SIZE AND DESIGN MAY VARY DEPENDING ON THE TEST AND MATERIAL.

NARRATION (VO):

MECHANICAL TESTS ARE TYPICALLY PERFORMED AT

ROOM-TEMPERATURE...,

BUT MAY ALSO BE DONE AT AN ELEVATED

TEMPERATURE...,

OR AT LOW-TEMPERATURE.

NARRATION (VO):

TEST SPECIFICATIONS OF THE AMERICAN SOCIETY FOR TESTING AND MATERIALS, OR 'ASTM', HAVE BEEN WIDELY ACCEPTED AS INDUSTRY STANDARDS AND

MANY HAVE BEEN ADOPTED BY THE AMERICAN NATIONAL STANDARDS INSTITUTE, OR 'ANSI'.

SCENE 15.

tensile testing

MND15A, tape MND07, 07:35:11-07:35:29 zoom in, hardness testing MND15B, tape MND05, 05:19:00-05:19:16 NARRATION (VO):

MECHANICAL TESTING PERTAINS MAINLY TO TESTING MATERIALS FOR PROPERTIES SUCH AS THEIR HARDNESS, STRENGTH, AND IMPACT TOUGHNESS, AND FOR TESTING MATERIALS IN VARIOUS MODES OF LOAD APPLICATION, SUCH AS TENSION, OR COMPRESSION.

--- TOUCH BLACK ---

SCENE 16.

MND16A, tape MND14, 14:24:19-14:24:52 zoom out, hardness testing

NARRATION (VO):

HARDNESS IS A MATERIAL'S RESISTANCE TO INDENTATION AND ALSO PERTAINS TO A MATERIAL'S RESISTANCE TO SCRATCHING OR ABRASION.

SCENE 17.

continue previous shot

MND17A, CGS: Brinell Hardness Test Rockwell Hardness Test NARRATION (VO):

MATERIAL HARDNESS CAN BE DETERMINED USING A VARIETY OF HARDNESS TESTS, WITH THE TWO MOST COMMON BEING:

THE BRINELL HARDNESS TEST, AND THE ROCKWELL HARDNESS TEST.

--- TOUCH BLACK ---

SCENE 18.

MND18A, CGS: Brinell Hardness Test c.u., brinell test, ball indenting specimen

NARRATION (VO):

MND18B, tape MND02, 02:06:08-02:07:02 IN THE BRINELL HARDNESS TEST, A KNOWN LOAD IS APPLIED FOR A GIVEN PERIOD OF TIME TO A SPECIMEN SURFACE USING A HARDENED STEEL OR TUNGSTEN-CARBIDE BALL, CAUSING A PERMANENT

INDENTATION. STANDARD BALL DIAMETER IS 10 MILLIMETERS, OR APPROXIMATELY FOUR-TENTHS OF AN INCH.

SCENE 19.

MND20A, tape MND01, 01:44:02-01:44:31 zoom out, microscope used to read brinell specimen

NARRATION (VO):

THE DIAMETER OF THE RESULTING PERMANENT INDENTATION IS THEN MEASURED AND CONVERTED TO A BRINELL HARDNESS NUMBER. CONVERSION IS TYPICALLY DONE USING STANDARD TABLES SUPPLIED WITH THE TEST, BUT MAY ALSO BE CALCULATED MATHEMATICALLY.

SCENE 20.

MND20B, tape MND01, 01:44:58-01:45:28 c.u., microscope readout MND20C, tape MND01, 01:49:17-01:49:36 zoom out, using microscope

NARRATION (VO):

A MICROSCOPE ESPECIALLY DESIGNED FOR THE BRINELL HARDNESS TEST IS GENERALLY USED FOR DIAMETER-INDENTATION MEASUREMENTS. THIS MICROSCOPE PERMITS MEASUREMENT ESTIMATES AS MINUTE AS TWO HUNDREDTHS OF A MILLIMETER OR EIGHT TEN THOUSANDTHS OF AN INCH.

SCENE 21.

MND21A, tape MND02, 02:04:59-02:05:31 zoom in, brinell test

NARRATION (VO):

TO PERFORM A BRINELL HARDNESS TEST, SPECIMEN THICKNESS SHOULD USUALLY BE AT LEAST TEN TIMES INDENTATION DEPTH.

--- TOUCH BLACK ---

SCENE 22.

MND22A, CGS: Rockwell Hardness Test zoom out, rockwell harness test

NARRATION (VO):

MND22B, tape MND03, 04:05:21-04:05:51 THE ROCKWELL HARDNESS TEST INVOLVES THE USE OF AN INDENTOR FOR PENETRATING THE SURFACE OF A MATERIAL FIRST BY APPLYING A MINOR, OR INITIAL LOAD, AND THEN APPLYING A MAJOR, OR FINAL LOAD

UNDER SPECIFIC CONDITIONS. THE DIFFERENCE BETWEEN THE MINOR AND MAJOR PENETRATION DEPTHS IS THEN NOTED AS A HARDNESS VALUE DIRECTLY FROM A DIAL OR DIGITAL READOUT. THE HARDER THE MATERIAL THE HIGHER THE NUMBER.

SCENE 23.

MND23A, tape MND01, 01:30:50-01:30:58 zoom out, rockwell harness test MND23B, tape MND01, 01:34:49-01:34:59 major load being changed

MND23C, tape MND01, 01:38:22-01:38:40 zoom out, rockwell hardened steel ball

rockwell spheroconical diamond

SCENE 24.

MND24A, tape MND03, 04:02:14-04:02:39 zoom in, rockwell hardness test

SCENE 25.

MND25A, tape MND01, 01:38:46-01:39:18 zoom out, rockwell 'b' scale being used

NARRATION (VO):

THE MINOR LOAD APPLIED IS ALWAYS 10 KILOGRAMS, AND THE MAJOR LOAD MAY BE 60, 100 OR 150 KILOGRAMS. THE MOST COMMON INDENTERS ARE MND23D, tape MND01, 01:30:14-01:30:35 EITHER A SMALL ONE-SIXTEENTH INCH HARDENED STEEL BALL..., OR A SPHEROCONICAL DIAMOND, WHICH IS ALSO

REFERRED TO AS A BRALE INDENTER.

