Overview & System Description

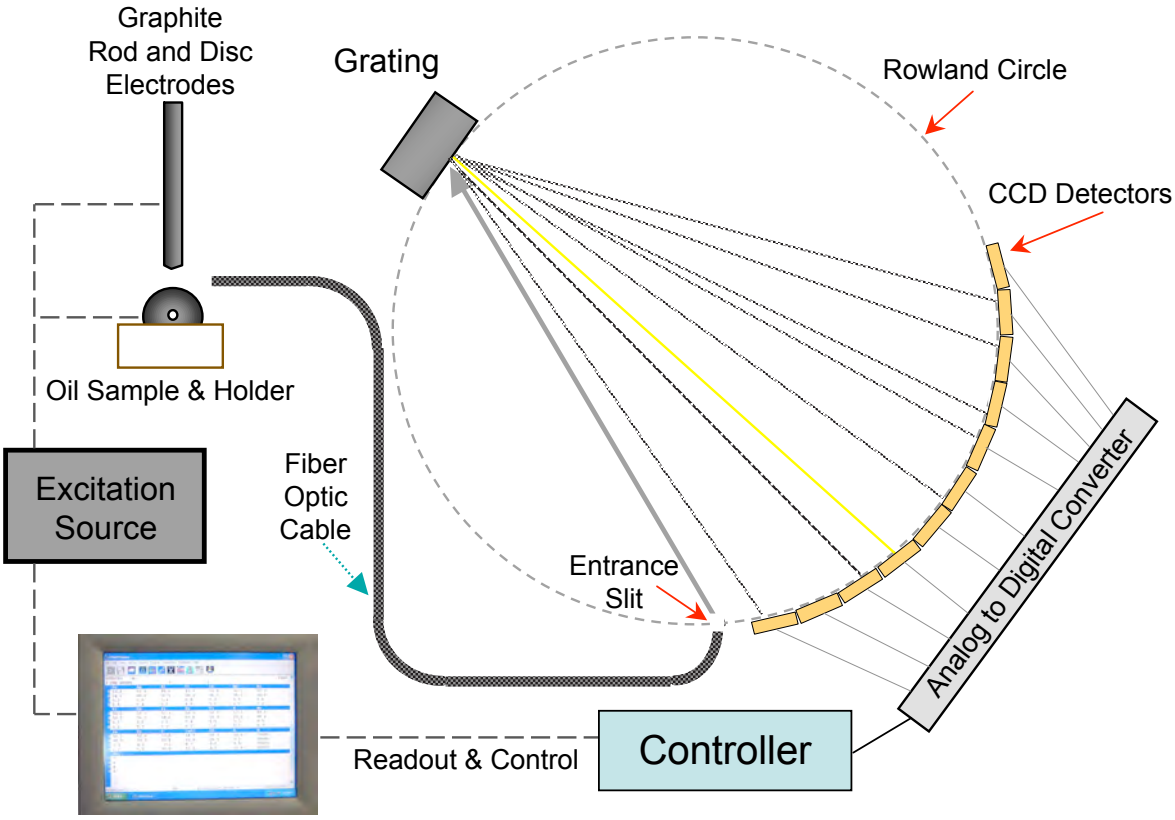
Spectroil M

Oil & Fuel Analysis Spectrometers

(For Serial Numbers Starting with 6001, Modifications 6 & 7)

Detailed Instructions for:

- **Spectroil M/N-W**
  Military Oil Analysis Spectrometer
- **Spectroil M/F-W**
  Fuel Analysis Spectrometer
- **Spectroil M/C-W**
  Commercial Oil Analysis Spectrometer
- **Spectroil M/F-LD**
  Light Fuel Analysis Spectrometer



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Manual Part No. M96112

Table of Contents

List of Effective Pages

Summary of Spectroil Modifications

Modification	Description
Mod 0	Original CID version of Spectroil M
Mod 1	Upgrade with SFTM port and frequency adjustement potentiometer
Mod 2	Addition of solid state excitation ignition module and SFTM port
Mod 3	Upgrade to combined solid state source
OilMWindows	Upgrade to Windows hardware and software
Mod 4	Upgrade to panel PC hardware and Windows XP
Mod 5	CE version of the Spectroil M
Mod 6	CCD Optic and New Software v. 5, starting w/serial number 6001
Mod 7	C.E. version of Mod. 6

Summary of OilMWindows Modification 6 Hardware and Software Manual Versions

Change	Version	Date	Description
First Issue	3.0	7/1/07	Complete update of Mod. 5 version 2.5 manual to include CCD optic & updated software.
Change 1	3.1	10/24/07	Update for CE version, Mod. 7, changes. Addition of optic removal procedure. Grammatical corrections
Change 2	3.2	10/31/07	More updates to Chapter 2 for CE certification.
Change 3	3.3	2/18/08	Created separate Overview & Systems Description Manual

Total Number of pages in this manual is 80 consisting of the following:

WARNING!!!
High Voltages are Present During the Operation of the Spectroil M!

Observe all Safety Precautions!

Turn OFF the Main Power Switch and unplug the SPECTROIL M before any work is performed.

Definitions

The following definitions apply to specific instructions throughout this manual.

WARNING!!!
An operating procedure or practice that may cause injury if not carefully observed or followed.

CAUTION!!!
An operating procedure or practice that may cause damage to the LNF if not carefully observed or followed

NOTE!!!
An operating procedure or practice that is essential to emphasize

Software CAUTION!!!

The Spectroil M computer is capable of running multiple software applications and/or operating systems. However, as designed, the computer processor is dedicated to the operation and control functions of the Spectroil M. Do not attempt to add any software or alter the original factory installed software without checking first with the Spectro Inc. Service Department.

Note on Oil Standards

The Spectroil M series of spectrometers can be calibrated for military or commercial applications. As a rule, the Spectroil M/N-W is calibrated and standardized with D-19, D-12 and D-3 series of standards, and the Spectroil M/C-W with V-21 or S-21 series of calibration standards.

Although this manual frequently refers to the military "D" series of standards, the operator procedures are identical for all types of Spectroil M spectrometers. Commercial customers should substitute their equivalent "V" or "S" series of standards throughout this manual.

WARRANTY

The warranty period of the Spectroil M family of spectrometers is twelve (12) months from date of installation or fifteen (15) months from date of shipment, whichever occurs first. Spectro warrants the Spectroil under conditions of operation against defects of materials and workmanship. All defective material will be replaced providing damage was not caused by improper use. Warranty applies to parts and labor only.

Chapter 1

Introduction / Theory of Operation

1.0 INTRODUCTION / THEORY OF OPERATION

1.1 INTRODUCTION

The Spectroil M, Figure 1-1, is a state-of-the-art optical emission spectrometer that has been specifically designed for the analysis of metals in lubricating oil and/or contaminants in gas turbine fuels. It is a compact, readily transportable, easy-to-use, accurate and repeatable, high speed laboratory or mobile oil analysis spectrometer.

The Spectroil M series of oil analysis spectrometers are based on the same design, but differ in their analytical program in order to meet the requirements of the customer and his application. The term "Spectroil M" will be used in this manual to describe the configurations of the spectrometer equipped with Modifications 6 & 7. Mod. 6 is for the Spectroil M with CCD optics and Mod. 7 is for the Spectroil M with CCD optics and hardware modifications required for it to display the CE mark.

Hardware changes for Mod. 7 (CE versions of the Spectroil M) will be noted as appropriate throughout this manual.

The entire Spectroil M family consists of the configurations as shown in Table 1-1. Separate manuals are available from Spectro Inc. for older configurations of the Spectroil and also for the robotics versions.

Figure 1-1, Spectroil M Oil and Fuel Analysis Spectrometer

Table 1-1, Spectroil M Family of Oil and Fuel Analysis Spectrometers

Market & Application	Software	Spectroil Model	National Stock Number
Air Force, Used Oil	Windows®	Spectroil M/N-W	6650-01-535-4271
Air Force, Used Oil (with Transit Case)	Windows®	Spectroil M/N-W	6650-01-415-1767
Army, Used Oil	Windows®	Spectroil M/N-W	6650-01-535-4276
Navy, Used Oil	Windows®	Spectroil M/N-W	6650-01-535-6287
Commercial, Used Oil	Windows®	Spectroil M/C-W	N/A
Commercial, Light Fuel	Windows®	Spectroil M/F-LD	N/A
Commercial, Heavy Fuel	Windows®	Spectroil M/F-W	N/A
Commercial, Used Oil, Robotic	Windows®	Spectroil M/R-W	N/A
Air Force, Used Oil (Obsolete)	DOS	Spectroil M	6650-01-388-8727
Commercial, Use Oil	DOS	Spectroil M/C	N/A
Commercial, Fuel	DOS	Spectroil M/F	N/A
Commercial, Used Oil, Robotic	DOS	Spectroil M/R	N/A

The Spectroil M is an analytical tool which detects and quantifies the presence of elements that exist either in small suspended particles or dissolved in natural or synthetic petroleum base products. Although state-of-the-art technology has allowed this optical emission spectrometer to be made smaller, faster, more accurate and easier to operate, the basic theory of its operation has not changed in over half a century. The Spectroil M employs the principles of optical emission spectroscopy (OES). This chapter gives a brief review of this technique. It is provided mainly for informational purposes and is not a prerequisite for operation of the Spectroil M. On the other hand, if more detailed information on the subject is desired, there are a number of excellent texts on OES which may be referred to. Please contact Spectro Incorporated if you would like more detailed information.

1.2 APPLICATIONS

1.2.1 Predictive Maintenance

Spectrometric oil analysis is applicable to any closed loop lubricating system, such as those found in gas turbines, diesel and gasoline engines, transmissions, gearboxes, compressors and hydraulic systems. In practice, an oil sample is periodically taken from a system. The spectrometer analyzes the sample for trace levels of metals worn from moving parts as well as contamination and additive element levels. The resulting data, when compared to previous analyses and allowable limits, may indicate a sound mechanism showing only normal wear, or it may point out a potentially serious problem in its early stages. With this advanced warning, steps may be taken to correct the situation before serious damage or injury occurs.

Spectrometric oil analysis works because fine particles are generated by relative motion of metallic parts in an oil-wetted system. The lubricating oil may be thought of as a diagnostic medium because the oil carries with it the particles generated by the wear contact. Abnormal wear modes such as corrosion, abrasion, severe wear, spalling, etc., cause an increase in the concentration of wear metals in the oil. Contaminants are detected and lubricant mix-ups or badly degraded lubricants are identified by the concentration of additive elements. Multi-element analysis, coupled with knowledge of the materials of construction, often allows identification of a specific component in distress.

The standard configuration for the Air Force and Navy Spectroil M/N-W is shown in Table 1-2a. The elements and concentration ranges are based on the analytical requirements dictated by the Joint Oil Analysis Program (JOAP). Table 1-2b shows the U.S. Army enhanced Spectroil M/N-W Analytical program which includes the basic 15 JOAP elements plus five additional elements.

Table 1-2a, Spectroil M/N-W Analytical Program

	Element	Concentration
1	Iron	0-1,000
2	Silver	0-1,000
3	Aluminum	0-1,000
4	Chromium	0-1,000
5	Copper	0-1,000
6	Magnesium	0-1,000
7	Sodium	0-1,000
8	Nickel	0-1,000
9	Lead	0-1,000
10	Silicon	0-1,000
11	Tin	0-1,000
12	Titanium	0-1,000
13	Boron	0-1,000
14	Molybdenum	0-1,000
15	Zinc	0-1,000

Table 1-2b, U.S. Army Enhanced Spectroil M/N-W Analytical Program

	Element	Concentration
1	Iron	0-1,000
2	Silver	0-1,000
3	Aluminum	0-1,000
4	Chromium	0-1,000
5	Copper	0-1,000
6	Magnesium	0-1,000
7	Sodium	0-1,000
8	Nickel	0-1,000
9	Lead	0-1,000
10	Silicon	0-1,000
11	Tin	0-1,000
12	Titanium	0-1,000
13	Boron	0-1,000
14	Molybdenum	0-1,000
15	Zinc	0-1,000
16	Barium	5-10,000
17	Phosphorous	5-10,000
18	Calcium	10-10,000
19	Cadmium	1-1,000
20	Potassium	1-1,000

NOTE: For JOAP correlation requirements, the Spectroil M/N-W must be factory calibrated with D-19 calibration standards supplied by the Technical Support Center - JOAP, Pensacola, Florida.

Commercial oil analysis and machine condition monitoring has experienced rapid growth in the last decade. The market is more diverse than the military application, and machine condition monitoring based on oil analysis can be found in all of the following industries:

- Commercial Laboratories
- Chemical Processing
- Electric Power Generating Companies
- Railroads
- Refineries
- Airlines
- Mining Operations
- Public Transportation Companies
- Steel Mills
- Manufacturing
- Marine Fleets

Commercial laboratories typically have a larger variety of oil wetted systems to support and their analytical layout can be more demanding. Applications are not limited to a few systems but include almost anything that uses oil as a lubricant. Typical requirements include generators, turbines, gear boxes, engines, compressors, transmissions and even hydraulic systems.

A standard configuration for the Spectroil M/C-W that meets the majority of commercial oil analysis requirements is shown in Table 1-3. It includes wear metals, contaminants and additive elements.

NOTE: The standard configuration of the Spectroil M/C-W consists of 21 elements and reference channels. Additional elements can be added upon request.

Regardless of the application, a well implemented and managed oil analysis program will provide cost savings and efficiency savings to the user.

Table 1-3, Spectroil M/C-W analytical Program

	Element	Concentration
1	Aluminum	0-1,000
2	Barium	5-6,000
3	Boron	0-1,000
4	Cadmium	0-1,000
5	Calcium	0-6,000
6	Chromium	0-1,000
7	Copper	0-1,000
8	Iron	0-1,000
9	Lead	0-1,000
10	Magnesium	0-6,000
11	Manganese	0-1,000
12	Molybdenum	0-1,000
13	Nickel	0-1,000
14	Phosphorus	5-6,000
15	Silicon	0-1,000
16	Silver	0-500
17	Sodium	0-6,000
18	Tin	0-1,000
19	Titanium	0-1,000
20	Vanadium	0-1,000
21	Zinc	0-6,000

Typical advantages of an oil analysis program include:

- **Reduced Maintenance Costs - By detecting a failure mode from its early stages, money is saved by;**
  - preventing total loss of the equipment,
  - limiting the amount of secondary damage. For example, if a bearing which is wearing abnormally is replaced before damage is done to the shaft it supports, a great deal of money is saved.

- **Increased Equipment Availability** - Monitoring of equipment will prevent unexpected failures and unscheduled downtime.

- **Improved Safety** - In some equipment, most notably single engine aircraft and helicopters, mechanical failures can be life threatening.

- **Extended Oil Drain Interval** - With a well planned oil analysis program, oil change intervals can often be extended giving savings in labor, equipment availability and oil consumed.

- **Longer Equipment Life** - One of the side benefits of an oil analysis program is improved cleanliness and physical condition of the lubricant. More attention is paid to contaminant levels so that filters are more likely to be in proper working order and better housekeeping habits are practiced around the equipment. Since ingestion of outside contaminants is one of the principal causes of wear, cleaner oil means extended overall equipment lifetime.

1.2.2 Fuel Analysis

The Spectroil M/F-W is the version of the Spectroil M that is configured to detect and quantify contaminants in gas turbine and diesel engine fuels. The operation and maintenance of a Spectroil M/F for this application is identical to all the other versions, only the application differs.

In the past 30 years, gas turbines have been modified so they may be fueled by all types of liquid fuels, including residual, distillate and crude oil. The physical properties and contaminant levels of these fuels are inconsistent and unpredictable, and vary depending on their source, refinery processing, handling and storage.

Heavy petroleum oil must be preconditioned to prevent high temperature corrosion and deposits in the turbine. Fuel treatment has thus become an extremely important part of any gas turbine burning alternate fuels. Spectrometric analysis with the Spectroil M/F is used to determine the amount of treatment required and the efficiency of that treatment. In particular, sodium and potassium concentrations must be accurately measured to less than 1 part per million, and vanadium concentrations must be determined to calculate the amount of magnesium treatment compounds to be added to the fuel. The typical configuration of

Table 1-4, Spectroil M/F-W Analytical Program

	Element	Concentration
1	Sodium	0-300
2	Potassium	0-300
3	Vanadium	0-500
4	Magnesium	0-1,500
5	Lead	0-500
6	Calcium	0-500
7	Chromium	0-500
8	Silicon	0-500
9	Nickel	0-500
10	Iron	0-500
11	Aluminum	0-500
12	Copper	0-300
13	Zinc	0-300

the Spectroil M/F-W is shown in Table 1-4.

NOTE: The typical configuration of the Spectroil M/F consists of 13 elements and reference channels. Additional elements can be added or deleted upon request

1.3 OPTICAL EMISSION SPECTROSCOPY, THEORY OF OPERATION

Optical emission spectroscopy (OES) is a technique for detecting and quantifying the presence of elements in a material. OES utilizes the fact that each element has a unique atomic structure. When subjected to the addition of energy, each element emits light of specific wavelengths, or colors. Since no two elements have the same pattern of spectral lines, the elements can be differentiated. The intensity of the emitted light is proportional to the quantity of the element present in the sample allowing the concentration of that element to be determined.

Figure 1-2 provides a simplified view of the events that take place in the OES process. To keep things simple, only one electron is shown which would be the case for a sodium atom. Illustration a. shows a sketch of an atom in its ground state. Under normal conditions, prior to excitation, the electrons in the atomic structure of each element revolve in their lowest energy or "ground state". During excitation, the energy of the source is imparted to the oil or fuel sample, causing it to vaporize. Atomic electrons absorb energy and are temporarily forced away from the nucleus of the atom into a higher, unstable orbit, as in Illustration b. After reaching this unstable state, the electrons release this absorbed energy as they return to the ground or stable state.

The energy released has a specific value corresponding to the particular electron transition which has occurred in the excited atom. The energy is given off in the form of light, as in Illustration c. The light has a specific frequency or wavelength (frequency is inversely proportional to wavelength) determined by the energy of the electron in transition. Since many transitions of different energy are possible for complicated atoms which have many electrons, light of many

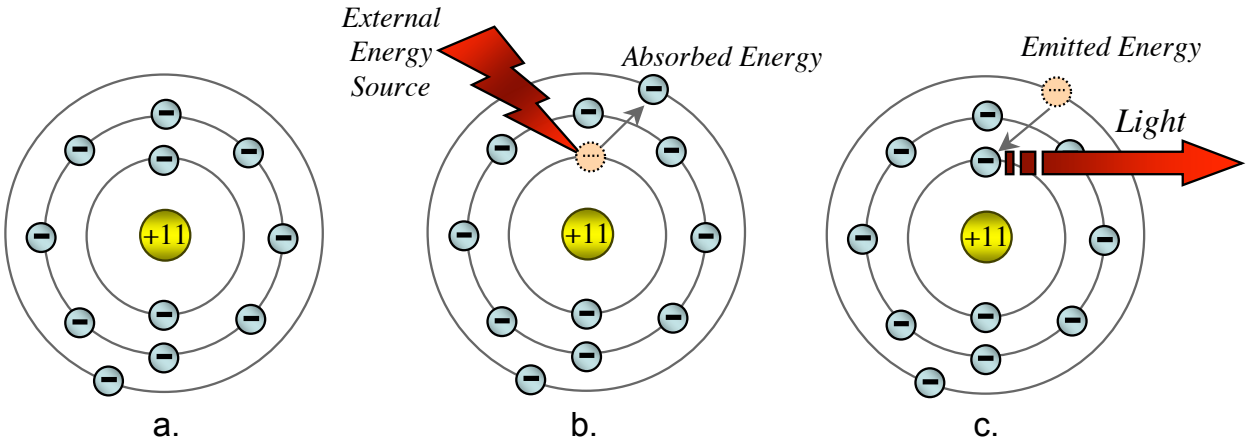

Figure 1-2, The Excitation process of the Atom

different wavelengths is emitted. These spectral lines are unique to the atomic structure of only one element. The intensity of the spectral lines is proportional to the concentration of the element present in the sample. If more than one element is present in the sample, spectral lines of distinctively different wavelengths will appear for each element. These lines must be separated in order to identify and quantify the elements present in the sample. Usually only one spectral line among many possible choices is chosen to determine the concentration of a certain element. This line will be chosen for its intensity and freedom from interference from spectral lines of other elements. To accomplish this, an optical system is required.

All optical emission spectrometers consist of three main components, these components are; 1. an excitation source, 2. an optical system, and 3. a readout system.

1. The excitation source introduces energy to the sample.

2. The optical system separates and resolves the resulting emission from that excitation into its component wavelengths.

3. The readout system detects and measures the light which has been separated into its component wavelengths by the optical system and presents this information to the operator in a usable fashion.

1.4 EXCITATION SOURCE

One typical method used in the excitation source in modern spectrometers is an electric discharge. The source is designed to impart the energy generated in an arc or spark to the sample. For oil analysis spectrometers, a large electric potential is set up between a disc and rod electrode with the oil sample in the gap between them. An electric charge stored by a capacitor is discharged across this gap creating a high temperature electric arc which vaporizes a portion of the sample forming a plasma. A plasma is a hot, highly ionized gas which emits intense light. The light given off as a result of this process contains emissions from all the elements present in the sample. These emissions can now be separated into individual wavelengths and measured, using a properly designed optical system.

The excitation source, in its most basic form, is generally a capacitive arc or spark discharge system which introduces energy into a sample. For a detailed description of the excitation source refer to Chapter 3 of this Manual.

1.5 OPTICAL SYSTEM

The purpose of the optical system in a spectrometer is to separate the light coming from the plasma into the discrete wavelengths of which it is comprised. Most people are familiar with the phenomenon illustrated in Figure 1-3, in which a prism is used to separate a beam of white light into a spectrum of different colors or wavelengths. The same principle is employed in the spectrometer, except that instead of a prism, an optical device called a diffraction grating is used to separate the discreet wavelengths.

Optical systems for emission spectroscopy generally take one of three configurations.

1. A fixed narrow band optical filter which passes only the wavelength that is of interest.

2. A monochromator which provides a single element readout where the wavelength of interest is selected by adjusting the position of the diffraction grating.

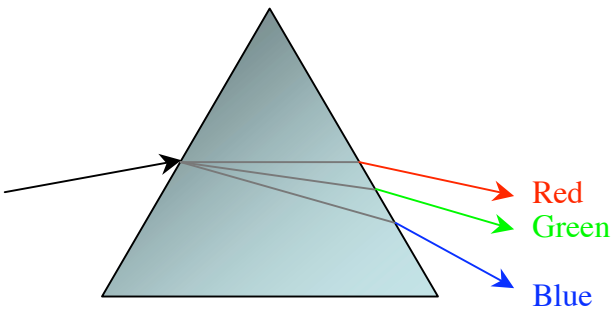

Figure 1-3, Refraction in a Prizm

3. A polychromator which enables simultaneous detection of many wavelengths.

The Spectroil M spectrometer uses a polychromator designed for the simultaneous determination of all programmed elements.

An important consideration when designing a spectrometer is the region of the spectrum where the wavelengths of interest occur. Many elements emit light in the visible region of the spectrum. However, there are elements which emit mainly in the Far Ultra Violet (FUV) region of the spectrum. This is significant because FUV radiation does not transmit well through air; rather, it is absorbed significantly. In such cases, it is necessary for the optical system to be mounted in a vacuum chamber so that the emitted light can reach the grating, be diffracted, and then be detected by the photomultiplier tubes. Thus, a sealed chamber and a vacuum pump become part of the system. All the wavelengths selected for the Spectroil M are in the visible region of the spectrum, thus avoiding the need for cumbersome vacuum optics.

Figure 1-4 shows the major components of polychromator used in the Spectroil M which is based on the Rowland Circle concept. Light from the excitation process (burn) exits the fiber optic cable and passes through the entrance slit and is concentrated on the diffraction grating by a lens. The entrance slit introduces light made up of all the elements present in the oil sample and defines the shape of the spectral lines at the focal curve after it is diffracted by the grating. The purpose of the grating is to separate (diffract) this light into its component wavelengths. These wavelengths are represented by a spectral line which are focused onto charge-coupled device (CCD) detectors placed along the focal curve. The CCD detectors convert the light energy into electronic signals which are processed by the readout system. The electrical signal is proportional to the intensity of the light, which in turn represents the concentration of the element in the oil sample.

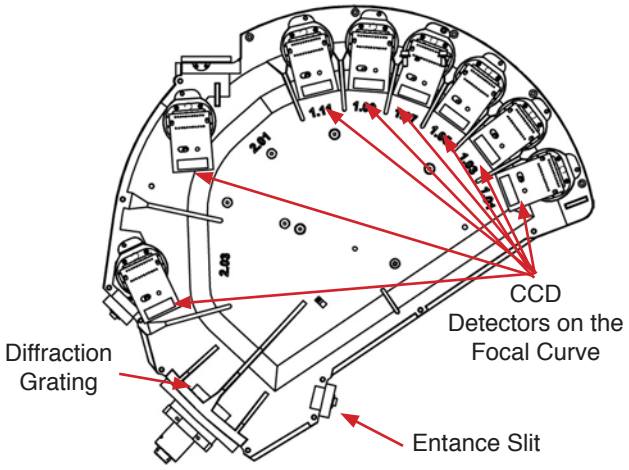

Figure 1-4, Polychromator Optical System

1.6 READOUT SYSTEM

In separating light into its component wavelengths, the diffraction grating directs spectral lines of light back toward the focal curve. If photographic film is placed on the focal curve to receive the light from the grating, the result is illustrated in Figure 1-5. Each line is an image of the entrance slit and corresponds to a specific wavelength of light. The darker the line, the greater the intensity of that spectral line. This is, in fact, how early spectrographs worked. Today, however, photographic film has been replaced by precisely located high

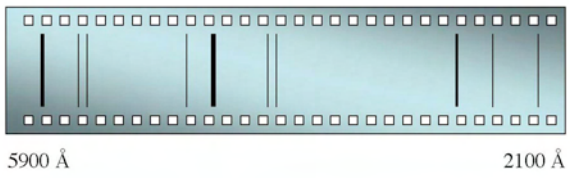

Figure 1-5, Photographic Film Exposed on the Focal Curve

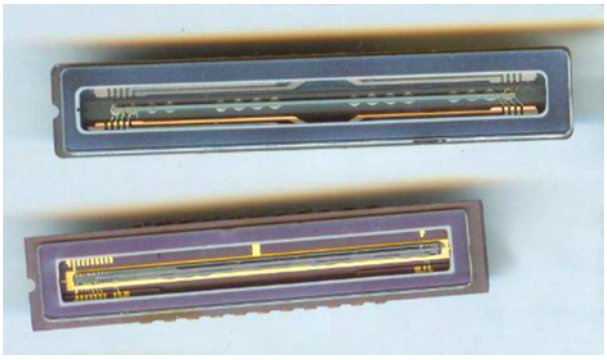

Figure 1-6, CCD Detectors

resolution CCD detectors, Figure 1-6.

A CCD detector is a semiconductor chip which is sensitive to light. The Spectroil M optic has 15 such CCD detectors which are mounted on the focal plane to cover the wavelength range of the analytical program. The chips are rectangular in shape and subdivided into a grid of 2048 pixels. When light from the excitation process by way of the entrance slit and grating strikes a pixel, it generates a small electrical charge which is stored for later read-out. The size of the charge increases cumulatively as more light strikes the surface, and the greater the brighter the light, the greater the charge. The CCD's are connected to electronic circuitry to power it, control it and read it out.

The readout system of the Spectroil M is controlled by an industrial grade processor and software. A clocking circuit and amplifier periodically reads the charge on a CCD chip and converts it from an analog to digital (ADC) signal to measure the light that has fallen on a pixel. The charge accumulated on a pixel is converted to an arbitrary number defined as "intensity" units.

At the end of the analysis, the total intensities for each element are compared to calibration curves stored in memory and are converted to the concentration of the element present in the sample. Concentration is usually expressed in parts per million (ppm). This information is displayed on a video screen, or can be printed out on a printer. Once the analysis is completed and the results recorded, the system is ready for the next analysis. The analysis results may be left on the screen, stored on the hard disk, or can be sent to an external computer.

User friendly software enables simple operation with automatic recalibration, while providing statistical functions for averaging and repeatability. For a detailed description of the computer electronics and readout system, refer to Chapter 1 of the Spectroil M Maintenance Manual. For a detailed description of the software dialog and features, refer to Chapter 3 of this manual.

This has been a greatly simplified description of Optical Emission Spectroscopy to provide an overview of the process for those unfamiliar with it. A detailed study of this technique is much more complex. For example, each element emits light at a number of different wavelengths, making it necessary for the spectroscopist to choose the best wavelength for the measurement being made; one with sufficient intensity, lack of interferences from other elements' spectra, etc. Luckily, thanks to advances in technology, the state-of-the-art in spectroscopy has advanced to the point where it has become a readily available and easy-to-use tool for material analysis, as the Spectroil M demonstrates.

Chapter 2

Site Selection & Installation Requirements

2.0 SITE SELECTION AND INSTALLATION REQUIREMENTS

2.1 RECOMMENDATIONS FOR LABORATORY OPERATIONS

There are several considerations that should be taken into account regarding the installation of any analytical instrument. Careful consideration of the site selection and prior knowledge of installation requirements will expedite the installation of the Spectroil M and establish an efficient analytical environment. The following items in the specified sections must be considered before commissioning the Spectroil M.

2.1.1 Transporting and Uncrating

Transporting any instrument from one location to another requires thoughtful attention in advance of the actual shipment if the instrument is to arrive at its destination in good working condition. The Spectroil M is ruggedly designed and constructed to be insensitive to typical transportation shock and vibration. It is, however, an analytical instrument that contains assemblies which are optically aligned and subject to damage or misalignment if abused. For this reason it is recommended that whenever possible, the instrument be air freighted from location to location. Once the instrument arrives at an air freight terminal, the normal means of forwarding transportation is by truck. Statistically, if damage to the instrument will occur, it most probably will happen during ground transportation. For this reason it is recommended that the instrument be shipped in a transit case such as the one described in Section 3.6.9. The transit case has wheels for movement or it can be relocated using a fork lift. If a proper transit case is not available, the Spectroil M can

be secured to a wooden shipping pallet which will serve as a shock absorbing medium. Whenever possible, use a fork lift to move the instrument and shipping pallet from one means of transportation to another.

Once the instrument arrives at its destination, it must be uncrated and set up for operation. During this procedure, it should be carefully inspected for evidence of shipping damage. If obvious damage has occurred during shipment, it is advised that the damage be documented and photographed in order to obtain reconciliation from the freight transport organizations. If it is apparent that the damage will impair the operation of the instrument, contact Spectro Incorporated Field Service.

2.1.2 Location in the Laboratory

The location that is selected for the Spectroil M in a laboratory application is important. Do not locate the instrument close to open windows and/or heating units. Proper site selection will ensure that the instrument will remain stable without special environmental controls and that recommended periodic maintenance can be conducted as required. Sufficient work space should be left clear around the perimeter of the spectrometer to provide maintenance personnel with access to the various panels. The dimensions for the Spectroil M are shown in Table 2-1. Since the Spectroil M can always be moved to provide panel access, it can also be located in tight fitting locations. However, care must be taken to avoid blocking the rear air intake and exhaust ports.

2.1.3 Initial Setup

The Spectroil M is normally delivered as a complete system and in one shipping container. The container includes the Spectroil M and all accessories.

