Model 420d

Digital Mine Methane Monitor
GMI P/N: 20190, 20440, 20441
Revised
01/90

MANUFACTURED BY:
GENERAL MONITORS
26776 Simpatica Circle
Lake Forest, CA 92630
Telephone 714 581-4464
FAX 714 581-1151

DISTRIBUTED BY:
NATIONAL MINE SERVICE COMPANY
P.O. Box 310
795 Old Route 119, North
Indiana, PA 15701
Telephone 412 349-7100
FAX 412 349-7352

PREFACE

The purpose of this manual is to familiarize you with the operation of the Model 420d Mine Methane Monitoring System. This system provides you with a reliable additional element of safety for mining operations by continuously sensing for dangerous concentrations of methane gas. Never compromise the safety of you or your co-workers by operating mining machinery without the monitoring system in operation. Don't take short-cuts that involve safety risks. Remember to give the sensor a visual inspection before each shift. Excessive coal dust, or other contammination, on the dust guard can prevent the sensor from "seeing" methane. In the interest of the safety of you and your co-workers, we suggest that you continue to read this manual so that you are fully acquainted with the system, its operation and benefits.

GENERAL MONITORS

LIST OF DRAWINGS

GENERAL MONITORS

CONTENTS

GENERAL MONITORS

MODEL 420d

DIGITAL MINE METHANE MONITOR

INTRODUCTION

Your Methane Monitoring System is a product of General Monitors, Inc., a high technology leader in the development of gas monitoring instruments. It was supplied through our exclusive distributor, National Mine Service Company who should be consulted if additional information is required for installation or service.

The Model 420d is a Digital Mine Methane Monitor designed for installation on continuous miners, other face cutting equipment and loaders. It complies with CFR Title 30 Part 27 and is approved for use by the Mine Safety and Health Administration with Certification No. 32A-16/MS Ext. 3. In Canada it carries Energy Mines and Resources Certification No. 366.

The cast iron controller unit houses a miniature electronic module encased in an ABS plastic enclosure. The controller electronics module is a plug-in, quick disconnect package which permits fast service exchange. The small size also permits the unit to be mounted in limited space conditions. The Model 420d Digital Mine Methane Monitor provides you with a reliable additional margin of safety for mining operations by continually sensing for dangerous concentrations of methane gas. Should the monitor detect methane gas, the digital readout will display the concentration level. It will inform you of dangerous gas build-ups by flashing an amber light to indicate Low Alarm when the gas concentration exceeds 1%, and if the build-up continues to the 2% level, a red light will also be displayed to indicate a High Alarm condition. The high alarm alarm condition is extremely hazardous, therefore in order to prevent ignition of the gas, the mining machine (or other face equipment) will be automatically shut-down by the monitor. In order to restart the machine, "Reset" the monitor with the reset switch, or "Reset" will be automatically activated on auto reset models. For your protection, reset will not occur until the monitor senses and displays less than a 2% gas concentration.

GENERAL MONITORS

MODEL 420d SPECIFICATIONS

CONTROLLER:

Dimensions:	4.5" W x 5.75" L x 4.0" H.
Weight:	6 Lbs.
Mounting:	Not Position Sensitive. Any Convenient Position.
Temperature Range:	0° to 150°F (-18°C to 66°C)
Power Input:	8VDC Limited to 0.75 AMPS.
Digital Readout:	0.0 to 5.0% Methane by Volume.
Repeatability:	± 2% Full Scale.
Linearity:	± 5% Full Scale.
Alarm Circuits:	HIGH, LOW and MALFUNCTION.
	LOW at 1% AMBER Flashing LED.
	HIGH at 2% RED LED.
	MALF. RED LED.
	(Note: Alarm Set points can be adjusted lower at factory).
Electrical Classification:	Intrinsically Safe.
Control Switches:	"Test", checks electronic circuitry and shutdown.
	"Reset", re-energizes shutdown contactor when gas is below 2%.
	Note: Reset is automatic for remote control units. Switch not provided.