NARRATION (VO):

DEPENDING ON THE TYPE OF MATERIAL TO BE TESTED, THERE ARE A VARIETY OF ALTERNATIVE ROCKWELL SCALES, WITH TWO OF THE MOST COMMONLY USED BEING THE 'B' AND THE 'C' SCALES.

NARRATION (VO):

THE 'B' SCALE IS USED FOR DETERMINING THE HARDNESS OF SOFTER MATERIALS SUCH AS ALUMINUM, BRASS AND SOFT STEELS. THE HARDENED STEEL BALL INDENTOR IS USED ALONG WITH A 100 KILOGRAM MAJOR LOAD TO OBTAIN A VALUE EXPRESSED AS 'HARDNESS R-B' NUMBERS.

SCENE 26.

MND26A, tape MND01, 01:33:58-01:34:17 zoom in, rockwell 'c' scale being used

NARRATION (VO):

THE 'C' SCALE IS USED ON HARDER MATERIALS. IT

USES THE BRALE INDENTER AND A 150 KILOGRAM MAJOR LOAD. THE OBTAINED 'C' SCALE VALUE IS EXPRESSED AS 'HARDNESS R-C' NUMBERS.

SCENE 27.

MND27A, tape MND01, 01:31:08-01:31:23 zoom out, rockwell test with digital readout screen

NARRATION (VO):

THE PRIMARY ADVANTAGE OF THE ROCKWELL HARDNESS

TEST IS ITS ABILITY TO DISPLAY A HARDNESS

VALUE DIRECTLY WITHOUT RESORTING TO CUMBERSOME

MATHEMATICAL CALCULATION.

--- TOUCH BLACK ---

SCENE 28.

MND28A, tape MND16, 16:37:44-16:38:08
zoom out, tensile testing of rubber
MND28B, CGS: Metal

Plastic Rubber Wood

MND28C, tape MND03, 03:41:00-03:41:53 zoom out, compression testing

MND28D, CGS: Tension/Tensile

Compression Impact

Fracture Toughness

Fatigue Creep NARRATION (VO):

MAJOR CLASSES OF MATERIALS, SUCH AS METAL,

PLASTIC, RUBBER AND WOOD ARE OFTEN ASSOCIATED

WITH SPECIFIC PROPERTIES. THE VALUES RELATED

TO THESE PROPERTIES ARE DETERMINED USING A

VAST ARRAY OF MECHANICAL TESTS, WITH THOSE

FEATURED IN THIS PROGRAM INCLUDING:

TENSION, OR TENSILE,

COMPRESSION,

IMPACT,

FRACTURE TOUGHNESS,

FATIGUE,

AND CREEP.

--- TOUCH BLACK ---

SCENE 29.

MND29A, CGS: Tensile Tests

MND29B, tape MND07, 07:05:00-07:05:12 specimen failing during tensile test MND29C, tape MND15, 15:48:12-15:48:25 zoom in, specimen with extensometer

MND30A, tape MND03, 03:23:56-03:24:10

NARRATION (VO):

TENSILE TESTS PERTAIN TO THE APPLIED LOAD
BEING PERPENDICULAR TO THE CROSS-SECTIONAL

AREA OF THE MATERIAL SUPPORTING THE LOAD.

zoom out, stress strain diagram

EXTENSOMETERS, OR STRAIN GAGES, ATTACHED TO THE SPECIMEN PERMIT DETERMINING ELONGATION DURING THE TEST AND AFTER SPECIMEN FAILURE. DATA OF APPLIED LOAD AND CORRESPONDING ELONGATION PERMIT CONSTRUCTION OF STRESS-STRAIN DIAGRAMS.

SCENE 30.

MND29D, tape MND14, 14:29:52-14:30:25 diagram

MND30B, CGS: Yield Strength Ultimate Tensile Strength

Elongation

Reduction-In-Area

NARRATION (VO):

wide, tensile test with stress strain FROM THESE DIAGRAMS, MATERIAL PROPERTIES SUCH AS YIELD STRENGTH, ULTIMATE TENSILE STRENGTH, ELONGATION AND REDUCTION-IN-AREA ARE

DETERMINED.

SCENE 31.

MND31A, CGS: Yield Strength

MND31B, tape MND15, 15:52:53-15:53:40 YIELD STRENGTH IS THE STRESS REQUIRED TO

zoom in, specimen elongating

NARRATION (VO):

PERMANENTLY ELONGATE, OR DEFORM, A MATERIAL A SPECIFIC AMOUNT, COMMONLY 0.2% OF TOTAL

SCENE 32.

MND32A, CGS: Ultimate Tensile

Strength

MND32B, tape MND15, 15:53:40-15:53:52

specimen elongating and breaking

NARRATION (VO):

ELONGATION.

ULTIMATE TENSILE STRENGTH IS THE MAXIMUM STRESS A MATERIAL CAN WITHSTAND JUST PRIOR TO

FRACTURING.

SCENE 33.

MND33A, tape MND15, 15:41:12-15:41:40 zoom out, tensile test, specimen

breaking

MND33B, CGS: Elongation

MND33D, CGS: Reduction-In-Area

MND33E, tape MND15, 15:42:59-15:43:16 SPECIMEN. REDUCTION IN AREA IS THE PERCENT

zoom out, measuring reduction-in-area MND33F, tape MND15, 15:42:26-15:42:38 DECREASE IN CROSS-SECTIONAL AREA AT THE

alternate shot, checking elongation

NARRATION (VO):

ELONGATION IS THE PERCENT INCREASE IN ORIGINAL

GAGE LENGTH AS DETERMINED FROM THE FRACTURED

FRACTURE. BOTH VALUES ARE MEASURES OF THE

MATERIAL'S DUCTILITY.

SCENE 34.

MND34A, CGS: Yield Strength Ultimate Tensile

> Strength Elongation

Reduction-In-Area

MND34B, tape MND15, 15:22:22-15:22:34

placing specimen in machine for

compression testing

SCENE 35.

MND35A, CGS: Compression Testing compression test

SCENE 36.

MND36A, tape MND15, 15:25:33-15:25:44 wide, part loaded to universal testing machine

c.u. strain gage attached to specimen strain gage removed, freeze last frame if necessary

NARRATION (VO):

THESE PROPERTIES, AS WELL AS OTHERS, PERTAIN TO VARIOUS LOAD-APPLICATION MODES.

--- TOUCH BLACK ---

NARRATION (VO):

MND35B, tape MND03, 03:42:04-03:42:16 COMPRESSION TESTING IS USED TO DETERMINE THE PROPERTIES OF MATERIALS UNDER COMPRESSION.

