1 Basic Clandestine Drug Manufacture

Before a clandestine lab investigation can begin, the investigator must be able to recognize that such a lab exists. To do this, he must be familiar with the basic techniques used to produce controlled substances. Provided in this chapter is information concerning basic manufacturing techniques used by clandestine lab operators. Legitimate sources of chemicals and equipment will be used in the explanations, followed by examples of underground alternatives.

Clandestine labs come in a variety of shapes and sizes; their sophistication is limited only by the education and imagination of the operator. Complicated equipment and exotic chemicals are not required to manufacture drugs of abuse or explosives (controlled substances). Most of the equipment and chemicals found in a lab have legitimate uses and can be obtained from a variety of legitimate retail outlets. Therefore, the forensic clandestine lab investigator must be able to recognize the combinations of equipment and chemicals that are used to manufacture controlled substances and to determine whether the combination is coincidental or intentional.

A clandestine laboratory is literally a secret room or building equipped for scientific research or manufacture. Clandestine labs may not be illegal. The substances they produce and the act of manufacturing them is what may be controlled.

Webster's Dictionary defines manufacturing as "…the act of making goods, by hand or machinery." The legal definition of manufacturing is different. The Code of Federal Regulations (21 CFR 1300.01) defines manufacture as "… the producing, preparing, propagating, compounding or processing of a drug or other substance or the packaging or repackaging of such substance or labeling or relabeling of the commercial container of such…" This definition relates more directly to the production of drugs of abuse and is applicable in one form or another throughout the United States. Investigators should compare the federal definition with their local statutes and consult with district attorneys responsible for prosecuting clandestine labs about any differences.

The legal definition includes acts of packaging and labeling that are not normally associated with the "making of goods." The acts of preparing the final product for distribution or sale expand the perception of laboratory operations from the traditional mixing and extracting of chemicals. Under this definition, the mirror act of making little ones out of big ones is the same as making the big ones to begin with.

Many criminal statutes dealing with the manufacture of controlled substances state that the possession of chemicals and equipment for the purpose of manufacturing a controlled substance is illegal. The statute may not specify that all of the equipment and chemicals must be present, only that a combination exist that is sufficient for a reasonable person to believe that a manufacturing operation exists. Other statutes may require all of the components of the operation to be present. Either situation places the burden of demonstrating how the different components can be utilized to manufacture a controlled substance on the government. Understanding the different manufacturing processes will allow the investigator or prosecutor to differentiate and articulate how the presence of cold medications, rubbing alcohol, coffee filters, and glass jars can be legitimately present in one situation and yet be used in a clandestine lab that manufactures a controlled substance in another.

The manufacture of explosives is a slightly different issue. The simple possession of explosives is not regulated to the extent drugs are. Explosives have a wide range of legitimate applications. However, for public safety reasons, the manufacture, distribution, and storage of explosives is regulated. In the interest of public safety, the U.S. government regulates the importation, manufacture, distribution, and storage of explosive material through 27 CFR 55 and Chapter 40 of Title 18 of the United States Code (18 USC 40). As with the drug laws, there may be additional restrictions on the possession, manufacture, distribution, and storage of explosives or explosive material that are enacted by state and local statutes.

1.1 Lab Operators

There are three distinct categories of clandestine lab operators: small-scale, commercial, and educated (Table 1.1). The size of the lab may vary among operator categories, but the principles that demonstrate an operation exists remain the same.

Table 1.1 Operator Characteristics

Characteristic	Small-Scale Operator	Commercial Operator	Educated Operator
Chemical education	No	Yes	Yes
Drug user	Yes	Maybe	Maybe
For profit	No	Yes	Maybe
Legitimate chemical supply	No	Maybe	Yes
Single location operation	Yes	No	Yes
Local distribution	Yes	No	Maybe

The lab of a *small-scale operator* is the one most commonly encountered. He is generally a drug user, using his own product as well as selling a portion to support his habit. Financial gain is, therefore, often not the only objective of this operation. All stages of such an operation usually take place at one location. Generally, these operators have no chemical education. They obtain their chemicals through retail purchases at grocery stores and drugstores, local chemical supply houses, or mail order suppliers. At times, they will shoplift over-the-counter preparations that contain regulated precursor chemicals. Operations are conducted in single-family homes and apartments as well as hotel and motel rooms. These operations are found in the poorest part of a city or the most affluent. The types of motels and hotels used vary from skid row to major luxury chains. The distribution of the final product is usually in the same area as the lab, and the operator is usually the dealer.

The *commercial operator* manufactures for financial gain. These operators may or may not be users. Different portions of a commercial operation may take place at separate locations in an effort to avoid detection by law enforcement. The commercial operation may have one "cook" who holds the knowledge concerning the manufacturing process. He may or may not have chemistry training. The cook is usually only at the lab site during critical portions of the operation. For the balance of time, so-called "lab rats" are present to monitor the operation and secure it from theft or detection. The commercial operator has an established network to obtain large quantities of the necessary chemicals and equipment required to manufacture his product. A separate distribution network for the final product is usually established away from the lab to avoid detection. The commercial operator does not generally participate in street-level sales.

During the 1960s, outlaw motorcycle gangs began producing their own methamphetamine in these labs, and they dominated the distribution of the drug within the United States. Today, there are two major forces fueling the methamphetamine trade within the United States: well-organized manufacturing and trafficking groups based in Mexico, and a widely scattered series of local methamphetamine producers, predominantly based in rural areas around the country. They operate the well-organized, high-volume "superlab" defined by the Drug Enforcement Administration (DEA) as a clandestine lab operation that is capable of producing 10 pounds or more of methamphetamine in a single production cycle. The DEA estimates that less than 5% of clandestine labs seized are classified as superlabs. Concentrated in California and Mexico, they are estimated to produce over 80% of the methamphetamine available in the United States today.

