

## Appendix 5

### **INTRODUCTION**

The 289H Loop Surveillance System (LSS) differs from older monitoring systems in a number of important ways. To appreciate the usefulness of PressureMAP diagnostics in servicing the 289H LSS monitor, it helps to understand some of those differences.

Conventional monitoring systems were designed before the advent of computerized management systems, such as PressureMAP. These conventional monitors were designed to be stand-alone units. They had to be both the brain and the brawn of the monitoring system; each unit had to contain all of the computing and data storage capability required to monitor its offices. Since a monitor for a single office spends most of its time doing the relatively simple work of scanning devices, the higher computing functions of each unit are idle most of the time. In terms of a loop surveillance system, with one monitoring unit per office, this means that there is a tremendous amount of redundant capability and additional service costs inherent in maintaining the extra hardware.

### **FUNCTIONAL OVERVIEW**

The idea behind the 289H Loop Surveillance System was to build the most simple and maintenance free monitoring units possible. This was accomplished by utilizing the computing and data storage capabilities of the PressureMAP computer so it could accomplish most of the functions that were usually performed by each monitoring unit. PressureMAP became the brain of the system. That meant the individual monitoring units could become relatively simple information gathering devices. PressureMAP's high power computers cannot only perform the computing functions better and faster than the old monitoring units, but they can perform these functions for as many as 250 separate units (with office extender licenses). So, by working in tandem with the PressureMAP system, the 289H LSS provides higher performance with no internal programming or backups to perform. The natural result of a simpler machine is that less maintenance and service are required compared to the old, more complicated monitoring units.

The simplicity of the 289H LSS monitors also allows them to be extremely versatile. Virtually any kind of monitoring device, with the exception of addressable transducers, can be monitored by the 289H. The 289H works with three types of relay cards: subscriber, dedicated and Sparton Dedicated Replacement Card (SPDR). It can communicate with PressureMAP using either a modem or network connection, depending on the type of controller card installed in the 289H. The standard Controller Card equipped with on-card modem communicates at 2400 or 9600 baud via a proprietary System Studies Incorporated communications protocol that employs error correction. The LAN Controller Card utilizes a 10 Base-T Ethernet connection. Both of these communication modes minimize connect time which will in turn considerably reduce the work load on PressureMAP.

Operationally, the 289H LSS works much like conventional monitors, except that it leaves many of the data conversion and data analysis functions to PressureMAP, and does not require redundant programming. The 289H LSS continually scans devices, gathering readings and storing data, until PressureMAP calls to upload the latest information. The MAP software then converts the device data readings to pressure readings, flow readings, temperature readings, etc.

If the device being queried is on a subscriber line, the 289H LSS checks the pair to see if the line is busy. If it is not busy, the 289H LSS takes a reading. If it is busy, the 289H LSS skips that line until the next polling cycle.

### ***Types of Calls Placed Through PressureMAP***

There are three main types of calls placed to the 289H LSS through PressureMAP. The most common is the scheduled call. PressureMAP calls the 289H LSS every two hours to obtain a full report of all monitoring devices. During these calls, PressureMAP will check the device programming. If it is found that the 289H LSS lacks data for a particular device, that device data will be downloaded from PressureMAP. This procedure eliminates the need to ever do a backup or restore on the 289H LSS monitor. The second type of call is for realtime readings, and the third type is for performing diagnostics.

In addition to the three types of incoming calls, the 289H will also initiate a call to PressureMAP if it detects a potential alarm condition. For example, if one or more device readings exceeds the alarming parameters that have been established by the user, the 289H LSS will immediately contact PressureMAP. The software then analyzes the reading(s) and sends out an appropriate dispatch if one is warranted.

### ***Line Testing***

Unlike other cable pressure monitoring units, the 289H LSS also performs several unique line-testing functions. When the 289H LSS detects an open on a pair, it will determine whether the open is inside or outside the CO. The 289H LSS also checks for foreign voltage on the pair, with a threshold of 10 VDC and/or 6 VAC setting the "VOLT" bit. If the 289H LSS is corrupted and fails to answer the telephone, it will be automatically reset after three calling attempts, or six rings of the phone.

Despite the simplicity and self-correcting attributes of the 289H LSS monitor, there are times when a user might want to analyze how the 289H LSS is set up, or run a particular diagnostic test. The 289H LSS diagnostics program provides for such internal monitoring with the following reports and tests:

- System Configuration
- Calibration Test
- Realtime Reading Test
- Specific Device Information
- Capacitance Test
- Ping Relays Test
- Cold Reset
- Leakage Test
- AC Voltage Test
- DC Voltage Test
- Pair Diagnostics
- Dialout Phone Number Information
- Device Alert Information
- Access Number Translations (if capability is enabled)
- Get Tone Settings
- Set Tone Default
- Route Tone

The procedures for running these tests, and explanations of the results, are presented later in this section. Charts at the end of this section provide conversions from milliamperes to the corresponding device reading value, and the equivalent information for resistive devices.

**Note:** Some of the option listed above may not be available, depending upon the version of PressureMAP being used. Explanations in this appendix pertain to Version 26 and above.

Please note also that a Pair Diagnostics report for a 289H LSS-monitored device may be generated via PressureWEB™. The report provides the following output: Voltage DC (Tip/Ground and Ring/Ground), Voltage AC (Tip/Ground and Ring/Ground), Resistance (Tip/Ring Ohms, Tip/Ground Ohms, Ring/Ground Ohms), and Capacitance.

### **289H Board Numbering Conventions**

Each monitored device in a loop surveillance system is attached to a pair of conductors, called a device pair, which is terminated at a connector block in the central office. From the block the electrical connection to the 289H monitor is completed using a connector cable, which plugs directly into a relay board installed in the chassis. There are three types of boards used with the 289H LSS: subscriber, dedicated and Sparton Dedicated Replacement Card (SPDR). The Subscriber Relay Card accommodates up to 25 device pairs; the Dedicated Relay Card accommodate a maximum of 50 dedicated device pairs; and the SPDR can read up to 36 devices wired to a Telxon dedicated block.

Each 289H chassis has 16 relay board slots, which are designated as Card 1, Card 2, etc. Understandably, a board in the fifth slot is designated as board number five, and the device pairs connected to it are numbered sequentially beginning with the number one. Each device in the PressureMAP database is referenced by specifying its board/pair identification. For example, device 10 on the eighth relay card would be Device # 008-10. (More detailed information on device/access numbers is available in Section 4 of this manual and the 289H Device Data section of the *PressureMAP System Data Entry Manual*.) In addition to the individual relays on a board, which the 289H uses to initiate readings on device pairs, the dedicated and subscriber boards both contain a calibration resistor. For purposes of calibration, the resistor represents device 26 on a subscriber board and device 51 on a dedicated board.

