FUNDAMENTAL MANUFACTURING PROCESSES

Thermal & Abrasive Waterjet Cutting - TWC

SCENE 1.
FMP01A, CGS: FBI warning
text centered on black to transparent gradient
FMP BKG, motion background

WARNING

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SCENE 2.
continue motion background
FMP02A, CGS: disclaimer
white text, centered on background

Always read the operating manual and safety information provided by the manufacturer before operating any manufacturing equipment.

Make sure all machine guards are in place, and follow all safety procedures when working with or near manufacturing equipment.

SCENE 3.
FMP SME, SME logo open, with music

SCENE 4.
FMP04A, FMP open, with music
TWC04B, edited peter carey narration

MUSIC UP AND UNDER

NARRATION (VO):

THE FUNDAMENTAL MANUFACTURING PROCESSES VIDEO SERIES, EXAMINING THE TOOLS AND TECHNIQUES OF PRECISION MANUFACTURING.

SCENE 5.
continue FMP open
TWC05A, CGS: Thermal & Abrasive Waterjet Cutting
white text, centered on background
FMP05B, blue background
FMP05C, sound slug
FMP05D, half screen line
FMP05E, SME4468, 13:55:35:00-13:56:02:00
laser audio slug

NARRATION (VO):

THIS PROGRAM IS AN INTRODUCTION TO THERMAL AND ABRASIVE WATERJET CUTTING.

SCENE 6.
TWC06A, SME4475, 20:04:32:00-20:04:58:00
zoom out, laser cutting of part
TWC06B, CGS: Oxy-Fuel Cutting
TWC06C, SME4462, 04:27:22:00-04:27:31:00
oxy-fuel cutting of steel plate
TWC06D, CGS: Plasma Cutting
TWC06E, SME4470, 14:09:51:00-14:10:01:00
plasma cutting of metal
TWC06F, CGS: Laser Cutting
TWC06G, SME4471, 15:24:51:00-15:25:02:00
laser cutting of metal

NARRATION (VO):

THERMAL CUTTING PROCESSES USE HEAT FOR CUTTING. THREE OF THE MOST COMMONLY USED THERMAL CUTTING PROCESSES ARE:

OXY-FUEL...,

PLASMA...,

AND LASER.

SCENE 7.
TWC07A, SME4457, 23:58:40:00-23:58:51:00
waterjet cutting of part
TWC07B, CGS: Abrasive Waterjet Cutting

NARRATION (VO):

BY CONTRAST, ABRASIVE WATERJET CUTTING USES ABRASIVE EROSION FOR CUTTING INSTEAD OF HEAT.

SCENE 8.
TWC08A, SME3435, 01:09:50:00-01:09:56:00
laser cutting of plastics
TWC08B, SME4457, 23:39:39:00-23:40:00:00
waterjet cutting rubber
TWC08C, SME4457, 23:32:04:00-23:32:20:00
waterjet cutting ceramic
TWC08D, SME4441, 08:15:04:00-08:15:56:00
wide, oxy-fuel cutting of plate
TWC08E, SME4468, 13:43:06:00-13:43:36:00
laser cutting workpiece

NARRATION (VO):

THERMAL...,

AND ABRASIVE WATERJET CUTTING PROVIDE PRECISION, NON-CONTACT CUTS IN A WIDE VARIETY OF MATERIALS. THESE PROCESSES PRIMARILY CUT INTERNAL AND EXTERNAL SHAPES OUT OF FLAT SHEET AND PLATE MATERIALS, BUT ARE ALSO USED TO TRIM PREVIOUSLY FORMED SHAPES.

SCENE 9.
TWC09A, SME4438, 05:06:00:00-05:06:14:00
zoom out, waterjet cutting sheet metal
TWC09B, SME4443, 10:43:57:00-10:44:12:00
oxy-fuel cutting with multiple heads
TWC09C, SME4467, 09:47:58:00-09:48:11:00
plasma cutting operation starting
TWC09D, SME4467, 09:32:23:00-09:32:37:00
zoom out, laser cutting operation

NARRATION (VO):

TYPICALLY, ALL THERMAL AND ABRASIVE WATERJET CUTTING METHODS CUT THROUGH MATERIALS IN ONE PASS, AND SYSTEMS CAN ACCOMMODATE MULTIPLE CUTTING HEADS TO CUT NUMEROUS SHAPES SIMULTANEOUSLY. EACH METHOD, AND ITS VARIATIONS, HAS ITS OWN

ADVANTAGES AND DISADVANTAGES, DEPENDING ON THE CUTTING APPLICATION.

SCENE 10.
TWC10A, SME4467, 09:08:26:00-09:08:33:00 wide, plasma cutting
TWC10B, SME4456, 22:09:25:00-22:09:33:00 pan, laser cutting
TWC10C, SME3921, 16:07:29:00-16:07:36:00 zoom out, waterjet cutting
TWC10D, SME4441, 08:29:27:00-08:29:50:00 wide, oxy-fuel cutting of plate
TWC10E, CGS: Work Material & its Thickness
Cut Intricacy & Quality Requirements
Desired Cutting Speed
Metallurgical Effects
Environmental Concerns
Cost of System
Cost per Foot/Meter of Cut

NARRATION (VO):

CHOOSING THE MOST EFFECTIVE AMONG THESE PROCESSES DEPENDS ON SEVERAL FACTORS, SUCH AS:
THE WORK MATERIAL AND ITS THICKNESS,
CUT INTRICACY AND QUALITY REQUIREMENTS,
DESIRED CUTTING SPEED,
METALLURGICAL EFFECTS,
ENVIRONMENTAL CONCERNS,
COST OF SYSTEM,
AND COST PER FOOT, OR METER, OF CUT.

SCENE 11.
TWC11A, SME4441, 08:19:31:00-08:19:41:00 oxy-fuel cutting
TWC11B, SME4447, 14:22:48:00-14:23:02:00 plasma cutting
TWC11C, SME4467, 09:30:37:00-09:30:47:00 laser cutting
TWC11D, SME3921, 16:11:04:00-16:11:14:00 waterjet cutting
TWC11E, composite thermal and waterjet images
TWC11F, ANI: upper left matte
TWC11G, ANI: upper right matte
TWC11H, ANI: lower left matte
TWC11I, ANI: lower right matte
TWC11J, ANI: borders and background
TWC11K, SME4116, 06:13:37:00-06:14:00:00 milling operation
TWC11L, SME4474, 19:16:37:00-19:17:06:00 laser cutting operation
TWC11M, SME4471, 15:15:28:00-15:15:55:00 part fixtured for laser cutting
TWC11N, SME4505, 11:33:16:00-11:33:40:00 torch and gas, cut beginning
TWC11O, SME2815, 01:05:40:00-01:05:45:00 zoom out, abrasive waterjet cutting particles
TWC11P, SME4441, 08:38:59:00-08:39:10:00 laser panel open showing electrical system
TWC11Q, composite nest of four cutting processes

NARRATION (VO):

THERE ARE ADVANTAGES COMMON TO ALL THESE METHODS OF CUTTING. UNLIKE MACHINING METHODS THAT USE MECHANICAL FORCE, THEY DO NOT REQUIRE A VARIETY OF PERISHABLE CUTTING TOOLS TO SHAPE PARTS, OR ELABORATE WORKHOLDING METHODS TO CLAMP PARTS SECURELY.
THESE PROCESSES DO, HOWEVER, USE CONSUMABLES SUCH AS TORCH TIPS OR GASES...,
ABRASIVE PARTICLES...,
OR SOMETIMES A SIGNIFICANT AMOUNT OF ELECTRICAL ENERGY.