The *educated operator* is the least-encountered type of clandestine lab operator. He usually has formal training in chemistry that was obtained through traditional education or from on-the-job training. He also has legitimate access to sources of regulated chemicals. He may even be using his job site as a manufacturing location without the knowledge of his employer. The educated operator may be a hybrid between the small-scale and the commercial operator. In some instances, he acts as the cook in operations that require chemical expertise, such as the synthesis of lysergic acid diethylamide (LSD) or fentanyl and its analogs. At other times, he can be found in a small-scale operation working as manufacturer and distributor. Graduate students, engineers, and government chemists have all been arrested for manufacturing controlled substances while using their employer's facility, or for purchasing chemicals and equipment through their employer without his knowledge. The educated operator may or may not have a distribution network established. He may or may not be a drug user. Profit is much more the driving force for the educated operator than for his uneducated small-scale counterpart.

1.2 Manufacturing Processes

There are a number of different processes that can be used to manufacture a controlled substance. The one employed will depend on the starting materials used and the end product desired. Each process may be encountered alone or in combination with one or more of the others. One clandestine lab may incorporate multiple manufacturing processes to obtain the end product. The four basic manufacturing processes used in clandestine labs are extraction, conversion, synthesis, and tableting.

The following is a generic example of a multimethod process. The necessary precursor chemical is extracted from a bulk substance and then converted into substance "B." Substance B is then combined with three other chemicals to synthesize compound "C." Compound C is extracted from the reaction mixture and then converted from the freebase into its salt form. The salt form is then extracted from the liquid, with the resulting product packaged (tableted) for distribution. This single operation, thus, actually contains seven processing steps.

It is not uncommon for large-scale clandestine lab operators to perform individual manufacturing processes at separate locations. This is once again done in an effort to avoid detection. Precursor chemical extraction may take place at Location 1. Synthesis and purification extractions then occur at Location 2. Conversion into the salt form may be done at a third location. And, packaging for sale may be done at the point of distribution.

The presence of only one process of the sequence does not make it any less a clandestine lab. It is the investigator's responsibility to recognize the process or part thereof and to articulate how it fits into the manufacturing method the operators are using.

1.2.1 Extraction Process

Extraction labs remove raw materials from a mixture. This is accomplished by using the desired component's physical and chemical properties to separate it from the mixture (Figure 1.1). No chemical change in the raw material occurs during the process. Examples of extraction labs include hashish production, coca paste productions, and extractions from pharmaceutical preparations.

Separating the resin containing the cannabinoids and THC from the marijuana leaves produces hashish and hash oil. Hashish is made by physically removing the resin from the leaves. The resin obtained is then collected and compressed into brick form. Hash oil is obtained by removing the resin from the leaves through the use of solvent extraction. In either case, the chemical structure of the extracted cannabinoids remains intact.

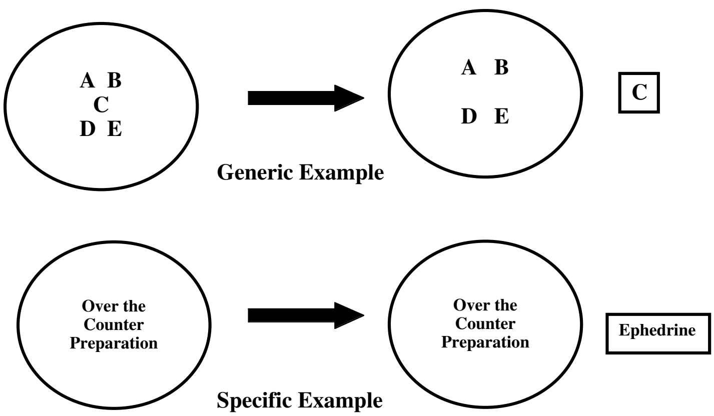

Figure 1.1 Extraction lab chemistry.

The production of heroin begins with the removal of raw opium from the poppy. This physical extraction does not change the chemical structure of the morphine or codeine contained in the opium. It only removes it from the plant so the morphine can be processed into heroin. Some operations take the additional step of chemically extracting the morphine from the opium prior to conversion into heroin.

A number of over-the-counter pharmaceutical preparations contain the precursor chemicals used for the manufacture of controlled substances. These preparations are placed into a solvent, and the desired component is allowed to dissolve into the liquid. The liquid containing the component is removed from the solids and evaporated, leaving the component of interest.

Some pharmaceutical preparations contain a controlled substance in an aqueous solution. The item of interest is extracted from the solution by simply evaporating the water. This process may not be illegal. However, the resulting product may be. The act of extracting chemicals that are regulated from uncontrolled preparation may demonstrate the intent to do an illegal act.

1.2.2 Conversion Process

The conversion process takes a raw material and changes it into the desired product. This involves minor structural changes within the molecule of the compound, or of the chemical's *salt form*. Functional groups may be added or removed from the molecule, somewhat like pieces on a Tinkertoy®. The drug of interest can be changed from its salt form to the freebase form or from the freebase form to the salt form. Examples of the conversion process include the conversion of cocaine hydrochloride into freebase or "crack" cocaine and the conversion of ephedrine or pseudoephedrine into methamphetamine.