The 289H's Controller Card has two limits relative to the size of the system: 1) each controller can address a maximum of 1000 devices on dedicated and subscriber pairs; 2) those 1000 devices can be arranged on a maximum of 32 boards. Since each 289H LSS chassis can accommodate only 16 boards, two chassis would be required: a primary chassis and an expansion chassis.

### **PROCEDURES FOR THE 289H LSS DIAGNOSTICS TESTS**

Before you can begin working with the 289H Diagnostics programs, you must first bring PressureMAP's *289H Diagnostics Menu* to your screen. The following procedure explains how to do that. The Menu Level assigned to your User Account will determine where you start in this procedure. If you entered at the *System Options Menu*, begin this procedure at Step 1. If you began at the *MAP Programs Menu*, go to Step 2. If you have trouble gaining access to the MAP System, please contact your System Administrator or call the System Studies Technical Support Department.

```

System Options                                MAP Series XX.XX.XX
01/02/2014  08:43                            System Studies Incorporated
-----
System Options
-----
    1. Select MAP Program
    2. Select MAP Data Entry
    3. System Administration
    4. Language Selection
    Q. Quit

Choice?

```

SCREEN A5-1: PRESSUREMAP SYSTEM OPTIONS MENU

**Procedures:**

If you logged into the *System Options Menu*, you should see SCREEN A5-1 above.

1. From the *System Options Menu*, press **1** followed by **<Return>**. You should then see the screen illustrated in SCREEN A5-2.

**Note:** If the Menu Level assigned to your User Account brought you into the PressureMAP system at a level other than System Options or MAP Programs, you cannot get into the Diagnostics Program. See the definitions of menu levels and quick logins in the introduction to Section 5, User Management, in the *PressureMAP System Administration Manual*.

```

MAP Programs                                MAP Series XX.XX.XX
01/02/2014  12:42                            System Studies Incorporated
-----
MAP Programs
-----
    1. PressureMAP
    2. ReportMAP
    3. CableMAP
    4. AlarmMAP
    5. DryerMAP
    6. CPAMS Diagnostics
    7. User Initiated Operations
    Q. Quit

Choice?

```

SCREEN A5-2: MAP PROGRAMS MENU

2. From the *MAP Programs Menu*, select *CPAMS Diagnostics*. Press **6** followed by **<Return>**. You will then be prompted for the name of the office you intent to work in:

CPAMS Diagnostics for which office?

Selecting an office is done by entering either the office name or office number at the prompt. To enter an office name, type the full name of the office, or enter an abbreviation that represents the desired office.

Abbreviated office names are allowed anywhere within the MAP library of programs and have a minimum length of two characters. For example, if a system has an office: "1. SALT CREEK," then SA, SAL, and SALT would all be legitimate office name abbreviations. As well, if the system also had the offices: "2. WALLINGFORD" and "3. WASHINGTON," then SAL would uniquely specify office 1, WAL would specify office 2, and WAS would specify office 3. Although the abbreviation WA is ambiguous, MAP programs will accept such an office name by choosing the first office that matches the abbreviation; in this case, it would be office 2.

At the office name prompt, you may obtain a complete listing of the offices entered into the PressureMAP system. By typing a question mark (?) followed by **<Return>**, you will be presented with a listing in selection spreadsheet format. Move to the office you wish to monitor, and press **<Return>** to select it.

If you press **<Return>** without entering an office name, you will be taken back to the *MAP Programs Menu* where you can choose to run a different MAP program, or re-access CPAMS Diagnostics.

After inputting an office name or number (in this example, Salt Creek) you will see the message:

```
1. Salt Creek
Calling Salt Creek (baud rate). Hit <Esc> to quit.
```

If the office that you select does not answer, you will see the message:

```
Office does not answer; waiting...
```

Then after about 20 seconds, you will see:

```
Attempting to call again...
```

When the connection is made, you will see a message similar to the following:

```
CONNECT (baud rate).
Collecting configuration information from 289 LSS...
```

### ***The 289H LSS Diagnostics Tests***

The procedures for running the Diagnostic Tests are easy. In most cases, you simply select the test you wish to perform, and the MAP program does the rest. With some of the tests, however, you will need to enter the specific device, access number, or board number that you wish to inspect. After contact is established and the testing is completed, results from the testing are output to the computer terminal (or printer) where you can study the outcome. All test procedures begin at the PressureMAP *289H Diagnostics Menu* illustrated in SCREEN A5-3.

**Note:** Depending upon the configuration of your 289H monitor and the version of PressureMAP you are using, not all of the options shown in the screen below will necessarily display.

```

289 LSS Diagnostics Menu
-----
 1. System Configuration
 2. Calibration Test
 3. Realtime Reading Test
 4. Specific Device Info
 5. Capacitance Test
 6. Ping Relays Test
 7. Cold Reset
 8. Leakage Test
 9. AC Test
10. DC Test
11. Pair Diagnostics
12. Dialout Phone Number Information
13. Device Alert Information
14. Get Tone Settings
15. Set Tone Default
16. Route Tone

Choice?

```

SCREEN A5-3: 289H DIAGNOSTIC MENU

If you wish to step back to the previous menu (for example, if you wish to run tests on a different office), press **<Return>** without selecting a Diagnostics Test. If you do so, the phone connection to the office will be dropped, and you will be at a prompt where you can select a new office and/or test mode.

### System Configuration

Selecting the System Configuration option (by pressing **1** followed by **<Return>**), will display a screen similar to the one illustrated in SCREEN A5-4. This screen displays the current status of the 289H LSS office you have selected. By viewing the data displayed on this screen, you can determine what slots are filled, which boards are in the 289H monitor, and if the 289H is terminating calls correctly.

```

System Configuration for Salt Creek          CPAMS Diagnostics XX.XX.XX
10/23/2013 13:37                          System Studies Incorporated
-----
LSS Engine:   289H LSS                      Version:      G.02/G.02
Password:     Set                          System Reset: No
Exit State:   Wait SOH State                Exit Status:  Normal Termination

Inventory:
  Slot  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
Chassis ---
  1 | SRA SRB SRC SUB SUB SUB DED
  2 |
  3 |
  4 |

Hit <Return> to return to the 289H-M LSS Diagnostics menu.

```

SCREEN A5-4: SYSTEM CONFIGURATION FOR 289H LSS

The key fields displayed on the System Configuration screen are described below:

—*LSS Engine* identifies which type of monitor you are connected to, either a 289H or 289. The original 289 LSS monitor did not have alerting capability, nor did it provide all of the diagnostics functions described here for the 289H LSS.