SENSOR:

Type:	Continuous diffusion, low temperature catalytic bead.
Body Material:	P/N 10001-1 Alum., P/N 10058-1 Stainless Steel.

GENERAL MONITORS

MODEL 420d SPECIFICATIONS

SENSOR: (cont'd)

Temperature Range:	-65°F to 200°F (-55°C to 93°c)
Response Time:	Typically 6 second time constant for 2.5% Methane by Volume.
Zero Drift:	Less than 5% per year.
Service Life:	2 to 3 yrs. normal service.

SENSOR HOUSING:

Cast Aluminum Housing and Lid for domestic version, P/N 1800823.

Cast Iron Housing and Lid for Canada and Export Version, P/N 20481

Sensor & Conduit Openings 3/4" pipe tap. 3 Position terminal block.

POWER SUPPLIES

P/N 20147 AC Power Supply.

Input Power:	120, 240, 460, 575 VAC Selective Multi-voltage Transformer.
Output Power:	8 VDC.
Current:	Limited to 0.75 Amps. Intrinsically Safe Output.
Shutdown Contactor Rating:	1 HP. at 600V.
Dimensions:	4.87" W x 8.00" L x 3.55" H.
Permissible Enclosure:	P/N NMSC 8080-1970.

P/N 20148 Low Voltage DC Power Supply.

Input Power:	64 or 128 VDC Selective Dual Voltage Transformer.
Output Power:	8 VDC.
Current:	Limited to 0.75 Amps. Intrinsically Safe Output.

GENERAL MONITORS

MODEL 420 SPECIFICATIONS

POWER SUPPLIES: (cont'd)

P/N 20148 Low Voltage DC Power Supply. (cont'd)

Shutdown Contactor Rating:	1 HP
Dimensions:	4.87" W x 8.00" L x 3.55" H.
Permissible Enclosure:	P/N NMSC 8080-1970.

P/N 20361 High Voltage DC Power Supply.

Input Power:	150 to 550 VDC Switching Regulator.
Output Power:	8 VDC.
Current:	Limited to 0.75 Amps. Intrinsically Safe Output.
Shutdown Contactor Rating:	1 HP. at 600V.
Dimensions:	4.87" W x 8.00" L x 3.32" H.
Permissible Enclosure:	P/N NMSC 8080-1970.

Type of System Application	System Part No.	Control. Manual/ Remote	Controller Assembly Reset Type	Power Supply Assembly Voltage	Sensor Assembly	Domestic or Export	Approval - - - - Country
Continuous Miners	20441-X1X11	Manual	20200 Manual	20147 120/240/460/575 VAC	1800823-1	Domestic	MSHA USA
Continuous Miners Loaders and Cutters	20441-X1X21	Manual	20200 Manual	20147 120/240/460/575 VAC	20481	Export	EMR Canada
Continuous Miners with Remote Control	20441-X1112	Remote	20457 Automatic	20147/20467 120/240/460/575 VAC	1800823-1	Domestic	MSHA USA
Continuous Miners with Remote Control	20441-X1122	Remote	20457 Automatic	20147/20467 120/240/460/575 VAC	20481	Export	EMR Canada
Lee-Norse Co. Continuous Miners	20441-X2X11	Manual	20200 Manual	20487-1 120/220/440/550 950 VAC	1800823-1	Domestic	MSHA USA
Lee-Norse Co. Continuous Miners	20441-X2X21	Manual	20200 Manual	20487-1 120/220/440/550 950 VAC	20481	Export	EMR Canada
Lee-Norse Co. Continuous Miners	20441-X3X12	Remote	20457 Automatic	20487-2 120/220/440/550 950 VAC	1800823-1	Domestic	MSHA USA
Lee-Norse Co. Continuous Miners	20441-X3X22	Remote	20457 Automatic	20487-2 120/220/440/550 950 VAC	20481	Export	EMR Canada
System for Continuous Miners	20440-X1X1X	Manual	20200 Manual	20361 150 to 530 VDC	1800823-1	Domestic	MSHA USA
System for Continuous Miners	20440-X1X2X	Manual	20200 Manual	20361 150 to 550 VDC	20481	Export	
System for Scoop Loaders	20190-X1X1X	Manual	20200 Manual	20148 64 or 128 VDC	1800823-1	Domestic	MSHA USA
System for Scoop Loaders	20190-X1X2X	Manual	20200 Manual	20148 64 or 128 VDC	20481	Export	
System for Diesel Powered Mine Vehicles	20730-X111X	Manual	20200 Manual	20732 12 VDC Bat/Alt.	1800823-1	Domestic	MSHA USA
System for Diesel Powered Mine Vehicles	20730-X112X	Manual	20200 Manual	20732 12 VDC Bat/Alt.	20481	Export	EMR Canada