SCENE 12.
TWC12A, SME4474, 19:38:08:00-19:38:32:00
plasma cutting of part
TWC12B, ANI: c.u. thermal cut part with heat affected zone
TWC12C, ANI: c.u. thermal cut part with heat affected zone highlighted
TWC12D, SME4474, 19:10:33:00-19:10:43:00
laser cutting of part
TWC12E, SME4354, 06:02:45:00-06:02:59:00
zoom in, milling operation
TWC12F, SME4462, 04:19:07:00-04:19:28:00
zoom out, oxy-fuel cutting operation

NARRATION (VO):

THERMAL CUTTING PROCESSES SHARE TWO MAIN DISADVANTAGES. FIRST, HEAT CHANGES THE STRUCTURE OF THE METAL ADJACENT TO THE CUT, CREATING A 'HEAT-AFFECTED ZONE'. THIS HEAT-AFFECTED ZONE IS AN AREA OF PROCESSED MATERIAL HAVING A MICROSTRUCTURE AND PROPERTIES THAT ARE DIFFERENT FROM THOSE OF THE BULK MATERIAL. SECONDLY, TOLERANCES MAY BE LESS ACCURATE THAN WITH A HARD-TOOL MACHINED CUT, DEPENDING ON THE CUTTING METHOD AND PROCESS PARAMETERS.

SCENE 13.
TWC13A, SME4471, 15:19:11:00-15:19:28:00
laser cutting operation
TWC13B, SME4471, 15:17:36:00-15:18:00:00
person removing spatter off of part

NARRATION (VO):

MOREOVER, IN SOME THERMAL CUTTING SITUATIONS, LABOR-INTENSIVE SECONDARY FINISHING OPERATIONS MAY BE REQUIRED, SUCH AS REMOVING SLAG OR SPATTER FROM THE PART.

SCENE 14.
TWC14A, SME4447, 14:24:53:00-14:25:13:00
plasma cutting with a lot of smoke
TWC14B, CGS: Fuel Gases
Cutting Flames
Hot Slag
Electrical Shock
High Noise Levels
Intense Arc Radiation/
Laser Light
TWC14C, SME4124, 15:44:41:00-15:45:08:00
zoom in, manual oxy-fuel torch cutting, worker wearing eye, ear, skin protection

NARRATION (VO):

THERE ARE ALSO SAFETY CONCERNS REGARDING FUEL GASES, CUTTING FLAMES, HOT SLAG, ELECTRICAL SHOCK, HIGH NOISE LEVELS, AND INTENSE ARC RADIATION OR LASER LIGHT. ADDITIONALLY, EYE, EAR, OR SKIN PROTECTION IS ADVISABLE UNDER CERTAIN OPERATING CONDITIONS.

--- TOUCH BLACK ---

SCENE 15.
TWC15A, SME4467, 09:21:30:00-09:21:45:00
zoom out, plasma cutting on ‘x-y’ table
TWC15B, SME4455, 21:23:33:00-21:23:58:00
5-axis laser on gantry
TWC15D, SME4471, 15:11:25:00-15:11:36:00
laser cutting with articulated-arm robots
TWC15C, SME3921, 16:10:30:00-16:10:45:00
zoom in, waterjet cutting composite part with robot
TWC15E, SME4470, 14:15:38:00-14:15:52:00
plasma cutting using punch press
TWC15F, SME4470, 14:17:34:00-14:17:46:00
wide, punch press operation

NARRATION (VO):

THERMAL AND ABRASIVE WATERJET CUTTING PROCESSES TYPICALLY CUT MATERIAL ON A TWO-AXIS ‘X-Y’ TABLE, BUT HAVE ALSO BEEN TEAMED WITH ARTICULATED-ARM ROBOTS OR 5-AXIS GANTRY SYSTEMS. MANY TYPES OF ROBOTS CAN CARRY A PLASMA TORCH, LASER, OR ABRASIVE WATERJET CUTTING HEAD FOR A RANGE OF CUTTING APPLICATIONS. SOMETIMES CUTTING METHODS ARE COMBINED WITH EACH OTHER OR WITH PUNCH PRESSES.

SCENE 16.
TWC16A, SME4475, 20:37:32:00-20:37:45:00
wide, laser cutting, nested parts finished
TWC16B, SME4475, 20:53:41:00-20:54:00:00
nesting of laser parts
TWC16C, SME4474, 19:23:14:00-19:23:23:00
nesting of plasma cut part
TWC16D, SME4474, 19:28:27:00-19:29:02:00
plasma cutting of part

NARRATION (VO):

TYPICALLY, MULTIPLE PARTS ARE CUT FROM A METAL SHEET OR OTHER MATERIAL. ARRANGING THE PARTS ON THE SHEET IS CALLED NESTING. NESTING SOFTWARE HELPS PROGRAMMERS ARRANGE PARTS AND CUTTING PATHS TO MAXIMIZE THE USE OF STOCK MATERIAL, MINIMIZING SCRAP DURING CUTTING.

--- FADE TO BLACK ---

SCENE 17.
TWC17A, CGS: Oxy-Fuel Cutting
white text, centered on background
FMP BKG, motion background

SCENE 18.
TWC18A, SME4441, 08:54:34:00-08:54:54:00
zoom out, oxy-fuel cutting of steel plate

NARRATION (VO):

OXYGEN-FUEL OR OXY-FUEL CUTTING WAS ONCE

THE ONLY FORM OF THERMAL CUTTING.

SCENE 19.
continue previous shot
TWC19A, ANI: cut away of two-part oxy-fuel torch, exterior preheating flame
TWC19B, ANI: cut away of two-part oxy-fuel torch, exterior preheating flame with jet of oxygen at the center
TWC19C, SME4443, 11:01:26:00-11:01:56:00
c.u. oxy-fuel flame cutting of steel plate

NARRATION (VO):

THE OXY-FUEL CUTTING PROCESS USES A TWO-PART TORCH -- A PREHEATING EXTERIOR OXY-FUEL FLAME, AND A JET OF HIGH-PURITY OXYGEN AT THE CENTER. CUTTING OCCURS FROM THE CHEMICAL REACTION BETWEEN OXYGEN AND A READILY OXIDIZED METAL, SUCH AS STEEL, IN THE PRESENCE OF HEAT.

SCENE 20.
continue previous shot
TWC20A, SME4441, 08:05:51:00-08:06:13:00
zoom out, tanks of gas
TWC20C, SME4441, 08:01:03:00-08:03:17:00
zoom out, torch started, metal brought to kindling temperature, compressed oxygen turned on, oxy-fuel cutting beginning
TWC20B, CGS: 1,650° Fahrenheit
900° Celsius
TWC20D, SME4462, 04:19:40:00-04:20:32:00
zoom out, torch started, metal brought to kindling temperature, compressed oxygen turned on, oxy-fuel cutting beginning, alternate shot

NARRATION (VO):

THE EXTERIOR FLAME IS PRODUCED BY A MIXTURE OF OXYGEN AND A COMBUSTIBLE GAS SUCH AS ACETYLENE, PROPANE, METHANE, OR OTHER GAS. IT PREHEATS THE METAL TO ITS ‘KINDLING TEMPERATURE’, WHICH IS AROUND 1,650 DEGREES FAHRENHEIT, OR 900 DEGREES CELSIUS. THIS IS THE TEMPERATURE AT WHICH THE METAL REACTS QUICKLY WITH OXYGEN.

SCENE 21.
continue previous shot

NARRATION (VO):

ONCE THE STARTING AREA REACHES THE KINDLING TEMPERATURE, THE OPERATOR TURNS ON THE JET OF COMPRESSED CUTTING OXYGEN. THE OXYGEN STREAMS FROM THE TORCH TIP INTO THE GLOWING-RED, PREHEATED METAL, CAUSING A FAST COMBUSTION REACTION.

SCENE 22.
TWC22A, SME4441, 08:49:43:00-08:50:14:00
oxy-fuel cutting of metal

NARRATION (VO):

THE RESULTING MOLTEN MATERIAL IS BLOWN THROUGH THE METAL BY THE STREAM OF CUTTING OXYGEN, EXPOSING FRESH METAL FOR CUTTING.

SCENE 23.
TWC23A, SME4447, 14:05:44:00-14:06:16:00
zoom out, oxy-fuel cutting operation
TWC23B, CGS: Oxygen Purity
Rate of Oxygen Supply
Torch Tip Size & Type
Distance from the Workpiece
Fuel Gas Type
Gas Flow Rates
Cutting Speed

NARRATION (VO):

MANY VARIABLES AFFECT THE OXY-FUEL CUT QUALITY, INCLUDING OXYGEN PURITY, RATE OF OXYGEN SUPPLY, TORCH TIP SIZE AND TYPE, DISTANCE FROM THE WORKPIECE, FUEL GAS TYPE, GAS FLOW RATES, AND CUTTING SPEED.

