BEST'S HAZARD INDEX

Line	Best's Hazard Index	Underwriting Comments
Automobile Liability	6	Frequent travel to client sites.
Automobile Physical Damage	0	
General Liability: Premises and Operations	8	Welding done on client sites; fire exposures.
Product Liability and Completed Operations	7	Certification important.
Environmental Impairment Liability	2	Applies only to workshop operations.
Professional Liability	0	
Workers' Compensation	8	Training and personal protective equipment important.
Crime	1	Slightly higher w/tools on premises.
Fire and E.C.: Property	4	Much higher with on-premise welding.
Business Interruption	3	Higher with on-premises welding.
Inland Marine	4	Higher with Bailee exposure.
Boiler and Machinery: Equipment Breakdown	0	

Low 1-3, Medium 4-6, High 7-9, Very High 10

SIC CODES AND CLASSIFICATIONS

1791	Structural Steel Erection
1799	Special Trade Contractors, Not Elsewhere Classified
3398	Metal Heat Treating
7692	Welding Repair

NAICS CODES AND CLASSIFICATIONS

238120	Structural Steel and Precast Concrete Contractors
238190	Other Foundation, Structure, and Building Exterior Contractors
332312	Fabricated Structural Metal Manufacturing
332811	Metal Heat Treating
811310	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance

RELATED CLASSIFICATIONS

Boiler Maintenance Contractors
Machine Shops
Ornamental Metalworking
Sheet Metal Work

SPECIAL EXPOSURES

Hot slag, sparks
Metal fumes
Transportation and storage of gas cylinders
Welding off premises
Pressure vessel welding
Ultraviolet radiation

RISK DESCRIPTION

Welding and brazing are hot work processes which use intense heat to join two pieces of metal. Welding heats the metal pieces to such temperatures that they become molten and join together. Brazing introduces a filler metal which is heated to join two pieces of metal. Cutting uses high temperatures to cut a piece of metal. There are three types of welding -- resistance, structural and pressure -- and two major methods -- electric arc and gas. For more information on the different methods, see Process or Service. This write-up will focus on welding hazards, although they do not differ greatly for brazing and cutting operations.

Welding, cutting and brazing are used in nearly every industrial classification. They can be used for applications as simple as joining two pieces of piping or as complex as constructing a bridge or building a submarine or nuclear reactor. Welding is done on repairs as well as new construction. Some welders are certified to do all types of welding; others will specialize in operations such as truck frame straightening, pipe welding, boiler repair or structural welding. Welding is also used in jewelry manufacture and repair, silversmithing and sculpture. See related classifications such as Silversmiths, Ornamental Metalworking and Jewelry Stores for information on such industries.

Welders may be permanent employees (e.g., on the maintenance/repair staff) or may work as contractors on a per-job basis. In this write-up, the welder will be considered a contractor -- one who performs welding operations for other people -- and the Hazard Index numbers will reflect this. The same processes and exposures will apply to welders in any industrial setting.

Welders may be unionized. They may operate out of a workshop or do much of their welding at client sites (e.g., in plants, in ships or on bridges). Some welders offer 24-hour service for crucial services such as boiler repair. Some also offer a pickup and delivery service. Welders may specialize in residential, commercial or industrial work.

Because an open flame is used and a wide variety of fumes are produced, welding is one of the most hazardous occupations. Management must have strict safety and health procedures, and these must be followed to the letter.

Welding may be done manually or mechanically. In automated welding, the machine will be controlled by a welding operator. Welding machines are used in some production processes because the nature of the task and the pieces to be welded are relatively uniform. The exposures associated with welder operators may be considerably less hazardous than those for welders; for more information, see Machine Shops.

Many industrial fires are caused by welding. According to surveys conducted by Industrial Risk Insurers, welding and cutting fires in 1989 had an average dollar loss of $191,000, and accounted for 5.4% of all fires. This is an increase from 1988, in which average dollar losses were $36,700, but welding fires as a percentage of total fires decreased from 1988's 7.1%.

In the past 20 years, welding processes have become more complex and exact. Lasers are being used more in welding where there is a high volume of repetitive welds, such as in robotics in assembly line operations, and in automobile manufacturing. Lasers are practical tools for most welding because few substances can withstand the energy flux of a high-powered laser beam. Lasers are used in situations where electrodes or physical contact is not desired or when minute quantities of high melting point metals are involved. This type of welding minimizes the size of the heat-affected area and the thermal damage to adjacent parts; lasers are also used in cutting functions. Lasers can have definite cost benefits; the equipment can, however, be expensive to install.

Can manufacturers are experimenting with laser welding instead of using the traditional resistance welding (in which an electric current is sent through a series of resistors in a circuit, producing enough heat and pressure to fuse the metal pieces together). The laser welding process is computer controlled, and officials say this method cuts production costs and lowers energy usage, but the speed is slower and the production rate is decreased.

To a certain extent, welding is becoming automated. Some manufacturers are testing arc-welding robots. Large, automatic welding machines, guided by computers, are used in industries such as shipbuilding. Shipbuilding also uses computers in steel plate cutting.

The American Welding Society (AWS) is the trade association for the industry. They set standards and certify welders in structural welding. The American Society of Mechanical Engineers (ASME) sets standards and certifies welders in pipe and pressure vessel welding.

Training and experience are very important in welding, but it also takes several years of on-the-job training for a welder to become skilled. Vocational schools and community colleges offer classes in welding. Welders need manual dexterity, good eyesight and good eye-hand coordination. Skilled welders can advance to positions as welding inspectors, technicians and supervisors. Welding engineers, who are college educated, develop new applications for welding.

MATERIALS AND EQUIPMENT

Welding torches, welding guns, power supplies, fuel supply, gas line or diesel-powered electric generators, electrical transformers, control mechanisms, cable, electrodes, electrode holders, clamps, hand tools, gases, gas cylinders, wire, wire feeder, fluxes and metal, vacuum pumps, transformer, transducer, refractory chamber, heat lamps, bell jar or retort.
Forge, anvil, exploding charges, tool dies, punch press.
Solvents: degreasers, cleaning agents.
Welding machines.
Personal protective equipment: welding helmet, leather apron and leggings, heating protection, gauntlet-type gloves, respirators.

PROCESS OR SERVICE

Welding is the process of joining two pieces of metal by fusing them with heat. This can be done by electric arc welding or gas welding. Resistance welding, an electric process, is the most widely used method. In this process, the welding arc converts electric energy into heat. The most common type of gas welding is oxyacetylene welding, in which a flame temperature of approximately 5,500o F is obtained through the controlled combustion of oxygen and acetylene.

Resistance welding is used in mass-produced sheet metal goods such as household appliances, automobile bodies, truck, trailer and railroad car bodies, vacuum tubes and electronic components. Equipment is usually permanently installed. In resistance welding, heat is generated at the joint by resistance to the electric current.

In gas welding, metals are joined by heating them with the flame from the combustion of a fuel gas or gases. Pressure and a filler metal may also be used.

In brazing, parts are joined by a heated filler metal. It is often used in jewelry making and in silversmithing. The filler metal and the flux are applied to the parts, which are heated in an oven or with a gas torch. The temperature is too low to melt the parts, but high enough to melt the filler metal, which melts into the joints and welds the parts together. This filler has a melting temperature over 800o F, but lower than the melting temperature of the base metal. The major brazing fillers are copper, tin, zinc and silver alloys.

Soldering unites two pieces of metal with a nonferrous filler material that has a melting point of less than 800o F. Lead and tin alloys are often used for soldering.