NARRATION (VO):

IN THE TEST, A SPECIMEN IS LOADED IN BETWEEN MND36B, tape MND15, 15:22:42-15:23:17 THE PLATENS OF A UNIVERSAL TESTING MACHINE. A MND36C, tape MND15, 15:25:02-15:25:13 STRAIN GAGE IS ATTACHED TO THE SPECIMEN AND A COMPRESSIVE LOAD APPLIED. ONCE THE LOADING REACHES A POINT JUST ABOVE THE LOAD CORRESPONDING TO THE YIELD STRENGTH OF THE MATERIAL, THE STRAIN GAGE IS REMOVED. THE LOADING IS THEN DISCONTINUED, UNLESS IT IS SPECIFIED TO LOAD THE SPECIMEN TO FAILURE.

--- TOUCH BLACK ---

SCENE 37.

MND37A, CGS: Impact Tests

wide, specimen set up for fracture

c.u. specimen set up

MND37D, tape MND15, 15:44:43-15:44:53

wide, pendulum released, reset after fracture

MND37E, tape MND05, 05:05:53-05:06:01 pendulum impact testing

MND37F, tape MND14, 14:36:19-14:36:30 zoom out, drop weight impact test

NARRATION (VO):

MND37B, tape MND15, 15:44:37-15:44:41 IMPACT TESTS ARE USED TO TEST A MATERIAL'S MND37C, tape MND15, 15:44:15-15:44:23 ABILITY TO RESIST SHOCK LOADING OR IMPACT BY DETERMINING THE ENERGY ABSORBED IN FRACTURING A PREPARED SPECIMEN AT HIGH VELOCITY. THERE ARE TWO BASIC TYPES OF IMPACT TESTS, PENDULUM...,

AND DROP WEIGHT.

SCENE 38.

MND38A, tape MND05, 05:08:27-05:08:44 zoom out, charpy impact test MND38B, CGS: Charpy Notched-Bar Impact Test Izod Notched-Bar Impact Test

SCENE 39.

MND39A, CGS: Charpy Notched-Bar Impact Test

MND39B, tape MND03, 03:03:59-03:04:11 wide, specimen set up for fracture MND39C, tape MND03, 03:10:17-03:10:28 c.u. specimen set up and fractured MND39D, tape MND03, 03:04:06-03:04:19 wide, pendulum reset after fracture MND39E, tape MND03, 03:04:40-03:04:49 zoom out, impact reading

SCENE 40.

MND40A, CGS: Izod Notched-Bar Impact Test

MND40B, tape MND16, 16:23:39-16:24:06 izod specimen supported, broken by blow from pendulum

SCENE 41.

MND41A, tape MND16, 16:22:52-16:23:15 c.u., specimen placed in izod machine for impact, fractured

MND41B, tape MND16, 16:02:53-16:03:08 c.u., specimen placed in charpy machine for impact, fractured MND41C, CGS: Izod Hammer Design izod hammer

MND41E, CGS: Charpy Hammer Design MND41F, tape MND03, 03:05:49-03:05:59 zoom out, charpy hammer

SCENE 42.

MND42A, CGS: Drop-Weight Impact Tests MND42B, tape MND16, 16:28:44-16:28:57 IN DROP-WEIGHT IMPACT TESTS, A KNOWN WEIGHT IS wide, drop impact test

NARRATION (VO):

THE MOST COMMON PENDULUM-TYPE IMPACT TESTS INCLUDE THE CHARPY NOTCHED-BAR IMPACT TEST, AND THE IZOD NOTCHED-BAR IMPACT TEST.

NARRATION (VO):

IN THE CHARPY NOTCHED-BAR IMPACT TEST, THE PREPARED SPECIMEN IS SUPPORTED AS A SIMPLE BEAM AND FRACTURED IN ONE BLOW DELIVERED BY A PENDULUM MIDWAY BETWEEN THE SUPPORTING ANVILS ON THE SIDE OPPOSITE THE NOTCH. THE ENERGY ABSORBED IS READ DIRECTLY FROM A SCALE.

NARRATION (VO):

IN THE IZOD NOTCHED-BAR IMPACT TEST, THE SPECIMEN IS SUPPORTED AS A CANTILEVER BEAM, WITH THE NOTCH ROOT IN LINE WITH THE VISE EDGE IN WHICH IT IS CLAMPED. IT IS BROKEN IN ONE BLOW DELIVERED BY PENDULUM TO THE NOTCHED FACE AT A SPECIFIED DISTANCE ABOVE THE VISE.

NARRATION (VO):

THE GENERAL FEATURES OF THE IZOD NOTCHED-BAR IMPACT MACHINE ARE THE SAME AS THOSE OF THE CHARPY NOTCHED-BAR IMPACT MACHINE. THE CHIEF MND41D, tape MND16, 16:19:45-16:19:55 DIFFERENCES ARE IN THE METHOD IN WHICH THE SPECIMEN IS HELD,

AND IN THE PENDULUM HAMMER DESIGN.

DROPPED FROM A KNOWN DISTANCE IMPACTING A SPECIMEN THAT HAS BEEN SECURED.

SCENE 43.

MND43A, tape MND16, 16:15:55-16:16:08 c.u., drop weight impact testing of plastic film

wide, plastic container impact tested MND43C, tape MND16, 16:31:25-16:31:40 impact testing of hard plastic, plastic shattering

MND43D, tape MND16, 16:11:55-16:12:05 impact testing of hard plastic, plastic shattering

impact testing of soft plastic

MND43F, tape MND16, 16:15:32-16:15:49 c.u. impact testing of plastic part with crack initiation, freeze last frame if necessary

NARRATION (VO):

DROP-WEIGHT IMPACT TESTS HAVE NUMEROUS MND43B, tape MND16, 16:14:40-16:14:52 ADVANTAGES OVER OTHER IMPACT-TESTING METHODS INCLUDING:

ITS USE WITH MOLDED PLASTIC PARTS AND SAMPLES, THE IMPACT IS UNIDIRECTIONAL WITH NO MND43E, tape MND16, 16:34:14-16:34:24 PREFERENTIAL DIRECTION FOR FAILURE. FAILURE ORIGINATES AT THE WEAKEST POINT AND PROPAGATES FROM THAT POINT,

> AND SAMPLES DON'T NEED TO SHATTER TO BE CONSIDERED FAILURES. DEPENDING ON REQUIREMENTS, FAILURE USING DROP-WEIGHT IMPACT TESTS CAN BE DEFINED BY DEFORMATION, CRACK INITIATION, OR COMPLETE FAILURE.