SCENE 24.
TWC24A, SME4505, 11:04:20:00-11:04:40:00
oblique angle oxy-fuel cutting operation
TWC24B, CGS: Material Type
Surface Condition
Angle of the Cut
TWC24C, SME4443, 10:47:52:00-10:48:20:00
zoom out, oxy-fuel cutting operation, alternate shot

NARRATION (VO):

OTHER MAJOR FACTORS IN OXY-FUEL CUT QUALITY ARE THE MATERIAL TYPE, ITS SURFACE CONDITION, AND THE ANGLE OF THE CUT, IF IT IS OTHER THAN STRAIGHT.

SCENE 25.
TWC25A, SME4447, 14:46:53:00-14:47:12:00
oxy-fuel torch, preheating metal, cutting through thick steel

NARRATION (VO):

OXY-FUEL CUTTING TORCHES SUPPLY THE PROPER FUEL GAS-OXYGEN MIXTURE FOR PREHEATING THE METAL, AND SUPPLY A STEADY FLOW OF OXYGEN FOR THROUGH-CUTTING.

SCENE 26.
TWC26A, SME4447, 14:37:02:00-14:37:38:00
tip of oxy-fuel torch being replaced
TWC26B, torch tip/nozzle 01
TWC26C, torch tip/nozzle 02
TWC26D, torch tip/nozzle 03
TWC26E, torch tip/nozzle 04
TWC26F, SME4447, 14:01:38:00-14:01:56:00
zoom out, oxy-fuel operation ending

NARRATION (VO):

THE TORCH’S CUTTING TIP AND GAS PRESSURE DETERMINE THE CUTTING ACTION. CUTTING TIPS OR NOZZLES COME IN A VARIETY OF DESIGNS TO SERVE DIFFERENT CUTTING

FUELS. THE DIAMETER OF THE CENTRAL JET OF OXYGEN MUST BE SELECTED IN PROPORTION TO THE DEPTH OF THE STOCK BEING CUT.

SCENE 27.
TWC27A, SME4462, 04:18:26:00-04:18:52:00
c.u., zoom out, red hot metal, compressed oxygen turned on, oxy-fuel cutting
TWC27B, SME4447, 14:54:47:00-14:55:09:00
zoom out, thick material being cut using oxy-fuel process
TWC27C, SME4443, 10:34:32:00-10:35:07:00
zoom in, thick material being cut using oxy-fuel process, alternate shot

NARRATION (VO):

THE TORCH TIP-TO-WORK STANDOFF DISTANCE IS ALSO DEPENDENT ON THE WORKPIECE THICKNESS. FOR THINNER MATERIAL, THE TIP IS KEPT CLOSE TO THE WORK AND MOVED RAPIDLY, WHILE FOR THICKER WORK, THE STANDOFF DISTANCE IS INCREASED.

SCENE 28.
continue previous shot
TWC28A, SME4443, 10:20:49:00-10:21:31:00
cutting starting on thick workpiece

NARRATION (VO):

ADDITIONALLY, THE THICKER THE CUT, THE MORE DIFFICULT IT BECOMES TO MAINTAIN CUT QUALITY. LARGER TORCH TIPS WITH GREATER OXYGEN FLOW ARE USED TO CUT THICK STOCK, CREATING A LARGER KERF, OR WIDTH OF CUT.

SCENE 29.
TWC29A, SME4462, 04:30:28:00-04:30:43:00
oxy-fuel cutting of thin plate

NARRATION (VO):

BY ADJUSTING THE CUTTING PARAMETERS IT IS POSSIBLE TO ACHIEVE A FAIRLY SMOOTH EDGE AND A FAIRLY NARROW KERF.

SCENE 30.
TWC30A, SME4447, 14:39:42:00-14:40:23:00
med, piercing pilot hole in of thick material
TWC30B, SME4447, 14:43:49:00-14:44:22:00
wide, piercing pilot hole in of thick material, alternate shot

NARRATION (VO):

CUTS WITHIN EXTREMELY THICK MATERIAL ARE COMMONLY STARTED BY PIERCING AN INITIAL PILOT HOLE. THIS IS ACCOMPLISHED USING PURE OXYGEN SUPPLIED THROUGH A TORCH TIP THAT SERVES AS A LONG PIERCING TOOL. AS

THE PURE OXYGEN REACTS WITH THE MATERIAL, THE TOOL IS FED THROUGH, GENERATING THE PILOT HOLE.

SCENE 31.
TWC31A, SME4408, 10:17:43:00-10:18:05:00
oxy-fuel cutting using manual/portable unit
TWC31B, SME4118, 08:09:05:00-08:09:46:00
oxy-fuel cutting using automated machine with numerous cutting torches

NARRATION (VO):

OXY-FUEL CUTTING MACHINES RANGE FROM MANUAL AND PORTABLE UNITS...,
TO LARGE AUTOMATED MACHINES WITH A MOTOR-DRIVEN CARRIAGE AND NUMEROUS CUTTING TORCHES.

SCENE 32.
continue previous shot
TWC32A, CGS: Torch Placement
Ignition
Fuel Pressure
Cutting Speed

NARRATION (VO):

MACHINES TYPICALLY HAVE ADJUSTMENTS FOR TORCH PLACEMENT, IGNITION, FUEL PRESSURE, AND CUTTING SPEED.

--- FADE TO BLACK ---

SCENE 33.
TWC33A, CGS: Plasma Cutting
white text, centered on background
FMP BKG, motion background

SCENE 34.
TWC34A, SME4474, 19:25:15:00-19:25:50:00
zoom out, plasma cutting of metal

NARRATION (VO):

PLASMA CUTTING USES AN ELECTRIC ARC AND AN EXTREMELY HIGH TEMPERATURE, HIGH-VELOCITY STREAM OF IONIZED GAS, OR PLASMA, TO CUT METAL.

SCENE 35.
TWC35A, SME4337, 23:27:44:00-23:28:09:00
zoom out, manual plasma cutting of metal
TWC35B, CGS: 9,000°-54,000° Fahrenheit
5,000°-30,000° Celsius

NARRATION (VO):

THIS PLASMA JET IS FORMED BY THE ARC AND A GAS MIXTURE, AND HAS A TEMPERATURE RANGING BETWEEN 9,000 TO 54,000 DEGREES FAHRENHEIT, OR APPROXIMATELY 5,000 TO

30,000 DEGREES CELSIUS.

SCENE 36.
TWC36A, ANI: jet concentrated as a vortex in a narrow spot, melting metal, and blowing it out of cut
TWC36B, SME4505, 11:22:02:00-11:22:18:00 plasma cutting of part

NARRATION (VO):

THE JET IS CONCENTRATED AS A VORTEX IN A NARROW SPOT, WHERE IT MELTS THE METAL AND BLOWS IT OUT OF THE CUT.

SCENE 37.
TWC37A, SME4470, 14:11:16:00-14:11:45:00 zoom out, plasma cutting of part on punch press

NARRATION (VO):

THE PLASMA CUTTING PROCESS OPERATES WITH HIGHER ENERGY THAN OXY-FUEL, SO IT CUTS FASTER AND CLEANER, AND REQUIRES NO PREHEATING. THESE ADVANTAGES HELP COMPENSATE FOR PLASMA’S HIGHER CAPITAL INVESTMENT COSTS.

SCENE 38.
TWC38A, SME4443, 10:15:43:00-10:16:05:00 plasma cutting of part
TWC38B, ANI: still of plasma, quarter screen
TWC38C, ANI: stills of plasma & solid ice, both quarter screen
TWC38D, ANI: stills of plasma, solid ice, & water, all quarter screen
TWC38E, ANI: stills of plasma, solid ice, water, & steam, all quarter screen

NARRATION (VO):

TO BETTER UNDERSTAND THIS CUTTING PROCESS, LET’S EXAMINE WHAT CONSTITUTES A PLASMA. PLASMA IS SOMETIMES DESCRIBED AS THE FOURTH STATE OF MATTER, IN ADDITION TO SOLID, LIQUID, AND GAS.