In oxygen cutting, the metal is severed or removed by the chemical reaction of the base metal with oxygen and the high temperature.

Before welding, brazing or cutting takes place, the metal surfaces must be cleaned and prepared. This may involve the application of some type of solvent. The area is then ready to be welded after the area has been cleared of all combustible materials.

A detailed description of the various types of welding and associated hazards is found in the chart at the end of the write-up.

NARRATIVE LINES OF LIABILITY

Automobile Liability

The Automobile Liability exposure will depend on whether the insured does welding on premises or on site. Most insureds do some type of workshop welding, but some may specialize in on-site work. Contractors who do extensive traveling will have an increased exposure.

Where does the insured work -- in the workshop or on-site? The insured may pick up smaller pieces, such as those for silver brazing or furniture, weld them on premises and deliver them when the job is completed. How does the insured obtain supplies? Larger companies may have supplies delivered because of the quantities involved. Smaller insureds may have to pick up their own. How often are such trips made?

Determine how often the insured travels to client sites. What is the radius of operations? Although some insureds set their own limit, such as 50 miles, the radius will typically depend on the size of the operation. Small shops will operate in a local area or county-wide; larger operations may travel to different states, as do insureds who specialize in a specific industry. Does the insured have a service-type contract with some clients and frequently travel to the same sites? What are the hazards of frequently traveled routes?

Does the insured offer 24-hour or emergency service? The exposure will increase if the insured often travels to unfamiliar locations during the night.

Contractors will have vans or small trucks. What are the age, type, condition and number of the insured's vehicles? Larger insureds may have a fleet exposure. Obtain MVRs on all drivers. Are commercial driver's licenses needed? Personal vehicles may be used for errands; check certificates of insurance.

How is equipment secured in transit? Vehicles must be specially adapted with racks to hold supplies in place. It is important that oxygen and gas tanks do not come loose and roll around, thereby distracting the driver; loose tanks also create an explosionhazard. The insured must follow all Department of Transportation (DOT) regulations regarding the transportation of gas cylinders and hazardous materials. Does the insured transport fuel tanks such as propane or natural gas? All DOT regulations must be followed.

Where are vehicles garaged when not in use? The underwriter should determine what type of maintenance schedule the insured follows.

General Liability: Premises and Operations

The operations hazard -- specifically the chance of fire -- will be severe if the insured does the majority of his welding at the client's site. The potential for and the severity of losses for damage to the client's premises are great. In addition to damage resulting from a fire, liability can include losses due to interruptions of the claimant's business. The underwriter may want to recommend a high deductible to limit the number of claims filed for small fires.

The extent of the exposure will be determined by the type of work the insured does. Clients may be commercial, industrial or residential. The insured may do welding on his own premises, on the client's premises, such as in a residence or factory, or on another job site of the client, such as a bridge or ship. What type of clients does the insured have, and where is most of the welding done?

The exposure will be greater if the insured does welding on a residential site because such sites will not have sprinkler systems. The insured must be extra careful in evaluating the potential fuel load. The same precautions must be taken as when working on an industrial site.

If the insured works outdoors, such as on new construction or bridges, the fire potential may not be as great as that for indoor welding.

If working in an industrial site such as a warehouse, the insured must determine the flammability of the contents and clear as much material as possible out of the welding area. The insured must have the client's cooperation in this matter before welding can begin, and the client's employees should handle all the moving.

When doing any welding, all spectators must be cleared from the area as they will be exposed to the same hazards as workers but lack the awareness of such hazards and the correct personal protective equipment. For example, bystanders may trip over equipment or be hit by stray sparks. How does the insured restrict access to work sites? If possible, work areas should be roped off or barricaded to keep out curious bystanders. Screens should be set up around the welding area to block ultraviolet radiation. In all cases, warning signs must be posted. The intensity of light may cause eye or skin damage. How does the insured alert people that welding will start and that they must clear the area? Those workers that must remain should be supplied with the correct personal protective equipment.

The insured should keep all work sites as neat as possible and refrain, if possible, from stretching wires or cords across walkways. Welders may, at times, elevate wires and hoses across walkways. All debris should be cleaned up before workers leave each day. Metal pieces that retain heat should be marked as hot, and the client and employees should be told not to touch them. Does the insured have a procedural and accountability program to ensure that all steps needed to protect third parties are taken? A specific program and written checklist can keep safety procedures consistent, even when the insured is working under unfamiliar conditions. For more information on safety hazards and the required personal protective equipment, see Workers' Compensation.

Before beginning work, the insured should evaluate the client's sprinkler system; some industrial operations may shut sprinklers off when hot work is being conducted, particularly if rate-of-rise heat detectors are used. If at all possible, the part should be removed from the plant and welded in a workshop. The insured should always carry portable extinguishers and not rely on clients' extinguishers. For additional information on specific hazards and loss control measures, see Fire and E.C.

The underwriter should examine all contracts and hold-harmless agreements between the insured and clients. Contracts should clearly state who has responsibility for damage and what procedures must be followed before hot work can begin. Most contracts assign the contractor the responsibility for the safety of welding and cutting operations. Contracts should also state whether the work area and the equipment or materials in it are considered to be in the insured's care, custody or control. This may vary from job to job. The contract should state in detail the work to be done and what materials will be used, so the client may alert his workers to potential hazards. If the

client lacks specific knowledge of welding hazards, the insureds should be prepared to provide material safety data sheets (MSDSs) and other health and safety information on welding materials and processes, so both the client and the insured remain in compliance with the OSHA Hazard Communication Standard. The contract should also specify pricing and how long the job will take.

Does the insured own or rent the welding equipment? If equipment is rented, the underwriter should read all rental agreements. The insured may also have contracts with suppliers and repair personnel. Check these contracts as well.

Does the insured ever subcontract out parts of a job? Are all subcontractors certified? How does the insured verify the qualifications of subcontractors? The underwriter should check the reliability of regularly used subcontractors and obtain certificates of insurance.

If the insured does most of his work on his premises, he may have clients pick up or drop off pieces, such as wrought iron furniture, to be worked on. All clients should remain in the office area and not be allowed in the work area. What is the condition of the office area? Rules of good housekeeping should be followed.

Does the insured store any metal pieces or do welding outdoors? If so, the premises must be fenced to prevent people from entering. For more information on premises security, see Crime.

If the insured rents the premises, the insured may wish to consider Fire Legal Liability coverage.

Product Liability and Completed Operations

The Completed Operations exposure could be severe depending on the insured's clients and the type of welding (i.e., structural or pressure vessel) done. In some cases, such as pressure vessel welding, the loss may result from an explosion caused by a faulty weld; after the fact, however, it may be difficult to determine if the insured's faulty work caused the explosion.

Insureds may work in commercial, industrial or residential areas. Claims in industrial operations could be more costly because it is more likely that extensive damage will occur. The loss potential of industrial welding can vary widely with the nature and use of the welded piece. For example, a faulty weld in a bridge could have disastrous results. A faulty weld in a storage tank could allow hazardous materials to leak into the ground, or an explosion could occur.

Claims could result from pipes or boiler seams bursting in homes or industrial operations. This could result in extensive property damage both from the force of the explosion and from resulting water damage.

Improperly welded pressure vessels as small as an oxygen tank or as large as a pressurized tank truck could burst as a result of pressure building on the faulty weld. This exposure is potentially the most severe, as the entire pressure vessel, not just the improperly welded area, could burst.

A faulty weld in furniture could cause the piece to collapse under strain; the same thing could happen to staircases, fire escapes and railings, and the results could be more severe. In addition, faulty welding or cutting done on machines or machine parts could cause the machine to malfunction or pieces to become loose while the machine is in operation.