> > --- TOUCH BLACK ---

SCENE 44.

MND44A, CGS: Fracture-Toughness Testing

MND44B, tape MND06, 06:13:54-06:14:11 zoom out, fracture toughness test MND44C, tape MND06, 06:04:39-06:05:06 fracture toughness test

NARRATION (VO):

FRACTURE-TOUGHNESS TESTING MEASURES A MATERIAL'S RESISTANCE TO BRITTLE FRACTURE AND CAN BE QUANTIFIED BY LINEAR ELASTIC FRACTURE MECHANICS. THIS APPROACH IS BASED ON THE ASSUMPTION AND EXPERIENCE THAT CRACKS OR MATERIAL FLAWS EXIST AND GROW WHEN THE INTENSITY OF THE STRESS FIELD NEAR THE EDGE OF THE CRACK REACHES A CRITICAL VALUE. IT ALSO ASSUMES THAT THIS INTENSITY IS PROPORTIONAL TO

THE SQUARE ROOT OF A CRACK PARAMETER, USUALLY HALF THE CRACK LENGTH.

SCENE 45.

MND45A, tape MND06, 06:09:36-06:09:48 loaded to machine

NARRATION (VO):

zoom out, fracture toughness specimen SPECIMENS ARE NOTCHED AND FATIGUE-CRACKED PRIOR TO FRACTURE TOUGHNESS TESTING.

--- TOUCH BLACK ---

SCENE 46.

MND46A, CGS: Fatigue Tests

zoom out, fatigue test

zoom in, fatigue test to cycles counter

NARRATION (VO):

MND46B, tape MND06, 06:17:21-06:17:36 FATIGUE TESTS CONCERN MATERIAL FAILURE UNDER MND46C, tape MND07, 07:31:04-07:31:20 REPEATED LOADING TO STRESSES BELOW THE YIELD STRENGTH, SUCH AS THE NUMBER OF CYCLES OF FULLY REVERSED TENSION TO EQUAL COMPRESSION TO CAUSE RUPTURE. THE STRESS BELOW WHICH FATIGUE FAILURE DOES NOT OCCUR IS CALLED THE ENDURANCE LIMIT AND THE NUMBER OF CYCLES THE MATERIAL CAN WITHSTAND ABOVE THIS LIMIT IS CALLED THE FATIGUE LIFE.

--- TOUCH BLACK ---

SCENE 47.

MND47A, CGS: Creep Tests

MND47B, tape MND07, 07:06:44-07:06:53 CREEP TESTS MEASURE A MATERIAL'S c.u. creep test specimen

MND47C, tape MND07, 07:07:22-07:07:37 placing thermal casing over creep specimen

NARRATION (VO):

CONTINUING CHANGE IN DIMENSIONS IN TIME UNDER STRESS. MATERIALS EXHIBIT CREEP, ESPECIALLY AT ELEVATED TEMPERATURES, EVEN AT MODERATE

STRESS.

SCENE 48.

MND48A, tape MND07, 07:14:24-07:14:50 zoom out, elevated temperature creep testing with weights

NARRATION (VO):

CREEP TESTS ARE USUALLY MADE AT CONSTANT TENSILE LOAD, USUALLY AT ELEVATED

TEMPERATURES, AND THE RESULTING MATERIAL ELONGATION IS NOTED AT TIME INTERVALS. THE LENGTH OF CREEP TESTS ARE TYPICALLY LONG, LASTING 1,000 HOURS OR MORE.

SCENE 49.

MND49A, CGS: Creep-Rupture Tests tilt up, creep rupture test

NARRATION (VO):

MND49B, tape MND07, 07:10:06-07:10:20 CREEP-RUPTURE TESTS ARE SIMILAR EXCEPT THAT THEY ARE CONTINUED UNTIL THE SPECIMEN FAILS.

--- FADE TO BLACK ---

SCENE 50.

MND50A, CGS: Non-Destructive Testing white text centered on black

SCENE 51.

MND51A, peter carey narration inspector looking at x-ray MND51C, tape MND09, 09:25:44-09:26:14 inspector looking at dye penetrant part

NARRATION (VO):

MND51B, tape MND09, 09:30:14-09:30:25 NON-DESTRUCTIVE TESTING, OR 'NDT', EXAMINES AN OBJECT OR MATERIAL IN A MANNER THAT DOES NOT IMPAIR IT'S FUTURE USEFULNESS. NON-DESTRUCTIVE TESTING IS DONE MAINLY TO PREVENT UNEXPECTED FAILURE AND ENSURE PRODUCT RELIABILITY.

SCENE 52.

MND52A, tape MND04, 04:18:28-04:18:38 wide, x-ray area prepared for test MND52B, tape MND04, 04:13:49-04:13:59 tilt, from x-ray head to part MND52C, tape MND04, 04:19:38-04:19:50 c.u. x-ray head on MND52D, tape MND04, 04:17:11-04:17:28 wide, x-ray head on MND52E, tape MND04, 04:13:02-04:13:21 zoom out, part on film MND52F, tape MND04, 04:33:10-04:33:34 x-ray film being washed MND52G, tape MND04, 04:53:20-04:53:42 zoom out, x-ray film being inspected

NARRATION (VO):

BASIC ELEMENTS: A SOURCE THAT DISTRIBUTES A PROBING MEDIUM TO THE APPROPRIATE REGIONS OF A TEST OBJECT; A MODIFICATION OF THE PROBING MEDIUM OR ITS DISTRIBUTION WITHIN A TEST OBJECT DUE TO DISCONTINUITIES OR VARIATIONS IN MATERIAL PROPERTIES;

ALL NON-DESTRUCTIVE TESTS INCLUDE SEVERAL

A SENSITIVE DETECTOR THAT IS RESPONSIVE TO CHANGES IN THE CHARACTER OR DISTRIBUTION OF THE PROBING MEDIUM;

A MEANS OF INDICATING OR RECORDING THE DETECTOR SIGNALS FOR INTERPRETATION; AND AN OBSERVER OR DEVICE CAPABLE OF INTERPRETING THE TEST OBJECT'S MATERIAL PROPERTIES OR DISCONTINUITIES.