The simplest conversion process is the conversion of a freebase drug to its salt form or conversion from the salt form to the freebase (see Figure 1.2a). The simple act of adding a strong acid or a base to a water solution containing a drug will convert it to its salt or freebase form. This act changes the physical and chemical properties of the drug, allowing it to be extracted from liquid solutions. Depending on whether an acid or a base was added to the water, the drug either dissolves into or precipitates out of the water. Structurally, the drug remains unchanged.

The addition or removal of a functional group from a molecule is another form of a conversion process. A chemical reaction adds to, or takes away, a portion of the original compound, leaving the skeleton of the compound unchanged (see Figure 1.2b). The resulting molecule will have different physical and chemical properties. In the case of drugs, the original and final compounds will have different physiological effects on the body from each other.

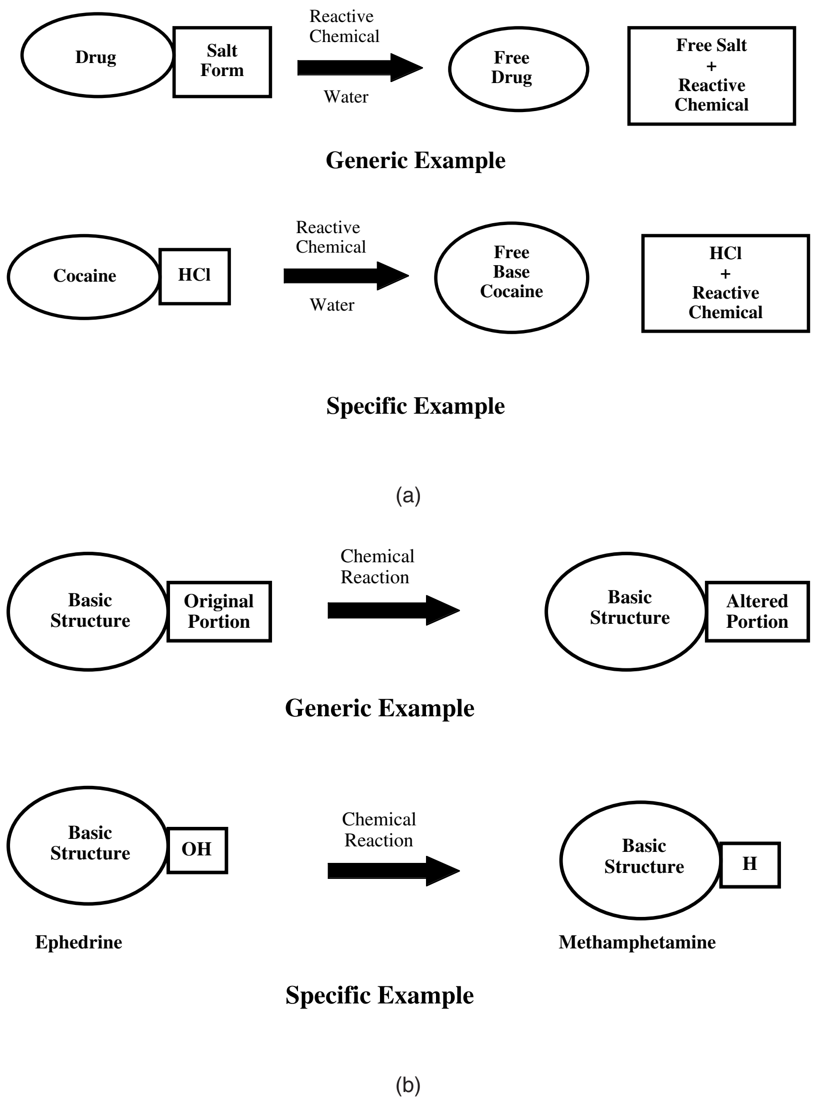

Figure 1.2 Conversion lab chemistry. (a) Salt form conversion. (b) Functional group conversion.

1.2.3 Synthesis Process

The synthesis process is a chemical reaction or series of chemical reactions in which molecules or parts of molecules are combined to create a new molecule. This process can be equated to a chemical erector set. It differs from the conversion process in that the skeleton of the resulting molecule is a sum of the molecules or significant parts of the molecules involved in the reaction. Lysergic acid diethylamide (LSD), phencyclidine (PCP), phenylac-

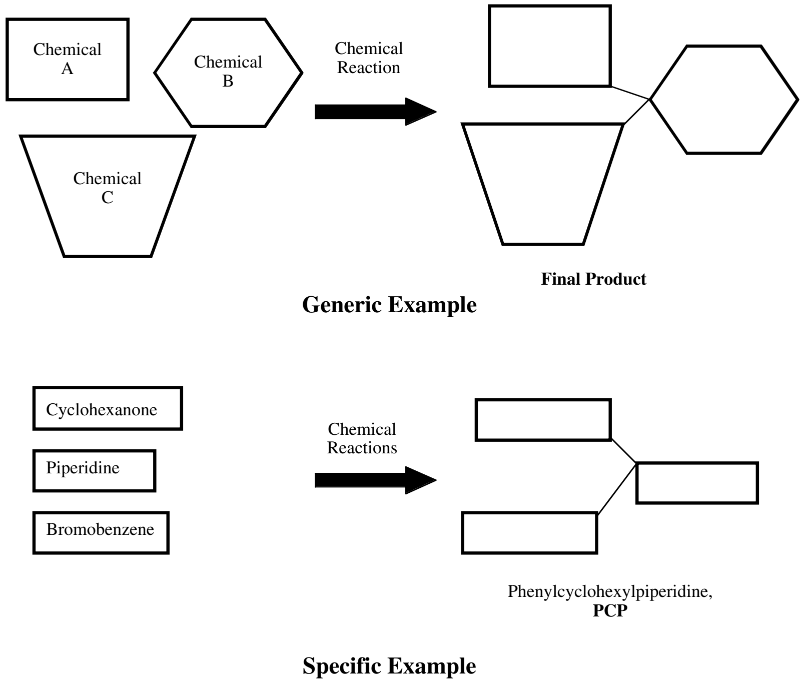

Figure 1.3 Synthesis lab chemistry.

etone (P2P), and certain methamphetamine reactions are examples of drugs produced using the synthesis process (Figure 1.3).