Table 2-1, Spectroil M Dimensions

US (metric)	
Length:	30.5 inches (775 mm)
Width:	25.0 inches (635 mm)
Height:	27.5 inches (700 mm)
Weight:	Approx. 250 pounds (114 kg)

NOTE: If the Spectroil is delivered in a transit case, remove the transit case cover and proceed with step 7.

To uncrate the Spectroil M for operation, the following procedure is recommended:

1. Before unpacking, move the instrument as close as possible to where it will be installed.

2. To uncrate the instrument remove screws along the base of the container and lift the top off the shipping pallet.

3. Remove the boxes which contain ancillary items for operation.

4. Pull out and fully extend the four (4) transport handles which are located near each of the four bottom corners of the spectrometer. Refer to Figure 2-1.

CAUTION: The weight of the Spectroil M is approximately 250 pounds (114 kg). The instrument should be moved with a fork lift or at least four personnel.

CAUTION: Take care to avoid pinching the fingers under the retractable transport handles when lowering the instrument.

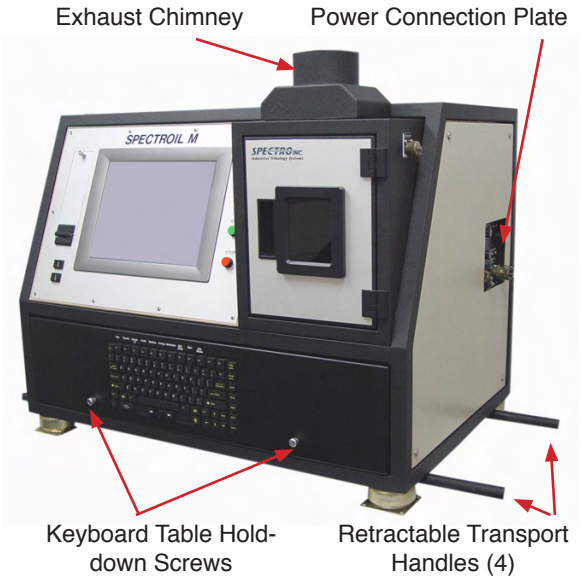

Figure 2-1, Location of Transport Handles

5. With a fork lift or four personnel, lift the instrument off the shipping pallet.

6. Move the instrument to the site selected for operation.

7. Locate and remove the input power cable. Remove the printer signal cable from the printer shipping box.

8. Remove the printer from the printer box.

9. Install the signal cable to the back of the printer.

CAUTION: Never connect or disconnect cables to the accessory power and signal plate with power applied to the instrument.

10. Refer to Figure 2-2 and connect the other end of the printer signal cable to the 25 pin female connector marked LPT1 on the accessory power and signal plate located on the left side panel near the back of the instrument. Secure the cable connector with the finger screws.

11. Refer to Figure 2-2 (left) for standard versions of the Spectroil M and 2-2 right for CE version of the Spectroil M. On standard versions, connect the male three pin 125 VAC plug of the printer power cable into the female connector labeled J3 125 VAC 50/60 Hz. This connector is located on the bottom left side of the accessory power and signal plate. On the CE version of the Spectroil M, the cover must be removed from the plug. Next, push the connector attached to the printer power cable onto the plug, twist in a clockwise direction to lock it in place..

12. Refer to Figure 2-3 and attach the male three pin MIL type plug of the electrode sharpener to the mating receptacle labeled J2 125 VAC 50/60 Hz. This connector is located on the power connection plate located on the right side panel near the back of the instrument. This connector is protected with fuse F2.

13. Refer to Figure 2-3 and attach the female MIL type connector for the input main power cable to the mating receptacle labeled J1 110/220 VAC 50/60 Hz. This connector is also located on the power connection plate.

NOTE: The analysis functions of the Spectroil M can be performed with just the START and STOP buttons on the control panel. When additional data such as sample ID must be entered, the Spectroil features a touch screen for this purpose, a built-in retractable keyboard, or a USB connection for an optional external keyboard.

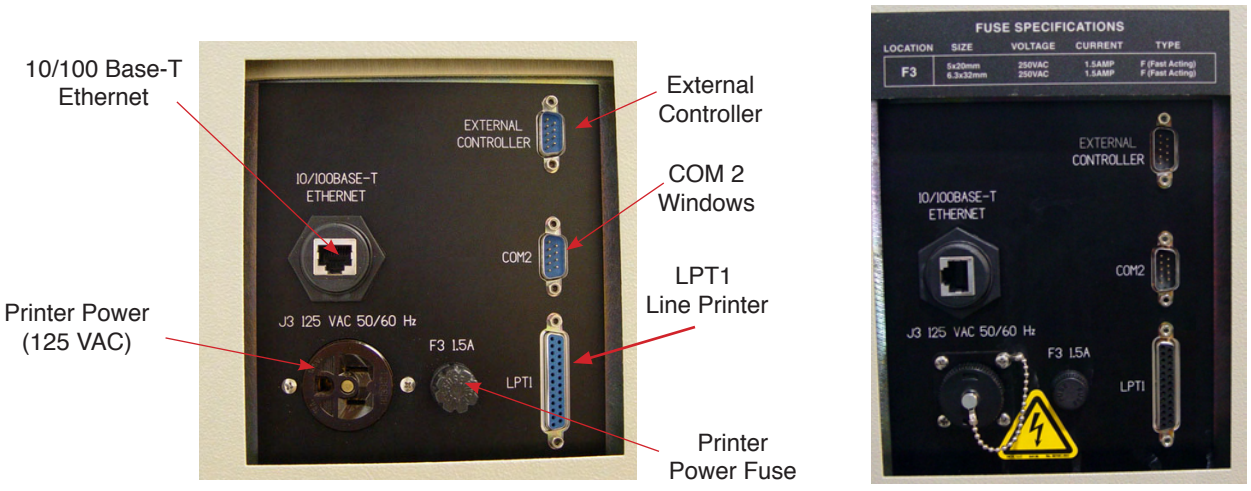

Figure 2-2, Left Side View Showing Accessory Power and Signal Plate Connections for Standard Spectroil M (Left) and for CE Version (Right)

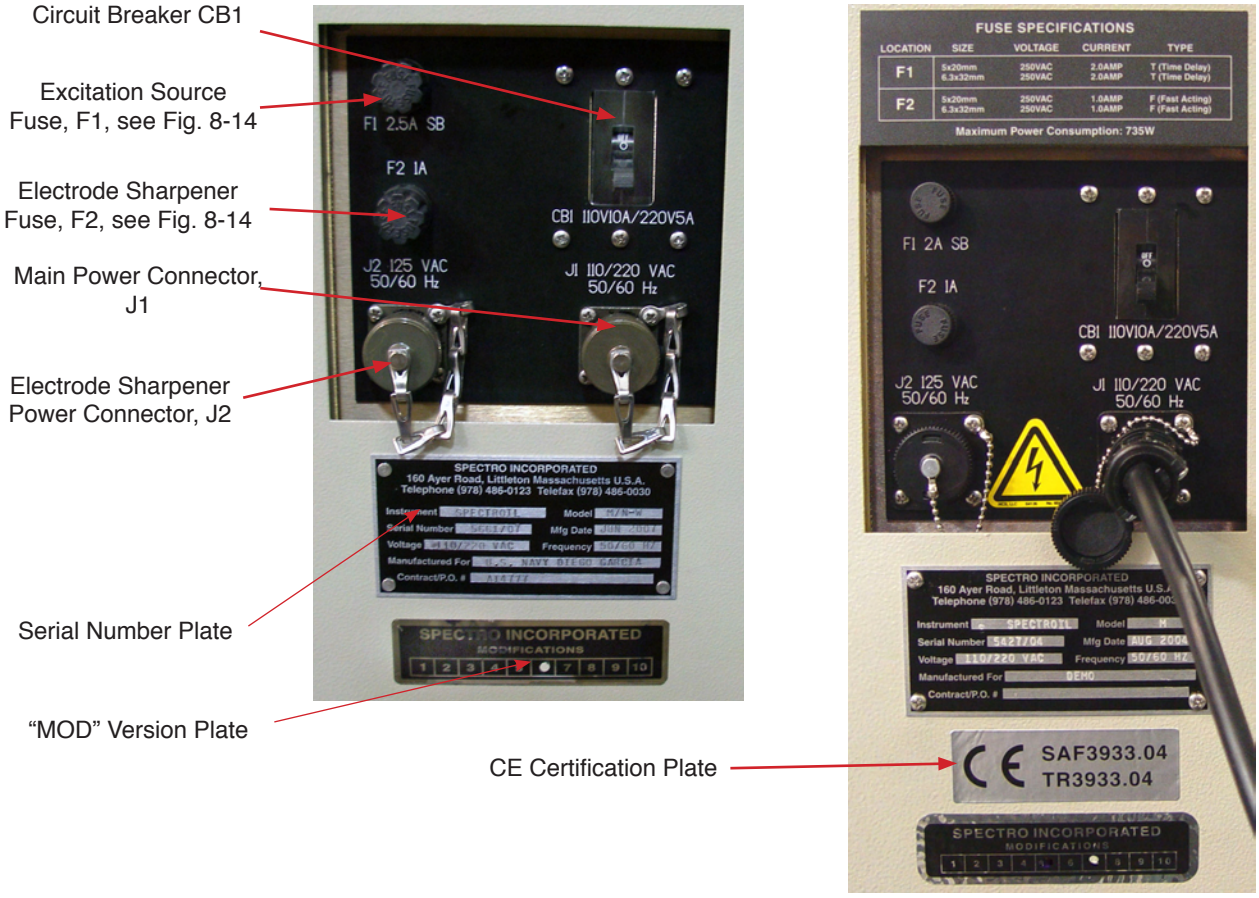

Figure 2-3, Right Side View Showing Input Power Connection Plate for Standard Spectroil M (Left) and CE version of Spectroil M (Right)

14. To use the retractable keyboard, loosen the two hold-down screws, Figure 2-1, by turning them counter-clockwise. Swing the keyboard up until it is level. Turn the two support handles located under the keyboard, Figure 2-4, until they line up with the keyboard hold-down screws. Tighten the hold-down screws.

When all steps in this procedure have been completed, the instrument is ready to have main power applied. The main power cable can be connected

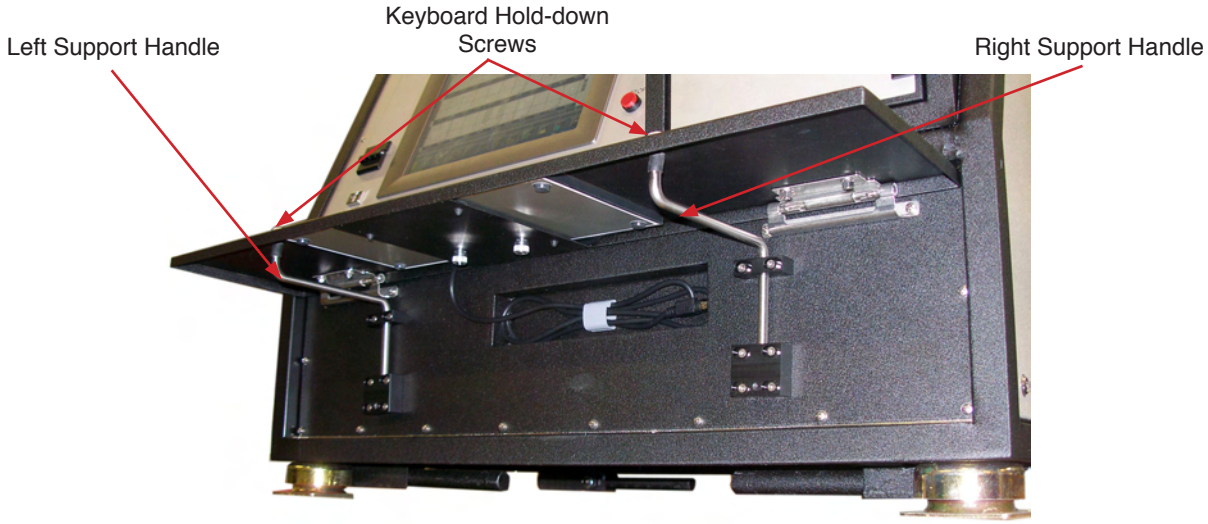

Figure 2-4, Keyboard Support Handles

to the input power source after the main power has been checked and is in accordance with the specifications stated in Section 2.1.4.

2.1.4 Input Power Requirements

The input power requirements for the Spectroil M are very flexible. The internally mounted voltage regulator is capable of accepting any AC voltage, either 110 VAC or 220 VAC at 50 or 60 Hz. The automatic voltage and frequency sensing circuitry is extremely accurate. This automatic system is designed into the Spectroil M to measure the input voltage and frequency as part of the initial power application process prior to the booting of the computer.

NOTE: The Source Frequency Test Meter (SFTM) can be used to determine the line frequency. Simply aim the SFTM toward a fluorescent lamp and press the momentary power switch for about 5 seconds. If the SFTM indicates 7200 +/- 100, the line frequency is 60 Hz. If the indication is 6000 +/- 100, the frequency is 50 Hz.

Tables 2-2 and 2-3 provide technical information about the input power specifications and the wiring requirements for the input plug. When correctly connected, the Spectroil is grounded through the main input power cord.

CE versions of the Spectroil M are delivered with a CEE 7/7 plug already attached to the input power cord.

Military versions are delivered with a Hubbel 125 VAC plug attached to the input power cord.

Table 2-3 is to be consulted if any other plug other than the CEE 7/7 or Hubbell 125 VAC is to be installed on the input power cord of the Spectroil M. It is recommended that a qualified electrical contractor, civil engineer or electrical technician be consulted to make any changes to the input power plug.

Table 2-3, Main Power Connections

Wire Color	Line
Brown (black):	High
Blue (white)	Low
Yellow/Green (green)	Ground*

**NOTE: It is imperative that a good ground connection is applied to the spectrometer. The ground connection can be verified with an AC voltmeter. Measure the voltage between the AC return and power earth ground of the receptacle. This voltage must be less than 5 VAC. If not, locate another receptacle and repeat the process or contact an electrician for assistance.*

NOTE: An earth ground can be created by connecting a 12 AWG wire from the foot of the instrument to a water pipe or steel rod that is driven at least 18 in (0.5 meters) into the ground.

2.1.5 Initial Power Application

The Spectroil M is designed to operate on an alternating current (AC) voltage supply, either 110 VAC or 220 VAC at a frequency of 50 or 60 Hz. This is accomplished by using an internally mounted regulating transformer and automatic voltage and frequency sensing software to monitor the incoming voltage/frequency. The software then automatically selects the optimum transformer operating configuration. The internal regulating transformer assembly and associated electronics and software minimize the possibility that an error can be made in selecting the proper input line voltage and frequency.

CAUTION: When operating on portable generators or light carts, do not attempt to apply

Table 2-2, Input Power Specifications

Item	
Input Voltage:	10/220 VAC +/- 10%, Single Phase
Frequency:	50 or 60 Hertz
Current:	15 Amperes
Power Consumption:	Maximum 735 Watts

power to the Spectroil M until a qualified electrical technician has verified that the input power, phase and frequency have met the specifications stated in Table 2-2.

CE versions of the Spectroil M are delivered with a CEE 7/7 plug already attached to the input power cord. Military versions of the Spectroil M are shipped with a Hubbell 125 VAC, 15 ampere plug attached to the power cord. In the event that the instrument is not installed by a factory representative and the receptacle which supplies the main input power is not suitable for the CEE 7/7 or Hubbell 125 VAC plug, it will be necessary to change this plug. It is strongly advised that a qualified electrical contractor or engineer perform the removal of the factory installed plug and the installation of the mating plug for the available receptacle. Under those circumstances, refer to the input wiring requirements in Table 2-3, or consult Spectro Incorporated Field Service for further assistance.

NOTE: If the Spectroil M was transported in extreme cold temperature, it should be brought to room temperature before power is applied.

Apply power to the Spectroil M by placing the circuit breaker CB1 in the up position. Refer to Figure 2-3 for identification of CB1. When power is initially applied to the Spectroil M via CB1, the operator can view the loading progress on the video monitor.

During factory setup, the software has been configured to automatically start up the OilMWindows® program. The OilMWindows® software will begin to load and you will see the Spectro Incorporated endorsement, shown in Figure 2-5.

The system then establishes communications with four files, a matrix, chip, and two binary files. Once the communication has been established and is secure, the OilMWindows® program completes the loading process by displaying the analysis program screen, Figure 2-6.

Figure 2-5, OilMWindows® Initialization Dialog

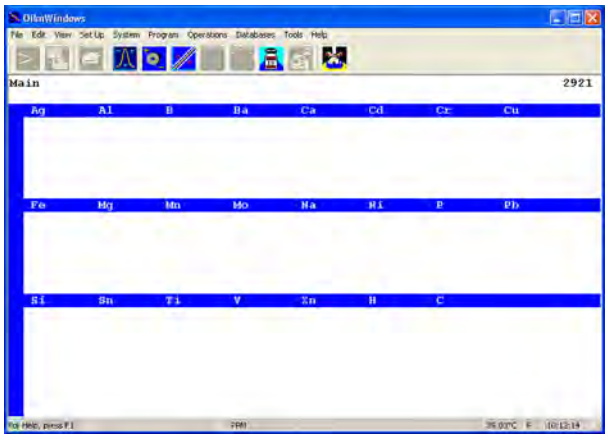

Figure 2-6, Analysis Program Screen

If the system fails to establish communication, a screen appears to select the Correct Configuration File Path. This will happen if the system cannot find a file such when a system has been updated or a file is corrupted. Refer to the Spectroil M Maintenance Manual Section 2.6.4.6 for assistance to diagnose and correct this condition.

The excitation source frequency must be checked and verified prior to operation for the spectrometer to meet accuracy and repeatability requirements for the JOAP. The reasons for this test are described in detail in the Spectroil M Maintenance Manual Section 2.4. Two methods to perform the test with the Source Frequency Test Meter (SFTM) are also provided.

The optic of the Spectroil M is heated, and when power is first applied to the instrument, it must be allowed to reach operating temperature. The temperature is constantly monitored by the software and it appears in the lower right hand side of

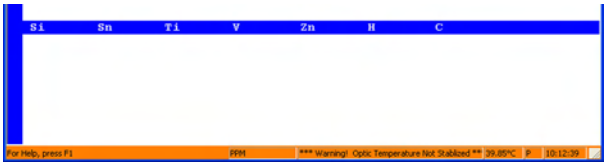

Figure 2-7, Temperature Instability Warning

the Analysis Program Screen along with a warning if the temperature is incorrect, Figure 2-7. The time it takes to reach operating temperature varies with the ambient temperature and can be as short as 30 minutes or as long as 3 hours in very cold climates. After the operating temperature has been reached, it will remain at that temperature as long as power has not been removed from the instrument. For that reason, it is a good practice to keep the instrument in the STANDBY mode when samples are not analyzed.

When the operating temperature of the optic has been reached, the Spectroil M can be prepared for sample analysis by placing the MODE switch to OPERATE, Figure 2-8 and following the instructions in Chapter 4.

2.1.6 Exhaust Ventilation

The Spectroil M incorporates the rotating disc arc discharge technique for the excitation source. This technique vaporizes the oil sample during the analysis process and consequently produces a fume that is exhausted from the sample excitation chamber. The sample excitation chamber of the Spectroil M is designed with an internal exhaust fan which produces 35 cfm (cubic feet per minute) (1 m^3/min) of air flow to exhaust these fumes. These fumes must be vented to the outside environment.

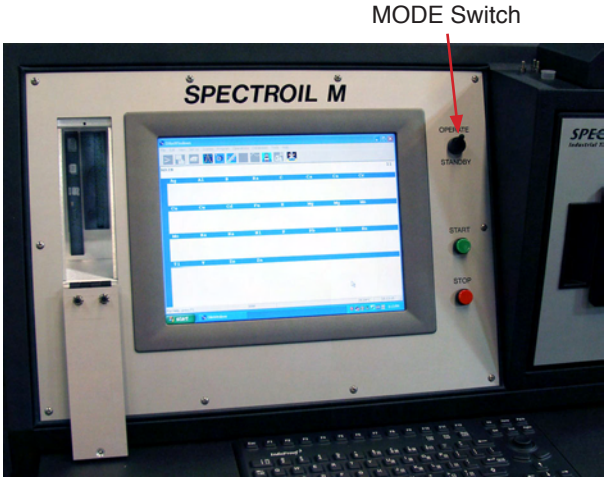

Figure 2-8, Control Panel

WARNING: During the sample excitation process, the Spectroil M burns less than 1 ml of calibration standard or used oil sample. Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke) will be present at trace concentrations too small to be effectively measured. Such odors are primarily a nuisance and produce no health issues to a healthy individual. However, the cumulative effect of continuous operation without an external duct to remove such fumes may cause irritation to an healthy individual or one with respiratory problems. For this reason the Spectroil M must be vented to the outside environment with the provided exhaust duct. For more information on calibration standards see also the MSDS forms delivered with them, or visit the Spectro Inc. website to download MSDS forms at: http://www.spectroinc.com/Service5MSDS.htm.

The exhaust fan in the Spectroil M is inside a chimney which is located above the sample stand. Refer to Figure 2-1. An exhaust duct must be connected to the chimney to ventilate the fumes to the outside environment. Up to 20 feet (6 meters) of standard (USA) 4 inch (10 cm) flexible exhaust duct is recommended. In order to maintain ample airflow, it is recommended that the length of this exhaust duct not exceed 20 feet (6 meters). For greater distances, an additional fan may be required to provide supplemental air flow.

NOTE: Too much ventilation will have an effect on the spark and instrument performance. If the Spectroil M exhaust is connected to an auxiliary exhaust system, verify that it does not exhaust too much air. This can be verified by observing the spark with and without the external ventilation system turned on. If in doubt, analyze a known standard oil sample several times and compare results with and without the external ventilation system turned on. The average and repeatability should be almost identical for both situations.

2.2 RECOMMENDATIONS FOR MOBILE OPERATION

The main application of the Spectroil M is for short term on-site analysis of lubricants and fuels where the decision on the performance of a mechanical system, such as an engine, or the quality of a gas turbine fuel must be known without delay. For this application, special consideration must be given to installation and operation since the spectrometer is subject to power interruption and is exposed to non-laboratory environments. The following sections will assist the operator to achieve accurate and reproducible analytical data:

2.2.1. Preparing the Spectroil M for Shipment
2.2.2 Transporting and Uncrating
2.2.3. Selecting a Suitable Location for Short Term Analysis
2.2.4. Operation from Light Carts and Portable Generators
2.2.5. Exhaust Ventilation
2.2.6. Power Application and Stabilization
2.3 Environmental Operating Conditions

Careful attention to the preparation of the Spectroil M in advance of shipment will ensure a successful mobile operation upon its arrival at the installation site.

2.2.1 Preparing the Spectroil M for Shipment

Although the mobile Spectroil M is designed and constructed to be rugged and capable of operating in harsh environments, careful attention must be paid to the preparation of the instrument prior to shipment. The recommended procedure is as follows:

1. Place the MODE switch located on the operator's control panel to the STANDBY position, refer to Figure 2-7.

2. Refer to Figure 2-3 and remove power from the instrument by placing the main circuit breaker CB1 located on the input power circuit breaker panel to the down (OFF) position.

3. Refer to Figure 2-3 and disconnect the input power plug from the voltage source and disconnect the cable from the connector labeled J1 located on the input power circuit breaker panel. Attach the protective cover to J1.

4. Refer to Figure 2-2 and disconnect the male three pin power plug from the female connector labeled J3 which supplies power to the printer. The connector is located on the bottom left side of the accessory power and signal plate.

5. Refer to Figure 2-2 and disconnect the signal cable labeled LPT1 on the accessory power and signal plate located on the left side panel near the back of the instrument. Remove the connector from the receptacle on the back of the printer. If used, remove any external USB devices and external data signal cable.

6. Carefully wrap the two cables (main power and printer signal) together. These should be packed inside the printer box along with the printer.

7. Re-pack the printer in its original box. If the original box and packing material are not available, obtain a suitable replacement and carefully pack the printer for transit.

8. Refer to Figure 2-3 and disconnect the MIL connector labeled J2 which provides power to the electrode sharpener. Attach the protective cover to J2. Wrap the cable around the electrode sharpener and pack in a separate cardboard box.

9. Close the sample excitation stand door and verify that the latch is engaged to be sure that it will not open in transit.

CAUTION: The weight of the Spectroil M is approximately 250 pounds (114 Kg). The instrument should be moved with a fork lift or at least

four personnel.

10. Secure the keyboard by loosening the two keyboard hold-down screws, Figure 2-4, swing the support handles towards the outside of the instrument, fold down the keyboard and tighten the hold-down screws.

11. Extend the four transport handles located beneath the instrument and with a forklift or four personnel, lift the Spectroil M off its table and center the instrument on its original shipping pallet. If the original shipping pallet is not available, be sure that the replacement pallet is capable of being moved by a forklift.

12. Place a sheet of protective material around the instrument to protect the finish. Place the printer box along the side of the instrument along with the accessories such as the keyboard, rod electrode sharpener, mouse and all consumables such as disc and rod electrodes and oil standards.

13. Check to be sure that all items placed on the side of the instrument are secured for shipment.

14. Secure the instrument to the pallet. Place the protective wooden box in which the instrument was delivered over the entire assembly.

15. Insert screws along the base of the wooden cover to secure it to the pallet. Band the cover to the pallet for additional security.

2.2.2 Transporting and Uncrating

(See Section 2.1.1)

2.2.3 Selecting a Suitable Location for Short Term Analysis

Site selection for operating the mobile Spectroil M will vary considerably from site to site depending on the application and requirements. For this reason, a recommended environment is not practical. There are, however, several general conditions that must be taken into consideration for mobile operation. One of the most important considerations is the location of the instrument once it arrives at the job site. It is strongly recommended that the instrument be operated in a closed environment such as a warehouse or a covered area, to protect it from direct sunlight, dust and rain. Environmental considerations such as temperature and humidity stabilization are not as stringent for the Spectroil M as they are for laboratory spectrometers. However, it is suggested that the Spectroil M be located away from direct sources of heat such as radiators, heating ducts, furnaces, and so on. The optical components of the Spectroil M are mounted on an A frame which has a low coefficient of heat expansion, but exposing the instrument to a sharp heat gradient may adversely affect the profile of the optics.

2.2.4 Operation from Light Carts and Portable Generators

NOTE: When operating on portable generators or light carts, do not attempt to apply power to the Spectroil M until a qualified electrical technician has verified that the input power, phase and frequency have met the specifications stated in Table 2-2.

The Spectroil M can be operated from a mobile or portable power source. This power source can be a light cart such as the NF-1 or TF-2 or a commercially available device such as a Homelite or Honda portable generator.

Operating the Spectroil M in a mobility environment with a portable power source may required additional consideration for reliable operation. Some of these considerations are the line voltage selection, generator frequency, voltage regulation, current handling capacity, load sharing, distance from the generator and power interruptions. This section will discuss the operating characteristics of the Spectroil M when operated in a mobility environment. The NF-1 light cart has two line voltages from which to choose. Selecting the line volt-

age for operation will depend on the load that it must share with other equipment and the distance between the Spectroil M and the portable power generator. Check to be sure that the characteristics of the generator meet the power requirements as stated in Section 2.1.4 of this manual.

In general, portable generators selected specifically for operating the Spectroil M are small, two man portable units that provide power at a single frequency, 50 Hertz or 60 Hertz. Some generators offer dual voltage capability and a DC (direct current) capability. Listed below in Table 2-4 are the minimum specifications for power capacity. Select the line voltage which is most available (the voltage which is supplying the least amount of other equipment or lights). If the spectrometer cannot be located within 20 feet of the generator, select a three wire extension cord of at least 12 AWG and no longer than 100 feet to connect the generator to the instrument. If an extension cord must be made to accommodate the mobility environment, all conditions as stated in Section 2.1.4 must be met prior to applying power to the instrument.

NOTE: Portable generators by their definition are not connected to a power earth ground return. Power earth ground is important in the operation of a spectrometer because it provides a return for radiated emissions generated by the arc during the analysis of a sample. When using a portable generator in a deployed environment, connect a ground strap or 12 gauge wire to the portable generator and a water line. If this is not feasible, drive a metal rod at least 12 inches into the ground near the generator and connect the rod to the earth ground contact of the generator with a ground strap or 12 gauge wire.

In a mobility environment, frequent power interruptions may be experienced. In these situations, the procedures set forth in Section 2.2.6 Power Application and Stabilization may not be applicable due to the length of the procedure and frequency and duration of the power interruptions. In these situations, it is recommended that the operator perform the daily standardization check (Section 4.2.4) to determine if the instrument needs to be standardized.

2.2.5 Exhaust Ventilation

Exhaust ducting may not be required since the main application of the mobile Spectroil M is to provide an on-site analysis capability where the sample quantity is not large or long term. Operating under this condition is acceptable provided that the site selected for the instrument is not in a confined non-ventilated area such as a small portable container. Discretion must be exercised depending upon the environment and the anticipated duration of the mobile operation. If exhaust ventilation is desired or required, refer to the exhaust ventilation recommendations for laboratory operation in Section 2.1.6.

2.2.6 Power Application and Stabilization

Initial instrument stabilization is an important consideration in the mobile operation. The quality of the analysis will depend directly upon the stability of the instrument. Provided that the instrument has been uncrated (Section 2.1.1), placed in the location for operation (Section 2.1.2 or 2.2.3), and all conditions regarding the power requirements (Section 2.1.4) and exhaust ventilating requirements (Section 2.1.6) have been met, the initial power can be applied to the Spectroil M (Section 2.1.5).

The excitation source frequency must be checked and verified prior to operation for the spectrometer to provide accurate and repeatable data. The reasons for this test are described in detail in Section 7.4. Two methods to perform the test, either with the Source Frequency Test Meter (SFTM) or an oscilloscope, are also provided.

It is necessary to allow the instrument and optic temperature to stabilize in order to achieve optimum performance. The optic of the Spectroil M is heated, and when power is first applied to the instrument, it must be allowed to reach operating temperature. The temperature is constantly monitored by the software and a reading appears in the lower right hand side of the Analysis Program

Screen along with a warning is the temperature is incorrect. The time it takes to reach operating temperature varies with the ambient temperature and can be as short as 30 minutes or as long as 3 hours in very cold climates. After the operating temperature has been reached, it will remain at that temperature as long as power has not been removed from the instrument. For that reason, it is a good practice to keep the instrument in the STANDBY mode when samples are not analyzed.

As stated in Section 2.2.3, do not locate the Spectroil M near a concentrated heat source that would create a temperature differential from one side of the instrument to the other. When the spectrometer has stabilized, perform an optical profile as described in Section 4.2.7, followed by a standardization as described in Section 4.2.5. After standardization and the daily standardization check, the instrument is ready to run samples.

It is possible that stability will be reached in much less time than one-half hour. If the instrument must be used soon after power is applied where it is questionable whether internal operating temperature has stabilized, it is recommended that the standardization be checked once or twice more during the first few hours of operation.

2.3 ENVIRONMENTAL CONDITIONS

The environmental conditions of the Spectroil family of spectrometers are:

- **Indoor or covered (under roof) use only**
- **Altitude: up to 2,000 meters (6,562 feet)**
- **Operating Temperature Range: 5 to 43°C (40 to 110°F)**
- **Maximum Relative Humidity: 90%**
- **Pollution Degree: 2**
- **Over Voltage Category: 2**

- **Prolonged Storage: - Military Preservation Method 52**

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Chapter 3

OilM Windows® Software Description

3.0 OilM WINDOWS SOFTWARE DESCRIPTION

3.1 INTRODUCTION

The Windows® operating system uses standard conventions to perform routine tasks. The tasks are identified as icons, dialog conventions and pull down menu options. These conventions as they relate to the OilMWindows software will be described in detail.