SCENE 53.

MND53A, tape MND09, 09:21:13-09:21:29 florescent dye penetrant inspection MND53B, tape MND04, 04:51:24-04:51:40 zoom in, inspector looking at x-ray film

magnetic particle inspector

NARRATION (VO):

AN INSPECTOR IS THE MOST IMPORTANT ASPECT OF ANY Non-destructive testing METHOD AND, THUS, MND53C, tape MND08, 08:37:31-08:37:48 MUST BE CERTIFIED FOR COMPETENCY. THERE ARE THREE LEVELS OF CERTIFICATION, WITH EACH REQUIRing SUCCESSFUL COMPLETION OF WRITTEN, PRACTICAL AND VISION TESTS. NON-DESTRUCTIVE TESTING METHODS REQUIRE SPECIALIZED CERTIFICATION that PERTAINS TO THAT SPECIFIC TESTING METHOD AND THE INDUSTRY IN WHICH THE INSPECTOR WILL BE WORKING.

SCENE 54.

MND54A, tape MND10, 10:38:08-10:38:22 zoom in, x-ray operation

MND54B, CGS: Visual Inspection

zoom out, visual inspection

MND54D, CGS: Liquid Penetrant Testing

MND54E, tape MND08, 08:45:18-08:45:28 zoom out, florescent liquid penetrant VISUAL INSPECTION..., applied

MND54F, CGS: Magnetic Particle Inspection

MND54G, tape MND08, 08:09:30-08:09:42 MAGNETIC PARTICLE INSPECTION...,

magnetic particle inspection

MND54H, CGS: Eddy-Current Testing

MND54I, tape MND12, 12:02:45-12:02:57

wide, eddy-current testing

MND54J, CGS: Ultrasonic Testing

MND54K, tape MND11, 11:16:02-11:16:15 AND RADIOGRAPHIC TESTING.

ultrasonic testing

MND54L, CGS: Radiographic Testing

MND54M, tape MND10, 10:07:11-10:07:22

NARRATION (VO):

THERE ARE SEVERAL NON-DESTRUCTIVE TEST METHODS

MND54C, tape MND04, 04:47:49-04:47:57 USED IN MANUFACTURING, WITH SOME OF THE MOST

COMMON BEING:

LIQUID PENETRANT TESTING...,

EDDY-CURRENT TESTING...,

ULTRASONIC TESTING...,

zoom out, radiographic head

--- TOUCH BLACK ---

SCENE 55.

MND55A, CGS: Visual Inspection

MND55B, tape MND04, 04:47:06-04:47:33

zoom out, visually inspecting part

NARRATION (VO):

VISUAL INSPECTION IS THE MOST WIDELY USED NON-

DESTRUCTIVE TESTING METHOD. VISUAL INSPECTION

IS SIMPLE, EASILY APPLIED, QUICKLY PERFORMED,

AND USUALLY INEXPENSIVE. THE TEST SPECIMEN IS

ILLUMINATED AND EXAMINED BY EYE, OFTEN USING

OPTICAL AIDS.

SCENE 56.

MND56A, tape MND04, 04:49:08-04:49:25

visual inspection using optical

comparator

MND56B, CGS: Mirrors

Magnifiers Rigid/Flexible Borescopes Microscopes

Video Devices having Rigid/Flexible Probes Optical Comparators

zoom out, visual inspection of part

NARRATION (VO):

THESE OPTICAL AIDS INCLUDE MIRRORS,

MAGNIFIERS, RIGID OR FLEXIBLE BORESCOPES,

MICROSCOPES, VIDEO DEVICES HAVING RIGID OR

FLEXIBLE PROBES, AND OPTICAL COMPARATORS.

VISUAL INSPECTION IS INSPECTOR-DEPENDENT AND

MND56C, tape MND04, 04:48:48-04:49:04 LIMITED TO DETECTING SURFACE FLAWS.

--- TOUCH BLACK ---

SCENE 57.

MND57A, CGS: Liquid Penetrant Testing MND57B, tape MND09, 09:26:14-09:26:44

inspector looking at dye penetrant

part

NARRATION (VO):

LIQUID PENETRANT TESTING IS A SIMPLE METHOD OF

DETECTING SURFACE DEFECTS, PITS, POROSITY OR

SEAMS ON ALL METALS AND OTHER NONPOROUS

MATERIALS.

SCENE 58.

MND58A, tape MND08, 08:50:22-08:50:34

florescent liquid penetrant applied

MND58B, tape MND09, 09:05:17-09:05:37 florescent liquid penetrant washed

off

NARRATION (VO):

A DYED LIQUID PENETRANT IS APPLIED...,

AND AFTER A PERIOD OF TIME, THE EXCESS IS

REMOVED AND THE PART IS DRIED.

SCENE 59.

MND59A, tape MND09, 09:18:48-09:19:00

zoom out, absorbent developer on part AN ABSORBENT DEVELOPER IS THEN APPLIED, MND59B, tape MND09, 09:24:28-09:25:18 florescent dye penetrant inspection

CAUSING THE PENETRANT TO BE DRAWN OUT OF ANY SURFACE FLAWS, THUS INDICATING THEIR LOCATION.

SCENE 60.

continue previous shot

zoom out, visible-dye penetrant inspection

NARRATION (VO):

MND60A, tape MND08, 08:51:23-08:51:43 PENETRANTS INCLUDE POST-EMULSIFIABLE, SOLVENT-REMOVABLE OR WATER-WASHABLE FLUORESCENT PENETRANTS,

> OR VISIBLE-DYE FORMULATED PENETRANTS. ABSORBENT DEVELOPERS CAN BE WET OR DRY.

> > --- TOUCH BLACK ---

SCENE 61

MND61A, CGS: Magnetic Particle Inspection

MND61B, tape MND08, 08:18:04-08:18:20 parts being magnetized

MND61C, tape MND10, 10:03:44-10:03:55 zoom out, flawed magnetic particle part

parts being magnetized, magnetic particles applied to parts

NARRATION (VO):

MAGNETIC PARTICLE INSPECTION IS A SENSITIVE MEANS OF LOCATING SURFACE AND NEAR-SURFACE FLAWS IN FERROMAGNETIC MATERIALS SUCH AS IRON, MND61D, tape MND08, 08:03:38-08:03:56 STEEL AND NICKEL AND COBALT ALLOYS. THE PART BEING INSPECTED IS MAGNETIZED AND FINE MAGNETIC PARTICLES ARE APPLIED TO THE SURFACE.