Even though the synthesis process sounds complicated, it may not require exotic equipment or lengthy reaction times. Some reactions can take place in plastic buckets in a matter of minutes or hours. Other reactions require sophisticated equipment or extended reaction times to achieve the desired results. The only way to differentiate between a conversion process and a synthesis process is to compare the structures of the precursor chemicals to those of the final product.

1.2.4 Tableting

Clandestine labs involved in the tableting process are placing the finished product into dosage forms or into smaller, more salable units for distribution. The tableting process derives its name from operations that place controlled substances into tablet form. The tableting process often includes pressing corporate logos onto the tablets to simulate legitimate pharmaceuticals.

Statutes in some jurisdictions include the act of packaging and repackaging in the definition of manufacturing. This language may interpret the act of placing the final product into a container for distribution (packaging) or dividing the container of final product into smaller containers (repackaging) as a manufacturing process. Thus, the act of making little ones out of big ones could also legally be equated to the actual production of the material.

This is a very subjective area. It is essential that the investigator consult with the local prosecutor to ascertain that the act of packaging items for sale or distribution can be statutorily considered manufacturing in that jurisdiction.

1.2.5 Combination Labs

A combination of processes is used to manufacture a controlled substance. It is not uncommon for more than one process to be observed at any given clandestine lab site. The size and scope of the operation will often determine how many processes are seen at the site.

A small-scale operator may extract the precursors needed from over-the-counter medication. He then converts the precursors into the controlled substance. Finally, he packages (tablets) the final product into dosage units or into smaller quantities for sale or distribution. All this can occur in a single hotel room, camping trailer, kitchen, or garage.

Commercial operators, in an effort to avoid detection, may choose to perform different phases of their operation at separate locations. The extraction of precursor chemicals from legitimate sources may occur at one location, and the synthesis may be done at another. The oily freebase compound is often transported to a third location and then converted to the solid salt form. The powder may then be transported to a final location, where it is prepared for distribution.

In both scenarios, the same processes existed: precursor chemicals were extracted; the precursor was converted or synthesized into the controlled substance; the controlled substance was converted into a usable form; and finally, the final product was packaged for distribution. The only difference is that in the first scenario, everything took place at the same location, while in the second, these processes occurred in four separate locations but under the same umbrella.

1.3 The Needs Triangle

Clandestine labs need equipment, chemicals, and knowledge to be complete. This Needs Triangle theme (Figure 1.4) is recurrent in many areas of science and life. As in any triangle, if any one of the three elements is eliminated, the system will not be complete. The amount of each component may vary, but each must be present for the operation to exist.

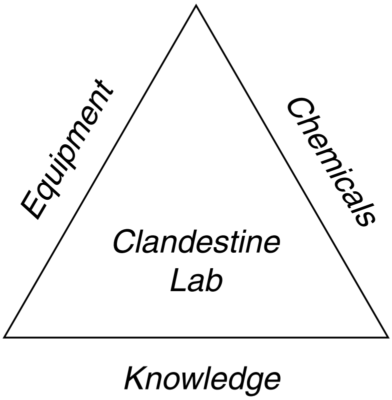

Figure 1.4 Clandestine lab needs triangle.

1.3.1 Equipment Needs

The equipment needs of a clandestine lab vary with the manufacturing method employed. Independent of the manufacturing method, two items are universally encountered: a triple-beam balance (found in any high school science lab), and surprisingly, pornography. Research indicates that methamphetamine and related psychomotor stimulants can increase the libido in users; this is in contrast to opiates, which decrease the libido. However, long-term methamphetamine use may be associated with decreased sexual functioning, at least in men. Pornographic materials and a triple-beam balance are seen so often in clandestine lab seizures that the inside joke of law enforcement is that their presence "officially" designates a clandestine lab.

All joking aside, common threads among the equipment needs of clandestine labs exist. Each manufacturing method will, of course, have its own equipment requirements that can usually be satisfied by using the scientific equipment that was designed to perform the process. However, to avoid detection, many clandestine lab operators designed alternatives to the traditional equipment, opting to use items that can be obtained from the grocery store or hardware store.

The manufacturing methods used by clandestine lab operators include reflux, distillation, and extractions. Understanding the mechanics of the scientific equipment used in the various manufacturing processes will allow the investigator to recognize the alternative equipment frequently encountered in clandestine labs.

1.3.1.1 Reflux

Refluxing is one of the most common methods used in the synthesis and conversion processes. This is a controlled boiling process in which the evap-

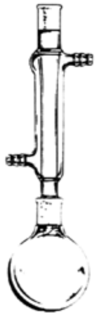

Figure 1.5 Basic reflux apparatus.

orated liquid is condensed and then returned to the reaction mixture. A slang term for the reaction mixtures found in clandestine labs is "soup," with the lab operator called the "cook." These are appropriate terms. In essence, the manufacturing of a controlled substance using the reflux method is similar to cooking soup.