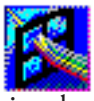
3.2 ICONS

The Windows operating system uses icons as a standard convention to perform routine tasks such as print, file, save, copy, paste, etc. Icons are a pictorial button or link to a specific program or function within a Windows application. The OilMWindows program is an application created using the Windows operating system and has custom icons to perform many of the routine functions.

This section will provide a brief description of all icons used in the OilMWindows program and the function each perform. Icons are either active or inactive depending on the function they perform and the setup of the instrument configuration. If an icon is in color, it is currently active. If the icon is grayed out, it is inactive and is not available to execute its function.

With the exception of the OilMWindows icon, all icons execute when left clicked one time with the mouse. The OilMWindows icon must be double left clicked to open the application from the Windows desktop. A detailed description of each software routine will be given in the operation section of this manual.

3.2.1 OilMWindows Icon



The OilMWindows icon is used to execute the OilMWindows program. A shortcut to the OilMWindows application has been created and placed on the desktop of the Windows program along with standard

icons such as My Computer, My Documents, the Recycle Bin, etc. Whenever power is applied to the Spectroil (M/N, M/C, or M/F), the software is configured to automatically execute the OilMWindows application, and upon completion of the loading process, the instrument and software will be in the main analysis program screen. From this screen all operating functions can be performed as described in Chapter 4 Operating Instructions

3.2.2 Cut Icon

The cut icon is the first icon that appears from the left on the tool bar on the OilMWindows analysis program screen. This icon becomes active once a measurement or burn is made and appears highlighted on the screen. To use the cut icon, the burn to be cut must be highlighted by placing the pointer over any portion of the burn and left clicking the mouse. Once the burn is highlighted left clicking the mouse on the icon will cut the highlighted burn and place it in the clipboard. It will remain on the clipboard until it is pasted into another application such as a word processing or spreadsheet document or deleted by performing another clipboard function such as cut or copy. Once a burn has been cut from the analysis program screen, it cannot be pasted back to the analysis program screen.

.2.3 Copy Icon

The copy icon is the second icon that appears from the left on the tool bar on the OilMWindows analysis program screen. This icon becomes active once a measurement or burn is made and appears highlighted on the screen. To use the copy icon, the burn to be copied must be highlighted by placing the pointer over any portion of the burn and left clicking the mouse. Once the burn is highlighted, left clicking the mouse on the icon will take a copy of the measurement and place it into the clipboard. The burn or burns will remain on the clipboard until it is pasted into another application such as a word processing or spreadsheet document or deleted by performing another clipboard function such as cut or copy. Unlike the operation of the cut icon, once a measurement has been copied from the analysis program screen, the original remains on the analysis program screen.

3.2.4 Print Icon

The print icon is the third icon that appears from the left on the tool bar on the OilMWindows analysis program screen. This icon becomes active once a measurement or burn is made and appears on the screen. The print function operates on command but the print function has two different modes that are defined by the configuration of the System Parameters of the OilMWindows program and/or the Windows operating system itself.

In the System Parameters dialog, the parameter "Print Each Individual Burn" appears. See Section 3.4.6.3 for a detailed description of this dialog. If this parameter is selected, each individual burn is printed when:

- automatically when print cache is full (approximately 8 measurements),
- the print icon is selected, or
- when a print dialog (such as Standardization Values) is selected.

In the example where a full page of individual burns are cached for printing, the print function will be automatically executed by the Windows operating system and the printout will consist of each individual burn with individual sample identification, and time and date in the header. Completing this action will clear the print cache and any additional measurements will begin to accumulate until either the print icon is selected or the cache becomes full again.

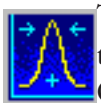
When the operator chooses to print less than a full page of individual burns, selecting the print icon will printout only those individual measurements in cache. This action will clear the print cache and any additional measurements will begin to accumulate until either the print icon is selected again, or the cache becomes full again.

If a series of measurements has been made as part of a diagnostic function such as Offsets or Profile and results in a dialog which has a print button, pressing the print button will result in a printout of the measurements in the printer cache and then a printout of the dialog from the diagnostic function.

In the Windows operating system, print functions are automatically controlled at the system level. This means that an instruction to print generally executes automatically only when the print buffer area for a standard page becomes completely full. The OilMWindows application has been modified to override the system print function to enable the operator to choose on command when to make a printout. The printout function of OilMWindows has two distinctly different formats. Which format is used for print functions is determined at the System Parameters level. See Section 3.4.2.7 of this manual for a detailed description of the "Print Individual Burns" function.

When "Print Individual Burns" is not selected in the System Parameters dialog, the print function is totally under the operator's control. If a series of measurements has been made and is currently displayed on the screen with or without an average, the operator may print theses measurements on demand. This can be accomplished at any point by left clicking the print icon. At that point, whatever measurements are accumulated on the screen will be printed out in the format that has a look similar to a screen print.

3.2.5 Profile Icon


The profile icon is the fourth icon from the left on the tool bar on the OilMWindows analysis program screen. The profile icon is active under most operating conditions except diagnostics such as BEC, Offsets, etc. When active, left clicking the profile icon will initiate a series of screen dialogs that will confirm the current profile dial setting and lead the operator through a step by step series of measurements that will ultimately result in the calculation of the new optical profile dial position. For a detailed description of the optical profile operation, refer to Section 4.2.7 of this manual.

3.2.6 Offsets Icon


The disc offsets icon is the fifth icon from the left on the tool bar on the OilMWindows analysis program screen. The offsets icon is a diagnostic function that is generally active under most operating conditions. This icon is used to perform the disc electrode offset function and is the only icon that when left clicked one time, will initiate the function and when left clicked a second time will terminate the function. Refer to Section 4.6 in this manual for a detailed description of this function.

3.2.7 Standardization Icon


The standardization icon is the sixth icon from the left on the tool bar on the OilMWindows analysis program screen. The solid line at 45 degrees represents the factory established calibration curve and the dotted lines to the right and left portray the current intensity possibilities for the elements of interest. This icon is used to perform a standardization of pre-selected calibration standards and compares the intensities produced by each element to the original intensities produced during factory calibration. One left click of the mouse will initiate the standardization routine where a set of dialogs step the operator through each pre-selected standard and results in the calculation of new standardization values and factors. Refer to Section 4.2.5 of this manual for a detailed description of the standardization function.

3.2.8 Average Icon


The average icon is the seventh icon from the left on the tool bar on the OilMWindows analysis program screen. The letter x with a bar overhead is the mathematical symbol of the average function. This icon becomes active when one or more measurements are made and remains active until all measurements are cleared from the screen. To calculate the average of a series of measurements, left click the

mouse one time on the average icon and the average of the measurements will be calculated and displayed on the screen.

3.2.9 Statistics Icon

The statistics icon is the eighth icon from the left on the tool bar on the OilMWindows analysis program screen. This icon represents mathematical calculations of a group of data displayed statistically. This icon becomes active only when there are three or more measurements on the display. It is used primarily to calculate the average, mean, and relative standard deviation of a population of measurements. To perform the statistics, left click the mouse on the statistics icon and a dialog will appear. This dialog can be printed for record keeping by pressing the print button on the statistics dialog box. Refer to Section 3.4.8.9 of this manual for a detailed description of the statistics function.

3.2.10 Sample Identification (ID) Icon

The sample identification icon is the ninth icon from the left on the tool bar on the OilMWindows analysis program screen. This icon represents an oil sample bottle that requires a sample ID. This icon is active any time a measurement can be made in any operating mode except diagnostics such as profile, offsets, etc. The format the sample identification can appear is determined by the Sample Identification dialog which can be found under the System pull down menu screen. This icon can be made active by left clicking the mouse. When activated, a dialog box will appear to permit entry of a single sample ID. A multiple button is available and if selected, will open a second dialog that will permit up to 50 sample identifications to be pre-entered. Refer to Section 3.4.6.5 of this manual for a detailed description of the sample identification function.

3.2.11 Data Transmit Icon

The data transmit icon is the tenth icon from the left on the tool bar on the OilMWindows analysis program screen. This icon represents data being electronically transmitted to an external computer for data storage and management. This icon becomes active when:

- the computer is selected under System/Hardware pull down screen,
- the Transmit Remote is selected under the System/System Parameters dialog, and
- elements have been selected for remote transmission in the Program/Channels/Channel Parameters dialog.

Once the remote data transmission capability has been properly setup, the format and destination that the data is to be transmitted or stored is determined. This is accomplished by selecting the System/Remote Computer pull down menu option. Left clicking the icon with the mouse will transmit either single or multiple measurements on command to a waiting remote computer. Refer to the Section 3.4.6.4 of this manual for a detailed description of the System/Remote Computer pull down menu. Refer to Section 3.4.6.3 of this manual for a detailed description of the System/System Parameters pull down menu, and refer to Section 3.4.7.4 for a detailed description of the Program/Channels/Channel Parameters pull down menu.

3.2.12 Burn Icon

The burn icon is the last icon on the right of the tool bar on the OilMWindows analysis program screen. This icon represents the rod and disc electrode with a sample cap of oil and an arc occurring across the analytical gap. This icon is active in all modes of operation including all test modes. Left clicking once with the mouse on this icon will initiate the burn cycle which consists of preburn time and measure time. Under normal operating conditions this time will be equal to approximately 30 seconds.

3.3 WINDOWS® DIALOG CONVENTIONS

The Windows® operating system uses two conventions that can easily be misinterpreted depending

on how and when the dialog appears and what the operator intends to do as a result of the dialog. These two conventions are the OK and Cancel buttons. These conventions are described below with examples of each.

3.3.1 OK Button

The OK button will appear in numerous dialog screens throughout the OilMWindows application. In all cases, this button is intended to be an instruction to the operating system and the OilMWindows program that whenever changes have been made to any data that was originally presented in the dialog, save this new data (including any changes) back to the program. The connotation "OK" does not mean that when data is originally displayed in a dialog and the operator does not choose to make any changes to this data set, then this data as it was presented is OK. This is the purpose and function of the Cancel button. Pressing the OK button when data is presented and no changes were made will save the original data back to the program but there are some dialogs where this convention will work opposite of the desired effect. In summary, if a dialog appears and contains data which the operator has control to accept as is, or change the original data to some other value, pressing the OK button will save these changes back to the program.

3.3.2 Cancel Button

The Cancel button will generally accompany the OK button when dialogs appear. The Cancel button is always intended to be an instruction to the operating system and the application program that the data (as it originally appears) in the dialog is 100% correct or acceptable and should be returned to the program without changes. Selecting the Cancel button actually terminates the operation or software instruction which presented the dialog. Always choose the Cancel button to retain the original values displayed in the dialog and to terminate the operation or software instruction which prompted the dialog.

3.4 WINDOWS® PULL DOWN MENU OPTIONS

Another standard convention of the Windows® operating system is the pull down menu system. In a Windows® compliant structure, applications are written in a similar format for ease of understanding and operating. For example the left most pull down is always File, then followed by Edit, View etc.

The OilMWindows application is written to comply with this structure and therefore should be easy for anyone who is familiar with Windows® applications to operate this software application. The nine main pull down menus used in the OilMWindows application are listed below along with a brief description of each. Detailed descriptions of each operation will be explained in the Operation Section of this manual.

3.4.1 Analysis Program Screen

The Analysis Program Screen, Figure 3-1, is the main screen that appears from the time the program is initially loaded and will remain as such for most of the operations that are operator dependant. Across the top of the analysis program screen in the upper left corner is the OilMWindows icon and the name of the program. Just below the header is a list of the pull down menu options. Below the pull down menu options are the icons. Below the icons is the current program name, 5281/03 in this example. Also included in this line is the reference element designation, H in this example. Along the right margin is the current burn count, 57 in this example.

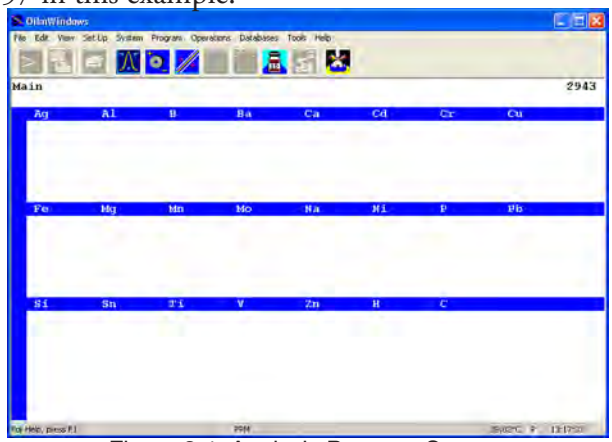


Figure 3-1, Analysis Program Screen

The next row down from the Program Name header is the sample identification line. The sample identification line can be divided into as many as six segments. Refer to Section 3.4.6.5 of this manual for a detailed description of the sample identification structure. Below the sample identification is the element symbols header and space for the analytical data. At the bottom of the screen is the tool bar that displays a small message about what function is current, the readout mode, current time and date plus the re size tab in the lower right corner.

3.4.2 File

In accordance with Windows® compliant screen structure, File must be the first pull down menu option. The File pull down option contains operations relative to data file functions such as Open, SaveAs, Delete, etc. as shown in Figure 3-2. These operations are normally set-aside for all the basic Windows® functions but have been modified in OilMWindows to include functions which are specific to the application. This section will describe each operation in general terms, then as they are used in the operation of the instrument, additional description will be given.

3.4.2.1 File/New

This pull down option provides the capability to develop a completely new analytical program to be used for specific wear metal or fuel analysis applications. When selected, a dialog, will appear requiring input to create a new program with a unique program name and description. Contact the Service Department at Spectro Inc. for information on how to create a new program.

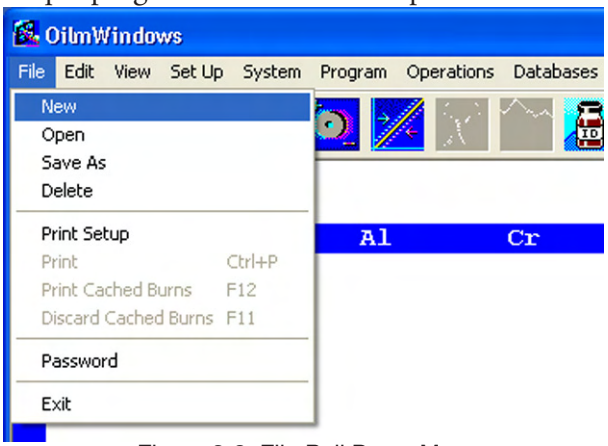


Figure 3-2, File Pull Down Menu

3.4.2.2 File/Open

This pull down option provides the ability to select one of the stored analytical programs. Selecting this option, Figure 3-3, displays a dialog with the header "Select Program" and the dialog contains the names of all available programs. Any of the available programs can be selected by highlighting the radio button and pressing OK, with the exception of the current program that is grayed out and cannot be selected because it is already loaded.

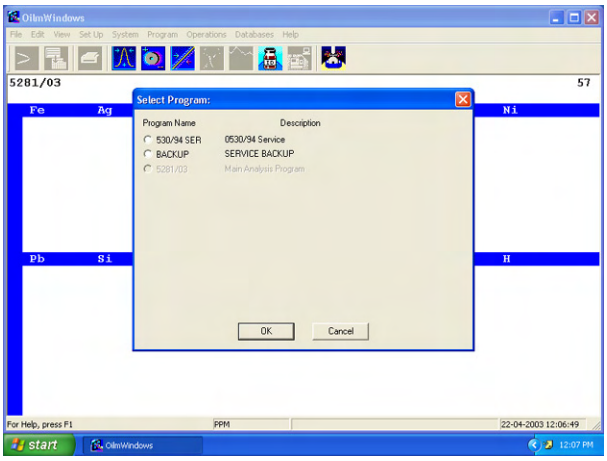


Figure 3-3, File/Open Menu

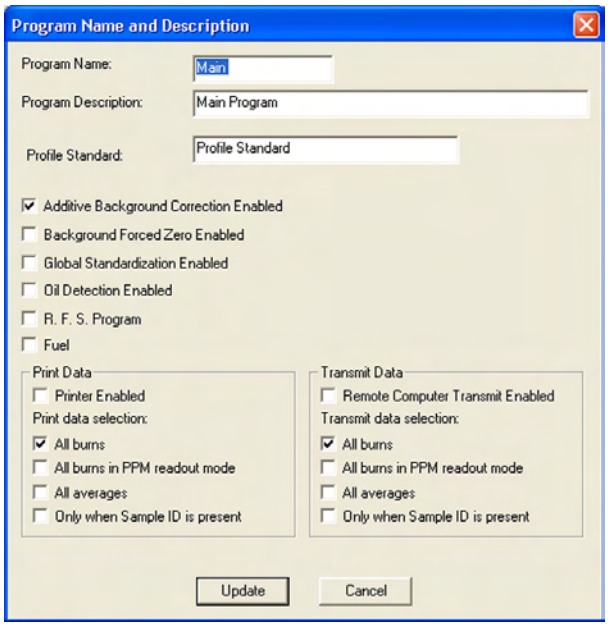


Figure 3-4, File/SaveAs Menu

3.4.2.3 File/SaveAs

This menu selection, Figure 3-4, provides a dialog with a header "Program Name and Description" and this dialog will provide the capability to copy the entire contents of the currently operating analytical program and save this content under a different program name. This capability is useful when the existing calibration curves and parameters are adequate for the application but the burn parameters or reference element selection need to be changed. Copying the existing analytical program and re-naming it will enable the operator to make the minimum amount of changes while retaining the majority of the analytical program such as the calibration curves. This menu selection is also the means to make a backup of the existing calibration curve for safety purposes.

3.4.2.4 File/Delete

This menu selection, Figure 3-5, provides the capability to select an analytical program to delete. Selecting this menu option will present a dialog with the header name "Delete Program" and this dialog will list all stored analytical programs. Selecting the radio button next to the program name and typing the name of the program exactly as it appears in the dialog can delete any analytical program. This is true except for the currently loaded program. To delete the currently loaded program, another program must be selected and loaded first using the File/Open menu selection. Once another program is loaded, the previously loaded program can be deleted using this menu option.

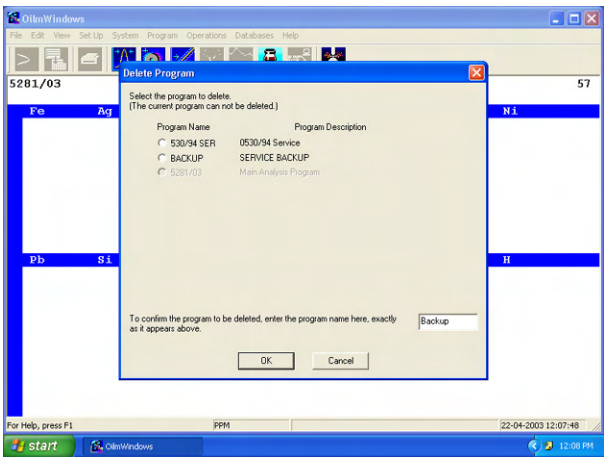


Figure 3-5, File/Delete Menu

3.4.2.5 File/Print Setup

This menu option, Figure 3-6, provides the capability to choose the printer driver that best suits the printer currently being used and/or the quality of print that is desired for the document to be printed. When this menu option is selected, a standard Windows® dialog will appear with a header indicating "Printer Setup" and will provide the option to select between the printer drivers (by name) that are currently loaded into the system. In this dialog, the operator may select the paper type and size that is currently being used as well as the orientation of the print. If the printer name (driver) does not appear for the printer currently being used, it may be necessary to select the "Settings" menu selection from the Windows® Start button and chose Printers to add the printer driver for the particular printer being used. Refer to the Windows® instruction manual for assistance in performing this function.

3.4.2.6 File/Print

This menu selection does not result in a dialog. Selecting this menu option will initiate a print command that will send the contents of the data currently on the screen to the local printer via LPT1. The data printed will look similar to that of a screen print. Selecting this menu option is identical to pressing the printer icon and all of the functions described in Section 3.2.4.

3.4.2.7 File/Print Cached Burns F11

This menu selection does not result in a dialog.

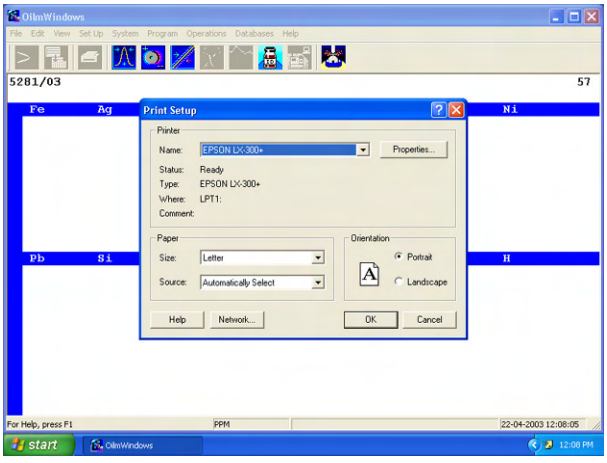


Figure 3-6, File/Print Menu

This menu selection is only active if "Print Individual Burns" has been selected in the Program/Program Parameters dialog. When "Print Individual Burns" has been selected, the Windows® operating system captures measurements as they are being made and waits until it can fill one complete page with this data. Selecting this menu option will force a printout of the contents of the cache, which is the storage area for one page.

In general, this area will hold approximately 8 to 10 measurements, depending on the number of elements for each burn. If the cache area contains only one or two measurements, only these measurements will be printed out. Once a set of measurements is printed out, the contents of the cache area are automatically erased. Any additional measurements will once again begin to accumulate in the cache area until this menu option is selected, the cache becomes full and the Windows® operating software forces a printout, the OilMWindows® software is shutdown via the Exit menu selection, or the close box in the header and the contents of cache are forced to be printed by the operating system. Function key F11 has been designated as the shortcut keystroke to initiate a Print Cached Burns function. Pressing Function key F11 at anytime the cache has measurements in queue will perform the same software function as choosing this menu selection.

3.4.2.8 File/Discard Cached Burns F12

This menu selection does not result in a dialog, and is only active if "Print Individual Burns" has been selected in the System/System Parameters dialog. When this menu option is selected, it will erase all contents of the cache storage area and is most useful to be certain that a series of measurements, perhaps for statistics purposes, does not include previous measurements. Function key F12 has been designated as the shortcut keystroke to initiate a Discard Cached Burns function. Pressing function key F12 at any time will perform the same software function.

3.4.2.9 File/Password

The password menu option provides security to maintain the integrity of the instrument software configuration and factory calibration settings. When this menu option is selected, Figure 3-7, a dialog will appear that will display the current status of the password protection (ON or OFF), the system identification, the burn count, and the date and time. From this information, a six-digit password can be calculated that would provide access to the optical hardware settings and the factory calibration curves. These two portions of the software are critical to the integrity of the instrument and the quality of the analytical results; therefore it is imperative that the user of this software and the instrument contact Spectro Incorporated to obtain this password. If the technical service department of Spectro Incorporated determines that is necessary to gain access to these modules of the OilMWindows® software, they will request the information contained in this dialog and calculate the password for the operator to enter.

CAUTION: Choosing this menu option and determining password access to certain modules of the software without technical instruction from Spectro Incorporated can erase all analytical program data!

3.4.2.10 File/Exit

This menu selection does not result in a dialog. When Exit is selected, it will terminate the OilMWindows® program and return the system to the Windows® desktop. This menu option per-

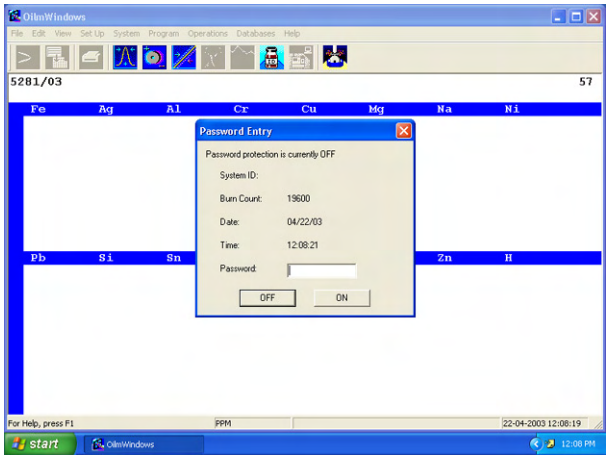


Figure 3-7, File/Password Menu

forms the same function as the close box in the upper right corner of the header.

3.4.3 Edit

In accordance with Windows® compliant screen structure, Edit should be the second pull down menu option. The Edit pull down option contains operations relative to data manipulation functions such as Cut, Copy, etc., Figure 3-8. These operations are normally set aside for all the basic Windows® functions but have been modified in OilMWindows to include functions which are specific to the application. This section will describe each operation in general terms, then as they are used in the operation of the instrument additional description will be given.

3.4.3.1 Edit/Cut

This menu option is used to cut one or more measurements and place them on the clipboard so they can be moved into another application for data management or manipulation. Up to twenty measurements plus the average can be cut and placed into the clipboard where this data may be pasted into a statistical analysis application, a graphing application or archive. To select the data to be cut and placed on the clipboard, place the pointer over any portion of the measurement and left click the mouse. This will highlight the measurement, and by choosing Edit/Cut, will remove this measurement from the analysis program screen and place it on the clipboard. If multiple, sequential measurements are to be cut, place the pointer over the first measurement and left click the mouse, then move the scroll bar to the last measurement to be cut, press and hold the SHIFT key and click the left button of the mouse. All measurements between the first measurement position and the last measurement position will be highlighted in black and available to be cut from the analysis program screen when Edit/Cut is selected.

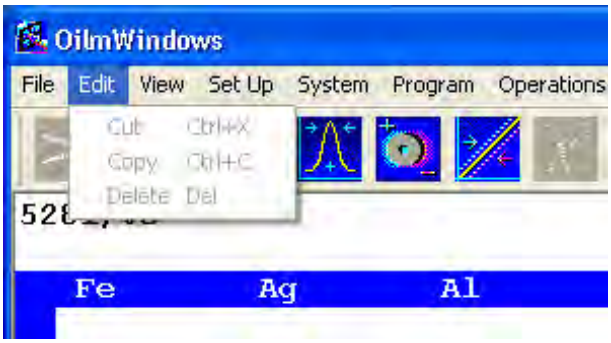


Figure 3-8, Edit Menu

3.4.3.2 Edit/Copy

The copy menu option works very similar to the Edit/Cut menu option with the exception that instead of removing the highlighted measurements from the analysis program screen, the contents are copied onto the clipboard where this data may be pasted into a statistical analysis application, a graphing application or archive. To select the data to be copied and placed on the clipboard, place the pointer over any portion of the measurement and left click the mouse. This will highlight the measurement, and by choosing Edit/Copy, will copy this measurement from the analysis program screen and place it on the clipboard. If multiple, sequential measurements are to be copied, place the pointer over the first measurement and left click the mouse, then move the scroll bar to the last measurement to be copied, press and hold the SHIFT key and click the left button of the mouse. All measurements between the first measurement position and the last measurement position will be highlighted in black and available to be copied from the analysis program screen when Edit/Copy is selected.

3.4.3.3 Edit/Delete

The delete menu option also works very similar to the Edit/Cut and Edit/Copy menu option with the exception that instead of removing the highlighted measurements from the analysis program screen and placing the contents into the clipboard, the measurements are removed from the analysis program screen and discarded. To select the data to be deleted, place the pointer over any portion of the measurement and left click the mouse. This will highlight the measurement, and by choosing Edit/Delete, will remove this measurement from the analysis program. If multiple, sequential measurements are to be deleted, place the pointer over the first measurement and left click the mouse, then move the scroll bar to the last measurement

to be deleted, press and hold the SHIFT key and click the left button of the mouse. All measurements between the first measurement position and the last measurement position will be highlighted in black and available to be deleted from the analysis program screen when Edit/Delete is selected.

3.4.4 View

In accordance with Windows® compliant screen structure, View is used as an option varying with the Windows® application. The View pull down option, Figure 3-9, contains operations relative to what is viewed on the screen. These operations are normally set-aside for all the basic Windows® functions but have been modified in OilMWindows to include functions which are specific to the application. This section will describe each operation in general and in basic terms, then as they are used in the operation of the instrument additional description will be given.

3.4.4.1 View/Toolbar

This menu option does not result in a dialog. This menu provides the option to choose whether or not to display the tool bar. When chosen, a check mark will appear to the left of the word Tool bar. The tool bar is the horizontal bar of icons that designate routine operations which are specific to the OilMWindows® application. To disable the Tool bar, highlight the Tool bar menu selection and release the left button of the mouse. The View pull down menu option will disappear and all icons will disappear. Reselecting the View pull down menu option will display no check mark to the left of the Tool bar. Moving the pointer over and highlighting the Tool bar and releasing the left mouse button will once again place a check mark to the left of the word Tool bar and restore the icon tool bar.

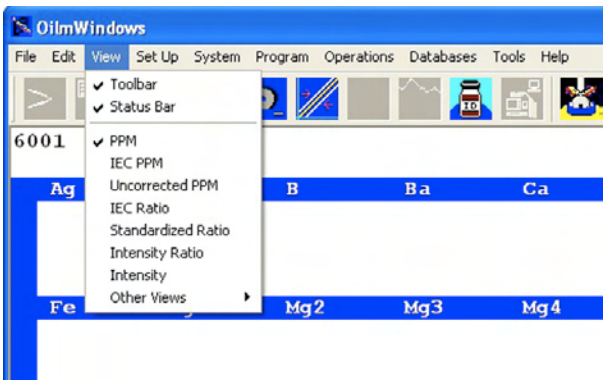


Figure 3-9, View Menu

3.4.4.2 View/Status Bar

This menu option does not result in a dialog. This menu provides the option to choose whether or not to display the status bar. When chosen, a check mark will appear to the left of the word Status Bar. The status bar is the horizontal bar that appears along the bottom of the analysis program screen and displays the readout mode (PPM) and time and date. To disable the Status Bar, highlight the Status Bar menu selection and release the left button of the mouse. The View pull down menu option will disappear and the status bar along the bottom will disappear. Reselecting the View pull down menu option will display no check mark to the left of the Status Bar. Moving the pointer over and highlighting the Status Bar and releasing the left mouse button will once again place a check mark to the left of the word Status Bar and restore the status bar.

3.4.4.3 View/PPM

The separation bar lists all seven available readout options, and PPM is the first available option and the one used for routine analysis. Highlighting this option and releasing the mouse button will select this readout mode. When selected, a check mark appears to the left of the readout mode, PPM.

One readout mode will always be selected. If the selection pointer highlighted a readout mode and the mouse was moved outside the submenu before the button was released for selection, the original readout mode will remain.

The PPM mode is used to display all analytical data expressed in concentration where the unit of measure is parts per million (PPM), and all cross-over channels are not displayed. This software function is used to display the analytical data in concentration which has been calculated from the standardized intensity ratio with any effect of in-

terelement correction factors applied. This standardized interelement corrected intensity ratio is applied to the calibration curve that has been generated from a calibration that normally has been performed at the factory before the instrument has been delivered. This is the mode of readout in which normal instruments operation will be performed.

3.4.4.4 View/IEC PPM
Highlighting this option and releasing the mouse button will select this readout mode. When selected, a check mark appears to the left of the readout mode, IEC PPM.