SCENE 39.
TWC39A, SME2809, 01:04:55:00-01:07:23:00 ice cube in pan, stove element heats up, melted to water, water turning to steam
TWC39B, SME4474, 19:30:48:00-19:31:10:00 plasma cutting operation

NARRATION (VO):

AS AN EXAMPLE, WHEN HEAT IS APPLIED TO ICE, IT PASSES FROM ITS SOLID STATE..., TO LIQUID...,
AND THEN GASEOUS STATE. IF ENOUGH ENERGY WERE THEN ADDED TO THE STEAM, IT WOULD BECOME IONIZED AND ELECTRICALLY CONDUCTIVE, BECOMING A PLASMA.

SCENE 40.
TWC40A, SME4337, 23:25:25:00-23:26:18:00

NARRATION (VO):

hand held plasma cutting using shop air
TWC40B, SME4470, 14:06:37:00-14:07:24:00
zoom out, mechanical plasma system cutting of part
TWC40C, CGS: Air
Water
Carbon Dioxide
TWC40D, SME4443, 10:05:33:00-10:06:00:00
zoom in, gas mixture plasma cutting of stainless steel or aluminum part
TWC40E, CGS: Argon
Hydrogen
Nitrogen

PLASMA CUTTING REQUIRES GAS OR GAS MIXTURES TO CREATE THE PLASMA ENVELOPE. HAND-HELD PLASMA CUTTING SYSTEMS USE SHOP AIR. MECHANICAL SYSTEMS FOR CUTTING STEEL OFTEN USE OXYGEN AS THE CUTTING GAS, WITH A SHIELD GAS OF AIR, WATER, OR CARBON DIOXIDE. FOR OPTIMAL CUT QUALITY WITH STAINLESS STEEL OR ALUMINUM, GAS MIXTURE COMPONENTS TYPICALLY INCLUDE ARGON, HYDROGEN, OR NITROGEN.

SCENE 41.
TWC41A, SME4443, 10:12:46:00-10:13:07:00
zoom out, wide, plasma cutting system
TWC41B, CGS: Torch
Power Supply
Arc Starting Circuit
TWC41C, SME4505, 11:16:08:00-11:16:20:00
zoom out, wide, plasma cutting system

NARRATION (VO):

THE PLASMA ARC CUTTING SYSTEM CONSISTS OF A TORCH, A POWER SUPPLY, AND AN ARC-STARTING CIRCUIT.

SCENE 42.
TWC42A, SME4505, 11:13:15:00-11:14:09:00
torch tip elements being assembled
TWC42B, SME4474, 19:24:02:00-19:24:12:00
zoom out, torch tip elements being assembled, alternative shot
TWC42C, SME4474, 19:30:03:00-19:30:28:00
torch tip elements being assembled, torch seated in plasma cutting machine, alternative shot

NARRATION (VO):

THE TORCH SERVES AS THE HOLDER FOR THE CONSUMABLE NOZZLE AND ELECTRODE, WHICH CONSTRICT AND MAINTAIN THE PLASMA JET IN A VORTEX.

SCENE 43.
TWC43A, SME4505, 11:14:49:00-11:15:05:00
pan, plasma power supply to plasma cutting operation

NARRATION (VO):

THE PLASMA CUTTING POWER SUPPLY IS A CONSTANT DIRECT CURRENT, OR ‘DC’ POWER SOURCE. THE OUTPUT CURRENT, OR AMPERAGE, DETERMINES THE SPEED AND CUT THICKNESS CAPABILITY.

SCENE 44.
TWC44A, ANI: arc starter in off position
TWC44B, ANI: arc starter in on position

NARRATION (VO):

TWC44C, ANI: TWC45B element, gas fed to torch
TWC44D, CGS: Arc Starter

THE ARC STARTER IS A HIGH FREQUENCY GENERATOR CIRCUIT THAT PRODUCES A HIGH ALTERNATING CURRENT, OR ‘AC’ VOLTAGE, WHICH IONIZES THE CUTTING GAS, ALLOWING IT TO BECOME CONDUCTIVE.

SCENE 45.
TWC45A, ANI: still of first frame, plasma cutting process
TWC45B, ANI: plasma cutting process, gas fed to torch, arc-starter sparking, pilot arc created, workpiece moves up into position, contact with pilot arc
TWC45C, CGS: Cathode

NARRATION (VO):

WHEN GAS IS FED TO THE TORCH, PART OF IT IS IONIZED BY THE HIGH-VOLTAGE ARC-STARTER BETWEEN THE CATHODE ELECTRODE IN THE TORCH AND THE TORCH TIP. WHEN THE POWER SUPPLY’S SMALL ‘DC’ CURRENT MEETS THIS HIGH VOLTAGE GAS, IT CREATES A PILOT ARC. THIS PILOT ARC LEAVES THE TORCH TIP AS A PLASMA JET AND BECOMES THE PATH FOR THE MAIN PLASMA ARC.

SCENE 46.
continue previous animation, workpiece moves up contacting pilot arc, forming main arc formed for cutting
TWC46A, CGS: Anode
TWC46B, SME4474, 19:34:26:00-19:34:39:00
plasma cutting operation starting

NARRATION (VO):

THE MAIN ARC FORMS WHEN THE PILOT ARC CONTACTS THE METAL’S SURFACE, WHICH THEN SERVES AS THE ANODE OF THE CIRCUIT. THE PILOT ARC THEN SHUTS OFF, AND THE CUTTING TORCH BEGINS OPERATION.

SCENE 47.
TWC47A, SME4474, 19:26:19:00-19:27:07:00
zoom out, height adjustment backing plasma torch off from beginning of cut, cutting process continuing

NARRATION (VO):

THE TORCH HAS AN AUTOMATIC HEIGHT CONTROL WHICH RAISES IT UP SLIGHTLY FOR CLEARANCE WHEN THE FIRST PUDDLE OF MOLTEN MATERIAL FORMS. ONCE THE METAL IS PIERCED, THE AUTOMATIC HEIGHT CONTROL RETURNS THE TORCH TO ITS INITIAL HEIGHT.

SCENE 48.
TWC48A, SME4474, 19:33:17:00-19:33:31:00
zoom out, molten metal blown through plasma cut
TWC48B, ANI: slag buildup on bottom of plasma cut
TWC48C, ANI: arrow

NARRATION (VO):

THE MOLTEN METAL IS BLOWN THROUGH THE CUT BY THE PLASMA STREAM. SOME OF THIS SLAG MAY COLLECT ON THE BOTTOM SURFACE, NEAR THE CUT.

SCENE 49.
TWC49A, SME4474, 19:27:21:00-19:27:39:00
zoom out, plasma cutting showing kerf
TWC49B, SME4470, 14:05:56:00-14:06:36:00
zoom out, fast plasma cutting operation

NARRATION (VO):

THE KERF WIDTH OF PLASMA CUTTING IS ROUGHLY EQUAL TO THE TORCH ORIFICE DIAMETER. PLASMA'S HEAT-AFFECTED ZONE IS NARROWER THAN IN THE OXY-FUEL PROCESS BECAUSE OF THE FASTER CUTTING SPEED. THE MORE POWER SUPPLIED TO THE PLASMA TORCH, THE FASTER THE CUTTING.

SCENE 50.
continue previous shot
TWC50A, ANI: tapered edge part on background
TWC50B, ANI: tapered edge part, kerf highlighted
TWC50C, ANI: tapered edge part, with magnifying glass image of rounded edge
TWC50D, ANI: magnifying glass as separate element

NARRATION (VO):

THE JET REMOVES MORE METAL FROM THE TOP OF THE KERF THAN FROM THE BOTTOM. THIS RESULTS IN SLIGHTLY BEVELED OR TAPERED CUTS. SOMETIMES THERE IS ALSO TOP-EDGE ROUNDING.

SCENE 51.
TWC51A, ANI: tapered edge part, kerf highlighted
TWC51B, ANI: top & bottom background masks
TWC51C, ANI: kerf gap highlighted
TWC51D, ANI: workpiece, kerf highlighted
TWC51E, ANI: background only
TWC51F, CGS: 1°-8°

NARRATION (VO):

DEPENDING ON THE CUTTING GAS AND MATERIAL TYPE, KERF ANGLES WILL RANGE FROM 1 TO ABOUT 8 DEGREES.