GENERAL MONITORS

COMPONENTS CHECKLIST

Before starting installation of the monitoring system, check to be sure you have a complete undamaged system. If shipping damage has occurred, or parts are missing it should be immediately reported to your closest National Mine Service Company warehouse.

The system includes the following:

1. The Controller Unit; the digital display readout in a cast iron housing, and the plug-in electronic module.
2. The Power Supply; an electronic power converter which reduces the primary input power to 8VDC for controller operation. Several different power supplies are available to suit a variety of mine power applications. Check the selection table on Page 5 to verify the proper unit for your application.
3. Permissible Box; for the power supply, not furnished when the power supply is to be mounted in the machine electrical control box. Permissible box, P/N NMS 8080-1970..
4. Sensor Assembly; consisting of a cast iron or cast aluminum housing with a removable sensor. Note, all export units are cast iron with a stainless steel sensor body.
5. Cable & Conduit; One length of 4 conductor 16 gauge cable 20 ft. long, one length of 6 conductor 16 gauge cable 20 ft. long and one length of 3 conductor shielded 16 gauge cable 25 ft. long. One length of MSHA approved flexible conduit with length as required by application.
6. Accessory Kit; containing conduit connectors, hose clamps, and gland nut assembly.
7. A Purge Calibration Kit; optional, if ordered.

GENERAL MONITORS

INSTALLATION

CONTROLLER UNIT

This is the readout portion of the system to indicate to the machine operator, methane gas concentrations. It should be located within convenient viewing range of the operator and within arms reach of his position. This is to enable the operator to actuate the test and reset push buttons. The digital readout panel should face the operator, either mounted to a bulkhead or, if a convenient mounting is not available, one can easily be made using a 3/8" x 6" x 6" steel plate edge welded vertically to the machine. Care should be taken so that clearance is provided for removal of the electronic module when the clear plastic cover panel has been removed. The controller unit should not be attached to the plate during welding operation. Access must be provided for the conduit to enter each side or the bottom of the controller housing.

POWER SUPPLY

Depending on the machine involved, the power supply is furnished with or without a permissible box. If space is available in the machine's electrical control box, the power supply should be installed there. If not, a permissible box must be utilized and mounted in available space on the mining machine. If space for the permissible box is available on a top horizontal surface without impairing the machine's use, this is a desirable location. If not, a vertical side or rear location can be used.

NOTE: Location of the permissible box on a hydraulic reservoir tank or other heat producing surface is not recommended. Again, provide access for conduit entering each end of the box. A weld-in nipple, with packing gland nut is provided for entry into the machine main electrical control box.

GENERAL MONITORS

INSTALLATION (cont'd)

SENSOR ASSEMBLY

The sensor assembly must be mounted as close as practical to the miner cutting head or loading arms. This is the required location for methane detection. Other considerations for sensor location:

a. The sensor should be mounted in the return air flow; that is, downstream of air flow across the face.

b. Location of the sensor housing must be on a vertical part of the main frame of the machine. This location must be protected by either an overhanging part of the machine or a heavy duty guard provided for that purpose.

c. Mount sensor housing in an area where vibration and shock are minimized.

d. Clearance must be provided for removal of the sensor and the sensor housing lid.

e. Provisions must be made for access to the sensor for calibration of the methane monitoring system.

f. The sensor end of the housing should be angled downward on continuous miners when cutting head is at its highest operating height to prevent accumulation of dust and to allow water to drain out.

g. The sensor should be protected from coal or rock damage, water spray, oil and grease.