—*Version #* indicates the Version numbers of the firmware built into the 289H LSS that you are examining. The characters to the left of the slash represent the version of the firmware built into the ROM in the 289H. The characters to the right of the slash indicate the patch level installed in the 289H. Because the firmware can be patched, the 289H can be updated via PressureMAP. Both firmware and patch versions are labeled with alphabetic characters to the left of the decimal point, and the numeric characters, 1 through 99, to the right of the decimal point.

—*Password* is either *Set* or *Reset*. Set indicates that a password is required to enter the 289H, while Reset indicates that a password is not required. Every time that PressureMAP calls the 289H, it sets the password to the one indicated on the *System Information Screen* in the PressureMAP Editor. If there is no password on the System Information Screen, *Reset* will appear in this field.

—*System Reset* is the same as rebooting a computer. The 289H has the ability to reset itself under a number of circumstances, or it can be reset on demand from PressureMAP. A special dispatch is generated whenever the 289H is reset. The *System Reset* field indicates whether the 289H has gone through a reset since the last time the 289H was called.

—*Exit State* indicates the state of the communications protocol when an end-of-session was detected. The normal reading is “Wait SOH State” but a message other than this is not normally a cause for alarm. This is primarily a tool that System Studies personnel use to diagnose a problem.

—*Exit Status* indicates how the last session ended and will usually read “Normal Termination.” It is similar to the *Exit State* field in that it may contain other messages and is primarily intended for System Studies’ use. Normal Exit Status are NORMAL TERMINATION, USER ABORT, and HUNGUP. RETRY EXCEEDED, PREMATURE TERMINATION, RECEIVED DATA, NO RESPONSE, ASYNC PROTOCOL RECEIVED, or DCD LOST may indicate a problem, call System Studies Technical Support if these types of status indicators persist.

OUT OF SYNC or BAD RESPONSE listed in the *Exit Status* field together with no readings indicate a problem. If any of these messages are displayed, please call System Studies Technical Support for assistance.

—*Inventory* is displayed in a table that shows what card type is loaded in each occupied slot in the 289H LSS monitor. SUB designates a Subscriber Card, DED identifies a standard Dedicated Card, and SRA, SRB and SRC represent the three configurations of the Sparton Dedicated Replacement Card (SPDR). Please note that 1) SPDR cards must be placed in the 289H chassis in front of other relay card types, and 2) they must be ordered (configured) as A, B, C, A, B, C, etc.

A blank space indicates that no card is present in that particular slot. UNK is displayed if the card is unrecognized; it indicates that the card is either not seated properly, is possibly defective, or is not supported by the system’s version of PressureMAP. An inventory is taken automatically whenever the 289H is reset.

Please note that the menu's *Chassis* designations (1, 2, 3, 4) represent older versions of the 289H LSS, which allowed multiple expansion chassis to be connected to the primary 289H LSS. Although the menu still shows these multiple chassis designations, 289H LSS hardware modifications make it impossible to use expansion chassis with the 289H LSS.

### Calibration Test

Prior to performing either a board scan or a set of realtime readings, PressureMAP performs a Calibration Test on the boards involved. From the results of the Calibration Tests, PressureMAP is able to adjust the subsequent device readings to compensate for any error in calibration of the device. This is referred to as normalizing the readings. The inclusion of this Calibration Test in 289H Diagnostics allows a user to initiate a Calibration Test and study the results.

To choose the Calibration Test from the 289H Diagnostics Menu, press **2** followed by **<Return>**. You will first be prompted for the board number that you would like to test:

Which board?

After typing in a board number followed by **<Return>**, you will be able to examine the report displayed in SCREEN A5-5. (See Introduction in this section for an explanation of how boards are numbered.)

Calibration Test for Salt Creek				CPAMS Diagnostics XX.XX.XX
01/02/2014 13:38		System Studies Incorporated		
Resistor	Counts	Volts	Ohms	Correction
Battery	39339	47.4		
Open (H)	28		+++++M	
3.8M (H)	983		3.934M	3.5%
100K (H)	36168		103.7K	3.7%
100K (L)	1313		102.9K	2.9%
10K (L)	10287		10.41K	4.1%
Short (L)	43362		96	
Which board?				

SCREEN A5-5: CALIBRATION TEST

- *Resistor* indicates which calibration resistor is being tested.
- *Counts* are the raw counts from the ADC as returned by the 289H. This information is useful to System Studies Technical Support personnel.
- *Volts* applies only to the battery calibration resistor and indicates the voltage of the CO batteries minus 0.7 volts.
- *Ohms* indicates the electrical resistance of each calibration resistor. The value in this field should be very close to the resistance implied in the name. For example, a 3.8 megohm calibration resistor could read 3.937M. A field with all pluses and a "M" for megohms ("+++++M") indicates a number whose magnitude is too great to fit in the field.

— *Correction* is the percentage difference between the theoretical resistance and the computed resistance. PressureMAP corrects readings using the calibrated values, resulting in less than a 1% error for a reading. Differences greater than 10% between the theoretical and computed resistance are reasons for concern and may indicate a faulty resistor.

At the bottom of the screen displaying the Calibration Test results, you will see the prompt:

```
Which board?
```

If you want to perform another Calibration Test, type in the board number followed by **<Return>**. To return to the *289H Diagnostics Menu*, just hit **<Return>**.

### ***Realtime Reading Test***

The Realtime Reading Test is primarily intended to be a tool for servicing the 289H. The realtime readings offered through the *Specific Device Information* option of the *PressureMAP Master Menu* is the preferred method of obtaining realtime readings for use when checking the pressurized cable system.

After a new device has been wired to the 289H LSS monitor and the device/access numbers have been entered into the PressureMAP database, PressureMAP must call for readings from the new device to install it in the database. After PressureMAP has called, you can initiate a realtime reading for the device for comparison with its manual reading.

After you select a Realtime Reading Test from the *289H LSS Diagnostics Menu* by pressing **3** followed by **<Return>**, you will see the message:

```
Calibrating...
```

After a few seconds, you will be asked for the device number that you would like to check:

```
Test which device?
```

You may select a monitoring device by entering either the device number or the corresponding access number. Access numbers are entered with a leading sharp character (“#”) to distinguish them from device numbers, and they may be abbreviated. For example, “#2-1” is interpreted as “002-01”. However, to look at a device with access number 001-02, you could enter either “#1-2” or “#2” since if you only specify the pair, the program assumes card 1.