The IEC PPM mode is used to display all analytical data expressed in concentration where the unit of measure is an interelement corrected concentration or (IEC PPM). The difference with this readout display and that of the PPM mode is that all selected element channels are shown with any and all interelement corrections. Comparing the results of Uncorrected PPM and IEC PPM data will confirm that an interelement correction is being applied and in the correct ratio. This mode of readout is generally used to observe the effect of the crossover logic and interelement correction factors. This is not a standard readout mode for normal operation.

3.4.4.5 View/Uncorrected PPM
Highlighting this option and releasing the mouse button will select this readout mode. When selected, a check mark appears to the left of the readout mode, Uncorrected PPM.

The Uncorrected PPM mode is used to display all analytical data expressed in concentration that has not yet been corrected as a result of the influences of other elements present in the sample or standard. This software function is used to display the analytical data in concentration (ppm) which has been calculated from the standardized intensity ratio without the affect of any interelement correction. This mode of readout is generally used to observe and determine if an interelement correction is required, and if so, the amount of interelement correction which is necessary to make the true concentration correct. This is not a standard readout mode for normal operation.

3.4.4.6 View/IEC Ratio
Highlighting this option and releasing the mouse button will select this readout mode. When selected, a check mark appears to the left of the readout mode, IEC Ratio.

Interelement correction factors are sometimes necessary when a large concentration of one element produces a spectral interference on another element, or the presence of a large concentration of one element suppresses the emission of another element. This is called additive and multiplicative interelement interference which increases or decreases the concentration output of the interfered element. These factors are determined by the ratio of interference caused by the interfering element on the interfered element.

The IEC Ratio mode is used to display all analytical data expressed in intensities ratios that have been corrected from intensity ratios by a factor derived from the result of the influences of other elements present in the sample or standard. This software function is used to display the analytical data in intensity ratios that have been calculated from the standardized intensity ratio with the affect of interelement corrections. This mode of readout is generally used to observe and determine if an interelement correction is required, and if so, the amount of interelement correction which is necessary to make the true intensity ratio correct.

This is not a standard readout mode for normal operation.

3.4.4.7 View/Standardized Ratio
Highlighting this option and releasing the mouse button will select this readout mode. When selected, a check mark appears to the left of the readout mode, Standardized Ratio.

Standardized intensity ratios are the same inten-

sity ratios which have been produced from an analytical measurement, but are adjusted by a standardization factor derived during the standardization procedure. The intensity ratios are then multiplied by a standardization factor which has been derived by comparing the current calibration curve intensities to those originally produced during factory calibration.

In an ideal example, if the intensity ratios produced during the last standardization match the original intensity ratios produced during factory calibration, the standardization factor would be 1.00. In this example, the intensity ratio values and the standardized intensity ratio values are identical. In practice, this would almost never happen, therefore the standardization factor generally ranges +/- 0.5 from 5.00. Shown below is the formula which is used to calculate the standardized intensity ratio factor for each element.

$$I_{SiR} = I_{Ri} \times F_i + A_i$$

where:

I_{SiR} = Standardized intensity ratio of element I

I_{Ri} = Intensity ratio of element I

F_i = Standardization factor of reference element

A_i = Standardization offset of reference element

The formula $I_{SiR} = I_{Ri} \times F_i + A_i$ can be applied as follows:

$I_{Ri} = I \times F_{Int\ Std}$

$$F_i = \frac{\text{Low Sample Expected - High Sample Expected}}{\text{Low Sample Obtained - High Sample Obtained}}$$

$$A_i = \frac{(HSE \times LSO) - (HSO \times LSE)}{LSO - HSO}$$

The purpose of the standardized intensity ratio is to compensate for variations in the intensities produced during standardization. These variations come from a variety of sources such as consumables, optical alignment and environment. It is important to periodically monitor this standardization factor to be sure that these variations do not exceed 0.5 to 5.0. Once the standardization factor is determined during the standardization procedure, this factor is applied to all measurements until the next standardization procedure is performed. The standardized intensity ratio will be used in the calibration curve to determine the concentration (ppm) equivalent. This is not a standard readout mode for normal operation.

3.4.4.8 View/Intensity Ratio

Highlighting this option and releasing the mouse button will select this readout mode. When selected, a check mark appears to the left of the readout mode, Intensity Ratio.

Intensity ratios are the same intensities which have been produced from an analytical measurement then ratioed or multiplied by a reference factor which has been derived by dividing a nominal or fixed reference intensity value by the actual intensity produced by the reference element (Hydrogen or Carbon) for that measurement.

In an ideal example, if the fixed reference intensity value is 10,000 and the intensity produced by one analytical measurement was also 10,000, the reference factor calculation would produce a factor of 1.00. In this example, the intensity values and the intensity ratio values would be identical. In practice, this would almost never happen, therefore the reference factor generally ranges +/- 0.3 of the nominal reference intensity value.

The purpose of the intensity ratio is to monitor a reference other than those elements present in the sample. In this case, Hydrogen or Carbon are the most common reference elements in oil analysis applications. If a series of measurements are made on the same sample, a certain amount of variation in the measurement is to be expected due to

variations in consumables, etc. Monitoring a reference channel and adjusting the intensity values of each analytical element by the same reference factor reduces this variation to produce more precise analytical data. Intensity ratio data is useful in performing diagnostic and performance evaluation of the instrument. It is not a normal readout mode for operation. Shown below is the formula which is used to calculate the factor for intensity ratio.

$$F_{int\ std} = \quad I_i \times I_{fr}/I_{Ref}$$

where:

I_i = Intensity for element I

I_{fr} = Intensity of fixed reference (10000)

I_{Ref} = Intensity of reference element

This is not a standard readout mode for normal operation.

3.4.4.9 View/Intensity

Highlighting this option and releasing the mouse button will select this readout mode. When selected, a check mark appears to the left of the readout mode, Intensity.

This mode is used to display all analytical data in the Intensity mode. Intensities are the most basic form of readout which is a linear relationship between the intensity of light and the voltage stored on an integrating capacitor. Intensity data is useful in performing diagnostic and performance evaluation of the instrument.

It is not a normal readout mode for operation.

3.4.4.10 View/Other Views

This sub-menu, Figure 3-10, provides forward and reverse integration signal values for each element without any calculations performed on the data. This readout mode is used primarily as a dignostic test.

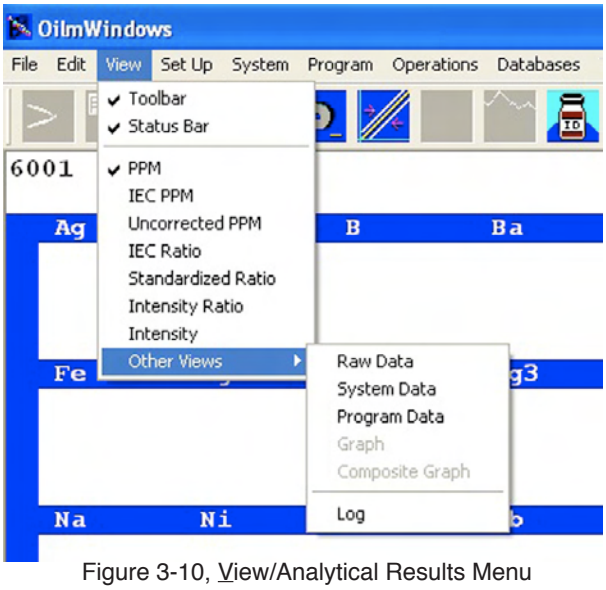


Figure 3-10, View/Analytical Results Menu

3.4.4.11 View/Other Views/System Data

This menu option does not result in a dialog. This option, Figure 3-11, presents a listing of all parameters that are specific to the system that is currently being used. This listing is for system parameters and is useful to view the settings all in one area. This listing can be printed for reference by clicking the printer icon or selecting the print function from the File/Print pull down menu.

3.4.4.12 View/Other Views/Program Data

This menu option does not result in a dialog. This option, Figure 3-12, presents a listing of all parameters that are specific to the analytical program that is currently being used. This listing is for analytical program parameters and is useful to view the settings all in one area. This listing can be printed for reference by clicking the printer

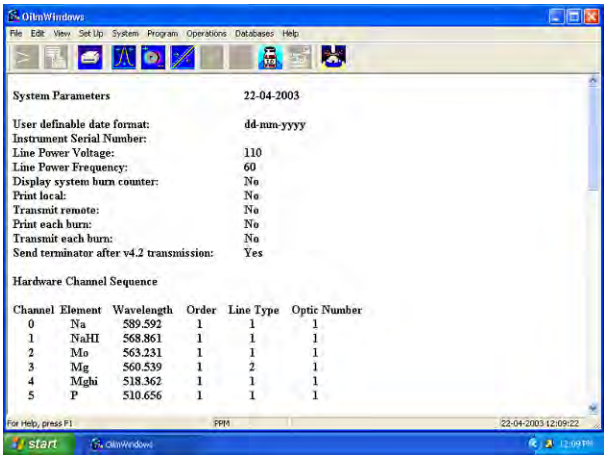


Figure 3-11, View/Sysatem Data Menu

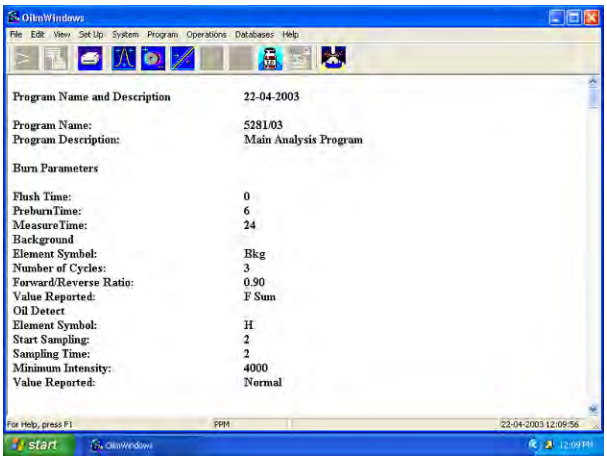


Figure 3-12, View/Program Data Menu

icon or selecting the print function from the File/Print pull down menu.

3.4.4.13 View/Other Views/Graph

This menu option provides the ability to graph the results for 3 or more sequential burns. The selection will be greyed out if fewer than 3 burns are available to plot. When the view is selected, the operator can determine which elements are to be plotted, Figure 3-13. To select the elements,

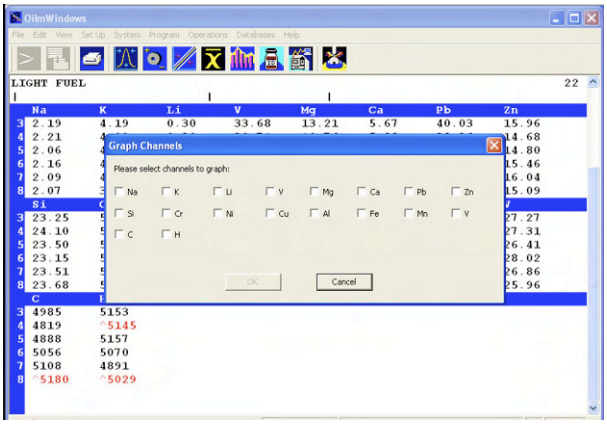


Figure 3-13, View/Graph Select Elements to Plot Menu

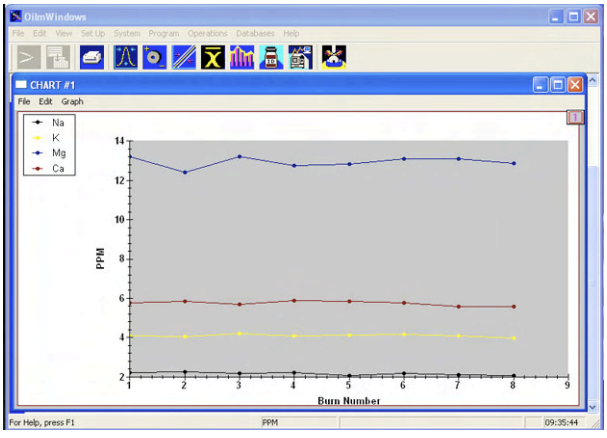


Figure 3-14, View/Graph Plot of Selected Elements

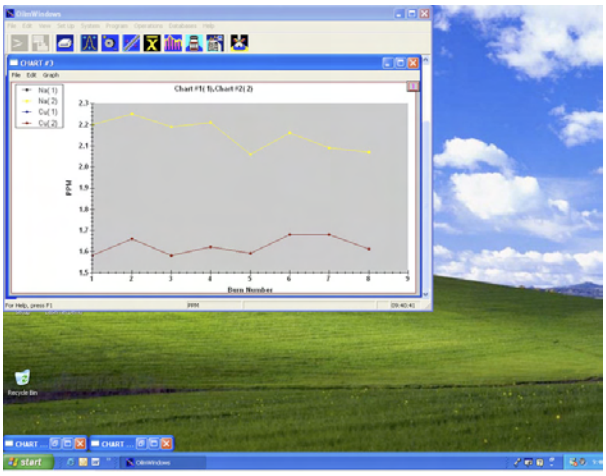


Figure 3-15, View/Composite Plot of Selected Elements

click on the box next to them and click on OK when done. In the example, Figure 3-14, 8 burns for Na, K, Mg and Ca were selected and charted (graphed).

3.4.4.14 View/Other Views/Composite

This menu option provides the ability to create a new graph from two or more sets of burns (charts). To apply this feature, set up a chart as described in Section 3.4.4.13 and minimize the view by clicking on the minimize button. Repeat the process for another chart of graphed elements. Select "Composite" from the "Other Views" pull down menu, select the elements to plot from the minimized charts and click on OK. A new graph (chart) created with the elements selected from the two minimized charts will be created. An example of a composite graph is shown in Figure 3-15.

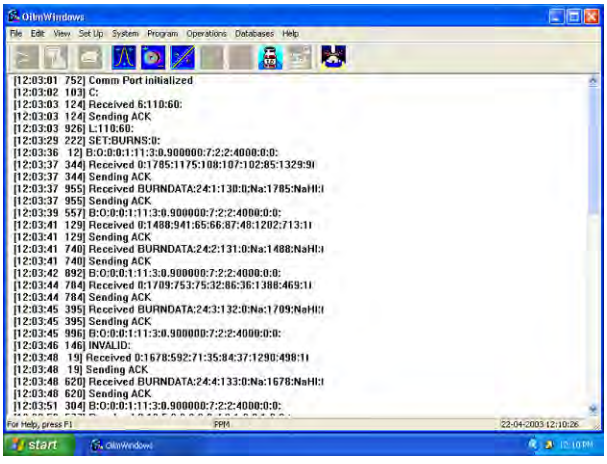


Figure 3-16, View/Log Screen

3.4.4.15 View/Other Views/Log

This menu option is used to monitor the communications protocol between the OilMWindows® operating system and the Internal Controller. This menu option, Figure 3-16, is only for diagnostic purposes only and is not intended for operator use.

3.4.5 SetUp

The SetUp pull down menu, Figure 3-17, is basically a diagnostic feature of the OilMWindows® software. It contains two menu options that pertain to the initial instrument setup and a diagnostic for troubleshooting. Both of these options will be described below.

3.4.5.1 SetUp/Interlocks On

Thus menu option does not result in a dialog. When selected, a check mark will appear to the left of the words "Interlock On". When the Interlock On is selected, it indicates that the sample stand interlock monitors, the hardware that detects the presence of the disc electrode, the rod electrode, the oil sample cap, and the analytical gap between the disc and rod electrode, are all active. In the manufacturing process and in certain troubleshooting conditions, it is desirable to disable these interlocks. Under normal operating conditions, disabling these interlocks can cause damage to the instrument or produce a bad analytical result. For this reason, this menu option is password protected. If, for any reason, the interlocks should be or must be bypassed, please contact the Service Department of Spectro Incorporated for instructions to calculate the password.

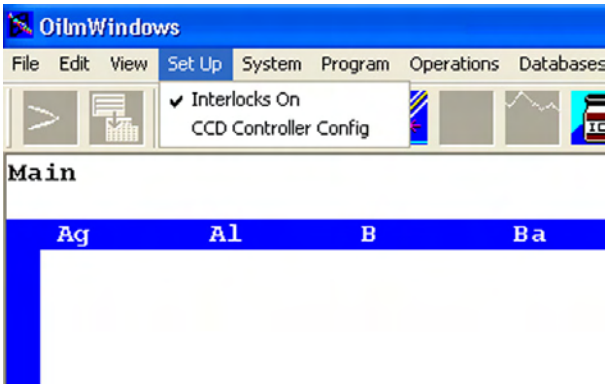


Figure 3-17, SetUp Menu

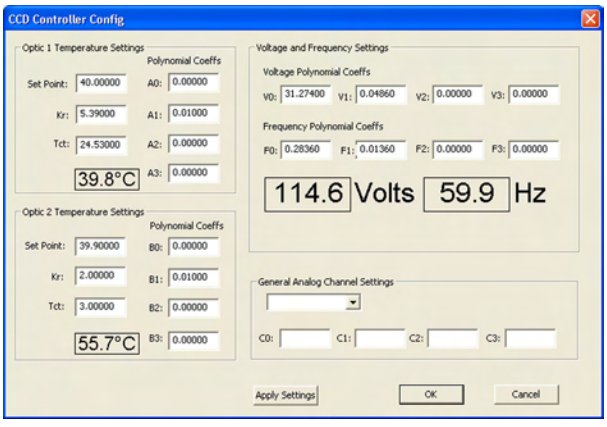


Figure 3-18, Set/Up/CCD Controller Configuratiojn

3.4.5.2 SetUp/CCD Controller Config

This menu option, Figure 3-18, is used to set the temperature of the Spectroil M optic and to view the operating voltage and frequency. Two optic temperature settings are provided for instances where the Spectroil M may have a second optic, such as for the element sulfur. These settings are set at the factory and do not require adjustment in the field.

The voltage and line frequency of the Spectroil M is monitored and set automatically by hardware. The readings provided in this screen are strictly for troubleshooting purposes.

3.4.6 System

The system pull down menu, Figure 3-19, provides software options that are used on a global or system wide basis. It is under the System pull down where specific hardware is configured in the software and communications protocol is established for remote data transmission to external computer systems. Listed below are descriptions of each menu option and the dialogs associated

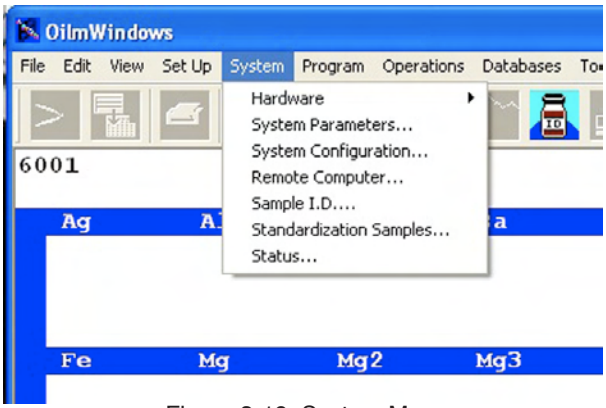


Figure 3-19, System Menu

with each.

3.4.6.1 System/Hardware

This menu option has three sub-menus, Figure 3-20, used to configure the spectrometer optical system, and to enable external computer data transfer and the printer.

3.4.6.1.1 System/Hardware/Optical

This menu item is used to setup the analytical program of your instrument. It allows you to define elements and wavelengths. A total of 512 are available.

The Matrix column shows the elements and wavelengths selected for your analytical program and the Available column are those available but not selected. The Limits column is used to set the "Clean Limit" for fuel applications and does not apply to used oil analysis applications.

3.4.6.1.2 System/Hardware/Computer

This menu option does not result in a dialog. When selected, a check mark appears to the left of the word "Computer". A check mark next to the word "Computer" indicates that some form of data exchange and/or archive to a file is capable. Without "Computer" active (no check mark) there can be no archive of data to the hard drive or external transmission of data. Once "Computer" is active (with a check mark) how the data gets handled is determined by the remote computer menu selection and the systems parameters menu selection both of which are under the system pull down menu. Deselecting or making this menu option inactive will automatically disregard any

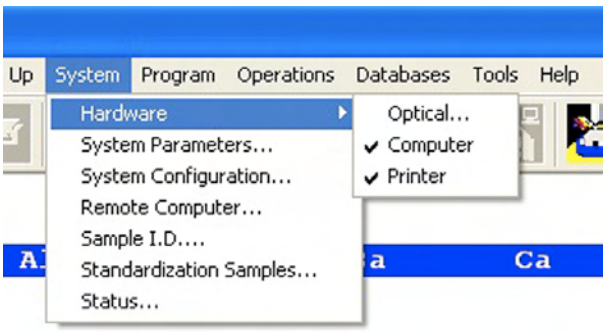


Figure 3-20, System/Hardware Submenus

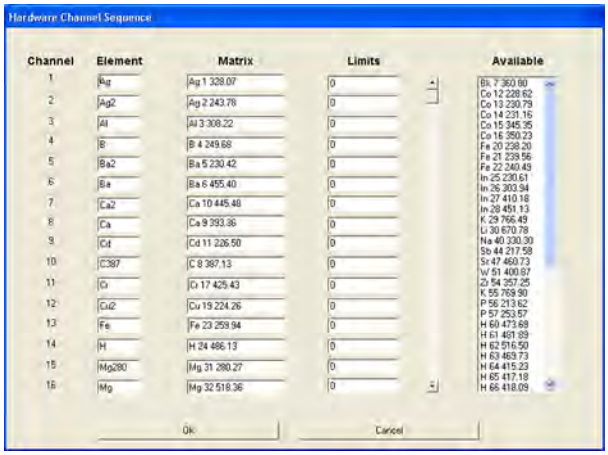


Figure 3-21, System/Hardware/Optical

settings in these system parameters and remote computer menu options.

3.4.6.1.3 System/Hardware/Printer

This menu option does not result in a dialog. When selected, a check mark appears to the left of the word "Printer". A check mark next to the word "Printer" indicates that some form of data exchange to a local printer is capable. Without "Printer" active (no check mark) there can be no transmission of data to LPT1 port on the left side of the spectrometer.

3.4.6.2 System/System Parameters

This menu provides a dialog of selectable parameters that are customized to each instrument, Figure 3-22. These parameters are for the most part factory settings, but are operator accessible in the event additional features are desired or required. The first parameter is the date format. This field allows the operator to determine the order that the day, month, and year will appear on the screen, printout, and stored when archived. The second field is the instrument serial number and this should never change. The third and fourth parameters the voltage and frequency settings but are disabled for this application.

The remaining check boxes are for a variety of system control features and parameters. A check mark in the box next to the parameter indicates that this parameter has been selected.

Display system burn counter is an alternative to

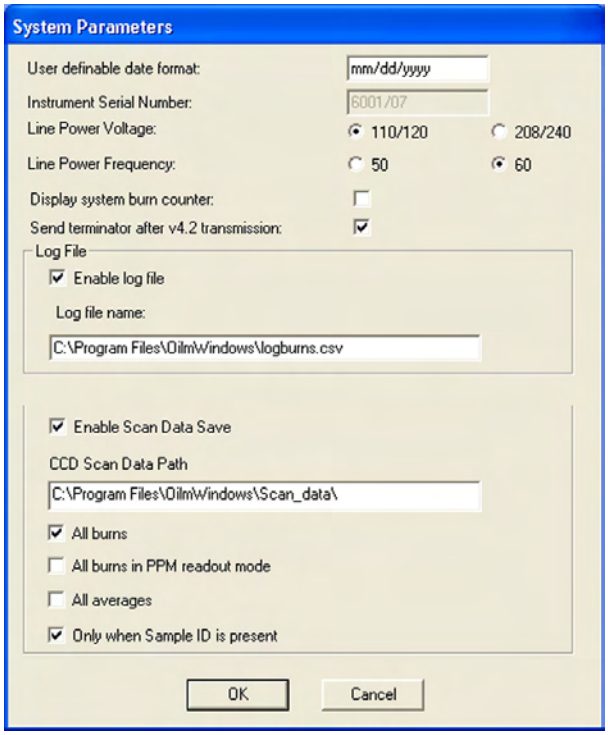


Figure 3-22, System/System Parameter Menu

the standard, which is to always display the user burn counter. The system burn counter cannot be reset, but the user counter can.

Send terminator after v 4.2 transmission is a feature required by some users to shut down the receive program after receipt of the last measurement transmitted.

Enable log file provides the opportunity to create a file that logs (stores) all analyses in that file. This is primarily used as a diagnostic tool. Log file name is the location on the hard disc where the log file is stored.

The Enable Scan Data Save can be enabled to collect, store and save all the pixel scan data. The selection boxes below it are used to filter the type of data that is collected.

3.4.6.3 System/System Configuration

This password protected menu item, Figure 3-23, is used to set various file paths when the instrument is setup at the factory. Changes are normally not required unless the instrument is upgraded with different hardware.

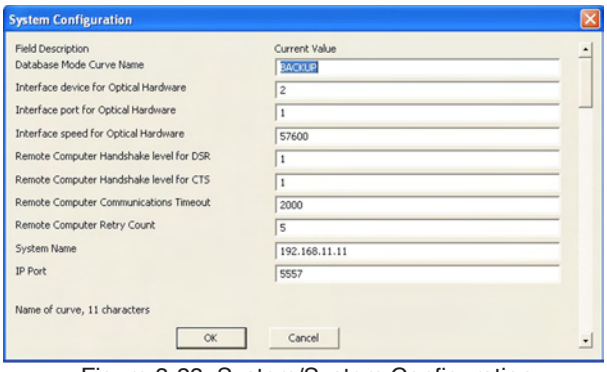


Figure 3-23, System/System Configuration

3.4.6.4 System/Remote Computer

This menu, Figure 3-29, provides a dialog of selectable parameters that permit the customizing of the protocol used to send measurements out to a remote or external computer system. These settings must be matched to the receiving computer in order for reliable data transmission to occur.

Note: in order to send data to en external computer, the check box for "Remote Computer Transmit Enabled" must be enabled, see Figure 3-4 or 3-34.

Mode

The Mode selection controls how the communications will execute. The choices are either single mode with one analysis at a time, or multiple mode where analyses are stored in a temporary location until they are ready to be sent as a batch.

The Single Mode of Remote Communications is used when each burn is to be transmitted, one at a

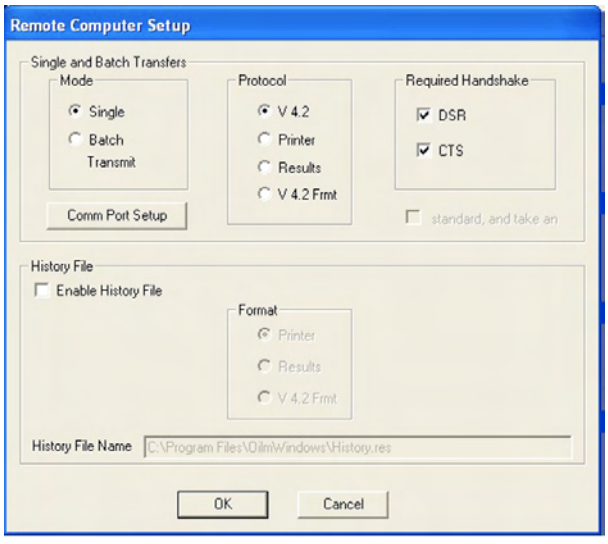


Figure 3-24, System/Remote Computer

time, either manually or automatically. When the "Transmit each burn" item is checked in the System Parameters dialog, transmission is automatic (the Transmit controls are disabled). Upon completion of each burn, the burn data is transmitted to the remote computer. When the "Transmit each burn" item is not checked in the System Parameters dialog, transmission is under operator control (the Transmit controls are enabled). When the operator selects the Transmit function, either by clicking the Transmit button, pressing the F2 key, or selecting Transmit from the Operations menu, the most recent burn is transmitted.

The Multiple (Batch) mode of Remote Communications is used when groups of burns are to be transmitted. Multiple (Batch) transmissions occur only when the operator selects the Transmit function, either by clicking the Transmit button, pressing the F2 key, or selecting Transmit from the Operations menu. All burns since the last transmission are transmitted at that time. If this is the first time the operator selected the transmit function, all burns since the Batch mode was enabled are transmitted. A status message appears in the center pane at the bottom of the OilMWindows screen, indicating that burns are being transmitted, and changes when the transmission is complete.

Protocol

There are four different transmission protocols offered. While the actual connection and transmission protocol may be similar in some modes, the format of the data varies from protocol to protocol.

V 4.2

This is a sophisticated communications protocol and data format option. A specialized receiver program must be running on the remote computer. Bi-directional handshaking and message acknowledgement occur on each transmission to insure data integrity.

The data format includes field separator control characters, and message framing. It is the responsibility of the receiver program to parse the message and extract the desired data fields.

Printer

This is a single direction communications protocol and a simple data format option. No specialized receiver program is required, but the remote computer must signal that it is connected and ready by raising the DTR and RTS signals. Once these signals are high, transmission occurs whenever there is data to be sent. There is no message framing or acknowledgement. A printer connected by a suitably configured serial port is an acceptable remote computer for this protocol.

The data format is identical to the standard single burn printout.

Results

This is a single direction communications protocol and a simple data format option. No specialized receiver program is required, but the remote computer must signal that it is connected and ready by raising the DTR and RTS signals. Once these signals are high, transmission occurs whenever there is data to be sent. There is no message framing or acknowledgement. A printer connected by a suitably configured serial port is an acceptable remote computer for this protocol.

The data format is a series of field values, separated by spaces. Each burn is terminated by a carriage return.

V 4.2 Frmt

This is a single direction communications protocol and a simple data format option. No specialized receiver program is required, but the remote computer must signal that it is connected and ready by raising the DTR and RTS signals. Once these signals are high, transmission occurs whenever there is data to be sent. There is no message framing or acknowledgement. A printer connected by a suitably configured serial port is an acceptable remote computer for this protocol.

The data format is nearly identical to the V 4.2

data format, but without the message framing and field separating control characters.

Required Handshake

This sub-menu is only active when protocol V 4.2 has been selected. In normal operation both handshakes, DSR (Data Set Ready) and CTS (Clear To Send) are selected.

Transmit max 9999.99

This box when selected provides the option to transmit analytical results up to 9999.99. When the box is not selected, the maximum results transmitted are 999.99.

History File

The history file can be enabled with a check mark. When enabled, the analyses sent to a remote computer are also stored on the hard disc of the Spectroil M. This provides a convenient backup file if it is determined at some point that there was a problem with the data transmission to the remote computer. Alternatively, this file can also be used as a temporary storage place prior to sending the entire file to a remote computer manually such as with a floppy disc, e-mail, etc.

The formats for the history file are identical to those described for the Protocol on the previous page.

The History File name is the location of the data file on the Spectroil M hard disc.

Comm Port Setup

The Comm Port Setup is a submenu of Remote Computer Setup. It is activated by clicking on its button located beneath the Mode box. When activated, it provides the options as shown in Figure 3-25.

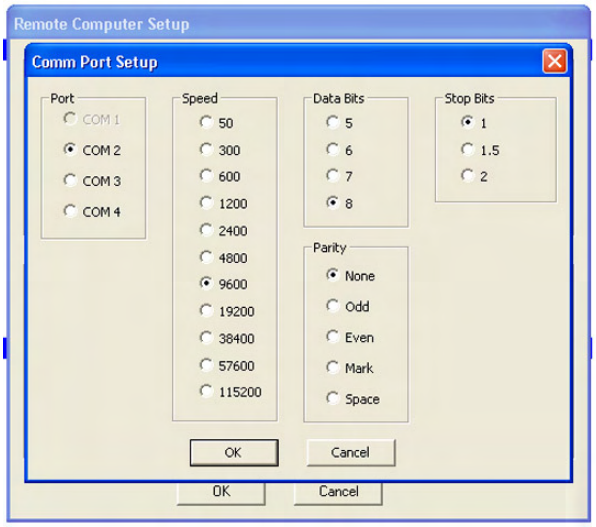


Figure 3-25, Comm Port Setup

Port

The communications port used for the link to the remote computer is selected in this box. It is important to note that this port is on the SBC system. Because COM 1 is reserved for communications with the OilMWindows system, only ports COM 2 and above are offered. The connection to the remote computer should be made from the selected port on the SBC system.