SCENE 52.
TWC52A, SME4467, 09:15:08:00-09:15:34:00
zoom in, plasma cutting operation

NARRATION (VO):

PLASMA CUTTING MAY BE USED ON ALL METALS, BUT IS ESPECIALLY EFFECTIVE ON

STAINLESS STEEL, ALUMINUM, AND OTHER NON-FERROUS, NON-OXIDIZING MATERIALS WHICH CANNOT BE CUT BY OXY-FUEL CUTTING.

SCENE 53.
TWC53A, SME4474, 19:31:48:00-19:32:02:00
zoom in, plasma cutting with water, air, or shielding gas

NARRATION (VO):

AIR, WATER, OR ANOTHER SHIELDING GAS REDUCES SMOKE AND IMPROVES THE CUT.

SCENE 54.
TWC54A, SME4470, 14:20:12:00-14:20:36:00
zoom in, plasma torch being used on cnc punch press
TWC54B, SME4470, 14:13:43:00-14:13:57:00
punch press punching holes
TWC54C, SME4470, 14:15:13:00-14:15:32:00
zoom out, plasma torch being used on cnc punch press

NARRATION (VO):

A PLASMA CUTTING TORCH IS SOMETIMES COMBINED WITH A COMPUTER NUMERICAL CONTROL, OR ‘CNC’ PUNCH PRESS FOR VERSATILITY AND EXTRA PRODUCTIVITY. THESE CNC MACHINES PUNCH INTERNAL HOLES WITH INTERCHANGEABLE PUNCHES AND DIES WHILE CUTTING CONTOURS USING THE PLASMA TORCH, SAVING PRODUCTION TIME.

--- FADE TO BLACK ---

SCENE 55.
TWC55A, CGS: Laser Cutting
white text, centered on background
FMP BKG, motion background

SCENE 56.
TWC56A, SME4455, 21:34:57:00-21:35:22:00
laser cutting part
TWC56B, SME4467, 09:53:22:00-09:53:36:00
laser cutting operation

NARRATION (VO):

LASER CUTTING USES A BEAM OF LASER LIGHT TO GENERATE HEAT FOR CUTTING METALS AND OTHER MATERIALS. LASERS OFFER SUPERIOR CUTTING PRECISION AND QUALITY COMPARED WITH OTHER METHODS, BUT ALSO REQUIRE HIGHER UP-FRONT EQUIPMENT INVESTMENT.

SCENE 57.
TWC57A, SME4468, 13:56:50:00-13:57:10:00

NARRATION (VO):

laser cutting opening in stamped part
TWC57B, CGS: Narrower Kerf
Narrower Heat-Affected Zone
Finer Edge
TWC57C, SME4474, 19:17:16:00-19:17:46:00
zoom in, laser performing narrow cut
TWC57D, SME4468, 13:47:57:00-13:48:18:00
contour cutting with laser
TWC57E, SME4444, 11:05:29:00-11:05:40:00
holemaking with laser
TWC57F, SME4468, 13:58:13:00-13:58:23:00
non-circular hole being lasered

LASERS' ADVANTAGES OVER OTHER THERMAL CUTTING PROCESSES INCLUDE A NARROWER KERF, NARROWER HEAT-AFFECTED ZONE, AND FINER EDGE. CUTS WITH A LASER CAN BE SMOOTHER THAN WITH THE OTHER THERMAL PROCESSES, AND MAY REQUIRE NO SECONDARY EDGE FINISHING. LASERS ARE COMMONLY USED TO CUT FLAT SHEET METAL STOCK...,
CONTOUR-CUT PREVIOUSLY FORMED WORKPIECES...,
OR GENERATE HOLES THAT ARE CIRCULAR...,
AND NON-CIRCULAR RAPIDLY.

SCENE 58.
TWC58A, SME4468, 13:40:47:00-13:41:16:00
zoom out, laser cutting workpiece

NARRATION (VO):

LASER CUTTING ALSO HAS LIMITATIONS.
ALONG WITH ITS HIGH CAPITAL EXPENDITURE, IT'S GENERALLY COST-EFFECTIVE ONLY FOR MATERIALS UP TO ONE-HALF INCH OR 13 MILLIMETERS THICK, ALTHOUGH THICKER MATERIALS CAN BE CUT. AND HIGH-REFLECTIVITY METALS SUCH AS ALUMINUM CAN BE MORE DIFFICULT TO CUT THAN STEEL.

SCENE 59.
TWC59A, SME4475, 20:05:05:00-20:05:36:00
wide, laser operation
TWC59B, CGS: LASER, highlight first letter of each word
TWC59C, CGS: LASER, words appear from letters: Light Amplification by the Stimulated Emission of Radiation
TWC59D, ANI: laser, coherent light
TWC59E, ANI: light bulb, random light

NARRATION (VO):

THE TERM 'LASER' IS AN ACRONYM FOR LIGHT AMPLIFICATION BY THE STIMULATED EMISSION OF RADIATION. A LASER PRODUCES AN INTENSE BEAM OF COHERENT LIGHT, AS OPPOSED TO ORDINARY RANDOM LIGHT.

SCENE 60.
TWC60A, SME4471, 15:05:48:00-15:06:09:00

NARRATION (VO):

laser cutting operation
TWC60B, ANI: principle of how a laser works, electrons generated, flowing through tube of gas
TWC60C, CGS: Cathode
TWC60D, CGS: Anode

LET'S EXAMINE HOW A LASER BEAM IS PRODUCED. WHEN A LASER'S HIGH VOLTAGE POWER SUPPLY IS ACTIVATED, THE CATHODE IN THE LASER GENERATES ELECTRONS WHICH FLOW THROUGH A TUBE OR ENCLOSED CAVITY TOWARD THE ANODE. THE TUBE CONTAINS CARBON DIOXIDE GAS OR USES ANOTHER LASING MEDIUM.

SCENE 61.
TWC61A, ANI: continue, principle of how a laser works, electrons colliding with gas atoms, raising, then falling, producing photon, process continuing
TWC61B, CGS: Photon
TWC61C, ANI: continue, principle of how a laser works, photon hitting other energized atoms, those atoms giving off photon in same phase

NARRATION (VO):

WHEN AN ELECTRON COLLIDES WITH A GAS ATOM, ONE OF THE ELECTRONS FROM THAT ATOM ABSORBS ENERGY AND JUMPS TO A HIGHER ORBIT. WHEN THAT ELECTRON FALLS BACK TO ITS EARLIER ORBIT, IT LOSES THIS EXTRA ENERGY IN THE FORM OF A PHOTON OF LIGHT. WHEN THIS PHOTON HITS ANOTHER ENERGIZED ATOM IN THE CO2 GAS, THAT ATOM GIVES OFF ITS OWN PHOTON HAVING THE SAME WAVELENGTH AND TRAVELS IN THE SAME DIRECTION AND PHASE AS THE FIRST PHOTON.

SCENE 62.
TWC62A, ANI: continue, principle of how a laser works, photons bouncing between two mirrors, becoming intense, beam bursts through one end of mirror

NARRATION (VO):

AS INCREASING NUMBERS OF PHOTONS ARE EMITTED FROM EXCITED ATOMS, THEY BOUNCE BETWEEN TWO MIRRORS UNTIL A FRACTION OF THE INTENSE BEAM BURSTS THROUGH A PARTIALLY REFLECTIVE AND PARTIALLY TRANSMISSIVE MIRROR AT ONE END -- THIS IS THE LASER BEAM.

SCENE 63.
TWC63A, SME4444, 11:26:14:00-11:26:27:00
zoom out, laser beam cutting part
TWC63B, SME4471, 15:20:53:00-15:21:23:00
zoom out, laser beam cutting part

NARRATION (VO):

A LASER BEAM CAN BE SUPPLIED AS A CONTINUOUS WAVE OR IN A SERIES OF BURSTS OR PULSES. A BEAM CAN ALSO BE FOCUSED INTO A SPOT SIZE DIAMETER OF LESS THAN ONE ONE-HUNDREDTH OF AN INCH, OR ONE-QUARTER OF A MILLIMETER. THE BEAM'S ENERGY HEATS, MELTS, OR VAPORIZES THE WORKPIECE MATERIAL.