It is important to note that the sharp designation is already allowed as a valid character in user defined device numbers, and continues to be allowed in these numbers. All user input entered with a leading sharp that exactly match an existing device number (leading sharp included) are NOT treated as access numbers, but reference the matching device number. For example, if a 289H office has a user defined device number “#11”, then a user entry of “#11” selects the device, NOT access number “001-11”.

Upon entering a valid device number, you will see the realtime reading for that device repetitively displayed on a screen similar to SCREEN A5-6. (Transducer Conversion Charts appear at the end of this appendix.)

Realtime Reading Test for Salt Creek 01/02/2014 13:38					CPAMS Diagnostics XX.XX.XX System Studies Incorporated			
Access #	Type	Counts	Scaled	Ohms	Range	Step	Status	Reading
001-01	P	261	261	3827875	H	20		9.5
001-01	P	261	261	3784143	H	20		9.5
001-01	P	261	261	3726756	H	20		9.5
001-01	P	261	261	3827875	H	20		9.5
001-01	P	261	261	3644736	H	20		9.5
001-01	P	261	261	3711221	H	20		9.5

SCREEN A5-6: REALTIME READING TEST—RESISTIVE DEVICE

Data entry errors can cause many problems with readings, so checking the data is a valuable tool for troubleshooting. For example, if device information is entered in PressureMAP with an incorrect TD Type, it can easily be checked on the *Specific Device Information Screen*. Another cause for errors is entering two different devices with the same access number. Duplicate access numbers can be identified by running a Device History for the entire office by *Access #*, as described in the PressureMAP section of the *PressureMAP System Operations Manual*.

#### **RESISTIVE DEVICE OUTPUT**

The nine fields displayed on the sample screen above are described as follows:

- *Access #* While the user is asked to input either the PressureMAP device number or the corresponding access number to do a realtime reading on a specific device, only the access number of that device is displayed. A list of device numbers with the corresponding access numbers can be reviewed in the PressureMAP Device Log.
- *Type* represents the second letter of the device type (for example, “F” for a flow device, “P” for pressure, and “B” for barometric pressure transducer).
- *Counts* are the raw ADC counts returned by the 289H. This information is useful to System Studies Technical Support personnel.
- *Scaled* shows the scaled counts that have been adjusted for any discrepancy based on the calibration. This information is also useful to the Technical Support personnel.
- *Ohms* indicates the resistance calculated from the scaled counts.
- *Range* indicates which range of the measurement circuit was used for the measurement (“H” = high range, “L” = low range). The high range is used for measurements above 100K ohms.
- *Steps* represents the approximate step number of a 20 step transducer. A reading of 100k ohms is step 1 and 3.8M ohms is step 20. A reading below step 1 displays as 0 and a reading above step 20 displays as ++.

— *Status* indicates the status of the pair. The status indicator message is the precursor to the “verbose” reading. NOISE could be caused by AC voltage on the pair, VOLT could be stray voltage on the pair of more than 10Vdc or 6Vac, and BUSY indicates that a subscriber pair was in use when the reading was taken.

— *Reading* represents the unbiased reading for that type of device. (The actual reading might be biased by an offset in the PressureMAP database, e.g., an SP device.) When running the Diagnostic Realtime Reading on a Trunk and Toll contactor, the usual reading will be replaced by a series of question marks. A VOLT reading in this column indicates the presence of lethal voltage on the pair.

### **CURRENT LOOP DEVICE OUTPUT**

Realtime readings for a current loop device vary from the information shown in SCREEN A5-8. There is no scaling of the counts and no steps are shown, but several additional data fields may be included. SCREEN A5-7 shows realtime readings for a current loop pressure device with a barometric pressure transducer installed in the office.

Realtime Reading Test for CEDAR CITY-U				CPAMS Diagnostics XX.XX.XX		
01/02/1999 17:44				System Studies Incorporated		
Access #	Type	Counts	Milli-Amps	Status	Absolute	Reading
001-28	P	7110	9.04		6.6	9.4
001-28	P	7114	9.04		6.6	9.4
001-28	P	7114	9.04		6.6	9.4
001-28	P	7109	9.03		6.5	9.3
001-28	P	7115	9.04		6.6	9.4
001-28	P	7109	9.03		6.5	9.3
001-28	P	7117	9.05		6.6	9.4
001-28	P	7126	9.06		6.6	9.4
001-28	P	7119	9.05		6.6	9.4
Test which device? 005						

**SCREEN A5-7: REALTIME READING TEST—CURRENT LOOP DEVICE**

The additional data fields that may display for current loop devices are described below.

— *Milli-Amps* indicates the electrical current output calculated from the data in the Counts field.

— *Delta P* represents the pressure differential value created by the Flow Finder orifice to which the current flow transducer is pneumatically connected. This value is converted to the appropriate flow reading for the range of device specified in PressureMAP.

— *Absolute* defines the actual pressure reading provided by the current loop device before its reading is adjusted for barometric pressure. This field appears only if a barometric pressure transducer is installed in the office.

Realtime readings will continue to be posted to the screen until **<Esc>** is pressed, at which time you will be prompted for another device number. Enter another device number followed by **<Return>** to perform another Realtime Reading Test. Hit **<Return>** to return to the 289H Diagnostics Menu.

### Specific Device Information

The fourth option of the menu, Specific Device Info, is provided so device information can be viewed without having to leave the 289H Diagnostic Menu. The screen of information that is displayed is essentially the same screen displayed by the PressureMAP option Specific Device Information. SCREEN A5-8, shown below, is described in detail in Section 2 of the *PressureMAP System Operations Manual*.

```

Specific Device Information for Salt Creek CPAMS Diagnostics XX.XX.XX
01/02/2014 13:38 System Studies Incorporated
-----
Device #: 001A Access #: 001-01 Type: UP
Address: MH-20 SOQUEL Loc: 15 Pipe: BA
TD Type: RA
Sheath(s): 02
Cable: 02 Prim Pair: 704 Sec Pair: Sort Key:
Plat #: UG-7 Stickmap: 5
Phone:
Latitude: Longitude:
Office 1 Loc: 14 Distance 1 (kft): 2.9 Field 1 Loc: 16
Office 2 Loc: Distance 2 (kft): Field 2 Loc:
Remarks:
Readings Curr Last Tdy -1 -2 -3 -4 -5 -6 Wk-1 Wk-2 Wk-3 Wk-4
-----