When making soup, the cook combines the ingredients and boils them for a period of time. The only equipment necessary is a stove and a pot with a lid. When making a controlled substance using the reflux method, the cook combines the ingredients and refluxes them for a period of time. The refluxing apparatus is a specialized stove and a pot with a lid (Figure 1.5).

A source of heat is needed to cook the soup. A heating mantle is used in a traditional reflux apparatus. This is the equivalent of the stove a chef uses to provide the heat required to boil the soup. The shape and size of the heating mantles vary to fit the reaction vessel used in the refluxing. (Appendix A depicts a variety of commercially available scientific equipment used in the various manufacturing methods.)

All stoves have a method of regulating the heat they provide. Add too little heat, and the soup will not boil, or add too much heat, and the soup will boil over. A rheostat is used to regulate the heat produced by the heating mantle. It is plugged into any standard electrical outlet and is the equivalent of the control knobs on an electric stove. Regulating the amount of heat administered by the heating mantle controls the rate of the reaction.

Commercially available oil or water baths can be used as an alternative to a heating mantle. The reaction vessel is submersed partially or totally in the oil or water to provide a uniform source of heat around the reaction vessel when the reaction temperature is critical.

A chef needs a pot in which to cook his soup. A boiling or reaction flask acts as the pot. As a general rule, a boiling flask has a single opening, or neck. Reaction flasks have multiple necks. The multiple necks on a reaction flask have legitimate purposes during the refluxing process. However, all that is necessary for a basic reflux apparatus is a single opening. The opening allows the ingredients to be added, pressure to be vented during the reaction, and the product to be removed. Many clandestine recipes for controlled substances require a triple-neck reaction flask, while in reality, a single-neck flask would suffice.

Boiling and reaction flasks are generally spherical with round bottoms that fit snugly into the appropriately sized heating mantle. The flasks encountered in clandestine labs vary in size from 25 ml (slightly less than 1 oz) to 72 l (approximately 18 gal). There are also boiling and reaction flasks that have flat bottoms to allow the flask to sit on a hot plate or ring stand without support.

The necks on boiling and reaction flasks generally have ground glass fittings that provide a sealed connection for various auxiliary items, such as condensers, addition flasks, or thermometers. Smooth-necked flasks exist. Sealing connections with auxiliary equipment is accomplished by using cork or rubber stoppers.

A chef places a lid on his pot to keep the soup from boiling dry. The steam from the boiling soup condenses on the lid and drips back into the soup, replenishing the evaporating liquid. The steam escaping from around the sides of the lid relieves excess pressure. A reflux apparatus operates in much the same way. Various types of condensing columns or condensers act as the pot's lid. Each type has a specific scientific application. However, in the world of clandestine labs, all condensers act as the lid on the boiling soup.

A condenser has a compartment through which cool water is circulated. Steam from the boiling mixture condenses on the cool surface of the compartment. The condensed liquid then drips back into the boiling mixture. Vapors that are not condensed escape through an opening, relieving excess pressure on the system.

In some instances, the uncondensed vapors are vented into some sort of absorbent material, helping to eliminate the odors associated with the production method. This also traps the toxic vapors generated by the reaction. Unvented fumes containing toxic compounds can affect the health of the lab operators or personnel tasked with the seizure of clandestine labs.

Not using a condenser has many hazards. Uncondensed vapors fill confined spaces that house clandestine labs and create a toxic environment. A reflux apparatus without a condenser can potentially boil dry, creating a different set of toxic or hazardous compounds.

The venting process can be potentially hazardous. If the condenser becomes obstructed, pressure will build in the reaction vessel as a result of the boiling liquid. If the obstruction is not removed, one or more of several dangerous situations may occur. The pressure of the expanding gas could clear the obstruction violently. The expanding gas may compromise the connection between the condenser and the reaction flask, turning the condenser into a projectile. The structural integrity of the reaction flask or condenser may be compromised and result in a boiling liquid expanding vapor explosion (BLEVE).

Clandestine lab operators commonly create reflux apparatuses utilizing ordinary household items. Hot plates have been used as heating mantles. Countertop deep fryers have been used as oil baths. Glass cookware items have been used as reaction vessels. Condensers have been fabricated from copper or PVC pipes. The only limitation is the operator's imagination, so the clandestine lab investigator must also be thinking creatively in order to recognize things for what they really are.

1.3.1.2 Distillation

Distillation is the separation of a liquid from a solid or other liquid using evaporation followed by condensation. It is a modification of refluxing. It can be used as a technique to synthesize and separate compounds or used solely as a separation technique.

Distillation uses the differences in the boiling points of the mixture's components to separate them. The component with the lowest boiling point will separate from a boiling mixture first. The mixture will maintain the temperature of the boiling point of that component until it has completely evaporated from the mixture. The mixture's temperature will then rise to the next lowest boiling point in the mixture.

Knowing the boiling point of the component of interest allows the operator to isolate it. Even if the operator does not have a thermometer, he can isolate the desired component if he knows the boiling plateau of the component of interest.

During the distillation process, a mixture of chemicals is boiled. As a result, precursor chemicals can be converted into a desired end product or combined with other precursors to synthesize a new compound during the boiling process. At the same time, the unwanted by-products are separated from the mixture by evaporation.