The sensor housing will be bolted at the selected location. Bolting with locknuts and/or lockwashers will facilitate easy removal in the event of damage.

GENERAL MONITORS

WIRING THE SYSTEM*

SENSOR HOUSING TO CONTROLLER

Extreme care must be taken in routing the three conductor shielded cable from the sensor housing to the controller at the operator's station. The cable must be protected from cuts or damage by moving parts of the machine. The cable should also be located so as to protect it from falling coal, rocks and abrasion. The sensor cable should also be isolated from other electrical leads to prevent the instrument from being influenced by spurious induced signals. The shield of the cable should be terminated at the controller on the terminal marked SG, TB1. The shield should not be terminated or grounded at the sensor housing. The sensor cable is supplied with crimped and soldered lugs on one end. Connect this end at the sensor housing. Cut to desired length at the controller end.

NOTE: When necessary to replace crimped lugs, always solder these lugs to insure proper operation of the sensor circuit. Splices are not permissible in this cable. The three conductor cable must be encased in flexible conduit hose. The conduit hose must be clamped at both ends using the No. 10 hose clamps provided.

Color Coding at sensor housing terminal block:

Sensor Wire Color		3 Conductor Cable Wire Color
Black	to	Black
Red	to	Green or Red
White	to	White

*Per applicable system connection diagram drawing No. 20408.

WIRING THE SYSTEM (cont'd)

Sensor connections within the controller box are made to TB1. Each lead should be stripped approximately 1/4" and lugs should be crimped and soldered before being connected to TB1 at its color coded position.

CONTROLLER UNIT TO POWER SUPPLY

For some installations the power supply will be assembled in a permissible enclosure. For other installations, the power supply is to be mounted within the machine's main electrical control box or other furnished permissible enclosures. In either case above, an additional entry port must be made in the main electrical control box. A weld-in packing gland is furnished for installation in the box.

A six conductor cable is used between the monitor controller unit and the power supply. The routing of the six wire cable from the controller unit will be determined by the type of installation. It is desirable to isolate this run from other high voltage cables when possible to prevent the line from being influenced by spurious induced signals. Insure that the cable run is protected from entanglement with machine moving parts, falling coal, rocks and abrasion or sharp edges.

If a permissible enclosure is furnished with the system, the six wire cable will be routed to the permissible enclosure. If the power supply is installed in the main controller box, the cable should be routed to this box.

In either case, the lugged end of the cable should be connected at the color coded terminals at TB2 in the power supply, then cut to the proper length and lugged at the controller unit.

WIRING THE SYSTEM (cont'd)

CONTROLLER UNIT TO POWER SUPPLY (cont'd)

After lugging, connect the cable to the proper color coded position on TB1. The six conductor cable must be encased in flexible conduit hose. The conduit hose must be clamped at both ends using the No. 10 hose clamps provided.

POWER SUPPLY TO MAIN POWER

Again, depending on whether the power supply is furnished in a permissible box or located in the machine main controller box, a four conductor cable is to be used. If a permissible box is used, route the cable to the machine main controller box using the same precautions for abrasion, cuts and damage from falling coal, rocks, etc. Again the cable run must be encased in flexible conduit hose and clamped at both ends with the No. 10 hose clamps furnished.

CAUTION: Every non-intrinsically safe lead which is carrying power from one enclosure to another, must be fused. When the 420d system includes a separate permissible enclosure, be sure that power from the machine controller box is taken from a fused connection rated for the cable size.