```

SCREEN A5-8: SPECIFIC DEVICE INFORMATION SCREEN

### Capacitance Test

If you choose Realtime Capacitance Test from the 289H Diagnostics Menu by pressing **5** and **<Return>**, you will first be asked for the device number to test. After entering a valid device number, or the corresponding access number, a screen similar to SCREEN A5-9 will be displayed. (Even though you are asked to enter the device number, only the access number will be displayed on the screen.) The display will include the raw capacitance counts, the capacitance (in picofarads), the distance of an open from the Central Office in thousands of feet (kilofeet), and a location indication.

```

Capacitance Test for NAME CPAMS Diagnostics XX.XX.XX
01/02/2014 13:39 System Studies Incorporated
-----
-----Tip Side----- -----Ring Side-----
Access # Counts p-farads K-feet Loc. Counts p-farads K-feet Loc.
-----
001-01 48365 139551 1.837 OUT 80932 233520 3.537 OUT
001-01 46829 135119 1.866 OUT 80813 233177 3.537 OUT

```

SCREEN A5-9: CAPACITANCE TEST DISPLAY

The capacitance test is used to determine how far the 289H is located from an OPEN on a pair. Although only a very rough estimate is given, it is useful to determine if the OPEN is within the CO or outside. Readings are displayed continuously until an **<Esc>** is entered. The screen that is displayed shows the status of the following fields.

— *Counts* is the raw response from the 289H's capacitance counter. This information is useful to System Studies Technical Support personnel.

— *P-Farads* is the capacitance in picofarads, computed from the raw counts. (One picofarad is .000001 microfarads.)

— *K-feet* is the rough computed distance of an open from the 289H monitor in thousands of feet. It is important that you NOT use this distance for fault locating because it is an extremely rough estimate.

— *Loc.* indicates whether the open is located inside (IN) or outside (OUT) the CO.

The test results will continue to be listed until you press **<Esc>**. At that point you will be prompted for another device number. Either enter the number of the next device that you would like to test, or press **<Return>** to go back to the 289H Diagnostics Menu.

### ***Ping Relays Test***

The Ping Relays Test is a simple test to determine whether all of the line selection relays on a given board are operating. The test requires that someone is listening near the 289H when it is performed. When the test is run, the relays on the chosen card “ping” with a distinctive rhythm. This pinging of the relays is performed repetitively, in groups of five, with a pause of approximately five seconds between repetitions. If the listener detects a gap in the sequence of pings, he can calculate which relay is not pinging.

There are two reasons why a relay would not ping during the test. One is that the relay is faulty, the other is that the line is busy. While busy lines are obviously not a problem when testing a dedicated board, they could confuse a test on a subscriber board. For that reason, this test provides a display that indicates busy lines.

When running this test on a dedicated board, the output displayed is the word “ping” for each time the board is pinged. For subscriber boards, the output displayed is a sequence of ones and zeros— one digit for each line. The first digit displayed corresponds to the first line on the selected card. A value of 0 indicates the line was free whereas a value of 1 indicates that the line was found to be busy. After removing the relays that were found to be busy during the test from the list of relays found to be silent, the remaining ones are determined to be faulty.

To run the Ping Relays Test, select it from the 289H Diagnostics Menu by pressing **6 <Return>**, and you will be asked for a board number to test:

Ping which board?

Upon entering a valid board number (see the introduction to this section for a description of how boards are numbered), you will see a display similar to SCREEN A5-10. In this example, all of the subscriber lines were found to be on hook except line 9 which was found to be busy all four times that the test was run.

```

Ping Relays Test for Salt Creek                CPAMS Diagnostics XX.XX.XX
01/02/2014 13:42                               System Studies Incorporated
-----
Pairs 1-25 00000 00010 00000 00000 00000

```

SCREEN A5-10: PING RELAYS TEST DISPLAY

The test will continue until you press **<Esc>**, after which you will be prompted for the number of another board to reset. You may then enter the number of another board, or hit **<Return>** to go back to the 289H Diagnostics Menu.

### **Cold Reset**

This option will remotely command the 289H to reset. Executing a Cold Reset wipes out patches and any knowledge of a device's status. If the 289H is equipped for Dedicated Tone capability, the reset monitor will default to the condition where pseudo-data tone is routed to all pairs. In addition, the password is reset so that none is required and a board inventory is taken automatically after the 289H is reset. A reset 289H containing dedicated cards will require the data to be reloaded via PressureMAP. PressureMAP's initial call, which reloads the device data, will take longer to complete than an ordinary scheduled call.

After choosing Cold Reset by pressing **7** followed by **<Return>**, you will see the message:

```

Do you want to cold reset the 289H LSS?
Y[es], N[o].

```

This message acts as a confirmation to make sure that a Cold Reset is not initiated by mistake. Pressing Y followed by **<Return>** will implement the Cold Reset. You will then see the message:

```

Cold reset accepted. It will not occur until we hang up.
Hit <Return> to return to the 289H LSS Diagnostic Menu.

```

The actual cold resetting process does not take place until after you hang up, which is accomplished by hitting **<Return>** to return to the 289H Diagnostics Menu, and then hitting **<Return>** again.

### **Leakage Test**

If you choose Leakage Test from the 289H Diagnostics Menu by pressing **8** and **<Return>**, you will first be asked for the device number to test. After entering a valid device number, or the corresponding access number, a screen similar to SCREEN A5-11 will be displayed. Even though you are asked to enter a device number, only the corresponding access number will be displayed on the screen.

```

Realtime Leakage Test for CITRUS HEIGHTS      CPAMS Diagnostics XX.XX.XX
03/04/2014  13:42                          System Studies Incorporated
-----
Access #      Tip/Ring Ohms      Tip/Gnd Ohms      Ring/Gnd Ohms
-----
001-15      6,816      100M      86,231,576

Test which device?

```

SCREEN A5-11: LEAKAGE TEST

The Leakage Test measures the actual resistance on tip/gnd, ring/gnd and across tip and ring. These measurements can be used to determine if a SHORT on a flow transducer circuit is due to leakage on the pair.

At the bottom of the screen displaying the Leakage Test results you will see the prompt:

```
Test which device?
```

If you want to perform another Leakage Test, type in the device number followed by **<Return>**. To return to the 289H Diagnostics Menu, just hit **<Return>**.

### AC Test

The AC test measures AC voltage on tip/gnd and ring/gnd. This test should be run to determine the actual voltage on the pair if the device has a VOLT message in the Status column during a realtime reading. If the device has acquired a VOLT reading during the normal call cycle, lethal voltage has been found on the pair. The AC test can also be useful when troubleshooting pressure transducer pressure drops. By running this test, wire problems can be diagnosed before a technician is dispatched to the field.