The equipment used for distillation is the same as that used for refluxing. The individual components of the apparatus are rearranged to allow gravity to separate the condensing liquid from the boiling mixture rather than return it. As with a reflux apparatus, the distillation apparatus (Figure 1.6) requires a heating mantle (stove), a boiling and reaction flask (pot), and a lid (condenser). The heating mantle provides the heat required to boil the ingredients in the reaction vessel. The vapors from the boiling ingredients then condense in the condenser. The orientation of the condenser is changed to allow gravity to separate the condensing liquid away from the boiling liquid instead of returning it to the mixture. It may then be collected in a reception flask.

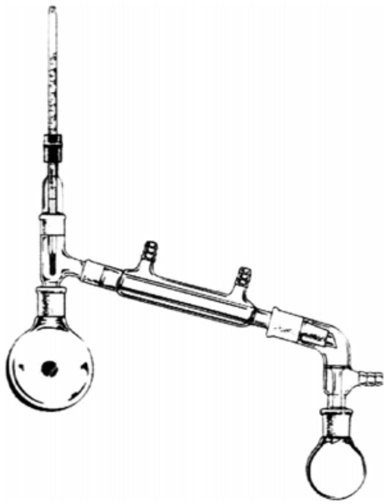

Figure 1.6 Simple distillation apparatus.

In simple distillation, the temperature of the boiling liquid is monitored to determine when the component of interest is evaporating from the mixture. Fractional distillation allows the separation of components with similar boiling points by monitoring the temperature of the vapors that traveled through a precooling (fractionating) column.

A vacuum pump may be attached to either system to aid in the distillation process. The vacuum pump draws the vapors into the condensing column rather than allowing the pressure from the boiling liquid to force them into the column. This expedites the process.

As with the reflux apparatus, clandestine lab operators often alter common equipment to create a distillation apparatus, when the need arises.

1.3.1.3 Hydrogenation

Hydrogenation is a chemical reaction that adds hydrogen to a substance through the direct use of gaseous hydrogen. Under high pressure, in the presence of a catalyst and hydrogen, ephedrine can be converted into methamphetamine. The hydrogenator (Figure 1.7) used in this method is commonly referred to as "the bomb" in scientific circles as well as in the clandestine lab world. Hydrogenators are commercially available. As with all scientific equipment, clandestine lab operators developed alternatives for this specialized piece of equipment.

1.3.1.4 Bucket Chemistry

There are certain manufacturing methods that do not require traditional chemical apparatuses. "Bucket" chemistry is an appropriate term, because these

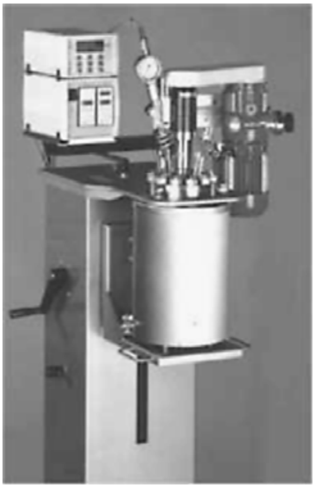

Figure 1.7 Commercial hydrogenator.

reactions can literally take place in a plastic bucket. The chemicals are placed into the container and allowed to react. At some point in time, an extraction process is undertaken to separate the final product from the reaction mixture. No heat is necessary, but cooling may be required. Phencyclidine and methamphetamine can be produced using nothing more than plastic containers.

1.3.1.5 Extractions

Extraction is the act of separating a constituent from the whole. It may be performed a number of times during the manufacturing process. Clandestine lab operators rely on the component's physical and chemical properties to isolate it from the rest of the substances.

The two types of extraction mechanisms are physical and chemical. The type does not necessarily correspond to the use of the component's physical or chemical properties, but it is simply a means of explaining the process.

Chemical extractions use a component's ability to dissolve in a liquid (solubility) to separate it from the bulk substance. The component being extracted may be the compound of interest or some unwanted by-product. The process does not require sophisticated equipment. All that is required is a container to hold the original mixture and a liquid that the desired material will not dissolve in.

Insolubility can be used as well. The salt forms of many drugs are not soluble in most organic liquids. When a free drug is converted into the salt form, it will precipitate out of an organic solution. During conversion of the drug from one form to another, its solubility properties are changed. This allows its extraction from the solvent and any by-products that are soluble in the solvent.

The compound of interest does not have to be in a solid form to be extracted by a liquid. A liquid can extract other liquids from each other. The acidity of a liquid may or may not allow a substance to dissolve in it. For example, freebase methamphetamine is an oily liquid at room temperature. It is soluble in acidic water solutions but insoluble in basic solutions. Thus, by adjusting the acidity of the liquid, methamphetamine can be chemically extracted from a water solution.

Physical extractions physically separate the components of interest. In many instances, the act of chemically separating the desired component is only half the battle. In one manner or another, the two chemically incompatible components need to be physically separated. Specialized equipment was developed to perform this task.

On the other hand, decanting and evaporation are two means of physical extraction that do not require specialized equipment. Both techniques use differences in their physical states to physically separate components or mixtures.

Decanting is a simple form of physical extraction that separates liquid and solid mixtures. The solid material is allowed to settle to the bottom of the container. The liquid is then carefully poured from the container, disturbing as little of the sediment as possible.

Gravity filtration is a simple physical extraction used to separate solids from liquids. All that is required is a funnel, a filtering material, and a receptacle for the filtered liquid. The filter device is placed into the funnel, and the solid–liquid mixture is poured into the funnel. Gravity draws the liquid through the filtering material, leaving the solid trapped in the filter. This type of filtration can be slow and may not be conducive to removing solids of fine particle size.