Speed

The selected speed must be the same on both the SBC system and the remote computer. In most cases, 9600 bits per second is the maximum sustainable speed.

Data Bits

The number of data bits controls the transmission word size. The selected word size must be the same on both the SBC system and the remote computer. In almost all cases, 8 data bits is the proper selection.

Parity

The parity option controls the transmission word error checking. The selected parity must be the same on both the SBC system and the remote computer. In almost all cases, no parity is the proper selection.

Stop Bits

The number of stop bits option controls the transmission word framing. The selected number of stop bits must be the same on both the SBC system and the remote computer. In almost all cases, 1 (stop bit) is the proper selection.

3.4.6.5 System/Sample ID

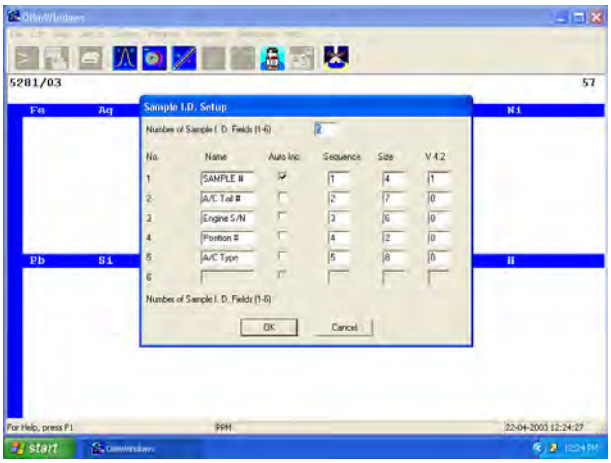


Figure 3-26, System/Sample ID Setup Menu

This menu option produces a dialog, Figure 3-26, that can be configured by the user to meet any combination of alpha-numeric characters for global sample identification. A sample can be identified by up to six field segments. This dialog permits the operator to choose how many field segments will be used for the sample identification and name each of these field segments. Each field segment may be auto-incrementing, which means that after the first sample number is entered and if all numbers that follow are in numeric order, they can be automatically filled in incrementing order saving time. The sequence of how the fields will appear can be determined or altered and the size of each field can be customized up to a maximum of 40 characters total. The last column of the sample I.D. dialog is for V4.2 protocol. This protocol is capable of storing up to two segments of the sample ID in the file. More than three segments are not permitted. That portion of the sample identification that has V4.2 assigned as segment 1 or segment 2 will be transmitted or stored under the V4.2 protocol. See Section 3.4.8.7 for a description of the sample identification data entry screens.

3.4.6.6 System/Standardization Samples

This menu option produces a dialog, Figure 3-27, which permits the entry of the names of all calibration standards that may be used to control the offset and slope of the calibration curves for each element. During calibration, a series of oil standards are measured and these standards plotted against the intensities achieved by each element

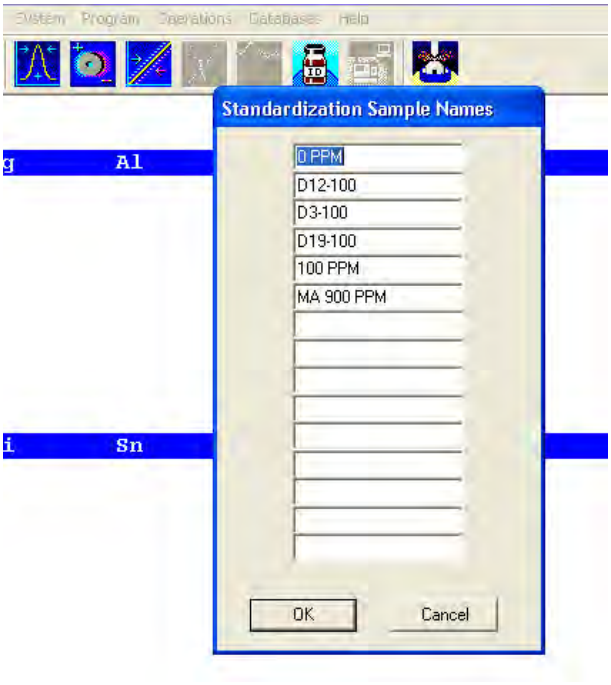


Figure 3-27, System/Standardization Samples Menu

result in a calibration curve. These calibration curves can be observed using the View pull down menu option. During normal operation, slight differences in environment and consumables result in a shift from the original factory calibration curves. During the process of standardization, a series of standardization samples are measured and compared to the factory calibration curve to determine if and what factor of correction should be applied. This dialog permits the entry of the calibration standard names to be used for the daily standardization operation.

3.4.6.7 System/Status

This menu option provides a dialog, Figure 3-28, which summarizes the status of the system. All of the information contained in this status screen is automatically updated and is for information purposes only. The only exception where operator intervention is permitted is to reset the User Spark Counter. This counter is generally reset after every 2000 burns and is frequently used as a maintenance milestone. When the instrument has reached 2000 burns, it is generally time to perform routine operator controlled maintenance such as thorough cleaning of the sample stand area and excitation source maintenance of the tungsten electrodes. After this maintenance

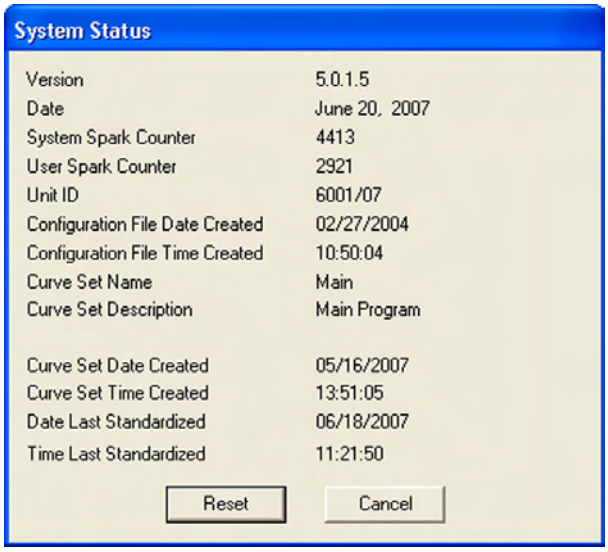


Figure 3-28, System Status Menu

has been performed, the operator resets the user counter and proceeds with normal daily maintenance functions.

3.4.7 Program

The Program pull down menu, Figure 3-29, provides software options that are specific to the development of a calibration curve set which is sometimes referred to as a configuration record. Once developed, this curve set is referred to as the analytical program and has a program name specific to the calibration parameters. When File/New is selected, the software will lead the operator through preset steps under this pull down menu. Listed below are descriptions of each menu option and the dialogs associated with each.

3.4.7.1 Program/Program Parameters

This pull down menu option results in a dialog, Figure 3-30, which permits the entry of a unique

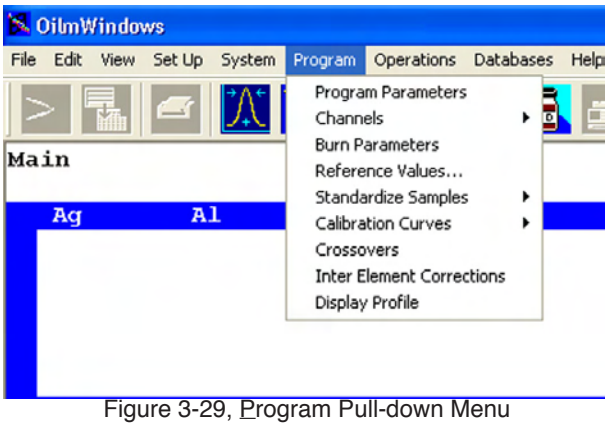


Figure 3-29, Program Pull-down Menu

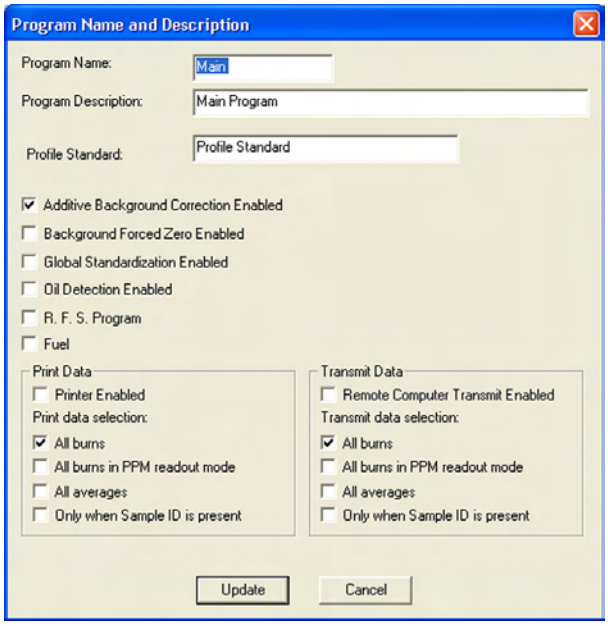


Figure 3-30, Program/ParametersMenu

program name and a description of this program. The program name cannot be more that 10 alpha-numeric characters. The program name is not case sensitive and may contain spaces. The program description can be up to 40 alpha-numeric characters, is not case sensitive and may include spaces.

Enable Additive Background Correction is a feature that controls which elements have no background correction and is primarily used in the commercial oil analysis application.

Enable Background Force Zero is a feature used in military instruments and necessary to obtain a correlated result as part of the JOAP Program.

Global Standardization is a feature when enabled that will apply the global standards to the selected program (Program Name).

Enable Oil Detection is a system feature to determine if the operator has loaded a sample cap filled with oil in the sample stand or an empty sample cap.

Enable RFS is an optional feature that selects source parameters, readout mode and the analytical configuration for the analysis of a sample by Rotrode Filter Spectroscopy (RFS). This function

should only be used with the optional RFS accessory.

The Fuel option, when selected, provides the ability for the data readout to generate negative numbers. This option is normally selected for fuel analysis programs and is used for the quality control of contaminated fuels.

The print data and Transmit output data options are used to select which data is to be sent to a local printer, remote computer or both. The selections for Print data and Transmit Data are identical.

If All Burns is selected, every analysis in very mode is sent to the selected output.

If All burns in PPM readout mode is selected, only analyses in the PPM mode will be sent to the selected output.

If all Averages is selected, only average values for a series of analyses will be sent to the selected output. This data output format is recommended for fuel analysis where two or more analyses are made to create an average.

If Only when Sample ID is present is selected, only analyses preceded by a sample ID will be sent to the selected output. This data output format is used when only actual sample analyses are to be sent to the selected output and not other analyses such as standardization, check burns, warm-up burns, etc.

3.4.7.2 Program/Channels/Sequence

The channel sequence dialog, Figure 3-31, is the first of three submenus to the channels selection from the Program pull-down menu. This selection determines the order or sequence that each element will appear in the analysis program screen. Displayed on the right side of this dialog is a listing of all channels that appear in the System/Hardware/Optical dialog. These elements are listed in alphabetic order. Placing the cursor in any element column position then using the selection pointer and left mouse button will transfer the selected element to the cursor position. List all elements in the order it is desired to have them appear on the screen. Next, select the reference element to be associated with each element from the available references listed on the right. NOTE: Reference elements are either Hydrogen (H) or Carbon (C).

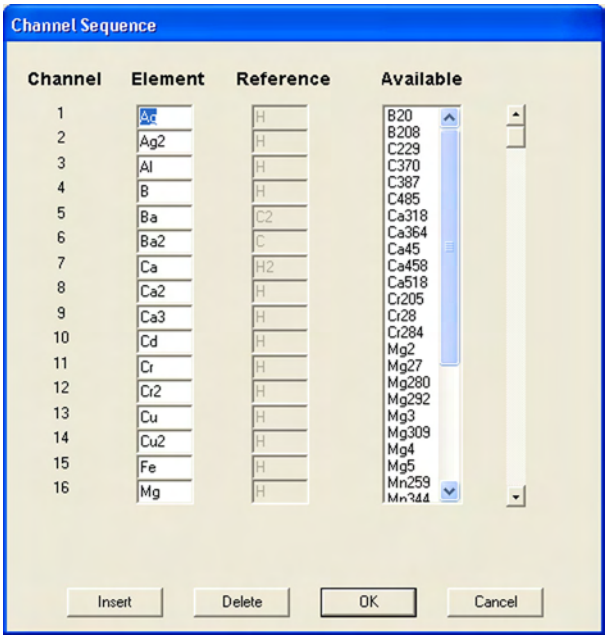


Figure 3-31, Program/Channels/Sequence

3.4.7.3 Program/Channels/Format

The channel format dialog, Figure 3-32, establishes three characteristics for each element. The first characteristic is the display mode. For each channel, it must be determined if the element's output is to be displayed in concentration or intensity when the readout mode is in PPM. All analytical channels are normally set to concentra-

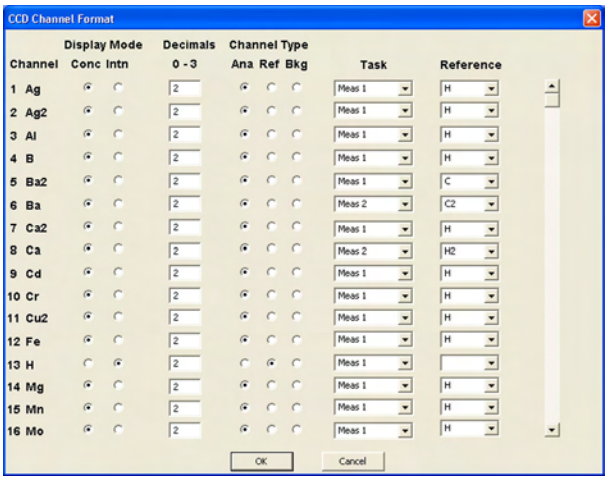


Figure 3-32, Program/Channels/Sequence

tion mode and all references are set to intensity mode. The second characteristic is the numeric resolution. This determines how many decimals appear to the right of the decimal when in the IEC PPM mode. This is always set to 2. The third characteristic is to identify the channel type. An element can be an analytical (Ana), reference (Ref), or a background (Bkg) channel. The next column, Task, allows you to select during which measurement cycle the signal from that channel is measured. The Reference column is used to select to which reference an analytical channel is tied.

3.4.7.4 Program/Channels/Parameters

The channel parameters dialog, Figure 3-33, controls five parameters associated with each channel. The first parameter is to determine if this channel will be active or inactive in this analytical program. The second parameter, if the channel is active, will determine if this channel is to be displayed on the screen. An active channel can operate without being displayed on the screen, as in the case of interelement corrections. The third parameter will determine if an active channel is to be printed on the local printer. The fourth parameter will determine if an active channel is to be transmitted to a remote computer or data management system on board the Spectroil. The fifth parameter determines if this channel will contribute to the calculation of profile position. All of these parameters are selected for one program only. Additional programs may have these parameters altered without effecting other programs.

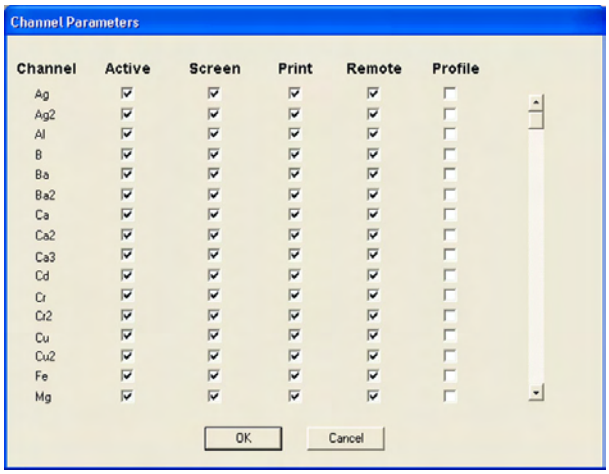


Figure 3-33, Program/Channels/Parameters

3.4.7.5 Program/CCD Burn Parameters

The burn parameters dialogs, Figures 3-34, 3-35 and 3-36 36, control several software aspects of the burn cycle. The left hand side of each dialog has a navigation bar where the burn duration can be divided into different sequence tasks.

The top of each screen has fields into which Oil Detect parameters can be set. The Oil Detect block has five fields (or segments). This block is part of the artificial intelligence and sample stand interlock monitoring hardware to protect the instrument from operator error. The first segment is Element Symbol and the element designated in this field is always Hydrogen (H) and its output is used to determine the presence of hydrocarbon emission in the first few seconds of the burn cycle. In the event the operator inadvertently installs a sample cap without oil or an insufficient amount of oil, the lack of Hydrogen output will trigger the termination of the burn cycle. Selecting the Enable Oil Detection flag in the System Parameters dialog can activate this feature.

Tasks are added on the navigation pane by double-clicking on a block in the navigation bar. The spectroil M is currently pre-configured to have three sequence tasks, a Pre-burn, Measure 1 and Measure 2.

The first time sequence is the Preburn Time, Figure 3-34. Preburn Time is 6 seconds (6000 ms), a cycle where the arc is initiated and the sample is introduced to the analytical gap for excitation.

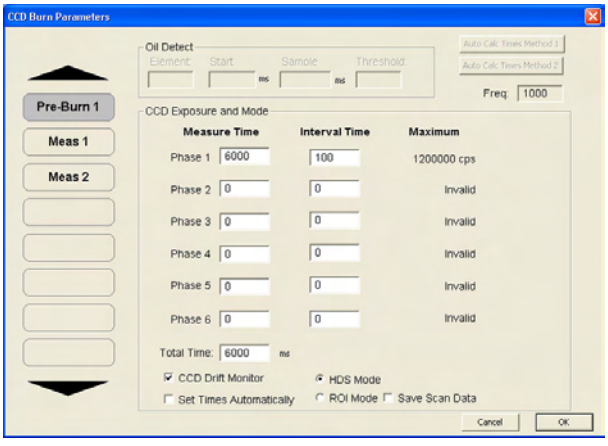


Figure 3-34, Program/CCD Burn Parameters, Pre-Burn

The purpose of the preburn period is to generate heat in order for the carbon disc electrode to absorb the sample until it becomes saturated. By the end of the preburn time, the sample temperature and analytical signal has reached stability and is suitable for measurement.

The combined Measure1 and Measure 2 time is typically 24 seconds, 19 for measure 1 and 6 for Measure 2, Figures 3-35 and 3-36. The interval is the time in milliseconds that the controller integrates the CCD. With an interval of 100, Measure 1 thus integrates the CCD 1900 times in the 19 seconds of measure time. During the Measure 1 and Measure 2 sequences the light intensity from the excitation process is measured and stored for each analytical channel. These intensities are used in a series of calculations to determine each elements concentration after background corrections have been made.

The other check boxes on the screens are currently not used and available for further development.

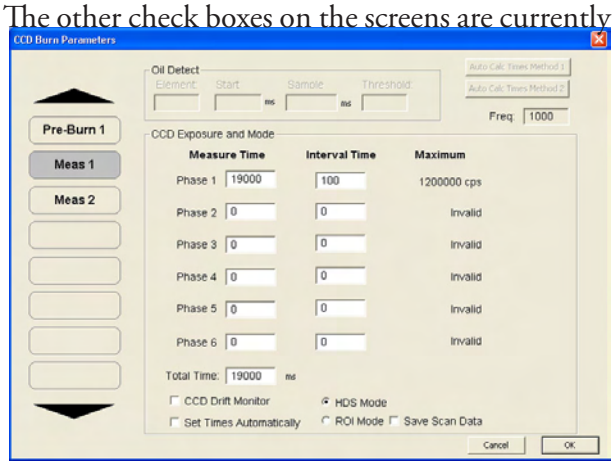


Figure 3-35, Program/CCD Burn Parameters, Measure 1

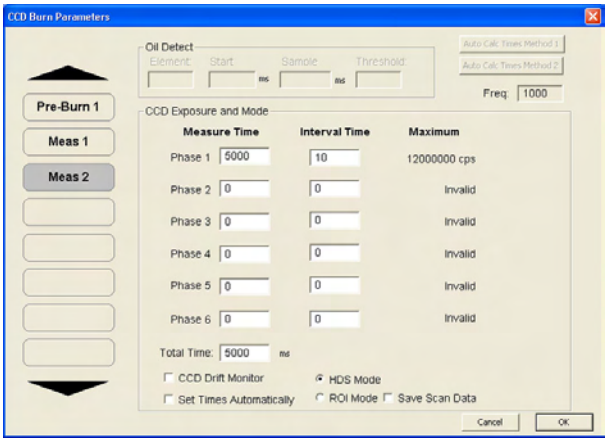


Figure 3-36, Program/CCD Burn Parameters, Measure 2

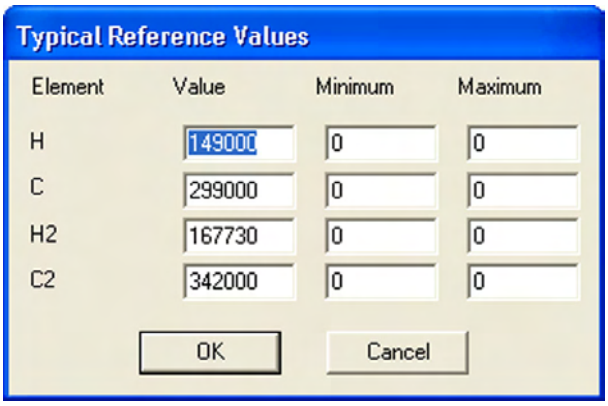


Figure 3-37, Program/Reference Values Menu

3.4.7.6 Program/Reference Values

This dialog, Figure 3-37 permits the entry of typical intensity values for the reference channels. These fixed values will be used as the dividend in the intensity ratio calculation that occurs each measurement. One intensity ratio is determined for each measurement and this ratio is multiplied times each element's intensity produced for that measurement and will result in an intensity ratio. Military instruments have only one reference element and that is Hydrogen (H). Commercial instruments may have a Hydrogen (H) and Carbon (C) reference channel. Reference selection is performed at the factory before initial calibration, but may be changed in the field depending upon applications and performance.

3.4.7.7 Program/Standardization Samples/ Standardization Names

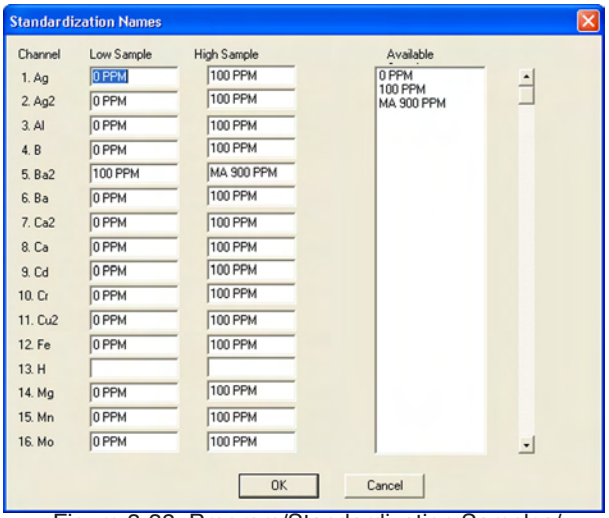


Figure 3-38, Program/Standardization Samples/ Stanadardization Names

This dialog, Figure 3-38, presents the available standardization samples entered at the system level under the System/Standardization Samples and permits the selection of these standards to be used as the Low Sample and the High Sample for each element channel. When standardization is performed, all standards that have one or more elements associated with the standard will be sampled to determine the offset and slope shift from the original factory calibration curves. The values obtained will appear in the Standardization Values description and result in factors that will be explained in the Standardization Factors description.

3.4.7.8 Program/Standardization Samples/ Standardization Values

This dialog, Figure 3-39, presents a table where the values obtained from the initial factory calibration curves are entered as standardization points. For every element, a low expected value is entered as well as a high expected value. Technically these values are for the low and high sample standard that were designated in the previous sample name dialog. These values are fixed and do not change over time; therefore they are the Expected values to obtain. In practice, these values do, however, change as a result of the environment and consumables. Therefore during the standardization process, the current values are obtained and automatically inserted in the Obtained column for each element in order that a comparison can be performed between the Expected and Obtained values. The comparison will result in a change in the standardization factors and offsets. This dialog is explained under Standardization Factors.

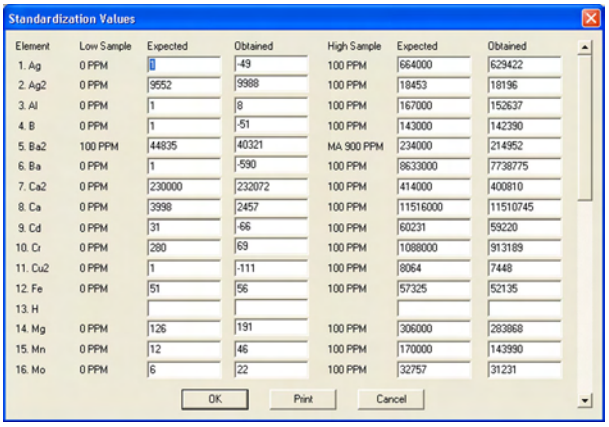


Figure 3-39, Program/Standardization Samples/ Standardization Values Menu

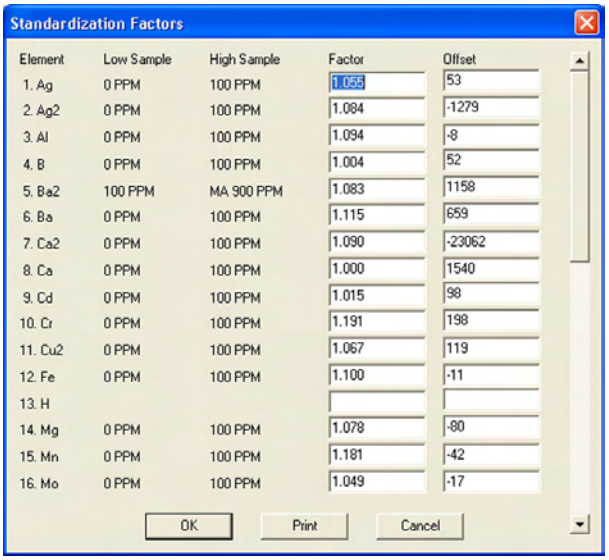


Figure 3-40, Program/Standardization Samples/ Standardization Factors Menu

3.4.7.9 Program/Standardization Samples/ Standardization Factors

This dialog, Figure 3-40, displays the factor and offset values that have been automatically calculated as a result of completing a standardization operation. During the standardization operation, intensity ratio values are obtained for the low and high standardization samples for all elements. These values are listed under Standardization Values. From these values, the offset and factors are calculated for each element. Under normal conditions, the factor is expected to be in the 0.5 to 5.0 range. This is an information only screen and altering these values may have a significant effect on the instrument's calibration.

3.4.7.10 Program/Calibration Curves

This dialog has two sub-menus, Breakpoint and Graph. It permits the entry and display of intensity ratio values obtained during factory calibration of a new instrument and its corresponding

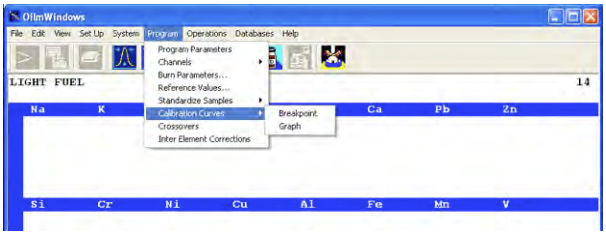


Figure 3-41, Program/Calibration Curves Menu and Sub-menu

graph, Figure 3-41.

The Breakpoint sub-menu when selected permits the entry and display of intensity ratio values obtained during factory calibration of a new instrument, Figure 3-42. The result is a calibration curve that may be viewed under menu selection View/Graph.

In order to maintain the integrity of the factory calibration installed in the Spectroil when it was originally manufactured, this dialog is password protected.

If the instrument's calibration is suspect, it is highly advised that the performance be discussed with the Service Department of Spectro Incorporated. If, technical discussions conclude that the calibration curves must be adjusted, a password will be calculated and instructions will be given to enter this password under the menu selection File/Password.

Each element that is active in this program will be displayed in alphabetical order on the right side of this dialog. Placing the selection pointer over the element symbol and left clicking the mouse will select that element's calibration curve to be displayed. The calibration curve intensity ratio values are on the left side and the concentration Ratio values are on the right side. On the far left side is calculated the intensity and concentration ranges which represent 5% above and below the

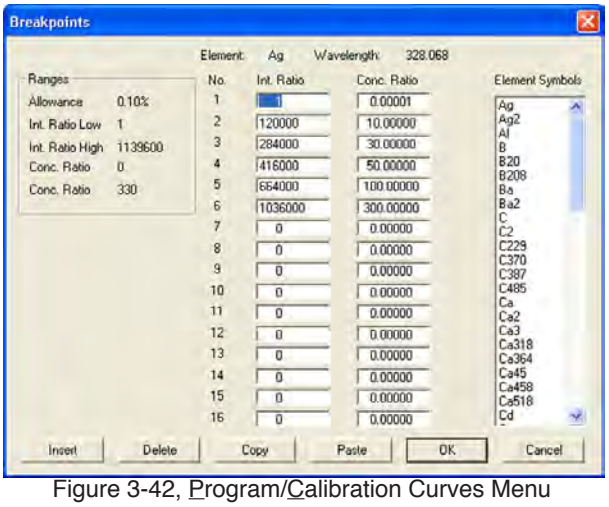


Figure 3-42, Program/Calibration Curves Menu Breakpoint Sub-menu

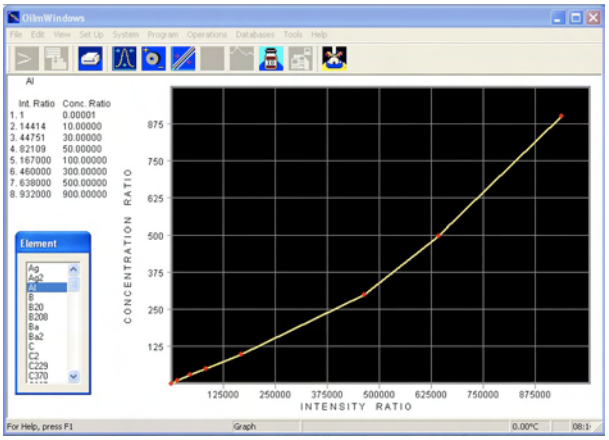


Figure 3-43, Program/Calibration Curves Menu Graph Sub-menu

intensity ratio value and 10% above the concentration value.

The Graph sub-menu option provides a basic graphic display of the calibration curve for each of the elements in the system. This menu option, Figure 3-43, presents a window of the element symbols and highlighting the element symbol by left clicking the mouse when the selection pointer is located on the element symbol will display the calibration curve for viewing. Pressing the print icon will make a printout of this calibration curve if the printer driver is properly selected for the graphic (not generic) mode. To exit this menu option, select View and select any readout mode to return to the analysis program screen.