SCENE 62.

continue previous shot

pan, inspection of magnetic particle parts

NARRATION (VO):

MND62A, tape MND08, 08:12:58-08:13:31 THE MAGNETIC PARTICLES MAY BE APPLIED DRY OR SUSPENDED IN A LIQUID MEDIUM. THE MAGNETIC PARTICLES ARE COLORED TO ENHANCE THEIR VISIBILITY, OR COATED WITH A FLUORESCENT MATERIAL FOR INSPECTION USING AN ULTRAVIOLET OR BLACK LIGHT.

SCENE 63.

MND63A, tape MND08, 08:23:26-08:23:44 zoom in, magnetic particle part with

inspector looking at magnetic

NARRATION (VO):

DISCONTINUITIES PERPENDICULAR TO THE MAGNETIC MND63B, tape MND08, 08:33:12-08:33:35 FIELD CAUSE A LEAKAGE FIELD TO FORM AT AND

particle parts

MND63C, tape MND10, 10:02:23-10:02:37 zoom in, magnetic particle part with flaw

ABOVE THE SURFACE OF THE PART AND HOLD THE PARTICLES THERE SO THAT THE DISCONTINUITY CAN BE VISUALLY EXAMINED. PARTS OF VIRTUALLY ANY SIZE CAN BE INSPECTED USING MAGNETIC-PARTICLE INSPECTION, ALTHOUGH THIN COATINGS OF PAINT AND OTHER NONMAGNETIC MATERIALS CAN AFFECT PROCESS SENSITIVITY.

SCENE 64.

MND64A, tape MND08, 08:16:13-08:16:38 zoom out, parts inspected and demagnetized

NARRATION (VO):

HIGH CURRENTS MAY BE REQUIRED TO CREATE A MAGNETIC FIELD WITHIN A PART, SO CARE IS NECESSARY TO AVOID LOCALIZED HEATING OR ARC BURNING. DEMAGNETIZATION AFTER INSPECTION IS MOST OFTEN A NECESSITY.

--- TOUCH BLACK ---

SCENE 65.

MND65A, CGS: Eddy-Current Testing MND65B, tape MND12, 12:04:25-12:04:33 EDDY-CURRENT TESTING INVOLVES THE USE OF A c.u., probing part

zoom out, eddy-current testing

NARRATION (VO):

MND65C, tape MND12, 12:10:29-12:11:20 VARYING MAGNETIC FIELD MADE BY A TESTING COIL. THIS COIL INDUCES SMALL, CIRCULATING CURRENTS CALLED EDDY CURRENTS INTO ELECTRICALLY CONDUCTIVE MATERIALS.

SCENE 66.

continue previous shot

c.u. eddy-current screen

NARRATION (VO):

MND66A, tape MND12, 12:07:13-12:07:27 ANY CHANGE IN THESE EDDY CURRENTS IS DETECTED BY A CHANGE IN THE COIL ELECTRICAL SIGNAL, WHICH CAN BE MONITORED TO REVEAL THE CAUSE, OR FLAW, IN THE MATERIAL.

SCENE 67.

MND67A, tape MND13, 13:27:33-13:27:51 coil probe placed in tube MND67B, CGS: Metal Sorting

NARRATION (VO):

APPLICATIONS INCLUDE METAL SORTING, SURFACE OR

Detection Thickness Gaging Internal Tube Inspection

wide, pulling probe from tube

Surface/Subsurface Flaw SUBSURFACE FLAW DETECTION, THICKNESS GAGING, AND INTERNAL TUBE INSPECTION. THE PROCESS IS MND67C, tape MND13, 13:25:00-13:25:12 SENSITIVE AND VERSATILE, BUT SENSITIVITY VARIES WITH FLOW DEPTH AND REFERENCE STANDARDS ARE REQUIRED.

--- TOUCH BLACK ---

SCENE 68.

MND68A, CGS: Ultrasonic Testing wide, ultrasonic operation MND68C, tape MND13, 13:18:19-13:18:34 FREQUENCY SOUND-WAVES INTRODUCED BY A c.u., transducer scanning part ultrasonic screen showing discontinuities

NARRATION (VO):

MND68B, tape MND13, 13:16:40-13:16:55 ULTRASONIC TESTING INVOLVES THE USE OF HIGH-MND68D, tape MND13, 13:19:12-13:19:26 TRANSDUCER INTO THE MATERIAL BEING INSPECTED TO DETECT FLAWS, MEASURE THICKNESS OR EVALUATE PROPERTIES. THE ENERGY OF THE ULTRASONIC WAVES IS REFLECTED BACK TO THE TRANSDUCER BY ANY DISCONTINUITIES, INDICATING THEIR PRESENCE AND LOCATION.

SCENE 69.

MND69A, tape MND15, 15:05:24-15:05:38 tilt down, immersion testing MND69B, CGS: Immersion Testing Contact Testing

NARRATION (VO):

ULTRASONIC TESTING IS ACCOMPLISHED USING ONE OF TWO BASIC METHODS:

IMMERSION TESTING,

AND CONTACT TESTING.

SCENE 70.

MND70A, CGS: Immersion Testing MND70B, tape MND15, 15:06:46-15:07:06 zoom out, immersion testing of part

NARRATION (VO):

IN IMMERSION TESTING, A WATERPROOF TRANSDUCER IS PLACED AT SOME DISTANCE FROM THE TEST SPECIMEN, AND THE ULTRASONIC SOUND-WAVES ARE TRANSMITTED INTO THE MATERIAL THROUGH A WATER PATH OR COLUMN.

SCENE 71.

MND71A, CGS: Contact Testing

MND71B, tape MND11, 11:16:47-11:17:08 IN CONTACT TESTING, THE TRANSDUCER IS PLACED c.u., ultrasonic testing

wide, ultrasonic testing

MND71C, tape MND11, 11:15:00-11:15:20 INTO DIRECT CONTACT WITH THE TEST SPECIMEN. A THIN LIQUID FILM COUPLANT IS REQUIRED TO ENSURE EFFICIENT TRANSMISSION OF THE ULTRASONIC ENERGY FROM THE TRANSDUCER TO THE TEST SURFACE.