To choose the Realtime AC Test from the 289H Diagnostics menu, press **9** and **<Return>**. You will be prompted for the device number to test. After entering a valid device number, or the corresponding access number, a screen similar to SCREEN A5-12 will be displayed. Even though you are asked to enter a device number, only the corresponding access number will be displayed on the screen.

```

Realtime AC Test for Salt Creek              CPAMS Diagnostics XX.XX.XX
01/02/2014  13:42                          System Studies Incorporated
-----
Access #      VAC      VAC
              Tip/Gnd      Ring/Gnd
-----
001-01      0.0412      10.0373

Test which device?

```

SCREEN A5-12: AC TEST DISPLAY

The AC voltage indicated in the VAC Tip/Gnd and VAC Ring/Gnd columns should be 1.0 VAC or less. At the bottom of the screen displaying the AC Test results you will see the prompt:

Test which device?

If you want to perform another AC Test, type in the device number followed by **<Return>**. To return to the *289H Diagnostics Menu*, just hit **<Return>**.

### DC Test

The DC test measures DC voltage on tip/gnd and ring/gnd. This test should be run to determine the actual voltage on the pair if the device has a VOLT message in the Status column during a realtime reading. If the device has acquired a VOLT reading during the normal call cycle, lethal voltage has been found on the pair. The DC test can also be useful when troubleshooting pressure transducer PSI drops. By running this test, wire problems can be diagnosed before a technician is dispatched to the field.

To choose the Realtime DC Test from the 289H Diagnostics menu, press **10** and **<Return>**. You will be prompted for the device number to test. After entering a valid device number, or the corresponding access number, a screen similar to SCREEN A5-13 will be displayed. Even though you are asked to enter a device number, only the corresponding access number will be displayed on the screen.

Realtime DC Test for Salt Creek		CPAMS Diagnostics XX.XX.XX
01/02/2014 13:42		System Studies Incorporated
-----		
Access #	VDC Tip/Gnd	Ring/Gnd
-----	-----	-----
001-01	0.0031	0.0000
Test which device?		

SCREEN A5-13: DC TEST DISPLAY

Readings in the two VDC columns should be under 1.0 volt, as shown.

At the bottom of the screen displaying the DC Test results you will see the prompt:

Test which device?

If you want to perform another DC Test, type in the device number followed by **<Return>**. To return to the 289H Diagnostics Menu, just hit **<Return>**.

PressureMAP's Pair Diagnostics function (Option #11 of the 289 Diagnostics Menu) provides all of the important pair diagnostic information for a specific monitoring device in one concise report. The data includes output from DC and AC voltage tests, leakage test and the capacitance test.

In order to access this information, select Pair Diagnostics from the 289H Diagnostics menu by pressing **11** and **<Return>**. You will be prompted for the device number to test. After entering a valid device number, or the corresponding access number, a screen similar to SCREEN A5-14 will be displayed. Even though you are asked to enter a device number, only the corresponding access number will be displayed on the screen.

You can choose to run Pair Diagnostics for another device by entering the device number followed by **<Return>**. Simply pressing **<Return>** at the **Test which device?** prompt returns you the 289H LSS Diagnostics Menu where you can make another option selection or return the MAP Programs Menu.

```

Realtime Pair Diagnostic Test for Salt Creek      CPAMS Diagnostics XX.XX.XX
05/14/2006 13:42                               System Studies Incorporated
-----
Access #          VDC          VDC
                  Tip/Gnd       Ring/Gnd
-----
001-14           0.0031       0.0038

Access #          VAC          VAC
                  Tip/Gnd       Ring/Gnd
-----
001-14           0.3844       0.3928

Access #          Tip/Ring Ohms    Tip/Gnd Ohms    Ring/Gnd Ohms
-----
001-14           100M           100M           100M

Access #          ----- Tip Side -----      ----- Ring Side -----
                  Counts p-farads K-feet Loc.    Counts p-farads K-feet Loc.
-----
001-14           640    1846    0.078    IN    686    1979    0.084    IN

Test which device?

```

SCREEN A5-14: PAIR DIAGNOSTICS DISPLAY

The next two options of the 289H Diagnostics Menu will only be displayed if the 289H that has been called is upgraded with alerting capabilities. If you do not see menu items 12 and 13 on the *289H Diagnostics Menu*, (SCREEN A5-3), and you wish to upgrade your 289H monitor with alerting capabilities, please call System Studies for more information.

### Dialout Phone Number Information

Selecting the *Dialout Phone Number Information* option (by entering the number **12** followed by **<Return>**), will display a screen similar to the one illustrated in SCREEN A5-15. This option allows you to determine the status of the current 289H phone number (or IP address) information structure, and test the alert dialout capabilities of the 289H LSS from PressureMAP.

```

Dialout Phone Number Information                                CPAMS Diagnostics XX.XX.XX
06/24/2014 10:33                                           System Studies Incorporated
-----
   PMAP ID      MAP Alert #          289 ID      Status      Attempts
-----
  1 | 0202      4759999          4234444    NORMAL      0
  2 | 0111      T9W14089231844   4234444    NO CARRIER  3
  3 | 0999      T192.168.0.1:3002 1433001    NORMAL      0
  4 |
Test dialout phone number? (y/n)

Hit <Return> to return to the 289 LSS Diagnostics menu.

```

SCREEN A5-15: DIAL-OUT PHONE NUMBER INFORMATION SCREEN

The data fields on the screen provide key information about the 289H LSS to be tested and the PressureMAP system initiating the dialout phone number test. Please note that the alerting configuration shown in this sample is merely intended to show the different formats for information that may be displayed; it does not reflect the setup of an actual 289H monitor.

— *PMAP ID* This is the “System Number” that was assigned by System Studies when the MAP System was installed.

— *MAP Alert Number* The phone number of the 289H’s alert modem is listed here. It can also be found in the MAP alert #: field of the PressureMAP’s office information screen. For 289H monitors using a network connection to PressureMAP, this field contains the IP address for the PressureMAP computer.

— *289 ID* This column contains the last seven digits of the PressureMAP office’s phone number or IP address, as input in the Phone number: field of the PressureMAP office information screen.

— *Status* The call error message (if any) is recorded in this column. If no modem errors have occurred in the last 289H alert transmission the message “Normal” appears. Other possible status conditions could include the following: No Answer, No Connect, Busy, Incoming, Retry Exceeded, No Response, Incorrect Response, No Modem Response, Undefined Error, etc. A complete list of 289H LSS Alert Modem Status Codes appears in Appendix 5 of this manual.

— *Attempts* The number in this column indicates how many unsuccessful attempts have been made to contact the 289H alarm modem. This number is reset to zero when PressureMAP connects with the alarm modem.