3.4.7.11 Program/Crossovers

This dialog, Figure 3-44, displays a table to enter the crossover point when one element wavelength exceeds its optimum analytical performance and

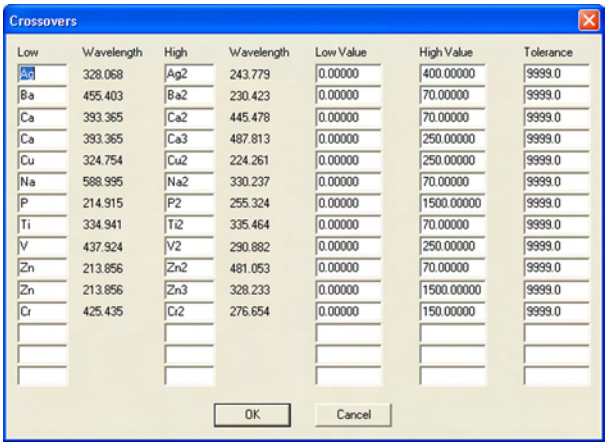


Figure 3-44, Program/Crossover Menu

crosses over a second wavelength of the same element that has superior performance in the higher concentration rages. In spectroscopy, there are several reasons why the physics of one spectral line exceeds its primary capability and a second wavelength of the same element is optimum for performance in that concentration range. In these cases, the crossover elements are identified and the high concentration range the high wavelength that becomes effective is listed.

3.4.7.12 Program/Inter Element Corrections

This dialog, Figure 3-45, permits the correction to be applied due to the influence of one elements presence and concentration on another element. Due to excitation characteristics and optical design, it is possible that one element may influence or interfere with another element. This interference has two conditions. One element's presence may enhance the presence of another element while another elements presence may suppress the presence of a second element. This is known as additive or multiplicative interference. This dialog permits the entry of the element that is being interfered with and the interfering element that is causing the interference. A choice of additive or multiplicative interference is available and the correction factor can be entered to null the interference. These interferences are normally installed at the factory and do not require alteration.

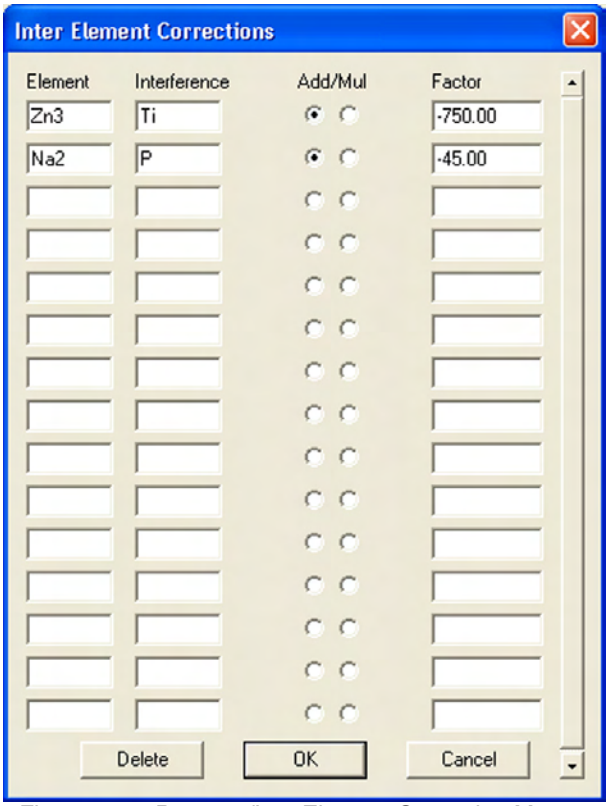


Figure 3-45, Program/InterElement Correction Menu

3.4.7.13 Program/Display Profile

This dialog shows a log with the status of the last two optical profiles, Figure 3-46. The screen shows the status of each CCD chip in the optic. This screen also appears automatically each time a profile is performed. The profile function must be repeated if any of the chips status is not OK

3.4.8 Operations

The Operations pull down menu, Figure 3-47, provides software options that are specific to the day-to-day operation of the spectrometer. These functions are standardization, profiling, etc. and do not result in one specific dialog but a series of

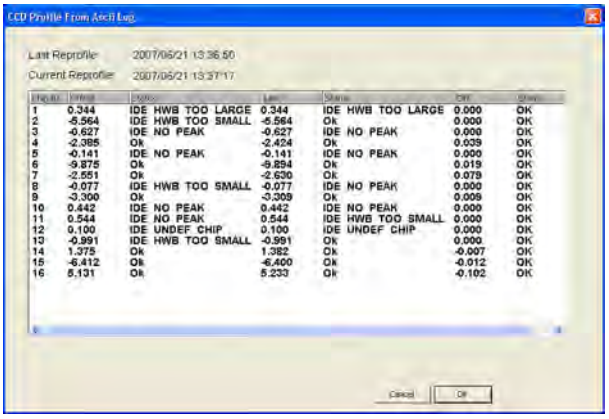


Figure 3-46, Program/IDisplay Profile

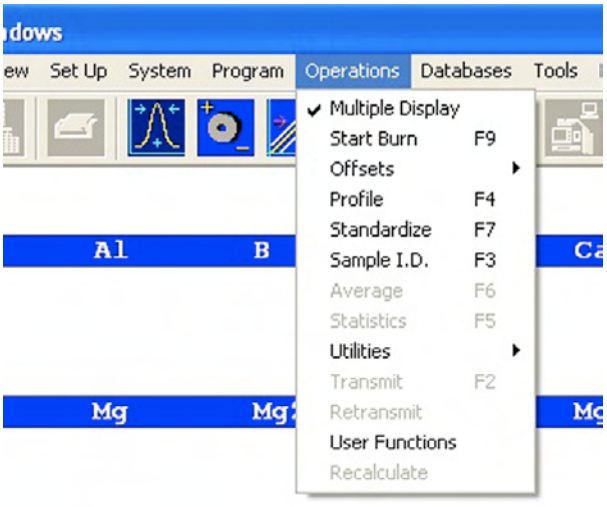


Figure 3-47, Operations Pull-down Menu

dialogs to complete the operation. In these cases, a quick description of the menu option will be provided and reference to the Operation Section of the manual will be given. In this section, we will provide full examples of the operation and all dialogs that will appear

3.4.8.1 Operations/Multiple Display

This menu option does not result in a dialog. This menu selection is to permit the accumulation of up to twenty measurements to appear on the screen so an average can be calculated. This is used for such functions as standardization, profiling and statistical analysis where the average of multiple measurements will be required, or in the case of profile, a comparison of nine measurements must be made. This option is active when a check mark appears to the left of the words Multiple Display. Choosing this menu option a second time will clear the check mark and place the readout software in a single burn mode. Single burn mode is required when single burn data transmission to an external computer or internal database management software is in use.

3.4.8.2 Operations/Start Burn F9

This menu option does not result in a dialog. When this menu option is selected by the pull down and released, the burn will begin and a progress box will appear. The first progress box to appear will be for the preburn period of time then change to the measure period and finally the BFZ period that has been assigned in the Burn Parameters dialog of the Program pull down menu. Pressing function key F9 on the keyboard or selecting the burn icon on the tool bar can also perform start burn.

3.4.8.3 Operations/Offsets/Perform Disc Offsets F10

This menu option does not result in a dialog, but does place the system and software into a special operations mode. When selected, a red banner will appear centered just below the tool bar with the word "OFFSETS". This indicates the software is not in a operating mode for unknown sample analysis. Selecting this menu option a second time will reveal that the software is set to perform this operation and will have a check mark to the left of the words Perform Disc Offsets F10. Releasing the mouse button when selected will remove the check mark and return the software to the normal operating condition as evidenced by the disappearance of the red banner. This operating function can also be initiated by pressing function key F10 on the keyboard, or by selecting the offsets icon on the tool bar. Refer to the disc offsets procedure in the Operations Section of the manual for a step-by-step description of the software.

3.4.8.4 Operations/Offsets/Display Offset Values

This menu option, Figure 3-48, displays a dialog containing factors that have been calculated from values that were obtained from a previous disc electrode offset procedure. This is a display dialog and it looks to the dialog that automatically appears upon completion of the disc electrode offset procedure. Upon completion of the disc electrode offset procedure (an average of the measurements), this same dialog will automatically appear except it will have the actual values listed in the Forward and Reverse columns. All buttons will be active at that time.

In this dialog example, the values for forward and reverse are gone indicating this is only a display of the offset values. The Print, OK, and Cancel buttons are the only buttons that are active. In the header next to Background Correction Factors are

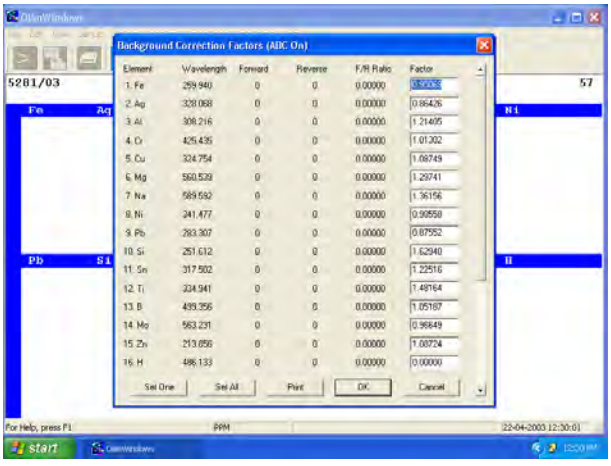


Figure 3-48, Operations/Offsets/Display Offset Values

the letters (ABC On) in parenthesis. This is to indicate that the Additive Background Correction has been selected (check marked) in the System/ System Parameters dialog. Additive Background Correction indicates that some elements are not background corrected, therefore, a factor of 0.00000 is set in the factor column for that element and if present when the disc electrode offset procedure is performed, the calculated F/R Ratio value will not be set into the Factor column for that element. Refer to the Disc Electrode Offset Procedure section in the Operating Section of this manual.

3.4.8.5 Operations/Profile F4

This menu option does not result in a single dialog, but rather a series of dialogs that will instruct the operator to perform the optical profile procedure. In addition to selecting this menu option for profiling, the function key F4 can be pressed or the profile icon can initiate the profiling sequence. Refer to the Operating Section of this manual for a detailed description of the software dialogs as they appear in the profile routine.

3.4.8.6 Operations/Standardize F7

This menu option does not result in a single dialog, but rather a series of dialogs that will instruct the operator to perform the standardization procedure. In addition to selecting this menu option for standardization, the function key F7 can be pressed or the standardize icon can initiate the standardization sequence. Refer the Operating Section of this manual for a detailed description of the software dialogs as they appear in the standardization routine.

3.4.8.7 Operations/Sample I.D. F3

This menu option will produce a dialog to permit the entry of one single ID, Figure 3-49, or provide the capability to pre enter multiple sample ID's, Figure 3-50, using the MULTIPLE button. Both dialogs are configured at the system level by the System/Sample ID option.

The Multiple Sample ID Entry dialog allows up to 50 sample identifications to be pre loaded to

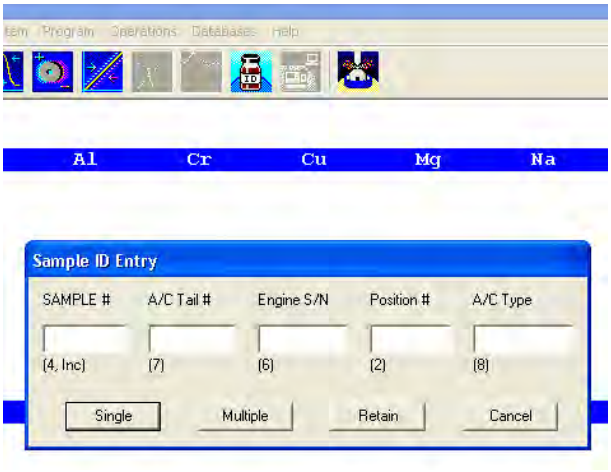


Figure 3-49, Single Sample ID Entry Menu

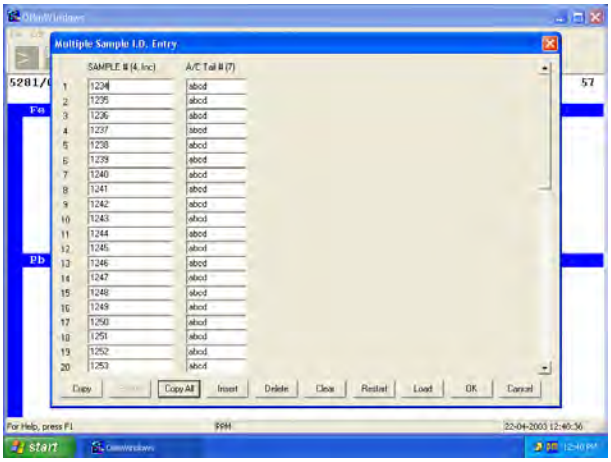
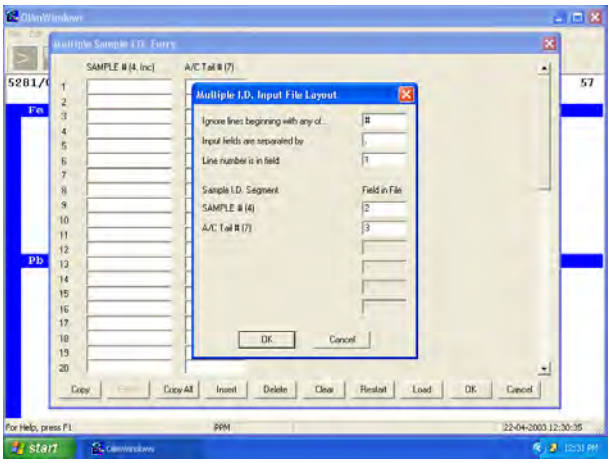


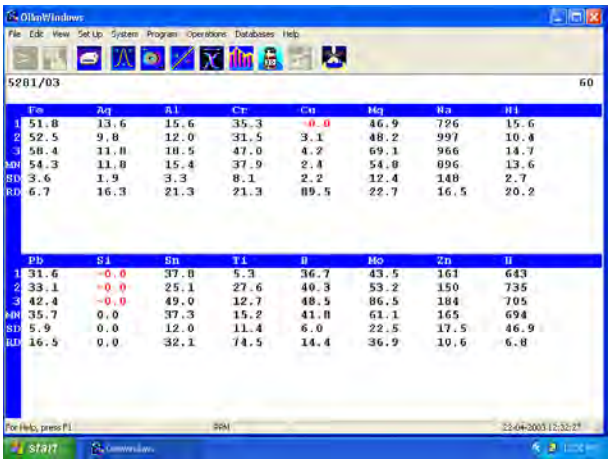
Figure 3-50, Multiple Sample ID Menu

facilitate rapid sample throughput. All sample ID fields are configured at the system level through the System/Sample ID menu option. Along the bottom of the Multiple ID dialog are buttons to expedite the entry of sample numbers. The Copy button will copy the contents of one field and permit it to be copied into another field of equal or greater field size using the Paste button. Copy All will copy one sample and insert it into all remaining empty fields in that column. If that column is set for auto increment, the sample number will increase one value per row. Insert, Delete, and Clear are self-explanatory.

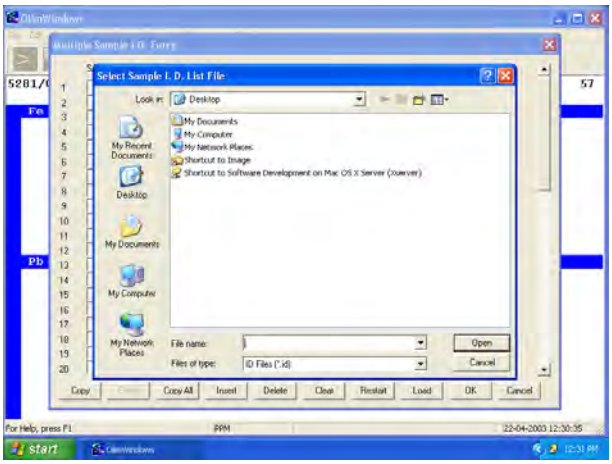
Click load to proceed. The first time that this option is enabled, an input file layout screen, Figure 3-51 appears and must be filled in with the user layout preferences. Click OK when complete and the a screen enabling the user to select the sample ID files appears, Figure 3-52.



3-51, Sample ID File Layout Preferences Screen



3-53, Operation Statistics F5 Menu



3-52, Sample ID File Selection Screen

3.4.8.8 Operations/Average F6

This menu option does not result in a dialog. This menu option is available only after two or more measurements have been made and appear on the screen. Selecting this option will perform a calculation of the average of a series of measurements and display the calculated value at the bottom of the individual measurements. Selecting function key 6 (F6) performs the same function.

3.4.8.9 Operations/Statistics F5

This menu option does not result in a dialog. This menu option is available only after three or more measurements have been made and appear on the screen. Selecting this option, Figure 3-53, will perform a calculation of the average, standard deviation and relative standard deviation of a series of measurements and will display the calculated value at the bottom of the individual measurements. Selecting function key 5 (F5) or the statistics icon performs the same function.

3.4.8.10 Operations/Utilities/BEC F8

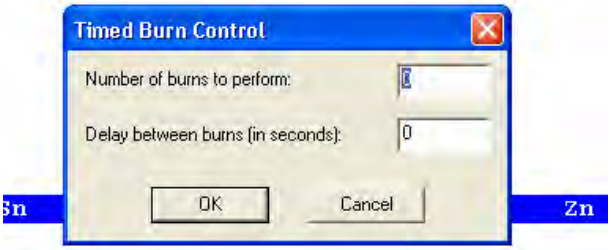
This menu option does not result in a dialog. Selecting this menu option places the instrument into a special diagnostic mode called the Background Equivalent Concentration (BEC) mode. When selected, a red banner will be centered along the top of the analysis program screen and be labeled BEC Mode. The BEC mode is used to determine the analytical sensitivity of each element and is reserved for production and field service requirements.

3.4.8.11 Operations/Utilities/Dark Current

This menu option does not result in a dialog. Selecting this menu option places the instrument into a special diagnostic mode called the Dark Current mode. When selected, a red banner will be centered along top of the analysis program screen and be labeled Dark Current. The Dark Current mode is used to determine the electronic stability of the photomultiplier tubes and is reserved for production and field service requirements. Refer to the Spectroil M Maintenance Manual for additional information about the dark current test.

3.4.8.12 Operations/Utilities/Timed Burns

This menu option, Figure 3-54, provides a dialog to permit the entry of a number of measurements to be made and the interval between these measurements. There are several diagnostic tests that require multiple measurements to be made. This



3-54, Operation/Utilities/Timed Burns Menu

dialog and software feature will perform these measurements in sequence without operator intervention between burns.

3.4.8.13 Operations/Transmit F2

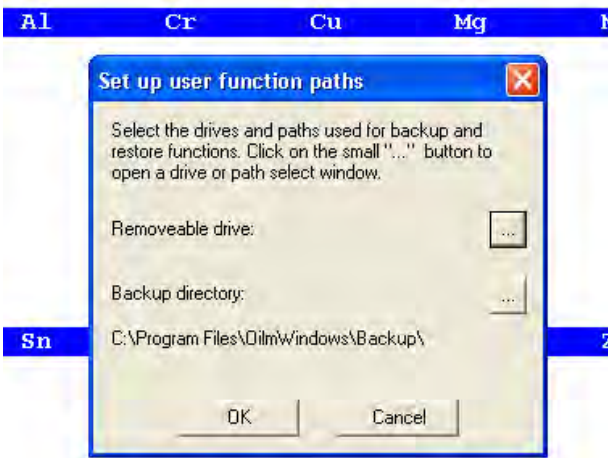
This menu option does not result in a dialog. Selecting this menu option will instruct the software to transmit the analytical results to an external computer or to a software application that may be resident on the Spectroil instrument. Pressing function key 2 (F2) or the transmit icon will perform the same function,

3.4.8.14 Operations/Retransmit

This menu option allows the user to retransmit (re send) the last burn when in a single burn mode, or the last batch of burns when in the batch mode.

3.4.8.15 Operations/User Functions

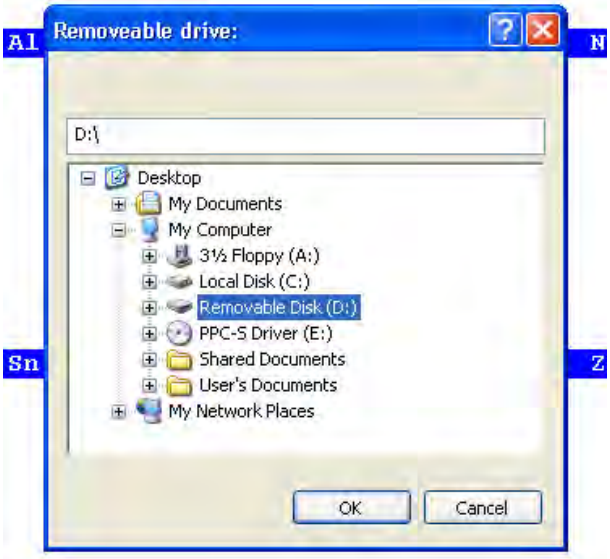
This menu option presents a dialog of user functions that may be performed to backup or restore critical data and application files. Backing up and restoring files is normally a maintenance function, and original copies of the backups are included in the documentation package of each Spectroil instrument.



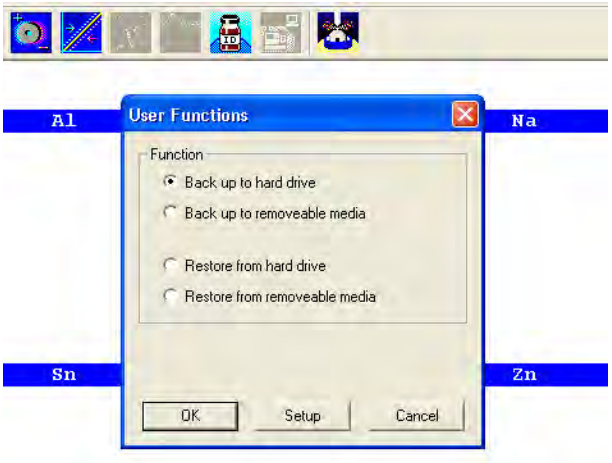
3-55, Set-up User Function Paths Screen

The first time that the user functions are selected, the set up user functions path screen, Figure 3-55 appears. Select removable drive and the screen as shown in Figure 3-56 appears to select the destination for the backup function. For most configurations the removable drive is the Zip Removable Disc Drive (D:). Select the drive and click OK. Next click OK on the setup user function paths screen and the user function screen, Figure 3-57 appears and will do so every time thereafter when the Operations/User Functions are selected.

The top portion of the function block is for backup of Program files and/or Data files. Program files are the executable (.EXE) files that control the instruments operation and the executable is



3-56, Removable Drive selection Screen



3-57, Operations/User Functions Menu

the same for all instruments. Data files (.CFG) contain the calibration data and these files are specific to your instrument.

The lower portion of the function block is for restoration of program and data files. The Setup button allows the user to change user functions paths, backup directories and the destination for backups.

3.4.8.16 Operations/Recalculate

This menu option allows the user to recalculate analytical results after a system change has been made. For example, the analytical results can be recalculated if an incorrect analytical program was used and after the correct one is selected.

3.4.9 Databases

The OilMWindows program supports transfer of burn data to a database program that resides on the spectrometer. Currently four options exist. Database transfer formats exist for AETC (a DOS based program for USAF applications), a generic database that generates a data transfer file, a sample identification driven (SID) database and PinPoint a Windows® based program that is part of OilMWindows. Refer to section 6.2 for a detailed description of the Pinpoint database software.

In all cases, the data transfer is accomplished by writing a file to the hard drive of the system after completion of a burn. In the AETC and PinPoint transfer modes, the file contains a single entry, and will be overwritten by the next burn. It is the responsibility of the user, or the database application, to retrieve the data from the hard drive before the next burn is made. SID database creates a spreadsheet file for a user designated sample ID field. The Generic transfer mode accumulates lines of data, one per burn, until it is deleted. It also provides for a substantial amount of user configuration.

The appropriate database may be selected from the Databases menu, Figure 3-58. When a database is active, a check mark will appear beside

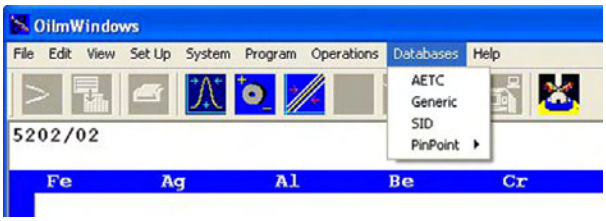


Figure 3-58, Databases Pull-down Menu

it. To de-activate a database, click on it a second time. Only one database may be active at a time. When one database is active, the menu items for the others are disabled.

3.4.9.1 Databases/AETC

When the AETC menu item is selected, the dialog in Figure 3-59 appears. The dialog contains two fields. The first field contains the number of channels per line to appear on each text line in the transfer file (see below). The second field contains the full path and file name for the transfer of the data. This file will be overwritten after each burn. It is the responsibility of the user, or the external database, to retrieve the data from the external file before the next burn is made.

The user has control of which elements are entered in the transfer file. Those elements checked under the Remote column of the Channel Parameter Dialog are listed in the transfer. The Channel Sequence Dialog specifies the order in which the elements appear.

The transfer file is a text file, written in a fixed format. A sample of the file appears as follows:

```
ID = ISample 01          IMobil1        08/21/2000
09:38:00
Burns =  1    CS = Test V1.38    Mode = PPM

 K      Li     Zn     Na     Mg     MgHi   Si     H
 14.7   1.0    1134   35.6   778    778    383
4964
```

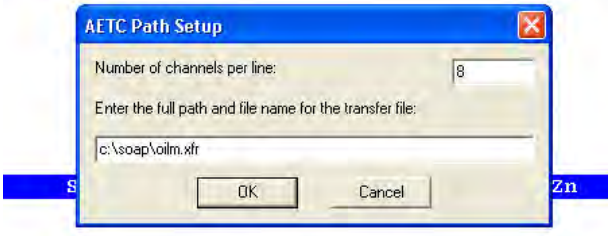


Figure 3-59, Databases/AETC Menu

```
 V       Cr      Mn      Ca      C       Ni      Cu
Al
 617     4919    671     28.1    5153    5079    4843
474

 VHi     Pb      Fe
 4890    4385    1266
```

The file format is identical for each burn, facilitating software parsing. The fields "ID =", "BURNS =", "CS =" and "Mode =" appear in the same position in each file. They provide pointers to the Sample ID, burn number, curve set (program) and readout mode respectively. The date and time will always appear following the sample ID.

Following the heading area will be the data from the specific burn. The data will appear in lines, with the number of elements in each line corresponding to the value entered in the "Number of channels per line" field in the AETC Setup Dialog.

The elements selected for display will be grouped in pairs of lines. The first line of each pair will contain the element symbol. The second line will contain the readout value for that element. A blank line will separate groups of lines.

3.4.9.2 Databases/Generic

When the Generic menu item is selected, the dialog shown in Figure 3-60 appears. The dialog contains a sequence of fields that provide control of the data to appear in the transfer file, as well as the name and path of the transfer file.

Figure 3-60, Databases/Generic Menu

The first field contains the full path and file name to be used for the transfer of the data. This file will accumulate a single text line after each burn. The file will continue to grow, containing a single line for each burn, until the user, or the external database deletes it. If the file does not exist, OilMWindows will create it when it is needed.

The second field is Elements to include and has three choices: On Screen, Remote or All. Three choices are offered by the dialog: On Screen, Remote, or All. Only one button may be checked. In all cases, the Channel Sequence Dialog specifies the order in which the elements appear.

When the On Screen button is checked, the same elements that appear on the OilMWindows screen will appear in the transfer file. When the Remote button is checked, those elements checked under the Remote column of the Channel Parameter Dialog are listed in the transfer. When the All button is checked, all elements appear in the transfer file.

The third field is the field separator character which allows the user to specify the character used to separate fields in the transfer file. This character may be any single ASCII character. In the example, it is a comma (,). It is the responsibility of the user to select a character, which will not appear in the data stream.

Following the separation character are the enabling options for the Date, Sample ID, and the Element names. Each field checked will appear in the transfer file.

The transfer file is a text file, written in a fixed format. A sample of the file, as configured by the dialog box settings in the illustration, appears as follows:

```
Al,38.99,Cr,26.74,Cu,358.20,Mg,10.45,Na,15.45,Ni,4Al,3
8.99,Cr,26.74,Cu,358.20,Mg,10.45,Na,15.45,Ni,47.76,P
b,39.97,Si,25.57,Sn,56.48,Ti,35.56,B,28.72,Mo,65.50,Zn
,293.05,Ba,62.98,P,141.96,Cd,17.67,K,48.70,H,4851,Bk
g,6510,Ag,8.38,DATE,10/25/2004,ID,This is the Sample
ID    ,So Is This     ,
```

The file is a series of text lines, one line per burn, with a carriage-return line-feed pair (ASCII 0D 0A) at the end. The line breaks in the illustration do not occur in the transfer file.

The first data on a line will always be the readout data from the specific burn.

If the Element names have been enabled, the elements selected for display will be grouped in pairs of fields. The first field of each pair will contain the element symbol. The second field will contain the readout value for that element. The chosen field separator character will appear after each field. There will be a trailing separator character after the last field.

If the Elements names have not been enabled, the elements selected for display will appear as a series of single fields. The chosen field separator character will appear after each field.

Following the data fields will be the date, if it is enabled. The character string "DATE" will appear, followed by a field separator character. Then the date will appear, in MM/DD/YYYY format, followed by a field separator character. When the date is not enabled, neither the "DATE" nor the date field will appear.

Following the actual date is the Sample ID. The character string "ID" will appear, followed by a field separator character. Then the sample ID will appear, followed by a field separator character. When the sample ID is not enabled, neither the "ID" literal nor the sample ID field will appear.

If the Date, Sample ID, and Element names options have not been enabled, the same burn would appear like this:

38.99,26.74,358.20,10.45,15.45,47.76,39.97,25.57,56.48
,35.56,28.72,65.50,293.05,62.98,141.96,17.67,48.70,48
51,6510,8.38,DATE,10/25/2004,ID,This is the Sample ID
,So Is This ,

3..4.9.3 Sample Identification Driven (SID) Database

The Sample Identification Driven (SID) database allows you to create data base files in spreadsheet format based on any part of a user selected Sample ID field. These user selectable delineated files with analysis data can be stored on the Spectroil's internal hard disk for further evaluation, or stored temporarily for transfer to an external computer or network. When stored on the Spectroil's hard disk, all future analyses for the selected Sample ID field will be stored and appended to the past analyses in that file (spreadsheet).