Training and certification are of the utmost importance to the insured. Both the American Society of Mechanical Engineers (ASME) and the American Welding Society (AWS) offer testing and certification procedures for welders. The ASME certifies welders in pipe and pressure vessel welding; the AWS certifies welders in structural welding. Does the insured specialize in structural or pipe and pressure vessel welding? Does the insured have the proper certification, or is he in the process of applying? It is a positive underwriting sign if the insured and all senior welders or supervisors are certified. What percentage of the insured's employees are certified? Some certifications have to be renewed every three months, others every year or three years. Are all of the certifications current? Has the insured ever had his certification or license revoked? State and local laws will also require certain permits and/or licenses. Is the insured in compliance with all such regulations?

What type of training does the insured and his employees have? All welders should, at a minimum, receive training from a vocational program. The insured may have an on-the-job training program. Does the insured have such a program? It is a positive underwriting sign if the insured has some type of ongoing training program and encourages and reimburses employees for complete welding classes and seminars. Assess the quality of the training program and the experience and qualifications of all instructors.

The insured may work with architects and engineers in completing jobs. Does the insured do any design work?

Because of the wide range of potential losses, which depend to a large extent on the nature of each job and client, underwriting considerations should focus on the insured's loss prevention and control program and procedures.

Before starting any job, the insured must discuss the exact use of the piece with the client and carefully evaluate the job to determine what welding is needed. Who determines what type of weld needs to be made and, if needed, what type of flux is used? An incorrect calculation could cause undue stress on the weld. Are all materials of the correct grade for the job?

When welding pressure vessels and pipes, the weld must be strong enough to withstand the pressure exerted from within. The insured must follow the welding standards set by ASME and AWS. Adequate time should be allotted for each job so that workers do not feel they must rush, which can cause workers to do the job incorrectly.

What are the insured's hiring criteria? Background checks, including the verification of all welding certifications, should be conducted on all potential employees. New employees should never be allowed to perform tests or weld without a supervisor. In one incident, a new employee falsified test results while checking welds; the faulty welds were found before any damage was done, but the potential for millions of dollars of damage existed.

What does the insured's loss history reveal? Does the insured do primarily new projects or make repairs? Is the welding done primarily on site or in a workshop?

How does the insured ascertain that the tools and materials are correct for the job (e.g., that the correct flux, if needed, is used, that the most appropriate type of welding is done)? All work must be evaluated thoroughly after welding, particularly when doing repairs. What tests does the insured perform to check for faults in welds? There are quality control devices available, but their findings can be subjective. What devices does the insured use? What training does he have in results interpretation? Rewelding to correct errors may

weaken joints.

What kind of quality control procedures does the insured employ? What kinds of tests are run on welds to assure that there are no faults or weak spots in them? Does the insured employ a certified welding inspector? It is a positive underwriting sign if the insured has a certified welding inspector check difficult welds.

If the insured installs railings on public buildings, they must conform to local building codes and ASTM standards. Boilers and pressure vessels must conform to state and local codes and must also follow ASME standards. Does the insured use the correct grade of metal for each job? The correct material depends on the project's dimensional and structural loading criteria as established by regulatory agencies, local building codes or special design requirements. ASTM provides standards for dimensional and strength requirements. Is the insured in compliance with them?

What is the condition of the equipment? It should be maintained according to manufacturer recommendations. Does the insured rent equipment? If so, he may be unfamiliar with how to operate it, and this may increase the chances of injury or accident.

Environmental Impairment Liability

If the insured does most of his work on his premises, there may be a slight Environmental Impairment Liability exposure. Possible hazardous materials include solvents used to clean and degrease metal pieces before welding is done. (See Workers' Compensation for information on solvents.) What solvents does the insured use and how are they disposed of? Small amounts may be disposed of in municipal waterways. Larger amounts may have to be carted away by an EPA-certified hazardous waste hauler. How much waste does the insured generate and how are large amounts disposed of? The underwriter should determine if the insured is in compliance with Environmental Protection Agency (EPA) requirements concerning the disposal of hazardous wastes.

The insured may also dispose of oil and grease. Small amounts can be disposed of in municipal waterways. What are the municipal O&G limits? How much oil and grease does the insured generate?

Any oil, grease, solvents or fluxes stored on the premises must be kept in metal containers, and the rooms where containers are stored should have a non-permeable floor and a raised ledge around the edge to contain any spills.

There may also be a noxious gas exposure from welding fumes. This will depend on the type of welding done. Assess the condition and efficiency of the insured's ventilation system. Air scrubbers may be needed.

The insured may heat-treat welds (i.e., heat the weld to a specific temperature to relieve stress) particularly in pressure vessels. Cyanide salts may be used in the process. How does the insured dispose of such hazardous materials?

Workers' Compensation

The Workers' Compensation exposure is severe for welders, but there are specific precautions that can be taken to prevent or limit injury. Employee training is very important, as are specific safety procedures and use of the correct personal protectiveequipment. The exposures will be largely the same whether the insured works on his own premises or at the client's site. It will be more difficult, however, to control hazards or implement loss control measures at the client's site. Does the insured have a procedural and accountability program to ensure that loss control measures are fully implemented at each job site?

The insured must comply with OSHA's code on welding, brazing andcutting. In early 1991, OSHA announced that it would revise its Welding, Cutting and Brazing standard (29 CFR 1910.252). The standard was reorganized in April, 1990, and will be revised again in the future; as of this writing, OSHA has not set any dates for the final rule. The underwriter should keep abreast of any new developments. The underwriter must also be aware of all state regulations and verify the insured's compliance with them.

The health hazards will depend on the type of welding or cutting being done, the type of filler metals, fluxes, coatings and base metals used and the length of time workers are exposed. In open- air welding or in large, well-ventilated maintenance shops, the hazards from airborne contaminants will be moderate. More toxic fumes (from copper, zinc or beryllium) will present a more significant exposure.

How many workers does the insured employ? Contractor shops will range in size from one-person operations to those employing hundreds. How many workers are full time, and how many are part time? What type of training and supervision is provided? Are workers made aware of the hazards of the substances they are working with? Material safety data sheets (MSDSs) must be available for workers to read. The insured must train all employees in safe working practices. Does the insured have an apprenticeship program in place? How many apprentices are on the site at one time?

What is the layout of the workshop? More than one welder in the area will increase the amount of fumes and light rays and is potentially hazardous. This also increases the chances of workers bumping into each other.

Pre-employment physicals should be given to all workers to determine if they have any respiratory ailments that might be aggravated by welding fumes. Fumes form when solids have been heated to their gaseous state, rapidly cool and condense into very fine solid particles. To lessen the amount of time they are exposed to welding fumes and radiation from arc welding, workers should have a schedule of breaks and lunch and be required to take them.

The correct personal protective equipment must be provided by the insured for all workers to protect them from burns and stray sparks. All personal protective equipment and clothing must comply with NIOSH standards, be approved by a nationally recognized testing laboratory (NRTL) and be fire and/or heat resistant. Additional personal protective equipment may also be needed depending on the industry the insured is working in (hard hats when in construction, skull caps when in automotive because there is little chance of falling objects). Protective gloves, preferably the gauntlet type, must be worn regardless of the type of welding being done.