After choosing Dialout Phone Number Information from the *289H LSS Diagnostics Menu* by pressing **12** **<Return>** you will see the message:

```
Test Dialout phone number? Y[es], N[o].
```

Pressing **Y** followed **<Return>** by will produce the following message:

```
PMAP_ID?
```

Enter the number assigned to the PressureMAP system to which you would like to place a test call. This is the three digit number located in the PMAP ID data field. The program responds with the following:

```
Please Wait, Disconnecting..
This test will take between 45 and 120 seconds
```

This part of the process sends a “force call” request to the 289H LSS, and then terminates the call in order to allow the 289H LSS to call PressureMAP. If PressureMAP cannot reach the 289H being called, it displays the following message:

```
Office does not answer; waiting..
Attempting call again...
```

Once the connection has been made and the “force call” request is initiated, PressureMAP hangs up and waits for the 289H’s call. The following displays indicates that PressureMAP is awaiting a call:

```
1      15      30      45      60
.....
.....

Test call was SUCCESSFUL!
```

Eventually PressureMAP will display the message above and redial the selected 289H LSS office so that other 289H LSS Diagnostics options can be selected, if desired.

### ***Device Alert Information***

This *289H Diagnostics Menu* option lists the set alert level and current reading for any device you select. You may enter more than one device number by using the list/range format described in the Preface section of the *PressureMAP System Operations Manual*.

Select the *Device Alert Information* option by entering the number **13** followed by **<Return>**. You will see a screen similar to the one illustrated in SCREEN A5-16.

Device Alert Information for 289H				CPAMS Diagnostics XX.XX.XX	
01/02/2014 13:37				System Studies Incorporated	
Device #	Access #	Type	TD Type	Scan Rdg	Alert Level
001-05	003A	UP	RP	8.5	8.0
001-06	003B	MF	RF	11.0	13.0
001-08	004B	TC	RP	(9949)	
001-09	005A	CA	RP	OK	(420K)
001-10	005B	CA	RP	ALRM	

Device alert information for which device?

SCREEN A5-16: DEVICE ALERT INFORMATION SCREEN

The data fields in this screen are described below.

- *Device #* The assigned number for the device. Note that this number can be the same as the access number if User Defined Device Numbering is turned off.
- *Access #* The access number for the device.
- *Type* The PressureMAP device type for the device.
- *TD Type* The transducer type. A list of possible transducer types is listed in Appendix 1 of the *PressureMAP System Data Entry Manual*.
- *Scan Rdg* A current “Realtime Reading” of the device. If this number is in parentheses, the device reading is displayed in measurement units (e.g. ohms or milliamperes) instead of reading units (e.g. PSI or SCFH).
- *Alert Level* This is the programmed device reading level that is used to generate a call to PressureMAP. A blank entry in this column indicates that the alarm threshold is not enabled. This condition usually occurs when a device has already alerted and cannot issue another alert, either because the reading has approached the extreme “bad” end of its range (e.g. near 0 if a pressure transducer) or, if the device is a contactor, the reading is now ALRM.

### **Tone Settings**

The 289H LSS dedicated tone capability provides the ability to place a data tone on all dedicated device pairs to prevent them from being used (“stolen”) for other purposes and to assist field technicians in locating a specific device pair(s). PressureMAP Diagnostics provides three menu options for tone generation control: Get Tone Settings, Set Tone Default, and Route Tone. The first two tone controls apply to the pseudo-data tone placed as a “pair-saver” to protect all dedicated pairs from unauthorized use. The third tone control allows the maintenance technician to place a “locator” tone on a specific pair. Each of these options populates a Tone Information Menu with data pertaining to the selection.

In order to utilize the full tone generation capabilities of the 289H LSS monitor, the 289H must be equipped with a Tone Utility Card (Part Number 9010-0016) and one or more Dedicated Tone Relay Cards (Part Number 9800-6110). In addition, the 289H Controller Card must be equipped with EPROM Version B.05 or greater. The pair-saver tone capability requires that the Dedicated Relay Cards are equipped with tone capacitors on each relay (Rev C and above – all versions purchased after December, 1998). However, the user-directed locator can be used with older “non-tone” Dedicated Relay Cards, as well as with the current model. If the 289H chassis has both types of dedicated cards installed, the locator tone will be available for all of the monitored pairs, but the pair-saver tone will only go out on pairs wired to the current “tone” cards. Please note that effective with PressureMAP Version 24, locator tone can also be routed to subscriber pairs. The tone generation capability is not available, however, for the Sparton Dedicated Replacement Card (SPDR) because of the Sparton cable’s common tip configuration.

**GET TONE SETTINGS**

To view the settings for tone being routed to all pairs, select the *Get Tone* option of the *289H LSS Diagnostics Menu*. Press **14** (or the appropriate number) and **<Return>**. A screen similar to SCREEN A5-17 will display showing the current tone settings for the 289H LSS.

```

Get Tone for <OFFICE NAME>                                CPAMS Diagnostics XX.XX.XX
03/11/2014  11:24                                         System Studies Incorporated
-----
CURRENT TONE SETTINGS:

Frequency (Hz)      Routed To          Reset Settings From
-----
High_Low_Alt       All                 Default

Hit <Return> to return to the 289 LSS Diagnostics menu.

```

SCREEN A5-17: GET TONE SETTINGS INFORMATION SCREEN

—*Frequency (Hz)* The information in this data field represents the type of pseudo-data tone applied to the relay contacts (device pairs) on the 289H's dedicated relay cards. The options and their frequencies are as follows:

- *High\_Low\_Alt* — High/Low frequency alternating tone: 1700/1300 Hz (data) and 580/450 Hz (locate)
- *High\_Freq\_Pulsed* — High frequency pulsed tone: 1700 Hz (data) and 580 Hz (locate)
- *Low\_Freq\_Cont* — Low frequency continuous tone: 1300 Hz (data) and 450 Hz (locate)
- *High\_Freq\_Cont* — High frequency continuous tone: 1700 Hz (data) and 580 Hz (locate)
- *Tones\_Disabled* — All tone disabled

—*Routed To* This field indicates the relays (device pairs) on which the pseudo-data tone has been enabled. By default, the 289H LSS routes the tone to all normally closed relay contacts.

—*Reset Settings From* A "Default" designation in this data field indicates that the alternating frequency tone was the original value. Any other entry in this field would identify a tone frequency that was selected prior to the currently selected value.

**SET TONE DEFAULT**

The next option on the 289H LSS Diagnostics Menu enables you to select the tone default settings which control the functions of the 289H LSS Tone Generator. All changes made from this menu override the original default settings until either the 289H LSS monitor is reset, or you initiate another change as described below.