SID Setup

To use the SID database, the Spectroil's system Sample ID must be setup to include the field that is to be used to establish the spreadsheet file. From the System pull down menu on the Analysis Program screen, select "Sample I.D……", Figure 3-61. A screen similar to the example in Figure 3-62 will appear. In the Sample I.D. Setup screen,

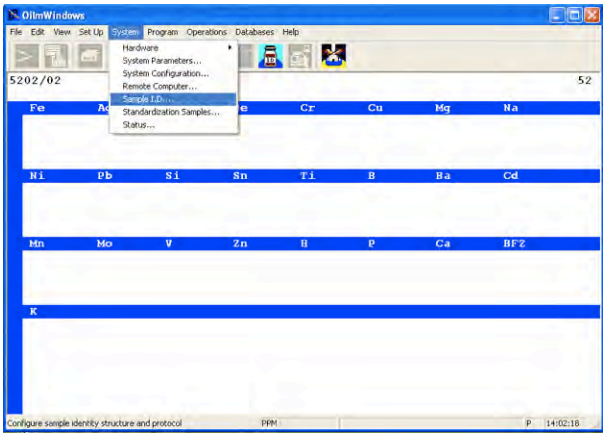


Figure 3-61, Select Sample ID to Setup SID

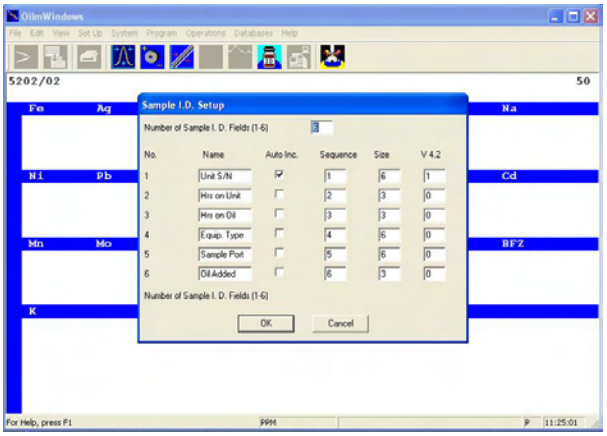


Figure 3-62, Sample I.D. Setup Screen

verify that the sample ID is configured per your requirements. Since the SID database will allow the choice of any of the name fields to be used for dynamic file naming, make sure to have a name for all working sample ID segments. The example in Figure 3-62 is used in this explanation.

SID Configuration

The SID database is initiated from the Database pull down menu on the Analysis Program screen. To configure the SID database, select "SID" from the Databases pull down menu, Figure 3-63. The first time that the database is setup, the SID Database Transfer File Setup screen, Figure 3-64 appears with empty fields. An explanation of the fields follows and a file filled-in with data for our example is shown in Figure 3-65:

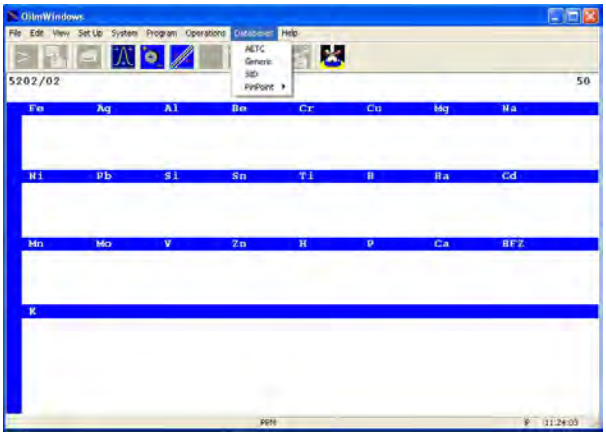


Figure 3-63, database Pull Down Menu

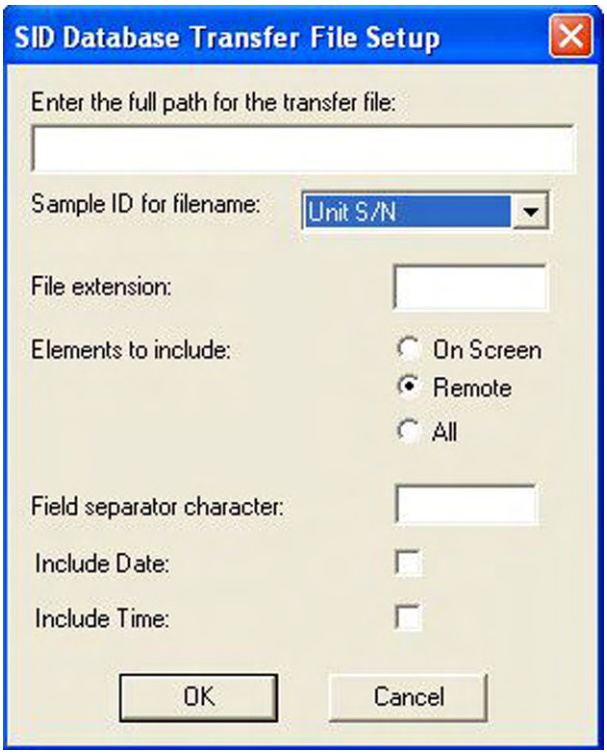


Figure 3-64, SID Database Transfer File Setup Screen

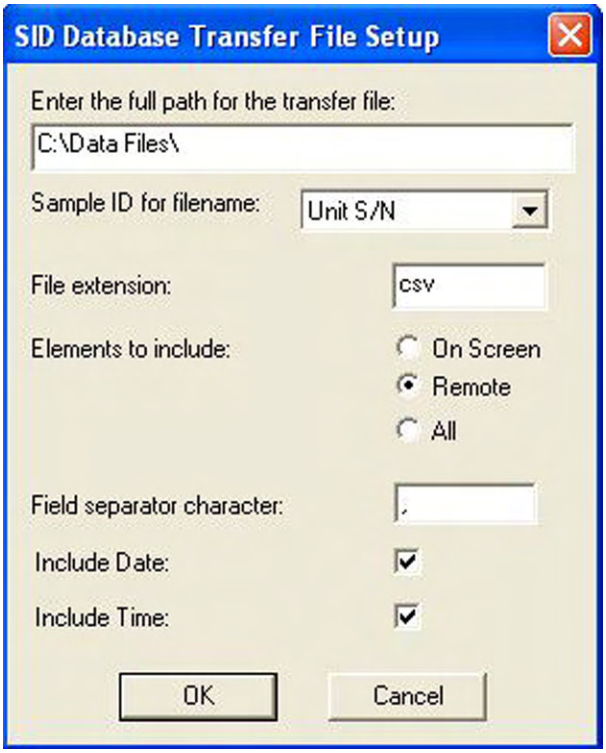


Figure 3-65, Example Filled-in SID Database Transfer File Setup Screen

• *Enter the full path for the transfer file:* This is the location on the Spectroil's hard disk where the database file is going to be stored. In our example, the file path is C:\Data Files\.

• *Sample ID for file name:* This drop down menu lists the names of all available sample ID segments that can be used for the spreadsheet file name.

Figure 3-66 is a sample of the file names available in our example.

• *File extension:* This is the extension to be used for the file name, our sample will use "csv" for spreadsheets.

• *Elements to include:* The analytical elements that will the included in the database file are determined by the setup in the menu Program>Channels>Parameters. In our example, Figure 3-67, the elements checked off for "Remote" transfer will be included in the SID data-

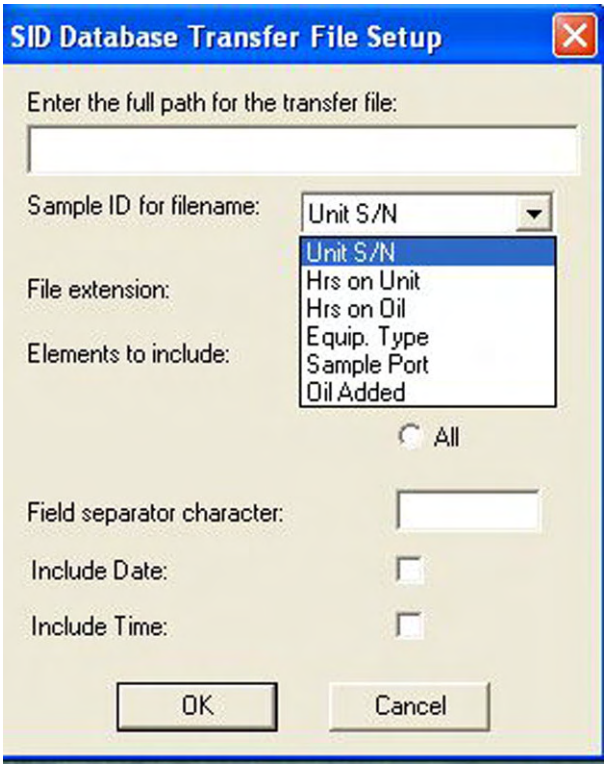


Figure 3-66, Example of Sample ID for Filename Drop Down Menu

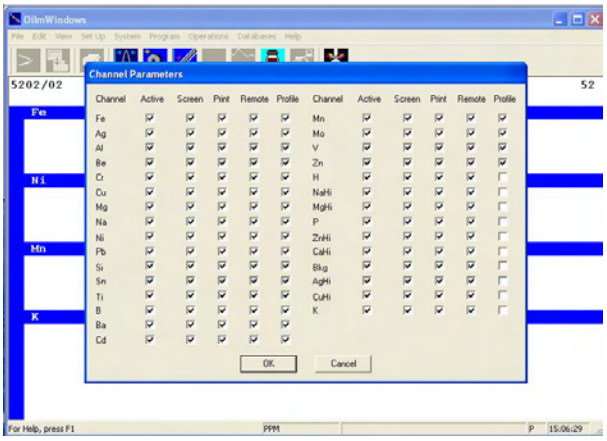


Figure 3-67, Elements to be Included in SID Database

base.

• *Field separator character:* The character entered will be placed between each field of data. In our example, a "," (comma) is used.

• *Include Date:* The date of the analysis is included in the database along with the analytical data.

• *Include Time:* The time of the analysis is included in the database along with the analytical data.

The SID database will be enabled once "OK" in the dialog box is selected.

SID Database Routine Use

The SID database can be used to store analytical data from routine samples after it has been configured. Analyses will be stored in files based on the Sample ID selected in the data base setup.

1. On the Analytical program screen, verify that the SID database is active. A check mark must be to the left of "SID" in the Databases pull down menu.

2. Enter the sample ID by clicking on the "ID" icon on the Analysis Program screen, or pressing function key "F3". In the "Sample ID Entry screen, enter the fields corresponding to the file where the data is to be stored, and any other user selected fields. In our example, data will be stored by Unit S/N (Unit Serial Number) as shown in Figure 3-68. Select "Single" if you are analyzing samples manually ("Multiple" is for applications where a robotic is used to analyze samples). The sample ID will appear in the upper left of the Analysis Program Screen.

NOTE*: A file is not created if the sample ID field chosen for creating that file is blank. Also, if the field contains non-file nameable characters (/, @, *, etc.), the file will be saved with an _ (underscore) replacing the character.*

3. Press the "Start Burn" icon on the Analysis Program screen or function key F9 to start the analysis of the sample.

4. Once the analysis is complete, a file is created in

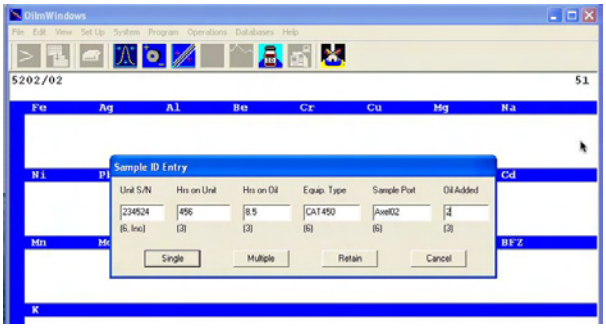


Figure 3-68, Sample ID Entry Screen

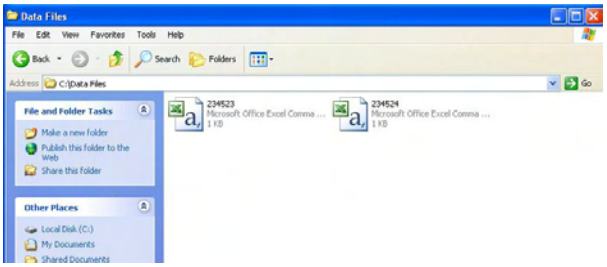


Figure 3-69, Example of SID File Storage Location

stored on the Spectroil's hard disk in the location specified in the SID database Transfer File Setup. In our example the files are stored on drive C in a folder called "Data Files", Figure 3-69. The files can be opened and data can be viewed in standard spreadsheet sheet format as shown in our example, Figure 3-70.

CAUTION: Do not open a file if analyses are in process and you plan to store data in it. No data is stored in an open file.

3.4.9.4 Databases/PinPoint

The Spectroil M database software PinPoint combines the operating functions of the spectrometer with a database capability to develop and maintain analysis data for any mechanical system. This function provides the capability to export analytical results from the spectrometer to an integral software program for record keeping and analytical data evaluation.

This optional software feature has two configurations, PinPoint or PinPoint PLUS. The only difference between these two configurations is that the PinPoint configuration records the analytical results in integers or whole numbers while PinPoint PLUS records the analytical results in decimal values. If you purchased either version of the PinPoint software, chapter 6 provides a detailed description of the function and capability of this software feature.

3.4.10 Tools

The tools menu, Figure 3-71, has functions for use by Spectro certified maintenance personnel. The functions are not available to the user.

3.4.10 Help

In accordance with Windows® compliant screen

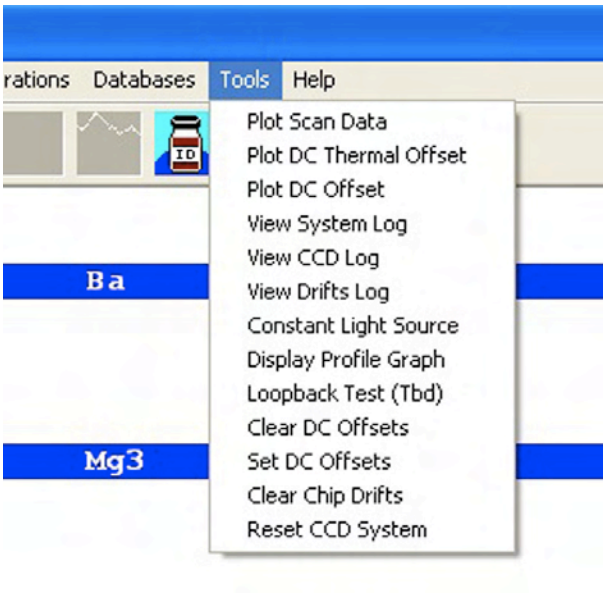


Figure 3-71, Tools Menu

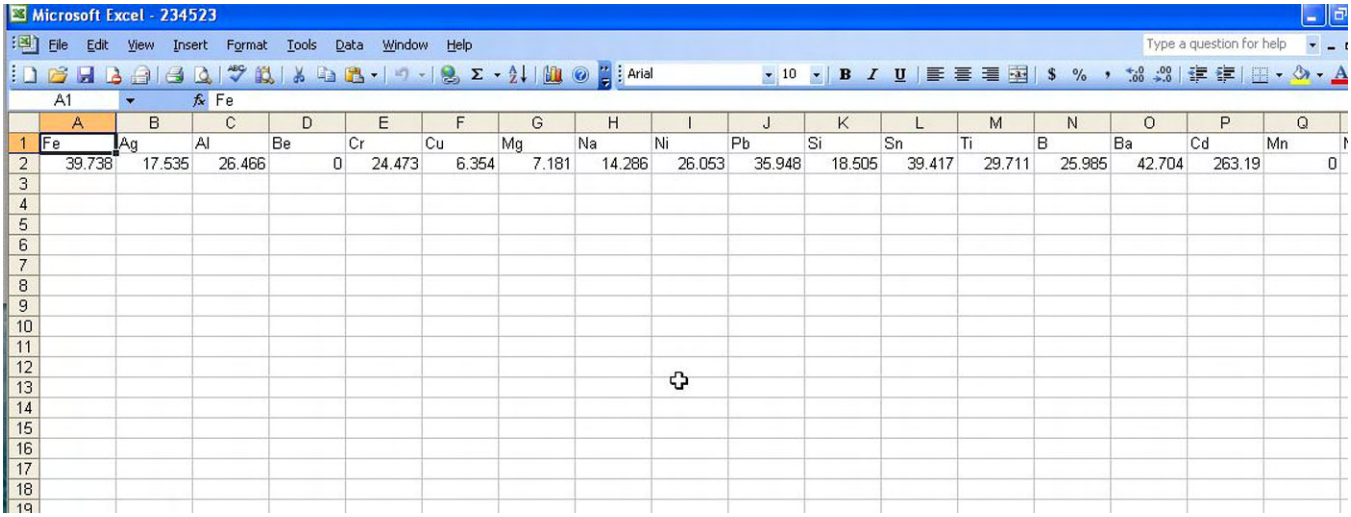


Figure 3-70, SID Data File in Spreadsheet Format

structure, Help must be the last pull down menu option. The Help pull down option contains two pull down menu options that comply with the Windows® structure. The menu options are Help Topics and About OilMWindows. This section will describe each operation in general and in basic terms, then as they are used in the operation of the instrument additional description will be given.

3.4.10.1 Help/Help Topics

This menu option opens an Adobe® Acrobat file that contains a Quick Help Section and the entire Spectroil Operation and User Maintenance Manual.

Links to summarized operating procedures are provided from the main Quick Help page along with links to the corresponding detailed section in the manual.

The table of contents from the Operation and User Maintenance Manual can also be used to quickly jump to the corresponding section in the manual. Each table of content section is linked to the appropriate page in the manual and access is provided by clicking on the link.

The entire Operation and User Maintenance Manual, or sections thereof, can also be printed if a hard copy of the document is preferred.

3.4.10.2 Help/About OilMWindows

This menu option, Figure 3-72 is about OilMWindows. This dialog provides the date and version of this software release and the name, address and e-mail address of Spectro Incorporated. Check the Spectro Incorporated web site for the listing of the current version number. Software upgrades can be obtained at no cost.

Figure 3-72, About OilM Windows Screen

Chapter 4

Functional Enhancements

4.0 FUNCTIONAL ENHANCEMENT

The OilMWindows software has function enhancement features that can be added on the instrument for specific applications. These features are:

• **PinPoint and PinPoint PLUS Database Software** - A fundamental data base program and report generator based on the Joint Oil Analysis Program (JOAP) operating requirements. PinPoint has the capability to store, sort, retrieve, perform statistical analysis and set alarms for spectrometric data.

• **Conductivity (TCT) Analysis** – A measurement that provides the user with the capability of simultaneous determining the thermal breakdown of the oil while analyzing the wear metal and contaminant concentrations.

4.1 ACTIVATING FUNCTIONAL ENHANCEMENT FEATURES

The function enhancement features are application dependant and exist in all instruments. However, they are not active unless ordered with the instrument when it was initially produced. These features can also be activated through a security dialog that is instrument specific. If at any time one or more of these features is desired, contact the Spectro Incorporated field service department for a quotation. Once ordered Spectro will provide you with instructions how to activate the feature of your choice.

4.2 PINPOINT AND PINPOINT PLUS

The Spectroil M database software PinPoint combines the operating functions of the spectrometer with a database capability to develop and maintain analysis data for any mechanical system. This function provides the capability to export analytical results from the spectrometer to an integral software program for record keeping and analytical data evaluation.

This software feature has two configurations, PinPoint or PinPoint PLUS. The only difference between these two configurations is that the PinPoint configuration records the analytical results in integers or whole numbers while PinPoint PLUS records the analytical results in decimal values. This section will provide a detailed description of the function and capability of this software feature.

Before this software feature can be used, it must be activated within the Windows® operating system. If PinPoint was purchased as an option at the time the spectrometer was initially configured and calibrated, it will already be active and ready for operation. If PinPoint was not originally purchased with the instrument, it can be activated at any time with the assistance of the Service Department of Spectro Incorporated. To activate this database function, follow the steps described in section 4.1.1 and 4.1.2.

4.2.1 Setting-up Databases / PinPoint

The analysis program screen, Figure 4-1, is the base of the Spectroil spectrometer operating software. All routine analytical functions such as sample analysis, standardization, averaging, printing, and data transmission etc. are performed from this screen. In addition, the top menu bar provides standard Windows® conventions for easy access to System, Program, Operation, and Database functions. PinPoint is a database function.

The Database drop down menu is used to access and expand the use of the PinPoint software. To activate the PinPoint software, move the cursor and highlight PinPoint from the databases drop-down menu. Highlighting the PinPoint selection for about a second will cause the sub-menu selections pull down menu to appear. This sub-menu displays additional functions which will be described in the next nine sections.

4.2.1.1 Databases/PinPoint / ON (OFF)

If PinPoint is already active (or ON), the first option that will appear is OFF. Highlighting this selection and releasing the left mouse key will turn the PinPoint capability OFF. Turning PinPoint software ON and OFF will be a routine function for day to day operation because all spectrometer functions such as standardization and profile are performed with the PinPoint software turned OFF. Figure 4-2 provides an example of the Databases and PinPoint sub-menu selection.

When the PinPoint software is ON a red banner with PinPoint DATABASE will appear across the top of the screen. When PinPoint is OFF, the banner does not appear Figure 4-3 provides an example of the analysis program screen when the PinPoint software is on and active.

Prior to using the database, it is necessary to generate two record files that can be used with analytical data from the spectrometer. These are the 'Units' files and 'Limits' file. It is practical to create the 'Units' files first, because this file name will be required in order to complete a 'Units' record.

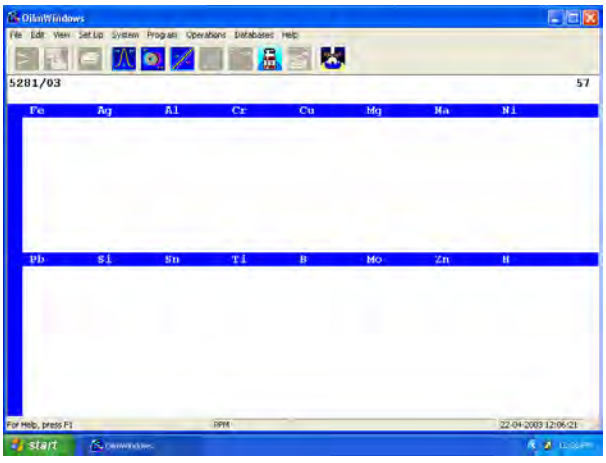


Figure 4-1, OilMWindows Analysis Program Screen

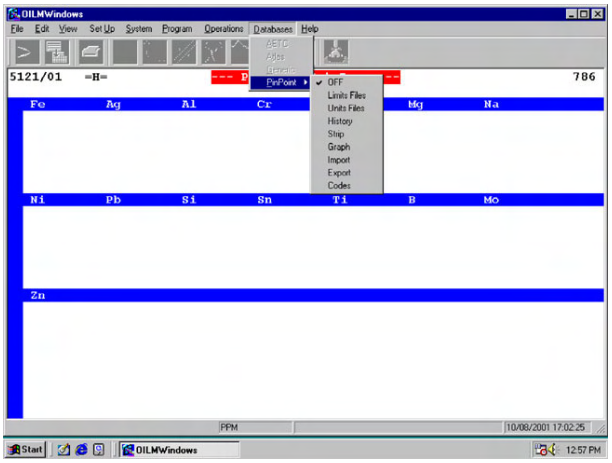


Figure4-2, PinPoint Database Pull Down Menus

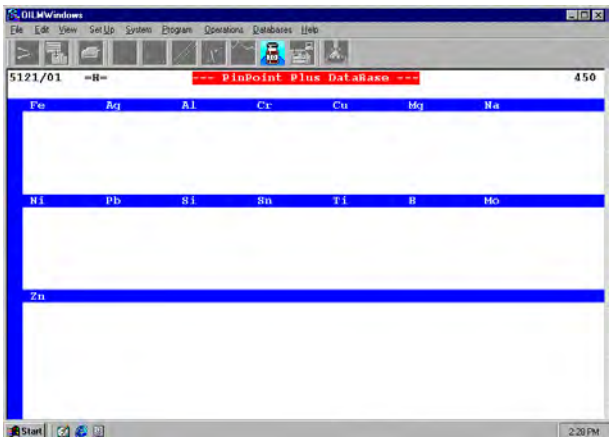


Figure 4-3, Analytical Screen with PinPoint Enabled

4.2.1.2 Databases/PinPoint /Limits Files

Select LIMITS from the PinPoint sub-menu. A dialog will appear that will list all LIMITS files that are currently in existence. A LIMITS file name can be as many as 10 characters, but it is recommended that the name be restricted to the least amount of characters necessary to identify the file. In general, the limits file is the same as the unit type it is associated with, for example a limits file for a F100 engine may be called F100. If a 'Limits File' already exists, these names will be displayed in the 'Select Limits File' window. The user can modify an existing file by highlighting the name and selecting the open button. The file can be modified and then a new name can be assigned using the SaveAs button on the dialog. Figure 4-4 below is an example of the Select Limits File dialog.

NOTE: LIMITS files can not be deleted from the Select Limits File dialog. To delete an obsolete LIMITS file, the operator must use the Windows® Explorer utility. LIMITS files can be found in the C:\Program Files\OilMWindows\Limits path.

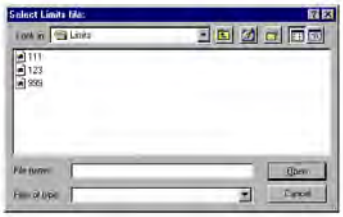


Figure 4-4, Select Limits File Dialog

Once the Limits folder is open and the LIMITS files are displayed in the right segment of the Windows® Explorer, simply highlight the file to be deleted and choose the Delete icon to move it to the Recycle Bin. Emptying the recycle Bin will permanently delete this file.

LIMITS VALUES- Once a LIMITS file has been selected from the dialog above, the Limits Value dialog will appear. Figure 4-5 is an example of the Limits Values Dialog for LIMITS file 999. The Limits Value dialog contains trend limits, element limits (normal, marginal, and high), and the graphics display page number for each element in the analytical program. A description of each field is given below:

- **Trend**- The rate of increase or decrease calculated in PPM/Hours.
- **Normal High Limit**- The highest allowable ppm value of the normal operating range.
- **Marginal High Limit**- The highest allowable ppm value of the marginal operating range.
- **High of High Limit**- The highest allowable ppm value of the high operating range.
- **Graphics Page**- The page, or order, this element will appear when GRAPH is selected.

To enter values for each element, place the cursor in the appropriate field and type the numeric value for that field. Pressing the TAB key will shift the cursor from the existing position to the next position in this table. When all data has been entered, the file must be saved.

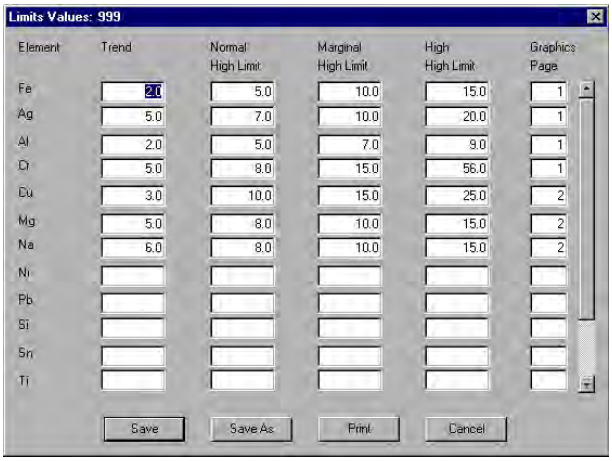


Figure 4-5, Limits Values Dialog

For military systems, these limits come from the JOAP T.O. but for commercial units, these limits may be supplied by the unit manufacturer or developed by the user.

The user can select the Save button if this is a new limits file, or the SaveAs button if an existing file has been modified from an existing file. If the SaveAs button is selected, the Select Limits File dialog above will reappear providing the ability to enter a new limits file name in the File Name field.

NOTE: There is no extension attached to this file, therefore the Files of Type will always appear blank.

A Print button is provided to make a hard copy of this record

4.2.1.3 Databases/PinPoint /Units Files

This dialog is used to enter a new or modify an existing unit record. Figure 4-6 is an example of the Select Unit Record dialog. In most cases this record is uniquely identified by the serial number of mechanical system (unit) being analyzed. To enter a new units file, the following fields must be complete. Pressing the TAB key will shift the cursor from the existing position to the next position in this table.

• **Unit (Serial) Number**- The manufacturers serial number of the mechanical component.

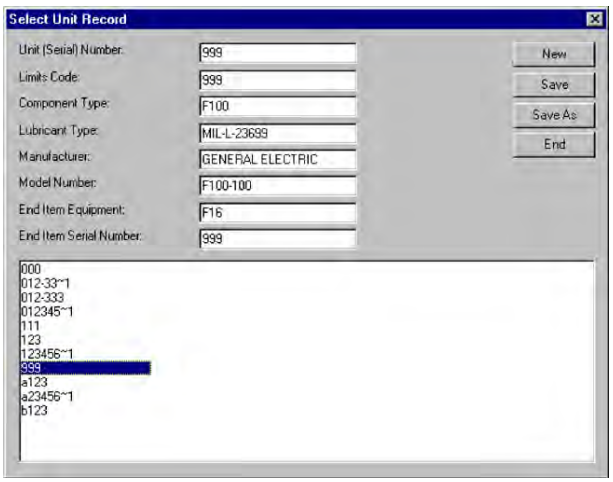


Figure 4-6, Select Unit Record Dialog

• **Limits Code**- The Limits Code containing the operating limits for this component.
• **Component Type**- The component name or make, such as turbine engine or F100.
• **Lubricant Type**- The type of lubricant that is used in this component.
• **Manufacturer**- The manufacturer of this component.
• **Model Number**- The model or version of this component.
• **End Item Equipment**- The type of equipment this component is installed into.
• **End Item Serial Number**- The serial number of the equipment this unit is installed into.

Once all fields have been entered, the Save button will store the record permanently and the unit number will appear in the list at the bottom of this dialog. To modify an existing record, highlight the record name within the 'Select Unit Record' window and double click the left mouse button. The information for the selected unit will be displayed in the fields above. TAB through the fields and make whatever changes are necessary then choose Save to make the changes permanent for that unit number. To modify an existing record for a similar system, change the unit number and any other fields as required then Press Save As to permanently save the changes without changing the original unit record.

To exit this dialog, choose the End button.

NOTE: UNITS files can not be deleted from the Select Units Record dialog. To delete an obsolete UNITS file, the operator must use the Windows® Explorer utility. UNITS files can be found in the C:\Program Files\OilMWindows\Units path. Once the Units folder is open and the Units files are displayed in the right segment of the Windows® Explorer, simply highlight the file to be deleted and choose the Delete icon to move it to the Recycle Bin. Emptying the recycle Bin will permanently delete this file.

5.2.1.4 Databases/PinPoint /History

This dialog is used to review and/or edit the chron-

ological history of a selected unit file. Selecting this feature will result in a Select History dialog appearing. If present, all existing unit files will be displayed at the bottom of the dialog. Highlighting and double clicking the left mouse button will open the file where the unit information will appear along with the quantity of records that are currently stored in history. The dates of the first history record and the last history record are also displayed. Figure 4-7 is an example of the Select History Record dialog.

Once the unit file has been selected, choosing the OK button will display all of the history for this unit. Figure 4-8 is an example of the history file for the selected unit number 999.

A header will appear above the unit history containing the Unit ID, the Limits Code associated with this component, the Lubricant Type, the component Manufacturer, the Component Type, the Model Number of the component, the Date and Time Modified of the last history record, the End Item Equipment Number and Serial Number and the serial number of the instrument the record was originally Created on and last modified on. An infinite number of analyses can be stored for any one unit, but in reality, history greater than the last 20 measurements is insignificant to the condition of the unit, unless of course the measurements are being taken with very short intervals.