SCENE 64.
continue previous shot

NARRATION (VO):

A LASER'S PERFORMANCE CAN BE ENHANCED BY USING ASSIST GASES OR LIQUIDS.

SCENE 65.
TWC65A, SME4465, 07:22:23:00-07:23:08:00
inert gas used with laser
TWC65B, CGS: Inert Gas
Reactive Gas
TWC65C, SME4465, 07:08:47:00-07:09:23:00
inert gas used with laser, alternate shot

NARRATION (VO):

FOR EXAMPLE, A HIGH-PRESSURE GAS JET CAN BE USED TO BLOW MOLTEN MATERIAL AWAY FROM THE CUT. THE GAS MAY BE EITHER AN INERT GAS -- TO PROVIDE A CLEAN, OXIDE-FREE CUT -- OR A REACTIVE GAS SUCH AS OXYGEN -- TO INCREASE CUTTING SPEED.

SCENE 66.
TWC66A, SME4467, 09:54:07:00-09:54:46:00
co2 laser cutting part
TWC66B, CGS: CO_2 Gas Laser
Neodymium-Doped
Yttrium-Aluminum Garnet/
YAG Solid-State Laser
TWC66C, SME4468, 13:25:27:00-13:25:52:00
zoom out, fiber optic lasering

NARRATION (VO):

LASER TYPES ARE NAMED FOR THEIR LASING MEDIUMS. THE MOST COMMONLY USED LASERS FOR CUTTING ARE THE CO2 GAS LASER, AND THE NEODYMIUM-DOPED YTTRIUM-ALUMINUM GARNET, OR 'YAG', SOLID-STATE LASER. ANOTHER SOLID-STATE LASER WHICH HAS GROWN IN IMPORTANCE IS THE FIBER LASER,

IN WHICH A LASER BEAM IS PRODUCED BY THE EXCITATION OF PHOTONS ALONG A LONG OPTICAL FIBER.

SCENE 67.
TWC67A, SME4468, 13:26:13:00-13:26:54:00
zoom out, fiber laser cutting operation
TWC67B, CGS: Laser
Beam Delivery System/
Beam Optics
CNC/Robotic Motion-Control
System for the Beam/Workpiece
Enclosure
Provisions for Fume Exhaust

NARRATION (VO):

ALL LASER CUTTING SYSTEMS HAVE CERTAIN COMPONENTS, INCLUDING:
A LASER,
A BEAM DELIVERY SYSTEM, INCLUDING BEAM OPTICS,
A CNC OR ROBOTIC MOTION-CONTROL SYSTEM FOR THE BEAM AND/OR WORKPIECE,
AN ENCLOSURE,
AND SOMETIMES PROVISIONS FOR FUME EXHAUST.

--- TOUCH BLACK ---

SCENE 68.
TWC68A, SME4460, 02:10:00:00-02:10:47:00
zoom out, 3d contouring with multi-axis robot
TWC68B, SME4455, 21:25:08:00-21:25:29:00
3d contouring with multi-axis robot

NARRATION (VO):

FOR 3-D CONTOUR CUTTING OF PREVIOUSLY FORMED SHEET METAL, LASERS MAY BE PAIRED WITH FIVE- OR SIX-AXIS ROBOTS. THE ROBOT-GUIDED LASER CAN OPERATE AT ANY ANGLE TO THE WORK. SENSORS ENSURE THAT THE LASER BEAM AND ITS FOCAL POINT ARE IN OPTIMUM POSITION RELATIVE TO THE METAL SURFACE.

SCENE 69.
TWC69A, SME4478, 08:43:38:00-08:44:26:00
laser being used on cnc turret punch press, 4478-015

NARRATION (VO):

AS WITH PLASMA CUTTING, A LASER SYSTEM CAN BE COMBINED WITH A COMPUTER

NUMERICAL CONTROLLED PUNCH PRESS FOR HIGH FLEXIBILITY, WITH THE LASER PERFORMING SOME OF THE OPERATIONS THAT WOULD BE DIFFICULT OR INEFFICIENT FOR THE PRESS OR PUNCHES TO DO.

--- TOUCH BLACK ---

SCENE 70.
TWC70A, SME4375, 05:15:20:00-05:15:30:00
laser holemaking on sheet metal
TWC70B, SME4375, 05:17:32:00-05:17:46:00
laser holemaking on tube
TWC70C, SME4456, 22:04:50:00-22:05:15:00
zoom out, laser holemaking, multiple holes

NARRATION (VO):

BECAUSE OF ITS SPEED, AUTOMATION, AND ABILITY TO PENETRATE VERY HARD MATERIALS, LASER HOLEMAKING IS A NON-CONTACT ALTERNATIVE TO CONVENTIONAL DRILLING PROCESSES.

SCENE 71.
TWC71A, SME4375, 05:10:50:00-05:11:08:00
laser holemaking on stamping
TWC71B, SME4475, 20:07:42:00-20:07:52:00
laser holemaking operation
TWC71C, SME4460, 02:07:52:00-02:08:06:00
zoom out, laser holemaking

NARRATION (VO):

LASER HOLEMAKING IS MOST OFTEN PERFORMED BY TREPANNING, IN WHICH THE FOCUSED LASER BEAM CUTS IN A CIRCLE. TREPANNING IS USED TO PRODUCE HOLE DIAMETERS ABOVE TEN-THOUSANDTHS OF AN INCH, OR ONE-QUARTER OF A MILLIMETER.

--- FADE TO BLACK ---

SCENE 72.
TWC72A, CGS: Abrasive Waterjet Cutting
white text, centered on background
FMP BKG, motion background

SCENE 73.
TWC73A, SME4439, 06:08:56:00-06:09:20:00
zoom out, abrasive waterjet cutting of material

NARRATION (VO):

THE ABRASIVE WATERJET EROSION PROCESS USES ABRASIVE PARTICLES SUSPENDED IN A HIGH-PRESSURE STREAM OF WATER TO CUT A

WIDE RANGE OF MATERIALS.

SCENE 74.
TWC74A, SME4457, 23:25:10:00-23:25:43:00
zoom out, abrasive waterjet cutting steel

NARRATION (VO):

ABRASIVE WATERJET CUTTING GENERATES NO HEAT AND LEAVES NO HEAT-AFFECTED ZONE, MAKING IT AN ALTERNATIVE TO THERMAL CUTTING. IN ADDITION, IT RELEASES NO TOXIC FUMES, TOXIC WASTES, DUST, OR CHEMICALS.

SCENE 75.
TWC75A, SME4462, 04:13:56:00-04:14:16:00
zoom out, abrasive waterjet cutting of plastic shapes
TWC75B, SME4457, 23:34:46:00-23:35:05:00
abrasive waterjet cutting ceramic tiles
TWC75C, SME4457, 23:42:27:00-23:42:55:00
abrasive waterjet cutting of rubber
TWC75D, SME3921, 16:09:33:00-16:09:59:00
abrasive waterjet cutting of composites
TWC75E, SME4457, 23:19:44:00-23:19:56:00
abrasive waterjet cutting thick steel

NARRATION (VO):

ABRASIVE WATERJETS ARE GOOD OPTIONS FOR CUTTING MATERIALS THAT GUM UP SAWS OR ARE SENSITIVE TO HEAT. WATERJETS ARE GOOD AT CUTTING LAMINATES OF DIFFERENT MATERIALS, INCLUDING CONSTRUCTIONS OF METALS AND NON-METALS, GLASS, RUBBER, OR FIBER COMPOSITES. BOTH THICK AND THIN MATERIALS MAY BE CUT USING ABRASIVE WATERJET PROCESSES.

SCENE 76.
TWC76A, SME4438, 05:20:00:00-05:20:30:00
zoom in, waterjet cutting system operating

NARRATION (VO):

INITIAL CAPITAL COSTS FOR WATERJET EQUIPMENT FALL IN THE SAME RANGE AS THOSE FOR PLASMA CUTTING, WHILE WATERJET CUTTING CAN SUPPLY ACCURACIES CLOSE TO THOSE OF LASER CUTTING.