The filter paper commercially made for gravity filtration applications is unnecessary. All that is required is something that will allow a liquid to flow through and keep the solid on the other side. In clandestine labs, coffee filters, sheets, and women's silk underwear have been found being used to filter solids from liquids.

Vacuum filtration is a method of expediting the filtration process (Figure 1.8). A vacuum is used to draw the liquid through the filtering material. It is an efficient method of separating liquid from solids and is most efficient for solids of fine particle size.

Commercial vacuum pumps are commonly found at the scene of clandestine drug labs. Clandestine lab operators may use alternatives, such as the compressor from a refrigerator or an air conditioner. Air compressors have also been replumbed to perform this function.

There are times during the manufacturing process when different types of liquids must be separated from each other. This is accomplished through

Figure 1.8 Vacuum filtration.

the use of a separatory funnel (Figure 1.9). The liquid combination is placed into the separatory funnel, and the aqueous and organic liquids are allowed to form two distinct layers. The valve at the bottom of the funnel is opened, and the liquid is allowed to drain until the layer separation reaches the valve. The valve is then closed, and the desired liquid is saved for further processing.

There are alternatives to the use of the separatory funnel. The top liquid layer can be simply decanted off away from the top. Turkey basters have been used to separate one liquid layer from another. A water bottle with a squirt top has also been utilized as a makeshift separatory funnel.

Evaporation can be used to separate a solid that is dissolved in a liquid and does not require specialized equipment. The liquid is allowed to evaporate, leaving the solid. An outside source of heat can be used to accelerate the process.

Distillation is a form of evaporation used to extract one liquid from another. As previously discussed, it requires specialized equipment to evaporate, condense, and capture the different liquid fractions. The temperature should be monitored. However, the compound of interest can be isolated if its position in the sequence of boiling plateaus is known.

There are some instances in which chemical and physical extractions are used in tandem. In the final purification stage of production, the salt form of a drug is placed into a funnel containing a filtering material. The solvent

Figure 1.9 Separatory funnel.

is removed from the final product through a filtration process. Then, a different solvent, one in which the final product is not soluble, is poured onto the substance. This liquid chemically extracts the by-products from the final product and is physically extracted from the solid by filtration.

1.3.2 Chemical Needs

The chemical needs of a clandestine lab make up the second leg of the triangle. Most of the chemicals used in the manufacture of drugs and explosives have legitimate uses. Many can be obtained without restrictions through chemical suppliers or from grocery, drug-, or hardware stores. Some of the chemicals with restrictions have legitimate alternatives or sources that do not have restrictions on their distribution.

Some clandestine lab operators have a pragmatic solution: if they cannot legally buy a chemical, they will make it. A case demonstrating this philosophy occurred in Arizona, where a clandestine lab operator was utilizing phenylacetic acid as a starting material in a methamphetamine synthesis. Phenylacetic acid is a regulated chemical. To circumvent this problem, the operator manufactured it using mandelic acid as a starting material. He converted the mandelic acid into phenylacetic acid and continued the synthesis from there.

All of the chemicals used in the manufacture of controlled substances have legitimate industrial uses. Some have legitimate home and hobby uses and may be found in anyone's kitchen, medicine cabinet, garage, or workshop. The key to forensic clandestine lab investigations is the ability to recognize combinations of chemicals that can potentially form a controlled substance.

Appendix B lists chemicals utilized in the manufacturing of controlled substances and their legitimate uses. Also noted are legitimate home or hobby uses for each chemical. This information can be used by the investigator to establish whether a reasonable person would deduce that there is a legitimate reason for the chemical to be at a particular location or in the possession of a given person. A variety of clandestine uses for a variety of chemicals in the manufacture of controlled substances are listed in Appendixes C and D. In Table A of Appendix C, generic indications of what certain chemicals can potentially be used to manufacture are presented. Related in Table B of Appendix C are specific combinations of chemicals used to manufacture controlled substances.

When obtaining a search warrant, investigators should be able to articulate that the chemicals known to be associated with the clandestine lab have legitimate uses but have no legitimate home or hobby use. Further, an investigator should be able to state which controlled substance this particular combination of chemicals may produce.

The three types of chemicals used in the manufacture of controlled substances are precursors, reagents, and solvents. All three types are used at some point during the manufacturing process.

A precursor chemical is a raw material that becomes part of the finished product. It is the building block with which the final product is constructed. In a conversion reaction, a precursor's chemical skeleton is altered to create the final product. In the synthesis process, precursors are chemically bonded together to produce the final product.

Reagent chemicals react chemically with one or more of the precursor chemicals but do not become part of the final product. During the process, a portion of the reagent may be part of an intermediate product but is removed prior to the formation of the final product.

The use of magnesium in the manufacture of PCP is an example. The magnesium reacts with bromobenzene to form the intermediate product phenymagnesium bromide. This intermediate product reacts with another intermediate product, phenycyclohexyl carbonitrile (PCC), to form phencyclidine (PCP). During the process, the magnesium is removed from the intermediate and returned to the reaction mixture solution.

A solvent does not chemically react with precursor or reagent chemicals. Solvents are used to dissolve solid precursors or reagents, to dilute reaction mixtures, and to separate or purify other chemicals.

Some of the chemicals perform dual roles. For example, hydriodic acid (HI) acts as a reagent and as a solvent in the reduction of ephedrine to methamphetamine. This is because HI is not pure hydrogen iodide. It is technically a solution of hydrogen iodide and water. The hydrogen iodide acts as the reagent chemical. The water acts as the solvent in which the reaction takes place.