The skin can be severely burned by exposure to ultraviolet radiation from the electric arc; this is also cancer causing. Long pants and long-sleeved shirts must be worn. Infrared radiation, from the arc, can also burn and damage the skin. Flameproof aprons, made from treated leather, should be worn to protect against sparks. Sparks can lodge in cuffs, pockets and rolled up sleeves. Pockets should be buttoned shut and all cuffs and sleeves worn rolled down. For heavier work, fire-resistive leggings should be worn. Capes and cape sleeves are recommended for overhead welding; these, too, can be made from leather. All clothing should be free from oil and grease.

Underneath the protective gear, wool clothing is preferable to cotton clothing because of its fire-resistive properties. Safety shoes with high tops or safety boots should be worn. When there is the risk of falling objects, the welder should wear a hard hat; otherwise, a flame-resistant skull cap can be worn to protect the head from stray sparks.

Hearing protection must be provided for two reasons: to prevent sparks from entering the ear canal and for noise protection from some noisier operations such as plasma arc cutting. In some cases, plasma arc cutting operations exceed 100 decibels; OSHA requires that hearing protection be worn whenever noise levels exceed 90 decibels. Pre-employment and annual audiometric testing should be conducted.

"Welder's flash" or "arc eye," an irritation characterized by a sensation of sand in the eyes, is caused by exposure to ultraviolet radiation from the electric arc. Gas-shielded arc welding produces particularly high concentrations of ultraviolet radiation. It may also burn the skin as in a sunburn. Any exposure without eye protection can result in permanent eye injury.

Infrared rays can cause cataracts and skin burns. Intense visible light can cause eye fatigue.

The welding helmet protects the eyes against dangerous light rays and from airborne sparks and debris. Welder helmets and goggles must have the proper filter plate for the work being done.For some small jobs, goggles may be suitable. For employees who wear corrective glasses, it is important that all headgear fit comfortably over glasses. Prescription goggles are recommended instead of wearing goggles over prescription sunglasses.

The use of laser welding can also damage the eye from the optically amplified light beam. It can do damage even at great distances because of its intensity. All welders should be given pre-employment and periodic eye examinations. Some insureds will require welders to work in pairs when using laser equipment.

Many metal pieces have to be cleaned and/or degreased before being welded. A variety of cleaning agents could be used. What cleaning solvents does the insured use, and how frequently is this done? All cleaning processes should be done in well-ventilated areas, and workers must wear gloves to protect their skin. In some cases, as when using acids, face shields must be worn.

Hydrochloric acid is a commonly used solvent; inhalation of its fumes will cause workers to choke. Sulfuric acid is an irritant to the respiratory system and the skin. When used to remove rust, scale and oxide from metals, it can form hydrogen, a flammable gas. Exposure to phosphoric acid can cause inflammation of the mucous membranes and irritate the skin. Nitric acids will burn the skin and irritate the respiratory tract. The underwriter should determine what concentrations of such acids are used, and how frequently these operations are conducted.

Alkaline mixtures commonly used in cleaning operations contain sodium or potassium hydroxide. These compounds may be added to water to make a solution. Inhalation of the resulting fumes canirritate the membranes and tissues of the respiratory tract. These alkalies can also irritate the skin.

Organic solvents may also be used to remove grease and oil from metals. Many organic solvents are flammable and present explosion hazards. The vapors can also irritate the eyes, nose and throat, cause dizziness, headaches and, in some cases, possible sensations of drunkenness. Such solutions will also irritate the skin.

Ultrasonic cleaning may also be used. In this process, an ultrasonic sound wave is passed through a solution, thereby creating a vibratory force which breaks off particles and contaminants from small metal parts. Manufacturer's instructionsshould be followed and the correct personal protective equipment worn.

Welding must not be done in the same area as cleaning and/or degreasing operations. When welding outdoors, such as repairing a bridge, workers should weld upwind of the fumes and gases produced to lessen their exposure to them.

Welders are exposed to a wide variety of fumes, many of which are extremely hazardous. Welding fumes may contain more than one contaminant from any of the following sources: the metals being welded, the coating or paint on the metal, the contents of the rod (including fluxes), the products of incomplete combustion, or ozone and nitrogen dioxide. Metal-containing particulate matter in welding fumes is associated with bronchial cancer. The correct personal protective equipment and ventilation system can lessen their effects on workers. In some cases, natural ventilation may be adequate. The insured must keep abreast of the acceptable threshold limits, as defined by the American Conference of Governmental Industrial Hygienists (ACGIH) and OSHA regulations, for any fumes workers may be exposed to. Fume levels must be monitored for several days in an area where the insured welds. Air sampling should be conducted regularly and sent to an accredited laboratory to be tested. How frequently does the insured have air samples tested?

Acetylene is commonly used to fuel torches and is mildly toxic if inhaled. Argon and helium, which are used less frequently, are classified as simple asphyxiants; they can displace oxygen from the air and asphyxiate workers. Propane and natural gas, two other fuels, are also asphyxiants. Carbon monoxide is generated from carbon dioxide-shielded metal arc welding. The small amount produced, however, is not a health hazard unless the welding is being done in a confined space. Chronic exposure can cause headache, nausea, dizziness and death.

Cadmium oxide is produced when working with cadmium-bearing silver alloys. If inhaled, cadmium fumes can cause pulmonary distress and shortness of breath. Chronic exposure can lead to emphysema and even death. Exposure to cadmium causes fluid to build up in the lungs and causes skin, urinary and gastrointestinal problems. It is a positive underwriting sign if the insured uses cadmium-free alloys, which are just as effective as cadmium-bearing alloys. Cadmium itself is classified by the federal government as a potential human carcinogen.

Lead may be present in some metal coatings. Exposure to lead causes lead poisoning, which can affect the central nervous system. This is particularly severe in the ship and bridge building industries where large quantities of zinc and lead paints and coatings are used to prevent rust and corrosion. The combustion of lead and zinc chromate paint primers may expose workers to hexavalent and trivalent chromium compounds, which have been classified as carcinogens by OSHA.

Nitrogen dioxide develops during electric arc and torch welding and can cause deep lung irritation and chemical pneumonia. It is

particularly problematic in automatic welding where a heavy electrode and high amperages are used. The amount of gas produced depends on the length of the arc, the voltage and the amperage. Exposure symptoms may appear hours after use and can damage lung tissue.

Ozone is present in electric arc welding and in the welding of aluminum and stainless steel. It causes headaches, breathing difficulties and dryness of the mouth and throat; exposure can result in bronchitis. Exposure will result from gas-shielded arc welding.

Manganese fumes, produced when welding with certain hard surfacing rods or stainless steel alloys, can cause inflammation of the lungs and gastrointestinal and nervous systems. Oxide fumes from magnesium may irritate mucous membranes. High concentrations of titanium dioxide may produce irritation of the respiratory tract. Vanadium, present in some welding filler wires, may severely irritate the eyes, throat and respiratory tract.

Copper, nickel and zinc fumes can cause metal fume fever, characterized by flu-like symptoms which last one to two days, a metallic taste in the mouth, fever, chills, nausea, fatigue and dryness of the mouth and throat. A temporary immunity follows the fever. Carbon-steel welding wire, used in solid wire metal inert gas welding, is copper coated. The use of non-copper-coated wire is preferred. Fumes from nickel increase the chance of lung and nasal cancer.

Beryllium fumes inflame lung tissues; this can take the form of a mild irritation of the nose and throat or a pneumonia-like condition which may be fatal. Chronic beryllium disease may develop years after being exposed to the metal. This disease ischaracterized by the development of tumor-like growths.

Phosphine (hydrogen phosphide), in high concentrations, will irritate the eyes, nose and skin. It is generated from welding on steel which was coated with a phosphate rustproofing.