SCENE 77.
TWC77A, SME2815, 01:18:42:00-01:18:52:00
wide, pan, abrasive waterjet system
TWC77B, SME2815, 01:15:55:00-01:16:05:00
zoom out, intensifier pump, pan to waterjet cutting
TWC77C, SME2815, 01:21:12:00-01:21:21:00

NARRATION (VO):

THE COMPONENTS OF AN ABRASIVE WATERJET SYSTEM INCLUDE A HIGH-PRESSURE

pan, plumbing and tank, handling water
TWC77D, SME2815, 01:22:05:00-01:22:16:00
zoom out, plumbing and tank, handling water, alternate shot
TWC77E, SME2815, 01:04:12:00-01:04:24:00
tilt, gantry delivery system guiding the cutting head
TWC77F, SME2815, 01:03:10:00-01:03:22:00
zoom in, waterjet nozzle assembly, forming waterjet

INTENSIFIER PUMP TO PROVIDE THE STREAM OF WATER...,
THE PLUMBING AND A TANK OR CATCHER UNIT TO HANDLE THE WATER...,
A GANTRY, ROBOT, OR OTHER DELIVERY SYSTEM TO GUIDE THE CUTTING HEAD...,
AND THE NOZZLE ASSEMBLY UNIT, WHICH FORMS THE JET.

SCENE 78.
TWC78A, SME4457, 23:29:52:00-23:30:17:00
zoom out, hopper, abrasive material flowing into it
TWC78B, CGS: Hopper
Metering Valve
Mixing Chamber
TWC78C, SME2815, 01:06:00:00-01:06:13:00
zoom out, hopper, abrasive material flowing into it, loop end, alternate shot

NARRATION (VO):
THE ABRASIVE DELIVERY SYSTEM INCLUDES A HOPPER TO HOLD THE ABRASIVE MATERIAL,
A METERING VALVE,
AND A MIXING CHAMBER, WHICH MIXES THE ABRASIVE PARTICLES INTO THE WATER STREAM.

SCENE 79.
TWC79A, SME2815, 01:16:51:00-01:17:04:00
booster pump
TWC79B, SME2815, 01:16:28:00-01:16:46:00
zoom out, intensifier pump
TWC79C, SME4465, 07:45:41:00-07:46:11:00
zoom out, waterjet cutting operation, part cut off

NARRATION (VO):
INCOMING WATER FIRST PASSES THROUGH A FILTER AND A BOOSTER PUMP TO PRESSURIZE IT. THEN THE INTENSIFIER PUMP, A HYDRAULICALLY DRIVEN DOUBLE-ACTING RECIPROCATING-TYPE PUMP, INCREASES THE PRESSURE TO CUTTING LEVELS, USUALLY BETWEEN 30,000 AND 60,000 POUNDS PER SQUARE INCH, OR APPROXIMATELY 200 AND 400 MEGAPASCALS.

SCENE 80.
TWC80A, ANI: circle appears with close-up of water fed into mixing chamber, loop beginning
TWC80B, ANI: arrow

NARRATION (VO):
THE WATER IS THEN FORCED THROUGH A JEWEL ORIFICE INTO THE MIXING CHAMBER LOCATED

WITHIN THE CUTTING HEAD.

SCENE 81.
continue previous animation
TWC81A, SME4438, 05:47:13:00-05:47:42:00
zoom out, waterjet cutting operation

NARRATION (VO):

DRY GARNET ABRASIVE IS FED INTO THE MIXING CHAMBER. THERE THE WATER ACCELERATES THE PARTICLES TO SUPERSONIC VELOCITIES. THE HIGH-SPEED SLURRY IS FOCUSED VIA A FOCUSING TUBE AND EXITS THE NOZZLE IN A JET STREAM. THE GARNET ABRASIVE SUSPENDED IN THE WATERJET DOES OVER NINETY PERCENT OF THE CUTTING.

SCENE 82.
TWC82A, SME4457, 23:19:16:00-23:19:36:00
zoom out, waterjet cutting, emphasis on cut & kerf

NARRATION (VO):

WATERJET CUTTING’S KERF IS APPROXIMATELY EQUAL TO THE NOZZLE DIAMETER, AND IS RELATIVELY SMOOTH. THERE IS A SLIGHT TAPER IN THE KERF WALL WHEN CUTTING MATERIAL THICKER THAN 2 INCHES OR 50 MILLIMETERS.

SCENE 83.
TWC83A, SME4457, 23:22:50:00-23:23:04:00
zoom out, rough waterjet cutting to separate material
TWC83B, SME3921, 16:07:38:00-16:08:07:00
zoom out, fine, finished composite part cut with waterjet process

NARRATION (VO):

THE CUT FINISH IS PROPORTIONAL TO THE FEED-RATE, AND CAN VARY FROM A ROUGH CUT EDGE MADE MERELY TO ACHIEVE SEPARATION, TO A FAIRLY FINE, FINISHED EDGE.

SCENE 84.
continue previous shot
TWC84A, CGS: Waterjet Pressure
Nozzle Diameter
Abrasive Material Size
Abrasive Material Type
Abrasive Material Flow Rate
Traverse Speed
Cutting Angle
TWC84B, SME4438, 05:54:44:00-05:55:32:00
abrasive waterjet cutting operation, hole

NARRATION (VO):

THE CUT’S SURFACE CHARACTERISTICS VARY WITH WATERJET PRESSURE,
NOZZLE DIAMETER,
THE ABRASIVE MATERIAL SIZE,

finished

TYPE,

AND FLOW RATE,

TRAVERSE SPEED,

AND THE CUTTING ANGLE.

MAXIMUM DEPTH-OF-CUT IS ACHIEVED BY DETERMINING AN ABRASIVE SIZE AND FLOW RATE THAT ARE NEITHER TOO SMALL NOR TOO LARGE FOR THE PARTICULAR WORKPIECE.

SCENE 85.
TWC87A, SME4438, 05:05:41:00-05:05:52:00
waterjet system using multiple cutting heads
TWC87B, SME2815, 01:08:25:00-01:08:40:00
zoom out, waterjet cutting underneath the water

NARRATION (VO):

ABRASIVE WATERJET SYSTEMS CAN UTILIZE MULTIPLE CUTTING HEAD CONFIGURATIONS FOR PRODUCTION APPLICATIONS. ADDITIONALLY, SINCE THE WATERJET JET STREAM CAN BE NOISY, SOME CUTTING APPLICATIONS ARE PERFORMED UNDER WATER.

SCENE 86.
TWC88A, ANI: waterjet warning label
TWC88B, SME3921, 16:12:34:00-16:12:57:00
wide, robotic waterjet in secure booth

NARRATION (VO):

AN ABRASIVE WATERJET SYSTEM CAN EASILY CUT THROUGH PEOPLE AS WELL. PROPER MACHINE SHIELDING IS NEEDED AGAINST THE HAZARD OF HIGH-PRESSURE WATER, WITH SAFETY SYSTEMS TO SHUT OFF THE PRESSURE SHOULD AN ACCIDENT OCCUR.

--- FADE TO BLACK ---

SCENE 87.
FMP RVW, CGS: Review
white text, centered on background
FMP BKG, motion background

NARRATION (VO):

LET'S REVIEW THE MATERIAL CONTAINED IN THIS PROGRAM.

SCENE 88.
TWC06C, SME4462, 04:27:22:00-04:27:31:00

NARRATION (VO):

oxy-fuel cutting of steel plate
TWC06E, SME4470, 14:09:51:00-14:10:01:00
plasma cutting of metal
TWC06G, SME4471, 15:24:51:00-15:25:02:00
laser cutting of metal
TWC07A, SME4457, 23:58:40:00-23:58:51:00
waterjet cutting of part

THE PRINCIPAL NON-CONTACT CUTTING PROCESSES INCLUDE:

OXY-FUEL...,

PLASMA...,

LASER...,

AND ABRASIVE WATERJET CUTTING.