SCENE 72.

MND72A, tape MND13, 13:12:26-13:12:51 zoom out, ultrasonic testing

NARRATION (VO):

METALS AS THICK AS 30 FEET, OR 9 METERS, CAN BE TESTED AS WELL AS PLASTICS, GLASS, CERAMICS, RUBBER, GRAPHITE AND CONCRETE. PROCESSING IS SENSITIVE AND FAST BUT CAN BE DIFFICULT FOR COMPLEX SHAPES. ADDITIONALLY, FLAWS IMMEDIATELY BENEATH THE SURFACE ARE DIFFICULT TO DETECT.

SCENE 73.

MND73A, tape MND11, 11:12:01-11:12:33 ultrasonic testing equipment being calibrated

NARRATION (VO):

ULTRASONIC TESTING EQUIPMENT CAN BE PORTABLE AND AUTOMATED. REFERENCE STANDARDS ARE REQUIRED THOUGH FOR CALIBRATING TEST EQUIPMENT AND CHARACTERIZING FLAWS.

--- TOUCH BLACK ---

SCENE 74.

MND74A, CGS: Radiographic Testing part going in for radiographic testing

MND74C, tape MND10, 10:09:00-10:09:11 zoom out, radiographic machine head

NARRATION (VO):

MND74B, tape MND10, 10:07:29-10:07:48 RADIOGRAPHIC TESTING IS BASED ON THE ABILITY OF X-RAYS AND GAMMA RAYS TO PENETRATE ALL MATERIALS AND THICKNESSES DIFFERENTIALLY. AN X-RAY MACHINE OR RADIOACTIVE ISOTOPE IS USED AS A RADIATION SOURCE.

SCENE 75.

MND75A, tape MND10, 10:17:07-10:17:21

zoom in, part setup with film
MND75B, tape MND11, 11:02:33-11:02:53
film coming out of processor

THIS RADIATION IS DIRECTED THROUGH A PART AND IMPRINTED UPON FILM STOCK OR AN ELECTRONIC DEVICE. ONCE PROCESSED, AN IMAGE IS OBTAINED SHOWING THE INTERNAL CHARACTERISTICS OF THE PART, WITH POSSIBLE IMPERFECTIONS SHOWING UP AS DENSITY CHANGES IN THE IMAGE.

SCENE 76.

MND76A, tape MND11, 11:07:44-11:08:26 c.u., inspector looking at x-ray film

NARRATION (VO):

c.u., inspector looking at x-ray film RADIOGRAPHIC TESTING IS USED TO DETERMINE THE

INTEGRITY OF WELDS BY LOCATING INTERNAL

DEFECTS SUCH AS INCLUSIONS AND POROSITY, AND

TO GAGE THE THICKNESS OF OBJECTS. RADIOGRAPHIC

TESTING ALSO PROVIDES PERMANENT FILM OR

DIGITAL IMAGING RECORDS.

SCENE 77.

MND77A, tape MND10, 10:15:32-10:16:06
setting up part for x-ray testing
MND77B, tape MND11, 11:03:14-11:03:26
zoom out, x-ray safety badge

NARRATION (VO):

RADIOGRAPHIC TESTING IS VERY COSTLY AND
DIFFICULT TO USE ON COMPLEX SHAPES THOUGH.

DEFECTS MUST BE AT LEAST 2% OF SECTION
THICKNESS FOR DETECTION. MANDATORY HEALTH
PRECAUTIONS ARE REQUIRED.

--- FADE TO BLACK ---

SCENE 78.

MND78A, CGS: Review white text on black MND78B, peter carey narration

MUSIC UP AND UNDER

NARRATION (VO):

LET'S REVIEW THE MATERIAL CONTAINED IN THIS PROGRAM.

SCENE 79.

MND79A, tape MND01, 01:02:52-01:03:02 metal material being hardness tested MND79B, tape 670, 02:12:43-02:12:58 metal part design on screen MND79C, tape 451, 18:17:03-18:17:33

NARRATION (VO):

BEFORE BEING MANUFACTURED, MANY MATERIAL...,
PRODUCT DESIGN...,

mold, up in risers MND79D, review music

zoom out, casting metal flowing into AND PRODUCTION DECISIONS ARE MADE TO ENSURE THAT A PART IS PRODUCED WITHOUT DEFECTS THAT COULD LEAD TO POOR PERFORMANCE ISSUES OR PREMATURE PART FAILURE.

SCENE 80.

MND80A, tape 114, 01:18:24-01:18:38 produced bolts coming off of conveyor MND80B, tape MND15, 15:34:01-15:34:20 zoom out, bolt being tested MND80C, tape MND01, 01:39:50-01:39:59 bolt being hardness tested

NARRATION (VO):

ONCE A PART IS PRODUCED, IT'S COMMONLY TESTED TO EVALUATE PRODUCT QUALITY AND TO IDENTIFY THE EXISTENCE, OR VERIFY THE ABSENCE, OF ANY PERFORMANCE-IMPAIRING FLAWS. THIS ENSURES THAT PARTS MEET RELEVANT CODE AND SPECIFICATION REQUIREMENTS.

SCENE 81.

MND81A, tape MND15, 15:13:45-15:14:04 bolt being sheared MND81B, tape MND04, 04:43:50-04:44:11 zoom in, magnetic particle part MND81C, CGS: Mechanical Testing Non-Destructive Testing

NARRATION (VO):

THERE ARE A VARIETY OF TESTS USED TO GAGE THE QUALITY OF MATERIALS AND PARTS THROUGHOUT THE MANUFACTURING PROCESS. THESE TESTS ARE GROUPED INTO TWO MAJOR CATEGORIES:

MECHANICAL TESTING,

AND NON-DESTRUCTIVE TESTING.

--- TOUCH BLACK ---

SCENE 82.

MND82A, CGS: Mechanical Testing wide, impact test direct shear test

NARRATION (VO):

MND82B, tape MND14, 14:21:01-14:21:21 MECHANICAL TESTING, WHICH IS ALSO KNOWN AS MND82C, tape MND06, 06:35:18-06:35:34 DESTRUCTIVE TESTING, IS USED TO GATHER SPECIFIC PERFORMANCE OR PROPERTY VALUES OF MATERIALS FOR PART DESIGN PURPOSES AND QUALITY CONTROL. THIS IS DONE BY FORCING MATERIALS TO FAIL USING VARIOUS TESTING LOAD APPLICATIONS.