Metal parts may be cleaned with chlorinated hydrocarbon solvents such as trichloroethylene. Very low levels (below set threshold limits) of chlorinated solvents can produce phosgene gas if they are decomposed by ultraviolet radiation or from the intense welding heat. Phosgene is a respiratory irritant that does not trigger a respiratory reflex action. Low-level exposure can cause throat and chest constriction, coughs, dizziness and headaches. High levels can cause the destruction of lung tissue.

Mercury vapors are produced by welding metals coated with protective materials containing mercury compounds. Exposure to these vapors can produce abdominal pain, renal damage and circulatory or respiratory failure. Chronic exposure may produce tremors, headache, and ear and eye damage.

If the insured does brazing or soldering, fluxes will be used. Fluxes can be classified as corrosive, intermediate or noncorrosive. Corrosive fluxes include acids and chloride compounds. Zinc chloride is used in soldering stainless steel, galvanized iron, cast iron and aluminum. Zinc chloride fumes can irritate the eyes and nose and lung tissue; skin contact will result in chemical burns. The inhalation of aluminum chloride fumes will irritate respiratory passages, as will stannous chloride fumes. Intermediate fluxes include lactic, benzoic and glutamic acids; these organic acids mildly irritate the skin and respiratory passages. A common noncorrosive flux is rosin dissolved in an organic solvent. Typical solvents are alcohol, turpentine and petroleum spirits; these are flammable and exposure to them can irritate respiratory passages. To eliminate the fire hazard, the insured may use nonflammable solvents; however, these may present a serious health hazard as they may decompose from heat or ultraviolet radiation into highly toxic gases.

Hazardous brazing fluxes include fluorobates, fluorides, potassium and sodium hydroxide. Fluorobates, when heated, can release fluorine fumes, which are a severe lung irritant. Fluoride compounds are used in brazing with silver magnesium and aluminum-silicon filler metals. Skin contact with fluoride compounds will cause severe irritation, and fumes will severely irritate the upper respiratory tract. Fluorides also come from some electrodes with fluoride-containing coatings and are released in large amounts when welding stainless steel.

Particulates of dusts and fumes can produce pneumoconioses, pulmonary irritants or toxic inhalants. Silicosis results from the inhalation of finely divided silicone dioxide. Siderosis results from the inhalation of iron oxide dust. Stannosis results from the inhalation of tin oxide dust over a long period of time. Anthracosis results from the inhalation of carbon black. Aluminosis results from the inhalation of aluminum, aluminum oxide or aluminum hydrate. Asbestosis results from the inhalation of asbestos. Copperosis results from the inhalation of copper fumes. Berylliosis results from the inhalation of beryllium dust or fumes.

The underwriter should be aware that asbestos, because of its flame-retardant properties, was formerly used in the welding process and that workers may suffer lingering effects from asbestos fibers. It should not be used because it is a proven carcinogen. Workers may encounter asbestos that was used to insulate pipes. Employees should be trained to recognize asbestos and report its presence to the insured immediately. Workers should never attempt to clean asbestos-covered pipes themselves. Work should not continue until the asbestos is removed by a qualified contractor.

For information on the hazards of commonly used metals and their dusts, see Machine Shops.

Respirators must be worn to prevent workers from inhaling potentially dangerous fumes and when working in confined areas. All respirators must comply with NIOSH standards and be approved by a nationally recognized testing laboratory (NRTL). The type of respirator used will depend on the type of welding and where it is being done. In confined spaces, an airline respirator or self-contained breathing equipment is necessary.

Because dusts and, to a lesser extent, fumes come from the material being worked on, the insured should find out from the client or conduct his own pre-welding tests to assess potential hazards and appropriate remedial steps. Does the insured have a policy of refusing jobs with high hazards, for example, cutting into asbestos linings in heating ducts?

Ventilation is essential in the work areas to lessen the effect of fumes on workers. A local exhaust ventilation system is best for brazing operations. In some cases, a natural ventilation system may be sufficient. What type of ventilation system does the insured use on premises -- mechanical or natural? Mechanical ventilation includes local exhaust, local forced and general area mechanical movement. Local exhaust ventilation must be located as near the welding operation as possible for greater efficiency. All ventilation system filters should be changed regularly, and welding should not be allowed if the system is not functioning properly. Before beginning any job, workers should be instructed to check the client's ventilation system and confirm that it is working properly. It should also be checked periodically during welding operations. Portable fans may also be set up around the work area to dispel fumes or blow them away from workers. Tests show that fume removal is more effective when air flow is directed across the welder's face, rather than from behind.

The insured should carry a first aid kit with burn cream with him to all clients; he must not rely on the client to have one. All

employees should be trained in basic first aid and in burn treatment. A first aid kit must also be easily accessible on the insured's premises.

The underwriter should evaluate the overall housekeeping of the insured's premises. Are all dusts and metal scraps cleaned up promptly? The insured cannot guarantee the safety and cleanliness of the client's premises, but should educate workers in safe work habits. Acceptable work conditions or safety procedures -- and whether they are the responsibility of the client or the insured should be specified in the contract (see General Liability). If certain conditions are not met, the workers should not take the job; if the client interferes with or compromises safety once work is begun, the insured should refuse to complete the welding job.

Workers can be burned from the welding arc and also from handling hot work pieces. Gloves must be worn whenever handling hot objects. Pieces that stay hot for long periods after welding is completed should have a sign in the area warning others not to touch.

When welding in high places, such as bridges or on top of tanks, workers must wear safety harnesses. When working inside confined spaces or in high places, the buddy system should be used.

What is the condition of all equipment? All equipment should be approved by an NRTL. The condition of all equipment should be checked regularly by the operators before, during and after welding operations. All missing, distorted, broken, leaking or worn parts must be promptly replaced. Are manufacturer's instructions followed regarding replacement parts and maintenance?

Workers may also be exposed to electric shock if they work in damp areas. The possibility also increases if they wear damp clothing. Is all equipment made and especially adapted for use in damp areas? Excessively damp clothing should be changed for dry. When welding in damp locations, workers should use dry insulation, particularly when welding in positions where large areas of the body come in contact with a conducive service (e.g., sitting or lying). Electric shocks usually do not cause severe injury, but can be dangerous under certain conditions. Mild shocks can produce involuntary muscle contractions which can lead to falls from high places, such as the top of tanks. Workers should never wrap the electrode cable around their bodies. Are all workpieces grounded?

All solvents and gas cylinders must be properly labeled with contents and storage instructions. Regulators from different fuels must not be interchanged as accidents can occur.

Workers can get cuts from sharp edges on equipment or rough edges on metal pieces. They can strain their backs from welding in awkward positions and from lifting heavy objects. Are the correct materials-handling devices provided and proper lifting techniques taught? Workers can also sustain head injuries from working in confined spaces and from overhead tools and equipment falling. Workers may also trip and fall over welding hoses and cables stretched on the floor.

What is the condition of work areas at the insured's premises? Are work areas ergonomically designed, and is there enough space between them to prevent workers form bumping into each other? The insured must be careful when using electric welding so that workers do not trip over wires. The work area should be kept as clean as possible during operations and everything promptly cleaned up when work is complete. All debris should be removed daily.

Fire is a distinct possibility, especially if the insured is working at a client's site and cannot control the fire hazard completely. What provisions has the insured made in case of a fire? They may extinguish small fires, but help should be obtained quickly to control large fires. See Fire and E.C. for more information.

Eating and smoking must be prohibited during welding, and workers must wash their hands before eating to prevent contamination. A separate lunch or break room should be provided.