SCENE 89.
TWC11Q, composite nest of four cutting processes
TWC81A, SME4438, 05:47:13:00-05:47:42:00
zoom out, waterjet cutting operation
TWC09B, SME4443, 10:43:57:00-10:44:12:00
oxy-fuel cutting with multiple heads
TWC13A, SME4471, 15:19:11:00-15:19:28:00
laser cutting operation
TWC13B, SME4471, 15:17:36:00-15:18:00:00
person removing spatter off of part
TWC12A, SME4474, 19:38:08:00-19:38:32:00
plasma cutting of part
TWC12B, ANI: c.u. thermal cut part with heat affected zone
TWC12C, ANI: c.u. thermal cut part with heat affected zone highlighted

NARRATION (VO):

THE SIMILARITIES AMONG THESE PROCESSES ARE:

THEY CUT IN ONE PASS,

THEY USE NO CUTTING TOOLS,

THEY CUT ANY SHAPE THAT A CNC MACHINE OR ROBOT CAN FOLLOW,

AND PART EDGES MAY REQUIRE SECONDARY FINISHING. ADDITIONALLY, ALL THE THERMAL CUTTING PROCESSES CREATE A HEAT-AFFECTED ZONE THAT CAN ALTER WORKPIECE PROPERTIES NEAR THE CUT.

--- TOUCH BLACK ---

SCENE 90.
TWC06B, CGS: Oxy-Fuel Cutting
TWC18A, SME4441, 08:54:34:00-08:54:54:00
zoom out, oxy-fuel cutting of steel plate
TWC19A, ANI: cut away of two-part oxy-fuel torch, exterior preheating flame
TWC19B, ANI: cut away of two-part oxy-fuel torch, exterior preheating flame with jet of oxygen at the center
TWC19C, SME4443, 11:01:26:00-11:0156::00
c.u. oxy-fuel flame cutting of steel plate

NARRATION (VO):

THE OLDEST THERMAL METHOD, OXY-FUEL CUTTING, USES A TWO-PART TORCH -- A PREHEATING EXTERIOR OXY-FUEL FLAME, AND A JET OF HIGH-PURITY OXYGEN AT THE CENTER. CUTTING OCCURS FROM THE CHEMICAL REACTION BETWEEN THE OXYGEN AND A READILY OXIDIZED METAL IN THE PRESENCE OF HEAT.

--- TOUCH BLACK ---

SCENE 91.
TWC06D, CGS: Plasma Cutting
TWC39B, SME4474, 19:30:48:00-19:31:10:00
plasma cutting operation

NARRATION (VO):

PLASMA CUTTING USES AN ELECTRIC ARC COUPLED WITH A HIGH-VELOCITY JET OF ELECTRICALLY CONDUCTIVE GAS TO CREATE A PLASMA JET, WHICH IS CONCENTRATED IN A SMALL SPOT TO MELT METAL INSTANTANEOUSLY.

SCENE 92.
TWC16D, SME4474, 19:28:27:00-19:29:02:00
plasma cutting of part

NARRATION (VO):

PLASMA CUTTING MAY BE USED ON ALL METALS, BUT IS ESPECIALLY EFFECTIVE ON STAINLESS STEEL, ALUMINUM, AND OTHER NON-FERROUS, NON-OXIDIZING MATERIALS WHICH CANNOT BE CUT BY OXY-FUEL CUTTING.

SCENE 93.
TWC37A, SME4470, 14:11:16:00-14:11:45:00
zoom out, plasma cutting of part on punch press

NARRATION (VO):

A PLASMA CUTTING TORCH IS SOMETIMES COMBINED WITH A COMPUTER NUMERICAL CONTROLLED PUNCH PRESS FOR VERSATILITY AND EXTRA PRODUCTIVITY.

--- TOUCH BLACK ---

SCENE 94.
TWC06F, CGS: Laser Cutting
TWC56A, SME4455, 21:34:57:00-21:35:22:00
laser cutting part
TWC56B, SME4467, 09:53:22:00-09:53:36:00
laser cutting operation

NARRATION (VO):

LASER CUTTING USES A CONCENTRATED BEAM OF LASER LIGHT TO GENERATE HEAT. THE BEAM FROM A LASER MAY BE ONLY TEN-THOUSANDTHS OF AN INCH, OR ONE QUARTER OF A MILLIMETER, IN DIAMETER.

SCENE 95.
TWC63A, SME4444, 11:26:14:00-11:26:27:00
zoom out, laser beam cutting part
TWC63B, SME4471, 15:20:53:00-15:21:23:00
zoom out, laser beam cutting part

NARRATION (VO):

LASERS PRODUCE A NARROWER KERF, A NARROWER HEAT-AFFECTED ZONE, AND A FINER EDGE THAN OTHER THERMAL CUTTING PROCESSES. IT IS MOST EFFECTIVE ON THINNER MATERIAL.

SCENE 96.
TWC58A, SME4468, 13:40:47:00-13:41:16:00
zoom out, laser cutting workpiece
TWC66B, CGS: CO_2 Gas Laser
Neodymium-Doped
Yttrium-Aluminum Garnet/
YAG Solid-State Laser
TWC66C, SME4468, 13:25:27:00-13:25:52:00
zoom out, fiber optic lasering

NARRATION (VO):

THE MAIN TYPES OF LASERS FOR CUTTING ARE THE CO2 GAS LASER,
AND THE NEODYMIUM-DOPED YTTRIUM-ALUMINUM GARNET, OR ‘YAG’, SOLID-STATE LASER.
THE SOLID-STATE FIBER LASER IS ANOTHER TYPE WHICH HAS GROWN IN IMPORTANCE IN RECENT YEARS.

--- TOUCH BLACK ---

SCENE 97.
TWC07B, CGS: Abrasive Waterjet Cutting
TWC73A, SME4439, 06:08:56:00-06:09:20:00
zoom out, abrasive waterjet cutting of material
TWC75D, SME3921, 16:09:33:00-16:09:59:00
zoom in, abrasive waterjet cutting of composites

NARRATION (VO):

THE ABRASIVE WATERJET CUTTING PROCESS USES GARNET ABRASIVE SUSPENDED IN A HIGH-PRESSURE STREAM OF WATER TO CUT A WIDE RANGE OF THICK...,
AND THIN METAL AND NON-METAL MATERIALS.

SCENE 98.
TWC74A, SME4457, 23:25:10:00-23:25:43:00
zoom out, abrasive waterjet cutting steel

NARRATION (VO):

ABRASIVE WATERJET CUTTING GENERATES NO HEAT AND LEAVES NO HEAT-AFFECTED ZONE, MAKING IT AN ALTERNATIVE TO THERMAL CUTTING.

SCENE 99.
TWC77A, SME2815, 01:18:42:00-01:18:52:00
wide, pan, abrasive waterjet system
TWC77B, SME2815, 01:15:55:00-01:16:05:00
zoom out, intensifier pump, pan to waterjet cutting
TWC77C, SME2815, 01:21:12:00-01:21:21:00
pan, plumbing and tank, handling water
TWC77D, SME2815, 01:22:05:00-01:22:16:00
zoom out, plumbing and tank, handling water, alternate shot
TWC77E, SME2815, 01:04:12:00-01:04:24:00
tilt, gantry delivery system guiding the cutting head
TWC77F, SME2815, 01:03:10:00-01:03:22:00
zoom in, waterjet nozzle assembly, forming waterjet

NARRATION (VO):

THE COMPONENTS OF AN ABRASIVE WATERJET SYSTEM INCLUDE A HIGH-PRESSURE INTENSIFIER PUMP TO PROVIDE THE STREAM OF WATER...,

THE PLUMBING AND A TANK OR CATCHER UNIT TO HANDLE THE WATER...,

A GANTRY, ROBOT, OR OTHER DELIVERY SYSTEM TO GUIDE THE CUTTING HEAD...,

AND THE NOZZLE ASSEMBLY UNIT, WHICH FORMS THE JET.

--- FADE TO BLACK ---

SCENE 100.
continue music, up and under
TWC CRX, CGS, ROLL: credits
white text, fade up mid-screen
FMP EXM, extended motion background

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SCENE 101.
continue motion background
FMP DIS, CGS: disclaimer
white text, centered on background

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 102.
FMP SME, SME logo open, with music