In order to change the default tone settings, you will need to select the appropriate option number from the *289H LSS CPAMS Diagnostics Menu* (Option #15), and follow the numeric entry with a **<Return>**. The Set Tone Default Information Screen will display as shown in SCREEN A5-17 above.

The five menu options listed in SCREEN A5-18 provide the ability to select the type of tone that the 289H LSS will use as a default value for the dedicated device pairs. Item #1, which is the standard default setting, places an alternating pseudo-data tone frequency on the pair(s). The frequencies associated with each Tone setting are detailed in the preceding *Get Tone Setting* description. The last option allows you to disable all tones.

```

Set Tone for <OFFICE NAME>                CPAMS Diagnostics XX.XX.XX
03/11/2014  11:24                        System Studies Incorporated
-----
CURRENT TONE SETTINGS:

Frequency (Hz)          Routed To          Reset Settings From
-----
High_Low_Alt           All                Default

289-H LSS Set Tone Menu
-----
 1. High/Low Frequency Alternating Tone
 2. High Frequency Pulsed Tone
 3. Low Frequency Continuous Tone
 4. High Frequency Continuous Tone
 5. All Tones Disabled

Select tone (1-5)

```

SCREEN A5-18: SET TONE DEFAULT INFORMATION SCREEN

### ROUTE TONE

The final dedicated tone option on the 289H LSS Diagnostics Menu selection makes it possible for you to select a specific card and relay (device pair) on which to place a tone. Please note that while tone is being routed to a specific pair, all other tones are silenced during the process. As soon as you end the tone routing session, the existing default tone setting is restored to all dedicated pairs.

Entering selection **16** (or the appropriate selection on the menu) followed by **<Return>** produces a screen identical to SCREEN A5-17. First you must select the desired frequency and type of tone to apply from the five choices offered. For example, if you want to route a high continuous tone, you would select option #4. PressureMAP would then prompt you for a card and pair designation.

Route to which card-pair?

You may designate a pair (or pairs) on which to place a tone by entering the access number of the associated device following the on-screen prompt. The access number format identifies the card position in the 289H LSS chassis as well as the appropriate relay on the card. For example, entering access number 003-18 instructs the 289H LSS to activate the tone coupling capacitor for relay number 18 on the third dedicated relay card in the chassis.

**Note:** When selecting a pair for routing, it is advisable to make sure that the card supports the locator tone function. No error message will be displayed if the pair entered does not have the required tone capability. (For information on the tone capabilities of the various relay cards, please refer to the card capabilities charts in Appendix 1 of this manual.)

Once you have selected the card/pair number(s) on which you wish to place a tone, PressureMAP instructs the 289H LSS to generate the desired tone. The routed tone will continue until you enter. The existing default tone setting is then restored to all dedicated pairs. A selection made with the Route Tone option does not replace the default tone setting.

## TRANSDUCER CONVERSION CHARTS

The following transducer conversion charts are included in this appendix section to provide helpful information when performing certain diagnostic tests. All but CHART A5-1 below provide transducer output values and the corresponding pressure or flow readings.

Relation of Cable Pressure, Transducer Resistance, and Voltmeter Reading		
Nominal Pressure Range (PSI) at Transducer	Electrical Resistance (kilohms)	Voltmeter Reading 120V Scale
0.0	100	50.0
0.5	110	47.5
1.0	122	45.0
1.5	135	42.5
2.0	150	40.0
2.5	166	37.5
3.0	186	35.0
3.5	208	32.5
4.0	232	30.0
4.5	265	27.5
5.0	301	25.0
5.5	344	22.5
6.0	400	20.0
6.5	468	17.5
7.0	568	15.0
7.5	698	12.5
8.0	898	10.0
8.5	1200	7.5
9.0	1820	5.0
9.5 & higher	3820	2.5

CHART A5-1

Pressure Transducer Conversion Chart (CPA/15)			
Pressure in PSI	Current in mA	Pressure in PSI	Current in mA
0.00	3.60-4.00	16.00	12.53
1.00	4.53	17.00	13.07
2.00	5.07	18.00	13.60
3.00	5.60	19.00	14.13
4.00	6.13	20.00	14.67
5.00	6.67	21.00	15.20
6.00	7.20	22.00	15.73
7.00	7.73	23.00	16.27
8.00	8.27	24.00	16.80
9.00	8.80	25.00	17.33
10.00	9.33	26.00	17.87
11.00	9.87	27.00	18.40
12.00	10.40	28.00	18.93
13.00	10.93	29.00	19.47
14.00	11.47	30.00	19.99
15.00	12.00		

CHART A5-2

Pressure Transducer Conversion Chart (CPA/30)			
Pressure in PSI	Current in mA	Pressure in PSI	Current in mA
0.00	6.00	16.00	13.46
1.00	6.47	17.00	13.92
2.00	6.93	18.00	14.39
3.00	7.40	19.00	14.85
4.00	7.86	20.00	15.32
5.00	8.33	21.00	15.79
6.00	8.80	22.00	16.25
7.00	9.26	23.00	16.72
8.00	9.73	24.00	17.18
9.00	10.19	25.00	17.65
10.00	10.66	26.00	18.12
11.00	11.13	27.00	18.58
12.00	11.59	28.00	19.05
13.00	12.06	29.00	19.51
14.00	12.52	30.00	19.98
15.00	12.99		

CHART A5-3

Flow Transducer Conversion Chart (SCFH/mA)				
Flow in SCFH				Current in mA
9.5	19.0	47.5	95.0	
0.0	0.0	0.0	0.0	3.6 - 4.03
1.0	2.0	5.0	10.0	4.04
2.0	4.0	10.0	20.0	4.18
3.0	6.0	15.0	30.0	4.40
4.0	8.0	20.0	40.0	4.71
5.0	10.0	25.0	50.0	5.11
6.0	12.0	30.0	60.0	5.57
7.0	14.0	35.0	70.0	6.17
8.0	16.0	40.0	80.0	6.84
9.0	18.0	45.0	90.0	7.59
10.0	20.0	50.0	100.0	8.43
11.0	22.0	55.0	110.0	9.36
12.0	24.0	60.0	120.0	10.38
13.0	26.0	65.0	130.0	11.49
14.0	28.0	70.0	140.0	12.69
15.0	30.0	75.0	150.0	13.97
16.0	32.0	80.0	160.0	15.35
17.0	34.0	85.0	170.0	16.81
18.0	36.0	90.0	180.0	18.36
19.0	38.0	95.0	190.0	19.99

CHART A5-4