Workers will be exposed to vehicular accidents if they travel frequently. See Automobile Liability for more information.

Crime

The insured will not have a large cash exposure as most payment transactions will be by check. What are the insured's billing procedures? All checks should be marked "For Deposit Only" upon receipt. Check disbursement and bank statement reconciliation functions should be separated, if possible. Shops that do residential work or automotive frame welding may be paid by cash or check. What are the average and maximum amounts of cash on hand? The insured may have small amounts of petty cash on hand. Bank deposits should be made daily.

Metals that are considered valuable, such as silver used in jewelry, may be a target for thieves. This exposure will change with the economy. How much and what type of metal does the insured keep on the premises? What are the average and maximum values of the materials? Where are they stored? Materials should not be stored outside unless the storage area is securely fenced and well lit. Tools and equipment kept in the workshop may be stolen, but the values involved will be low. A high deductible and careful attention to premises security are recommended. All buildings should have dead-bolt, double-cylinder locks on all doors. How is equipment secured when not in use?

There is the chance that equipment may be stolen from trucks or while on the client site; such losses are covered under Inland Marine.

Fire and E.C.: Property

Welding operations create a serious fire hazard. Fires could be started by sparks, molten slag, hot pieces of metal coming in contact with flammable materials, the flame or arc of the torch, improperly handled soldering irons and improperly applied grounding clamps. Other, non-industry-specific ignition sources include cigarettes and faulty electrical wiring. Carelessness has led to many welding fires and millions of dollars in losses. For example, sparks from welding and cutting operations ignited foam insulation on a commercial fishing vessel, causing $20 million in damages to both the vessel and the pier at which it was docked.

Potential damage and loss control measures will be discussed here; for on-site welding, claims will be paid out of General Liability.

For what type of clients does the insured primarily weld -- industrial, commercial or residential? Each type presents different fire hazards, but the precautions are the same.

In industrial situations, the insured should utilize a permit system which indicates to whom he is responsible and who authorized the hot work. Such permits should be signed and returned to the authorizing person when work is completed. The work permit should detail the correct pre-welding procedures to follow and give the insured the authority to implement necessary safety measures.

Before any work begins, the work area must be examined and the inherent hazards assessed. There are detailed on-site loss control procedures that welders must follow before any welding is done. Whenever possible, the welding should be done in an area designed for welding, such as a workshop. Some pieces, such as boilers, cannot be moved and must be welded where they are. Storage areas and construction sites have the highest incidence of cutting and welding losses; this is followed by waste disposal systems and paint spraying and coating operations. All flammable items must be cleared from the welding area. Sparks and molten bits of metal can fly for 30 or more feet, lodge in small cracks or holes and smolder for hours before bursting into flame.

The insured should never weld in dust bins, as dusts are extremely explosive. Welding should not be conducted in vapor degreasing areas or spray booths or near large quantities of easily ignitable substances such as baled paper or cotton.

The insured must prepare the on-site welding area before work is begun. All floors made of combustible material must be kept wet, covered with damp sand or protected with fire-resistive shields (e.g., sheet metal, fire-retardant cloths, sheets). The floor area, for a radius of 35 feet, must be swept clean of all combustible debris and dust. Floors must be inspected for cracks into which sparks could fly and smolder undetected. When welding or cutting operations are done near walls, partitions, roofs or ceilings made of combustible materials, fire-resistive shields or guards must be erected around the welding areas.

Stock and raw materials in the work area may be flammable and worth millions of dollars. Among the materials susceptible to ignition are combustible building construction such as floors, partitions and roofs; combustible contents such as wood, paper, textiles, chemicals and flammable liquids and gases; and combustible ground cover such as grass and brush. Any combustibles in the welding area should be removed; those that must remain must be covered with fire-resistant materials and shields. Objects located on the other side of partitions or walls must also be moved away from the area or covered with fire-resistive shields. All moving machinery, such as conveyors, should be shut down to prevent them from carrying sparks to other areas of the facility.

Although electric arcs or oxy-fuel gas flames have rarely been the direct cause of fires, fires and/or subsequent explosions have resulted when arcs or flames have overheated combustible materials in the work area. Fires have most frequently involved flammable liquids, oily deposits and combustible dusts, followed by wood, plastics, paper and building insulation.

The insured's assessment of the work area should include an examination of the client's fire protection measures and equipment. Is the work area adequately sprinklered, and are fire extinguishers located nearby? Residential occupancies most often are not sprinklered; dwellings such as apartment buildings may be.

Although unlikely, it is a positive underwriting sign if the insured refuses to weld in areas that are not sprinklered or do not meet the fire prevention conditions. This may not be possible if the insured will be doing extensive or very hot welding, which may set off sprinkler systems. In such cases, the client may opt to shut off the sprinkler system. If so, the client's decision should be documented and the building/area cleared of all workers. All pieces that can be moved must be taken out of the building and welded in the workshop or in an area where all fire conditions have been met.

Extinguishers should be conveniently located and must be appropriate to the hazard -- class A for areas that contain wood, paper and textiles, class B for flammable liquids, grease, oil and paints and class C for electrical equipment, motors and switches. The insured should carry portable extinguishers and rely on them rather than the client's, which may be empty or malfunctioning.

The insured may also have to prepare the equipment or piece to be welded. Welding operations cannot be carried out in the presence of fumes or gases because of the explosion hazard; all equipment on which welding will be done must be thoroughly cleaned, both inside and out. Special attention must be paid to hollow casings and containers, which are very hazardous and must be vented to prevent explosions.

Some metal pieces may have to be cleaned or degreased before brazing or soldering can begin because of a heavy buildup of grease or oil. Liquids used to do this may be flammable. A sufficient amount of time should pass between degreasing and welding to prevent an explosion hazard.

When working on pipes or tanks, all liquid or gas feeds must be shut off and drained to prevent accidental release, and the inside of the tank must be thoroughly cleaned so that no trace of gas or liquid residue remains. If even a trace of a flammable liquid remains, the entire tank could explode.

Before any welding begins, a safety inspection should be conducted. What type of welding equipment is used -- electric or gas? All equipment should be in good repair and serviced and operated as recommended by the manufacturer. Is all wiring properly insulated with no exposed wires? Anyone using electrical arc welding equipment must be sure that the ground clamp is firmly connected. If floors are wetted down, precautions must be taken against electrical shock. Electrode holders should be stored where they cannot make electrical contact with workers, conducting objects, fuels or compressed gas tanks. When welding is complete, the workers should make certain that no part of the electrode circuit is touching the ground; accidental contact can cause overheating and increase the chance of a fire.

All gas hoses should be checked for leaks. All worn hose should be replaced immediately. Hoses should be checked regularly for leaks; tape should not be used to repair leaks. Oil, grease and other substances which can spontaneously combust in the presence of oxygen must not be used on torches or regulators. What gases does the insured use to fuel welding torches? Acetylene, mixed with oxygen, is often used. It has a characteristic odor due to minor impurities and presents explosion and fire hazards when released. The insured should inspect all containers for leaks before use. Acetylene presents a major explosion hazard and must not be utilized at a pressure in excess of 15 psi gauge (or 30 psi absolute). Ventilation systems are important when working with gases. See Workers' Compensation for more information. Propane and natural gases are also used as fuels; both are extremely flammable. Argon and helium are used less frequently and are not flammable.

A fire watch (an individual equipped with portable fire extinguishing equipment and assigned to watch the welding area while welding is being done and for 30 minutes afterwards to check for smoldering fires in adjoining areas) must be present at all jobs. A fire watch

must also be present whenever welders are on break or lunch. How is the fire watch trained? A careful inspection of the work area must be made before the fire watch leaves for the day.