SCENE 83.

MND83A, tape MND06, 06:08:00-06:08:12

zoom out, shear specimen

MND83B, tape MND05, 05:12:13-05:12:22 zoom out, specimen for impact test MND83C, tape MND14, 14:25:36-14:26:00

zoom out, working with sheet metal specimens

THE MATERIAL PROPERTY EVALUATED IS BASED ON TESTING SPECIMENS OR SAMPLES WITH RESPECT TO THE SPECIFIC TYPE OF MECHANICAL TEST BEING ADMINISTERED. ALTHOUGH SPECIMEN CONFIGURATIONS HAVE BEEN STANDARDIZED FOR PARTICULAR TESTS, THEIR SIZE AND DESIGN MAY VARY DEPENDING ON

SCENE 84.

MND84A, tape MND14, 14:24:19-14:24:52

zoom out, hardness testing

MND84B, CGS: Hardness Tests

MND84C, tape MND15, 15:40:12-15:40:40

zoom out, tensile test, specimen

breaking

MND84D, CGS: Tension/Tensile Tests

MND84E, tape MND03, 03:42:04-03:42:16

compression test

MND84F, CGS: Compression Tests

MND84G, tape MND15, 15:44:40-15:44:53

wide, pendulum released, reset after fracture

MND84H, CGS: Impact Tests

MND84I, tape MND06, 06:04:39-06:05:06

fracture toughness test

MND84J, CGS: Fracture-Toughness Tests

MND84K, tape MND06, 06:17:21-06:17:36 AND CREEP TESTS.

zoom out, fatigue test

MND84L, CGS: Fatigue Tests

MND84M, tape MND07, 07:14:24-07:14:50

zoom out, elevated temperature creep

testing with weights

MND84N, CGS: Creep Tests

SCENE 85.

MND85A, CGS: Non-Destructive Testing

inspector looking at x-ray

MND85C, tape MND09, 09:25:44-09:26:14

inspector looking at dye penetrant

part

NARRATION (VO):

THE TEST AND MATERIAL.

THERE IS A VAST ARRAY OF MECHANICAL TESTS,

WITH SOME OF THE MOST COMMON TYPES INCLUDING:

HARDNESS TESTS...,

TENSION, OR TENSILE TESTS...,

COMPRESSION TESTS...,

IMPACT TESTS...,

FRACTURE-TOUGHNESS TESTS...,

FATIGUE TESTS...,

--- TOUCH BLACK ---

NARRATION (VO):

MND85B, tape MND09, 09:30:14-09:30:25 NON-DESTRUCTIVE TESTING, OR 'NDT', EXAMINES AN

OBJECT OR MATERIAL IN A MANNER THAT DOES NOT

IMPAIR IT'S FUTURE USEFULNESS. NON-DESTRUCTIVE

TESTING IS DONE MAINLY TO PREVENT UNEXPECTED

FAILURE AND ENSURE PRODUCT RELIABILITY.

SCENE 86.

MND86A, tape MND04, 04:18:28-04:18:38

wide, x-ray area prepared for test

MND86B, tape MND04, 04:13:49-04:13:59 ALL NON-DESTRUCTIVE TESTS INCLUDE SEVERAL tilt, from x-ray head to part

MND86C, tape MND04, 04:19:38-04:19:50 BASIC ELEMENTS: c.u. x-ray head on

wide, x-ray head on

zoom out, part on film

x-ray film being washed

MND86G, tape MND04, 04:53:20-04:53:42 DISTRIBUTION WITHIN A TEST OBJECT DUE TO zoom out, x-ray film being inspected

MND86D, tape MND04, 04:17:11-04:17:28 A SOURCE THAT DISTRIBUTES A PROBING MEDIUM TO

MND86E, tape MND04, 04:13:02-04:13:21 THE APPROPRIATE REGIONS OF A TEST OBJECT;

MND86F, tape MND04, 04:33:10-04:33:34 A MODIFICATION OF THE PROBING MEDIUM OR ITS

DISCONTINUITIES OR VARIATIONS IN MATERIAL

PROPERTIES;

A SENSITIVE DETECTOR THAT IS RESPONSIVE TO CHANGES IN THE CHARACTER OR DISTRIBUTION OF THE PROBING MEDIUM;

A MEANS OF INDICATING OR RECORDING THE DETECTOR SIGNALS FOR INTERPRETATION; AND AN OBSERVER OR DEVICE CAPABLE OF INTERPRETING THE TEST OBJECT'S MATERIAL PROPERTIES OR DISCONTINUITIES.

SCENE 87.

MND87A, tape MND10, 10:38:08-10:38:22

zoom in, x-ray operation

MND87B, CGS: Visual Inspection

zoom out, visual inspection

MND87D, CGS: Liquid Penetrant Testing VISUAL INSPECTION...,

MND87E, tape MND08, 08:45:18-08:45:28

zoom out, florescent liquid penetrant LIQUID PENETRANT TESTING..., applied

MND87F, CGS: Magnetic Particle Inspection

MND87G, tape MND08, 08:09:30-08:09:42 EDDY-CURRENT TESTING...,

magnetic particle inspection

MND87H, CGS: Eddy-Current Testing

MND87I, tape MND12, 12:02:45-12:02:57

wide, eddy-current testing

MND87J, CGS: Ultrasonic Testing

MND87K, tape MND11, 11:16:02-11:16:15

ultrasonic testing

MND87L, CGS: Radiographic Testing

MND87M, tape MND10, 10:07:11-10:07:22

zoom out, radiographic head

NARRATION (VO):

SOME OF THE MOST COMMON NON-DESTRUCTIVE

MND87C, tape MND04, 04:47:49-04:47:57 TESTING METHODS USED IN MANUFACTURING INCLUDE:

MAGNETIC PARTICLE INSPECTION...,

ULTRASONIC TESTING...,

AND RADIOGRAPHIC TESTING.

--- FADE TO BLACK ---

SCENE 88.

MND88A, CG, ROLL: credits white text on black, fade up midscreen

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SCENE 89.

MND89A, CGS: disclaimer
white text centered on black

Some machinery in this program had safety equipment removed to allow better recording of certain processes.

Always read the safety information provided in the manufacturers' manual before machine operation.

SCENE 90. MND90A, SME logo open, with music