In the ephedrine/HI reaction, the water in the hydriodic acid (HI) acts as the solvent. It does not become part of the final or intermediate products. It only provides the environment necessary to allow the iodide from the hydrogen iodide to attach to, and be removed from, the ephedrine molecule to form methamphetamine.

An organic liquid can act as a solvent during extractions. The desired compound dissolves in the liquid and can be separated from the bulk substance. No portion of the solvent becomes part of the compounds being extracted.

Many chemicals have a variety of names. Many have a common name along with an official name chosen by the International Union of Pure and Applied Chemists (IUPAC). Common clandestine lab chemicals also have one or more slang terms (that may vary regionally) associated with them. For example, 2-propanone is commonly referred to as acetone. Therefore, investigators should rely on a forensic chemist to sort the various chemical synonyms.

Pronunciation of chemical names and terms can also be a problem. An investigator verbally asked a chemist what "propozyfene" was. The chemist had never heard of the compound. It was not until the investigator spelled the compound that the chemist realized that the investigator was trying to pronounce Propoxyphene, a Schedule II narcotic drug. For this reason, it is suggested that when nontechnical personnel attempt to describe or identify chemicals, they either write the name of the chemical or select the chemical name from a prepared list of chemical names and synonyms.

1.3.3 Knowledge Needs

Knowledge is the final leg of the manufacturing triangle. Knowing how to combine the equipment and chemicals to produce a controlled substance is a necessary element. Knowledge is necessary to establish capability and criminal intent. Knowledge may come from education (schooling or professional training), mentoring/apprenticeship, underground literature, and often even simply handwritten recipes that are bought and sold as property. The Internet has unfortunately become a source for many "recipes" as well. Original methods were taken from academic chemical literature and translated into simple recipes that can be followed by someone with no chemical training.

There are numerous ways to manufacture any given controlled substance. Each method has its roots in legitimate chemical or pharmaceutical literature. An example of this was found in a clandestine lab that converted mandelic acid to phenylacetic acid that was then used as a precursor to methamphetamine. The origin of the recipe was tracked to a German pharmaceutical journal. The chemical proportions utilized by the recipe differed by a factor of 10 from the original article. The steps utilized in the reaction sequence were a translation from technical jargon into simple English (e.g., "reflux" in the original article was "boil" in the recipe, and "decant" was changed to "pour").

Underground literature is a large source of the knowledge used by clandestine lab operators. Books like *The Secrets of Methamphetamine Manufacture* (for drugs) and *The Anarchist's Cookbook* (for explosives and booby traps) have long been staple sources of "how-to" information. The information in these books originated in legitimate chemical research, and in some cases, the underground authors even cite the original source of the information. The scary part of this plagiarism is that these are often poor translations; lives are put in danger at every step of the process.

In the past, when the Leukart reaction was the methamphetamine manufacturing method of choice, clandestine lab operators served apprenticeships under experienced "cooks" to learn the tricks of the trade. Recipes were guarded zealously and bought and sold as commodities. Today, with the free flow of information over the Internet, these recipes can be obtained by anyone with a computer and a modem. There are Web sites dedicated to drug and explosive manufacture. There are newsgroups in which an operator can shop for a new recipe or source of chemicals and equipment: a strange sort of support group for the underground chemist.

The downside to this information source for the underground chemist is that all of the information is not good. Some of the recipes do not produce the desired product. Other recipes may explode when the operator follows the instructions provided.

One example of a recipe that does not work is the chickenfeed recipe for methamphetamine. There has long been a rumor that several manufacturers of chickenfeed place methamphetamine in their product to enhance the egg-laying capability of the chickens. If the clandestine lab operator follows a simple extraction process outlined in the recipe, so it goes, he should be able to isolate the methamphetamine. The only problem with the recipe is that the chickenfeed manufacturers do not place methamphetamine in their product.

Some states have a statute that makes the possession of chemicals and equipment for the purpose of manufacturing a controlled substance illegal. This can be problematic in that there are methods of manufacturing methamphetamine that utilize equipment and chemicals that can be commonly and legitimately found in any home in the United States. If this statute were interpreted literally, thousands of homes in the United States would be in violation of the statute. Just because there is over-the-counter cold or diet tablets, rubbing alcohol, iodine solution, swimming pool acid, glass jars, a turkey baster, and coffee filters at a location does not make it the site of a clandestine lab. In order to prove intent, the knowledge must be proven to be present as well. Did the person who possessed the items know how to combine them in the proper sequence to make a controlled substance?

Knowledge, alone, is not all that is required. If that were the case, half of the chemistry students at any given university would be in jail. The key to the statute is the words "for the purpose of." Did the person with the equipment, chemicals, and knowledge intend to combine them to create a controlled substance? This is the question that needs to be asked when evaluating the knowledge requirement. In essence, did the person have the requisite criminal intent?

1.4 Summary

Clandestine labs come in all shapes and sizes. Lab operators range from the small-scale operator who produces just enough to sustain his personal habit to the large-scale operator who produces pounds at a time for commercial profit. Clandestine labs are found in every segment of society and cross all demographics. Race, religion, age, sex, and economic status are neither indicators nor barriers.

All three legs of the clandestine lab triangle need to be present for a clandestine lab operation to exist. Equipment, chemicals, and knowledge must be present for the operator to produce the desired product. The equipment used ranges from technical and scientific to mere household kitchen utensils. The chemicals required vary from the exotic that are only available through scientific supply houses to those that can be purchased over the counter at any drug-, grocery, or hardware store. Even though a science degree is helpful, all a clandestine lab operator needs to be able to do is follow directions.