Smoking, by either the insured's employees or the client's, must be prohibited in any area where welding is done.

In addition to the loss control recommendations discussed here, all welding must comply with the following fire codes: NFPA 51, Installation and Operation of Oxygen-Fuel Gas Systems for Welding and Cutting, NFPA 51B, Fire Prevention in Use of Cutting and Welding Processes, and NFPA 70, National Electrical Code. If the insured does any maintenance that involves aircraft welding operations in hangars, the underwriter is advised to refer to the NFPA Standard for Aircraft Welding Operations.

Insureds who weld on their own premises must follow the same basic precautions as on-site welders; the overall exposure should be reduced, however, because the insured can exercise complete control over the work area and conditions. The underwriter should consider the following: where welding is done, the extent of fire protection (extinguishers and sprinklers) and the materials stored in the welding area. Some insureds may do welding only on their premises, while others will only weld off premises; some use a combination of the two. What are the age, construction and condition of the insured's premises? There may be a large workshop and a storage shed. Has the building been converted for the insured's use? The underwriter should check for faulty wiring. All debris should be removed daily.

Gas cylinders can be a fire hazard. Where are gas cylinders stored on the insured's premises when not in use? All cylinders must be marked as to their contents. Indoor storage of fuel gas is limited to 2,000 cubic feet or 300 pounds. of liquefied petroleum gas. All gas tanks must be stored in a well-ventilated, dry location, at least 20 feet from highly combustible materials, sparks, open flames, excessive heat and all flammable substances, and away from elevators, stairs or gangways. When cylinders are not connected for use, valve protection caps must be in place. Compressed gas cylinders may fall over and explode if not stored in an upright position and chained to a wall or post.

Oxygen tanks must be stored separately from other gas tanks by at least 20 feet and separated by a noncombustible barrier. This barrier should be at least five feet high and have a fire resistance rating of one hour. Empty tanks must be marked "MT" or "Empty" with the valves closed and valve caps securely fastened. How are such cylinders transported? They should be transported according to DOT regulations.

Does the insured store any flammable solvents or degreasers on the premises? This area must be separated from the work area by fire walls. Smoking must not be allowed in the work area. When any welding is done on the premises, the above conditions must be met. Fire extinguishers and smoke detectors must be located throughout the building. Extinguishers should be inspected and tagged annually. All employees should be trained in their use. What is the response time of the local fire department? Has the insured participated in prefire planning?

There may be a small office area on the insured's premises. See Accounting Firms for more information on general office hazards.

Business Interruption

The exposure will not be severe if most welding is done on the client's site. Welding equipment and materials are not difficult to replace. If the insured does welding primarily in his workshop, a loss may be more severe.

What type of welding does the insured specialize in -- commercial, residential or industrial? How much welding is performed on premises? What percentage of the insured's income does this represent? Does the amount and type of welding the insured performs vary in the course of a year? This may happen if the insured works primarily as a subcontractor in the construction industry. In the event of a loss, how quickly can replacement equipment be found? If the insured welds on his own premises, such as furniture repair for residential clients or silver brazing, determine how quickly replacement quarters can be found.

If the insured welds for one or two major clients (e.g., a general contractor), Contingent Business Interruption should be considered.

Insureds who specialize in new construction and bridge repair will experience a peak season during "good" weather months. A loss at that time could be more severe.

Inland Marine

Welding contractors will frequently work on the client's site and bring their own equipment. Equipment may also be stored on the truck. What are the average and maximum values of equipment stored on one truck or used at one site? Are any pieces specialized or unusually expensive? A record should be maintained of all equipment serial or other identifying numbers. The insured should mark all equipment with his name to discourage theft and/or facilitate recovery. A Contractor's Equipment Floater is recommended. What provisions are made so equipment is not stolen? When leaving the premises for lunch, equipment should be returned to the truck. Does the insured instruct employees to lock the truck whenever it is left unattended? Does the insured leave equipment at the client site overnight? This practice should be discouraged as it increases the chance of theft.

A Bailee exposure will exist if the insured repairs items on his premises. How typical is this of the insured's operation? What types of pieces are typically left in the insured's care, custody or control? Is the insured's work area at a client's site and the equipment or materials in it ever considered to be in the insured's care, custody or control? This should be clarified in the contract. See General Liability.

The insured may need Valuable Papers and Records coverage for contracts and for blueprints if the firm does design work. Accounts Receivable coverage may be necessary if the insured billsclients. Are computers used in office functions? If so, the insured should consider EDP coverage.

WELDING PROCESSES

BRAZING -- A special form of welding. Group of welding processes wherein coalescence is produced by heating to a suitable temperature and by using a filler metal having a liquidus above 800 degrees Fahrenheit and below the solidus of base metals. Used extensively in refrigerating and plumbing industries as well as space and aircraft.

Torch Brazing	Air gas, air acetylene, oxyacetylene and oxyhydrogen are gas mixtures used in brazing torches giving high flame temperature. Limited in use to those brazing filler metals which may be used with flux or are self-fluxing.
Furnace Brazing	Used extensively when the parts to be brazed can be preassembled or jigged to hold them in position, the filler metal can be preplaced, when multiple joints are filled simultaneously, when many assemblies are joined or when exacting atmospheric control is required.
Induction Brazing	Used extensively on parts which are self-jigging or where very rapid heating is required. Used when heating can be made to produce parts economically or where a large number of parts can be adapted to special machines.
Resistance Brazing	Used extensively when small areas are to be brazed and when material has a high electrode conductivity. Heat is provided by resistance of parts to the flow of low voltage, high current power.
Dip Brazing	Accomplished by immersing the assembly into a molten brazing flux or metal held at a desired brazing temperature.
Infrared Brazing	Uses radiant heat at controlled temperatures which produces energy that impinges on the part to be brazed.

RESISTANCE WELDING -- Processes wherein metal is fused by the heat obtained from the resistance of the work to the flow of electric current in a circuit and by the application of pressure before, during and after the application of current.

Resistance Spot Welding	Used on iron, steel, aluminum and its alloys, magnesium alloys, copper and its alloys, molybdenum, tantalum and tungsten, zinc, lead and its alloys, silver, nickel and its alloys, and coated materials. Typical resistance welding products are: aircraft, automotive products, building construction, communications equipment, domestic goods, electrical equipment, hardware.
Resistance Seam Welding	Similar to resistance spot welding, except that overlapping edges of sheet metal are passed between two narrow roller electrodes producing a continuous seam or a series of overlapping spots.
Resistance Projection Welding	A number of welds may be made simultaneously, depending upon the number of projected spots or bosses formed in the metal. Various sheet metal parts used in automobile and aircraft production are welded by this process.

Resistance Flash Welding	In flash welding, the parts are brought into light contact after clamping. A voltage causing a flashing action between the parts is applied and continues until the welding temperature is reached. Then a high forging pressure is applied suddenly, and the current is discontinued, completing the weld.
Resistance Upset Welding	Parts to be welded are gripped mechanically and pressed together while heat is generated by passage of a heavy current through the area. Used to weld small ferrous and nonferrous strips, wire, pipe and tubing.
Resistance Percussion Welding	Somewhat restricted. Used for joining parts of similar geometry to those joined by upset and flash welding but generally of a smaller cross section.

ARC WELDING -- Fusion welding process in which surfaces to be joined are fused by the heat of an electric arc. By bringing the work and the electrode together as conductors, an electric circuit is established; then by separating the conductors an arc is created in which the heat reaches a temperature of approximately 7000 degrees Fahrenheit. Arc welding depends upon the presence of a continuous current across the arc at voltage varying from 15 to 60 volts.