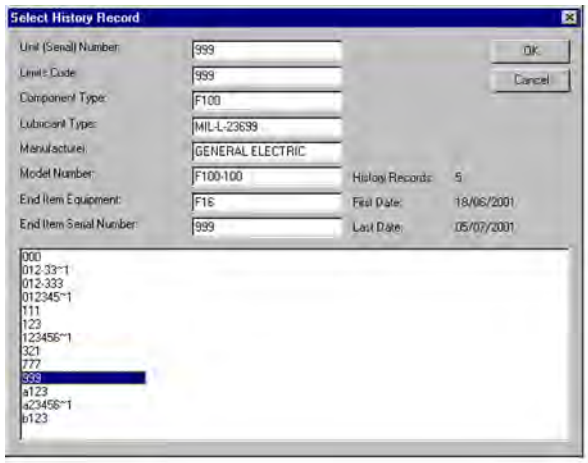


Figure 4-7, Select History Record Dialog

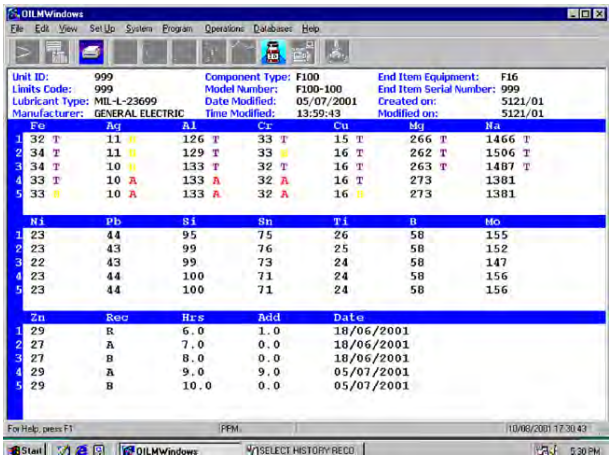


Figure 4-8, History Record Dialog

History records can be either deleted from this dialog, or edited on this screen. To delete one measurement from history at a time, simply place the pointing device on the measurement to be deleted and single left click the mouse button. The measurement selected will become highlighted in a black background. Once highlighted the measurement can be deleted permanently from history by pressing the DELETE key on the keyboard.

History records can also be edited in the event an error was made during the sample ID entry. To edit a measurement that is stored in history, place the pointing device over the measurement and double click the left mouse button. A dialog will appear and will provide fields for all data in the measurement. Edit the field/s that are in error and choose the OK button. Figure 4-9 is an example of the Edit History Record dialog for measurement 3 in the History Record dialog in Figure 4-8. Once the changes have been made exit this dialog by choosing the OK button.

Anytime history is edited, a dialog will prompt

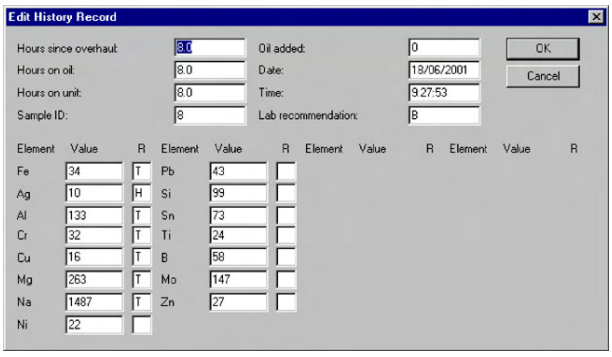


Figure 4-9, Edit History Record Dialog

you to re-evaluate the data after the changes have been made. It is always recommended that automatic data re-evaluation be performed

4.2.1.5 Databases/PinPoint /Strip

The STRIP function is intended as a housekeeping function to clear unwanted data from the database. History beyond a reasonable time period is no longer of any value in predicting the integrity of a mechanical system, especially if an overhaul of the component has been performed. To remove old history the STRIP function is used.

This feature permits the operator to choose how many records should be kept to view history numerically as well as graphically. The STRIP function retains the number of records entered in the Records to retain field. The value entered in the Records to retain field can not exceed the History Records value.

If ALL is selected, all unit files will have their history striped to the value entered in the Records to retain field. Figure 4-10 is an example of the "Select all records to strip" dialog.

4.2.1.6 Databases/PinPoint /Graph

The GRAPH function allows the user to view the history of a unit and graph each elements concentration versus time in PPM/Hrs. This graphic capability provides a visual indication of the concentration of each element respective to the acceptable limits and provides a trend line to represent the direction the concentration is taking.

To graph the history of a Unit file, place the pointing device on the unit to be graphed and double click the left mouse button to highlight the Unit file and the specific information for that unit will appear along with the number of records in history. Choose the OK button will prompt a second dialog to appear. Figure 4-11 below is an example of the Select History Record dialog for graphing.

Once selected, a second dialog called the Graph Parameters dialog will appear, Figure 4-12. This dialog provides options to display one element per page, two elements per page, four elements

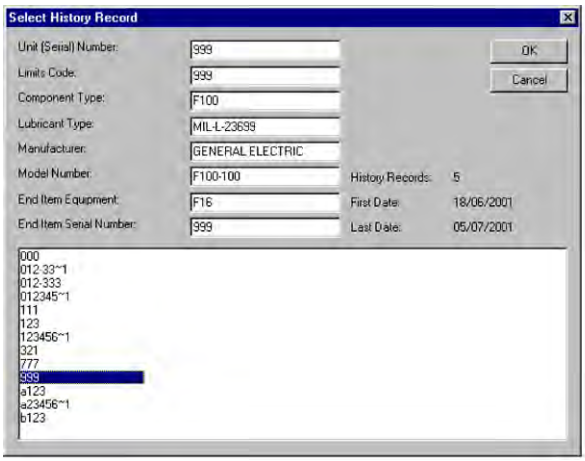


Figure 4-11, Select History Record for Graphing

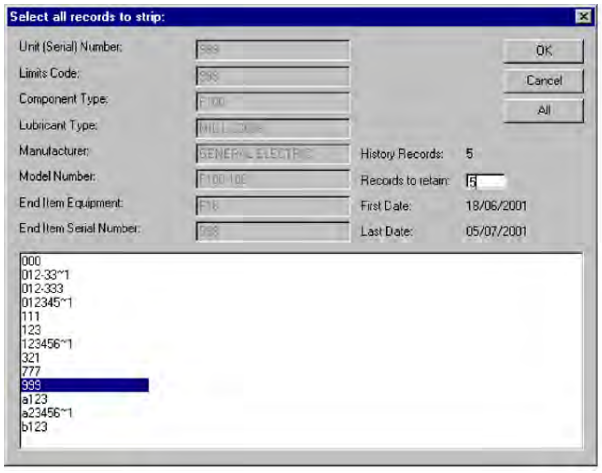


Figure 4-10, Select All Records to Strip Dialog

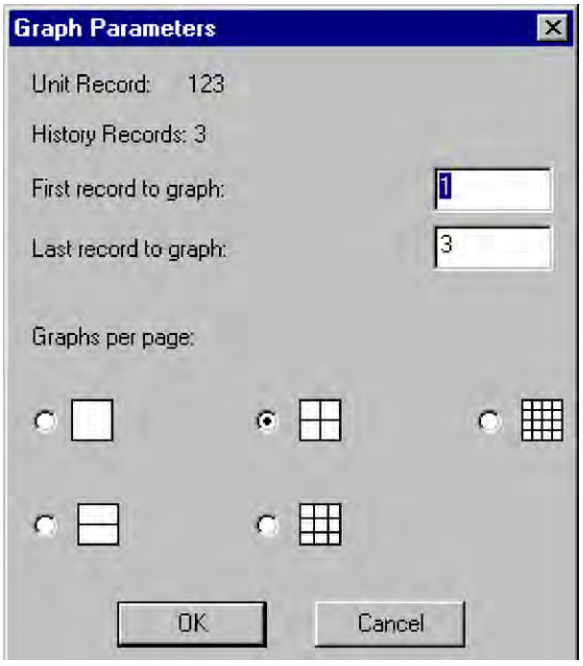


Figure 4-12, Graph Parameter Dialog

per page, eight elements per page or sixteen elements per page. Highlight the display pattern of choice.

The software will automatically offer to graph the first to last sample in the history file. If the history file is large, the resolution of the graphics may be insufficient to obtain a good visualization of the trend over time. Choose the first and last record to graph. Ten samples provides a good graphic representation of wear trends. When both choices have been made, choose the OK button and the software will display the graphs of the elements in the order you have determined they should be displayed in the LIMITS file.

Choosing the OK button after the Graphs per page and graphing range has been selected will result in a graphic display of the first elements designated in the LIMITS file for this unit. Figure 4-13 is an example of a typical graphic plot of the first four elements.

Press the PAGE UP and PAGE DOWN keys on the keyboard to move between pages of element graphs. Pressing the Print Icon will print these graphs for your records.

Each element is graphed with the hours on unit on the horizontal or 'x' axis versus the concentration on the vertical or 'y' axis with respect to the high, marginal, and normal ranges indicated by red, yellow, and green respectively. A trend bar in white will appear through the data points to indicate slope of the trend. These limits are derived from the data entered in this unit's 'Limits' record.

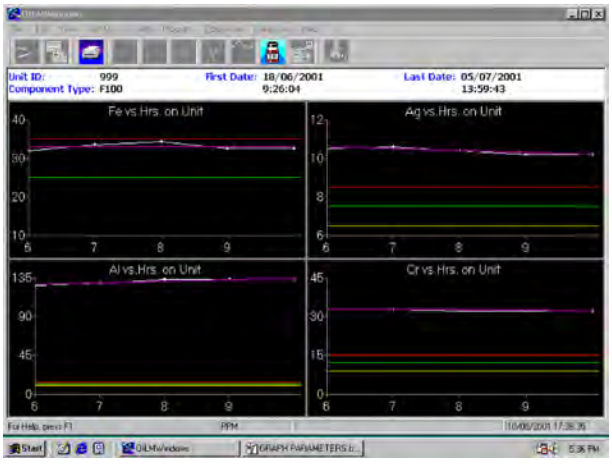


Figure 4-13, Graph Display

To exit the GRAPH feature choose VIEW / ANALYTICAL RESULTS / PPM to return to the HISTORY record for the unit graphed.

4.2.1.7 Databases/PinPoint /Import

This software feature permits the migration of unit records from one Spectroil M spectrometer to another Spectroil M spectrometer both having the OilMWindows® software and PinPoint® database software. This is particularly useful when aircraft go on deployment where their oil analysis records can travel with the aircraft and be updated while on deployment with a second instrument.

Selecting the IMPORT function will result in a dialog that permits the operator to select where the unit records to import are currently stored. In most cases the files will be on removable media such as a 1.44 Mbytes floppy, 120 Mbytes Super Disk or a Zip Disk.

Listed below in Figure 4-14 is an example of the Files to Import Dialog, In this dialog, navigate through the Look In field to locate the removable media that contains the files to import. In most cases these will be found in removable media 31/2 Floppy (A:) or drive (D:).

Once the files are located on the removable media, they must be highlighted as a group or indi-

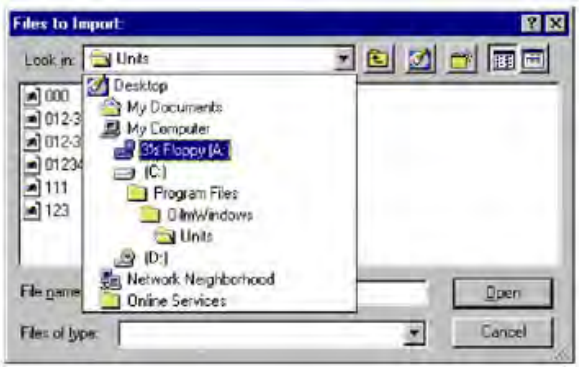


Figure 4-14, Files to Import Dialog Selecting the Source of Files to Import

vidually by single clicking the left mouse button. Each file selected will appear in the File Name field with quotations. Selecting the Open button on this dialog will copy the selected files from the removable media to the Units folder in OilMWindows where they will appear when PinPoint / UNITS is selected. Figure 4-15 is an example of highlighting the files to import.

4.2.1.8 Databases/PinPoint /Export

This software feature works very similar to the IMPORT function but permits the exportation of unit records from one Spectroil M spectrometer to another Spectroil M spectrometer both having the OilMWindows® software and PinPoint database software. This feature can also be a means of backing up the history of units.

Selecting this feature will result in a Export Destination Directory dialog that will require the operator to designate which removable media the unit records are to be exported to. Again, in most cases the drive designations will be either (A:\) or (D:\). Figure 4-16 is an example of this dialog.

Choosing the OK button will produce the Export Files Dialog. Select the files by highlighting them individually or together for export to the removable media. Choosing Open will copy these files to the removable media drive chosen in the paragraph above. Figure 4-17 is an example of the Export Files Dialog.

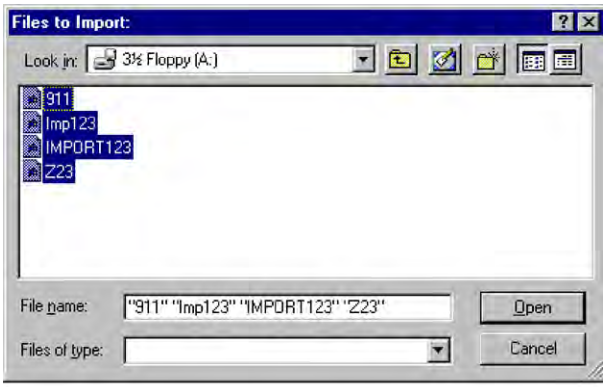


Figure 4-15, Selecting Files to Import

Figure 4-16, Files to Export Dialog Designating the Destination of the Files to Export

4.2.1.9 Databases/PinPoint /Codes

This dialog provides the capability to develop alpha designations and a brief description of each alpha maintenance recommendation code. These codes and descriptions will automatically appear and must be used to complete each sample analysis. Figure 4-18 is an example of maintenance recommendations and their associated codes.

4.2.2 Routine Operating Instructions for PinPoint and PinPoint PLUS Software.

This section will describe the normal operating steps required to use the PinPoint software. This description assumes that LIMITS files, UNITS files and CODES have all been completed. Data collection into the PinPoint database is automatic if PinPoint is selected as 'ON' from the database menu and the red banner appears across the top of the screen. If is does not, refer to the paragraph PinPoint / ON (OFF) above. The red banner must appear across the top of the screen as shown in Figure 4-8 in order to use the PinPoint database.

SAMPLE ID (Identification)- Once the PinPoint database is active or (ON), the only two icons that are active are the print icon and the sample identification icon. To make an analysis of a sample, left click the

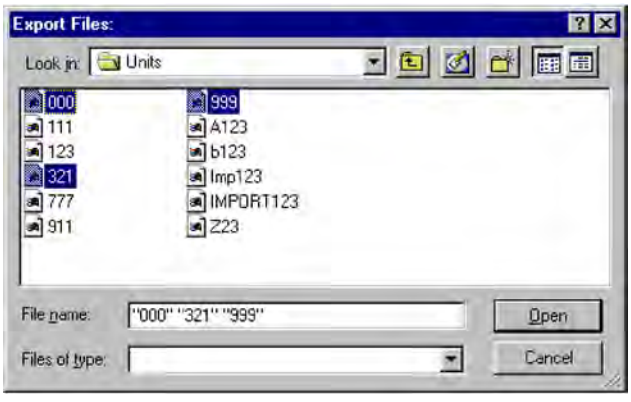


Figure 4-17, Export Files Dialog

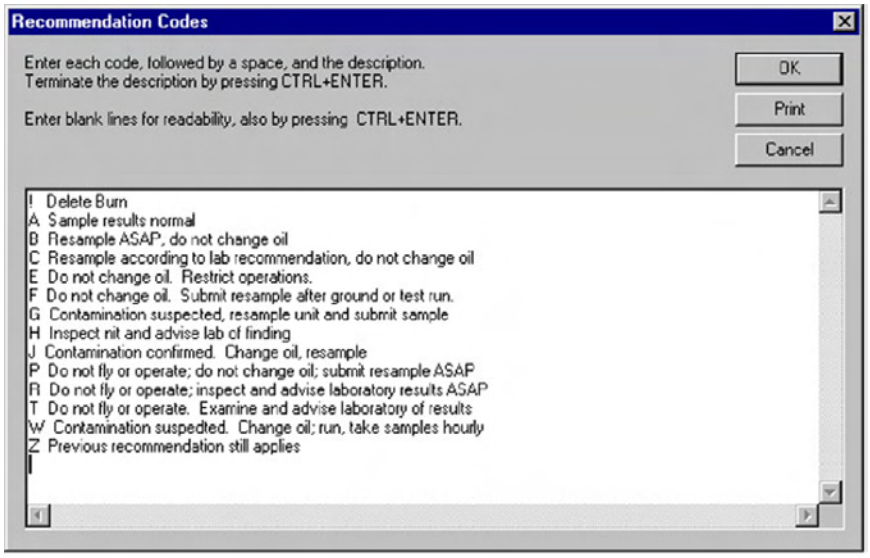


Figure 4-18, Recommendations Codes Dialog

SAMPLE ID icon. This will display the SAMPLE ID dialog. The sample identification dialog contains six fields. Listed below is a description of each field. Figure 4-19 provides an example of the SAMPLE ID ENTRY dialog.

SERIAL NUMBER- This is the serial number or unit number that appears in the UNITS file. If a unit serial number has history that already exists, the numbers that appear under each field are the last values entered. For example, for unit serial number 999, the last hours since overhaul was 8.0, hours on oil was 8.0, etc. If this is the first time a sample is to be analyzed for a new serial number, a number will appear in parenthesis and this value is the maximum digits permitted for this field

HRS OVERHAUL- This is the hours on the component since it was overhauled.

HRS ON OIL- This is the time in hours since the last oil change. **HOURS ON UNIT**- This is the total hours on the unit since manufactured. **SAMPLE #**- This is a unique identifier for this sample.

OIL ADDED- This is the amount of oil added since last sampling.

Once the sample identification entry has been completed, choose the OK button. This will cause the software to retrieve the history for this unit serial number, if it exists, and display it on the screen as shown in Figure 4-8

Using standard operating procedure, load the sample stand with electrodes and the oil sample to be analyzed. Press the START button on the operators control panel or the BURN icon on the screen and the analysis of the sample will begin. The progress bar dialog will display the Preburn

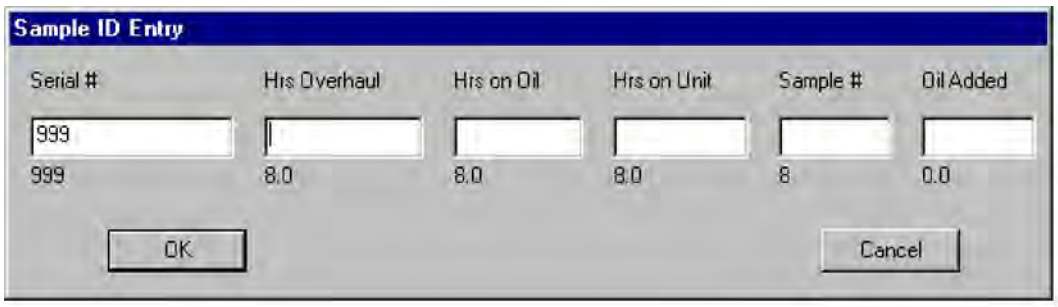


Figure 4-19, Sample ID Entry Dialog

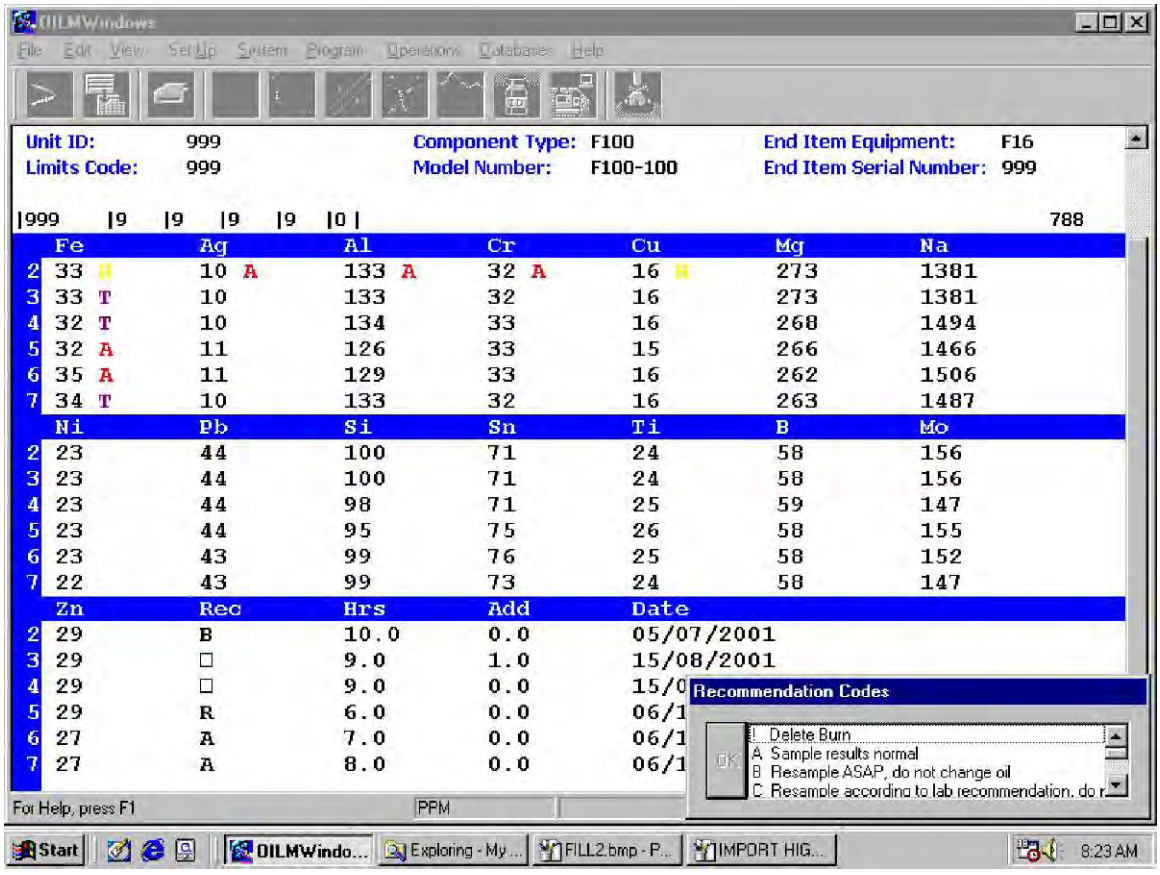


Figure 4-20, Recommendation Codes Dialog

and Measure times as the analysis is performed.

Upon completion of the analysis cycle, the analytical results for this sample will be displayed under the previous history and automatically, the recommendations dialog will appear. Under the column Rec. will be a square waiting for a recommendation letter to be assigned. Choose the letter that is appropriate with the recommendation language and either type that letter or place the pointer and left click the line to highlight the recommendation. Press the ENTER key on the keyboard or left click the OK button on the recommendations dialog to complete the analysis. Figure 4-20 is an example of the analysis waiting for the recommendation code to be assigned.

Once the recommendation code is assigned, once again the only two icons available are PRINT and SAMPLE ID. Repeat the procedure above to enter the next SAMPLE ID.

4.3 CONDUCTIVITY

The conductivity feature of OilMWindows provides the user with the capability of simultaneous measuring the thermal breakdown of the oil while analyzing the wear metal and contaminant concentrations. Thermal breakdown of the oil is an important parameter in gas turbine engines and some internal combustion systems. This feature requires that additional hardware be added to the Spectroil M either when the instrument is initially produced or upgraded in the field.

This capability is commonly referred to as the tandem conductivity technique (TCT) and this section of the manual will describe the hardware for the system. A complete and separate manual for the TCT system description and operation is available from Spectro Inc.

4.3.1 Introduction

Aircraft engines can sometimes experience a bearing failure as a result of lubricant starvation due

to scavenge tube blockage by heavily coked oil. Oil samples prior to, and after the problem initiation, usually exhibit a blackened appearance and burnt odor. The condition has been called "Burnt Oil".

The DOS or Windows® versions of the Spectroil M/N or M/C Oil Analysis Spectrometer equipped with the optional TCT technique can detect this condition so that corrective action can be taken prior to a major failure.

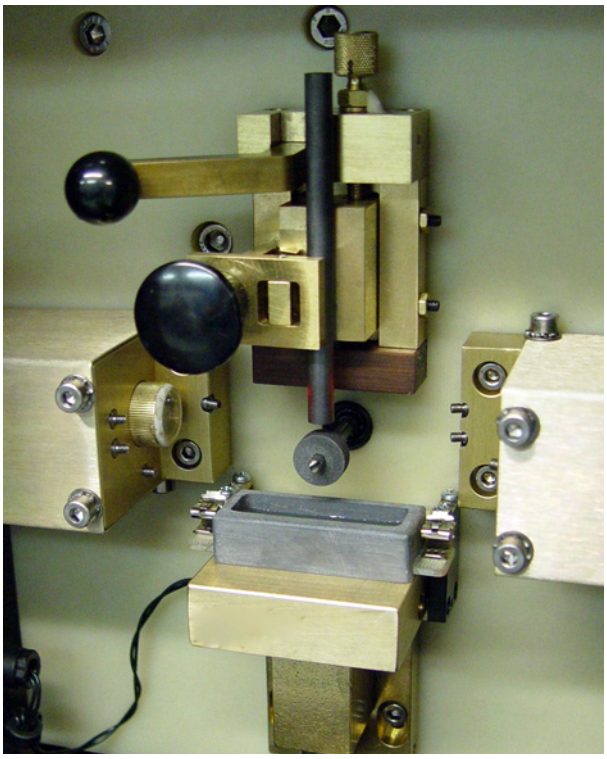
The Spectro TCT consists of a hardware and software upgrade to the standard Spectroil M/N or M/C. It can be installed in new spectrometers prior to delivery, or as an upgrade in the field to an existing Spectroil. The conductivity feature of the Spectroil M/N or M/C provides the user with the capability of simultaneously measuring the thermal breakdown of the oil while analyzing the wear metal and contaminant concentrations. The Tandem Conductivity Technique (TCT) performs a conductance measurement on a used oil sample to measure thermal breakdown. Conductance or (Electrochemical Conductivity) is defined as the ability of a substance to conduct electrical current, the reciprocal of resistance.

Conductance measurements of oil provide values proportional to the magnitude of oil degradation. A calibration is created using a precise zero baseline using a clean sample, and a known sample of specific degraded qualities. With this calibration, an unknown sample can be evaluated for deviation from the base line. Deviation is indicative of thermal and oxidative stressing of the oil.

4.3.2 Background

The Tandem Conductivity Technique (TCT) was developed initially to help in early detection of "burnt oil" in F100-PW-100/200/220/229 engines. TCT is based on a technique developed by the University of Dayton and Wright Laboratories, WL/POSL** and integrated into the Spectroil as an operational system by Spectro Inc.

* Centers, Phillip, Costandy Saba, James Wolf, "Tandem Technique for Fluid Testing", University of Dayton Invention Disclosure #205.

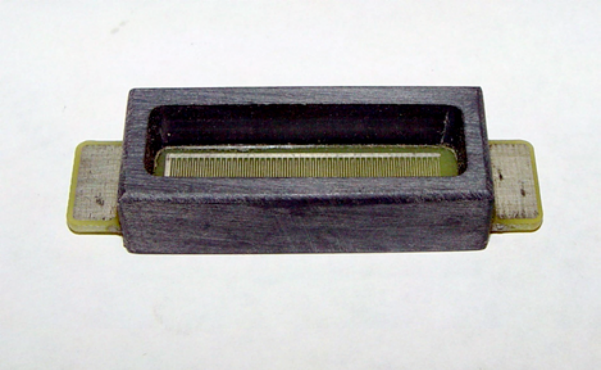


4-21, TCT Sample Holder in TCT Sample Table

4.3.3 The TCT System

The Spectroil M/N or Spectroil M/C spectrometer sample table, Figure 4-21, is modified to incorporate the electrical connection of a TCT sample vessel. When the sample table begins it's travel in the upward or raised position, a spring loaded subassembly of the sample table lowers the spring contacts to engage the sample vessel tabs. The spring contacts compress on top of the tabs until the extension spring tension of the subassembly comes to equilibrium. This keeps the spring load of the contacts pressing on the tabs for good electrical contact as the table continues to be raised to the full indexed position for spectrometric measurement. The electrical wires are routed through insulating blocks on either side of the table.

The sample vessel, Figure 4-22, contains a sensor designed for high sensitivity. It uses coplanar electrodes of highly conductive copper with a large surface area sheathed in a protective alloy material and mounted on a non-conductive substrate. The sensor covers a rectangular area about 4 cm^2, with electrodes that are about 300 micrometers in

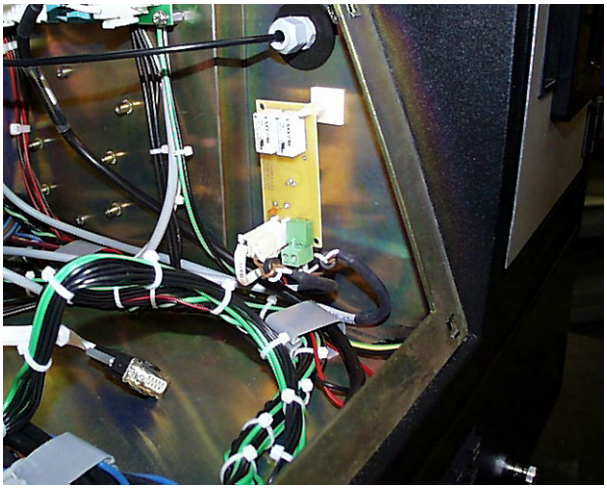


4-22, Sample Holder for TCT Analysis

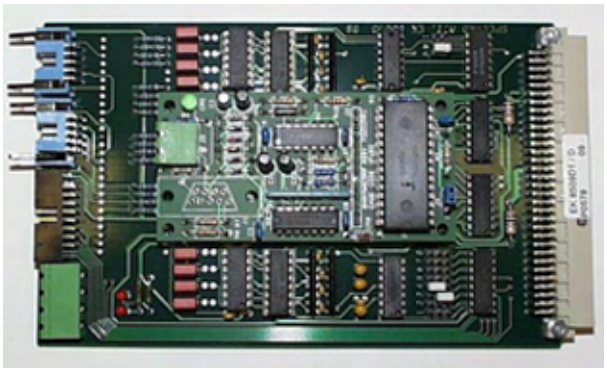
width and positioned very closely so that the distances between them are on the order of half their width. Any small changes in the conductance of the oil sample can be easily detected. The electrodes are connected to a circuit where the signal is amplified, integrated and displayed at the end of a normal spectrometric analysis.

The sample table is connected through the sample compartment bulkhead to a relay card, Figure 4-23. The relay card provides the TCT circuitry with electrical isolation during the sample burn process. The relay card is powered from a connection to the interlock monitor and power board. There is a signal cable connection on the card that connects to the TCT circuit board.

The TCT circuitry is located on the TCT circuit board, Figure 5-24, which is mounted onto the second integrator board of the spectrometer electronics. The TCT circuitry generates a waveform that is transmitted through grids in the sample



4-23, TCT Relay Card



4-24, TCT Circuit Board M56100

vessel. This waveform is then received on the other set of grids in the sample vessel. Through an amplification and comparative process, a conductivity voltage is generated. This voltage is then interpreted through the spectrometer analog to digital converter and read by the software.

4.3.4 TCT Benefits

TCT, when integrated with the Spectroil, provides a one step solution for the analysis of wear metals, contaminants and sample conductivity in a used oil sample. The combination of the two tests, wear metals and "burnt oil" into one test reduces equipment needs, training, maintenance, and time.

Key features of the TCT are:

- Provides early detection of "Burnt Oil"
- Conductivity measurement is part of routine spectrometric analysis output data
- Adds only 4 seconds to analysis time
- Replaces the COBRA analysis
- Can be installed as a field upgrade