Stud Welding	Welding process wherein coalescence is produced by heating with an arc drawn between a metal stud or similar part and the other part until the surfaces to be joined are properly heated when they are brought together under pressure. Used extensively in the following fields: automotive, boiler, construction, equipment manufacturing, railroads and shipbuilding.
Plasma Arc Cutting	The "plasma" is an ionized conducting gas exactly the same as that used un carbon arc welding. When jetted through a nozzle, the gas becomes a "plasma jet." Used as a high speed cutting tool. Particularly satisfactory in the cutting of aluminum and other nonferrous materials.
Submerged Arc Welding	Coalescence is produced by heating with an electric arc or arcs between a bare metal electrode, or electrodes, and the work. Pressure is not used and filler metal is obtained either from the electrode or welding rod. Welding zone is covered by flux.
Gas Tungsten-Arc Welding	Uses an inert gas to protect the weld zone from the atmosphere. Heat is developed by an electric arc between a tungsten electrode and the workpiece. Differs from metal-arc welding in that the electrode is not melted and used as a filler metal.
Gas Metal-Arc Welding	Gas metal-arc welding is accomplished by means of a gas shielded arc maintained between the workpiece and a consumable electrode from which metal is transferred to the workpiece. Used in automotive, aluminum containers, construction, aerospace, electronic, military, piping, surfacing and transportation industries.
Flux Cored Arc Welding	Process designed for welding ferrous metals. An arc welding process wherein coalescence is produced by heating with an arc, between a continuous filler metal electrode and the work. Shielding is obtained from a flux contained within the electrode.
Shielded Metal-Arc	Process wherein fusion is obtained by heating with an electric arc

Welding	between a covered metal electrode and the work. Shielding is obtained from decomposition of the electrode covering. Pressure is not used and filler metal is obtained from the electrode.
Carbon-Arc Welding	Group of arc welding processes wherein carbon electrodes are used. Carbon-arc is used only as a source of heat. Used rarely today.

GAS WELDING -- Process of several procedures. Base metals are joined through the fusion of a metal deposited between the surfaces of the metals to be joined. No pressure is required to accomplish the weld. Fusion heat is supplied by the combustion of suitable gasses.

Oxyacetylene Welding	Process of joining and severing metals by means of the heat produced by the burning of acetylene with commercially pure oxygen. The temperature of the flame is about 5500 degrees Fahrenheit. Also used in the plastics industry.
Oxyhydrogen Welding	Used to weld metals that may be welded at a low flame temperature, such as aluminum, aluminum alloys and lead, by means of the heat produced by the burning of hydrogen with commercially pure oxygen.
Pressure Gas Welding	Weld is produced by the application of pressure during the heating of the entire area of abutting metal surfaces. Heating is obtained from the combustion of gases. Oxyacetylene flame is almost always used. Filler metal is not.

SOLID STATE WELDING -- Basic mechanism in a number of joining processes in which time, temperature and pressure produce coalescence of the base metals without significant melting of the base metals. Joints can be made with strength equal to the base metal.

Ultrasonic Welding	Process for joining similar or dissimilar metals by the introduction of high-frequency vibratory energy into the mating surfaces to be joined. Unique in that no fluxes or filler metals are used, no electric current passes through the weld metal and usually no heat is applied. The workpieces are clamped together under moderately low static force, and ultrasonic energy is transmitted into them for a brief interval. Used for plastics.
Friction Welding	Heat is generated by clamping one of the two pieces to be welded in a stationery chuck and rotating the other with a load applied along the axis of rotation. Used for joining pipe or drill tubing to drill bits.
Forge Welding	"Blacksmith welding" -- the heating of two pieces of metal in a forge or other furnace until the metal reaches its plastic temperature (Steel is 2200 degrees Fahrenheit), the quickly joining the pieces together by hammer. Blows are delivered either manually or by power.
Explosion Welding	Especially useful in the production of composite metal plate. Overlapping ends of the plates are welded together when the upper piece is driven against the lower piece by the force of the exploding charge.

Diffusion Welding	Utilizes a thin intermediate metal between the bonding surfaces which react with he base metal at a lower temperature than the fusion temperature of the base material. Used for joining aluminumstraps and zirconium alloy components for nuclear fuel elements.
Cold Welding	Achieved through the application of pressure only. Pressures used are very high and cause considerable local distortion. Surface preparation is an important preliminary. Used in assembling aluminum containers.
OTHER PROCESSES	
Thermit Welding	Method of welding in which the required heat and molten metal is obtained from a chemical reaction. The reaction involves the combination of aluminum powder with metal oxides. Molten iron at an approximate temperature of 4500 degrees Fahrenheit is produced in less the one minute. Used in welding rails and cable.
Laser Beam Welding	Waves are produced by gases in a glass bulb and heated to incandescence by an arc or other means. Used to weld small devices of high thermal conductivity in electronics and space industries.
Induction welding	Coalescence is produced by the heat obtained from resistance of the work to the flow of induced electric current, with or without the application of pressure. Used in welding containers and sealing electronic components.
Electroslag Welding	Based on the generation of heat produced bypassing an electrical current though molten slag. Used for welding pressure vessels, structural members and, to some extent, ship construction.
Electron Beam Welding	Fusion joining process in which the workpiece is bombarded with a dense stream of high velocity electrons. Usually occurs in an evacuated chamber for a vacuum environment. Used with aircraft and turbines in the atomics industry.

UNDERWRITER'S CHECKLIST

- What type of welding does the insured do? How are welding torches powered? Does the insured do primarily repairs or work on new construction? Does the insured specialize in a certain industry or certain type of welding? Does the insured primarily work on the client's site or in a workshop? Are the insured's clients residential, commercial or industrial?
- How long has the insured been in operation? What do loss histories, particularly for Fire and E.C. and Workers' Compensation, reveal?
- Does the insured carry portable fire extinguishers with him to each job, along with a first aid kit? What job site preparation procedures does the insured follow to prevent fire losses to the client's property or injury to third parties?

- How many workers does the insured employ? Are they full or part time? What type of training do they receive? Are any workers certified by the American Welding Society for structural welding or by the American Society of Mechanical Engineers for boiler and pressure vessel welding? Does the insured do background checks before hiring new workers? Are all employees given pre-employment physicals and audiometric testing?
- What are the insured's billing procedures? Are all check marked "For Deposit Only" upon receipt?
- Does the insured supply workers with the correct personal protective equipment: leather apron and leggings, gauntlet-style gloves, hearing protection, welder's helmet and respirators when necessary?
- Does the insured own any small trucks or vans that are used to transport equipment and employees to job sites? Who drives such vehicles? How is equipment secured during transport? Does the insured comply with all Department of Transportation regulations regarding transporting hazardous materials and gas cylinders?
- What is the insured's radius of operations? Are trips frequently made to the same clients? What are the hazards of such routes? Do drivers need commercial driver's licenses?
- What kind of flux does the insured use in brazing? What metals does the insured work with frequently? What fumes are generated from the metals, rod coatings and metal coatings? Is the insured in compliance with all OSHA threshold exposure limits regarding fume exposure?
- Is the insured in compliance with all state regulations and the OSHA Welding, Cutting and Brazing standard?
- What is the condition of the insured's workplace? Is all equipment put away when not in use? Where are flammable solvents stored? How much welding does the insured do on his premises?
- Does the insured offer pick up and delivery services?