If the power supply is installed in the machine controller box, the four or five conductor cable should be routed within this box. This cable should then be cut to proper length. It is recommended that the end within the machine controller box be cut off. The lug end of the cable should be lugged and connected to the proper color coded terminals at TB1 (power supply).

Within the machine controller box connect the black lead to the fused "Plus Line". The red lead connects to the fused "Return". The green lead connects to the main contactor coil at the start/stop switch and the N.O. terminal on TB1 in the power supply. The white lead connects to the "Return".

GENERAL MONITORS

INSTALLATION CHECKOUT

Installation of the Model 420d Mine Methane Monitor system is now complete. Recheck all wiring installed in the permissible enclosure and/or the miner controller box. Insure that it conforms to the wiring schematic applicable to the particular installation being made. Recheck sensor housing wiring for connection to proper terminals.

If all wiring has been installed using good acceptable wiring practices, proceed with installation checkout.

Operation of the Model 420d Mine Methane Monitor will be the same for all installation. Operation of the mining machine will be in accordance with procedures for that particular machine.

Refer to the Servicing Section of this manual if results other than those noted are obtained.

MONITOR SYSTEM POWER"ON" TEST

NOTE: When power is first supplied to the Model 420d, results noted with a "cold" system may be slightly different from results noted with a "warmed-up" system. These differences are noted in the following procedure:

Insure that all mining machine switches for pumps, cutting head, headlights, leading arms, etc., are "OFF".

Important Notice: Some 420d Monitors, particularly those for remote control continuous miners, contain an optional "Automatic Reset" and do not have a "Reset" switch. Users of "Auto Reset" monitors should disregard "Reset" switch actuation in all operation instructions.

Turn "ON" mining machine main power and note the following:

GENERAL MONITORS

INSTALLATION CHECKOUT (cont'd)

"% METHANE" DISPLAY	Reading may rapidly increase from "0.0" to approximately "4.0" then return to "0.0". This is caused by an imbalance in the Wheatstone Bridge circuit during the warm-up cycle.
"ALARM" DISPLAY	May turn on red "HIGH" ALARM LED. Will hold until reset switch is activated.

NOTE: Should the "ZERO" potentiometer be adjusted too low, only the decimal point will be displayed. See "CALIBRATION" on Page 19 to adjust the "0.0" reading.

After a 1 minute warm-up:

"ALARM" DISPLAY - ALL Alarm LEDs "OFF".

The "ALARM" DISPLAY, in normal operation will provide indication of the following:

HIGH ALARM	Top Red LED "ON"
LOW ALARM	Amber LED flashes
MALFUNCTION	Lower Red LED "ON"

"TEST" PUSH BUTTON AND "HIGH" ALARM LATCH TEST

Depress "TEST" push button and hold in that position, note the following:

a. "METHANE" DISPLAY increases rapidly.

b. At 1.0% Methane - Amber Led flashes to indicate "LOW" ALARM.

c. At 2.0% Methane - Red LED "ON" to indicate "HIGH" ALARM.

d. In the "HIGH" ALARM condition the "Monitor-Cut-Off-Relay" is de-energized (contacts open).

Release "TEST" push button and note the following:

a. "% METHANE" DISPLAY returns to "0.0" - Red LED remains "ON".

b. "Monitor-Cut-Off-Relay" de-energized (contacts open).

Depress "RESET" Pushbutton.

a. Red LED "OFF".

b. "Monitor-Cut-Off-Relay" energized (contacts closed).

GENERAL MONITORS

INSTALLATION CHECKOUT (cont'd)

1.0% METHANE "LOW" & 2.0% METHANE "HIGH" SET POINT TEST

Remove Neoprene Bumper/Seal from controller housing. Loosen the four screws screws retaining the Lexan Cover Panel. Remove panel. Insert small alignment tool, furnished with the Model 420d Mine Methane Monitor, into the hole marked "ZERO" on the face plate. Locate the slotted screwhead in the hole for the "ZERO" potentiometer which controls the "% METHANE" DISPLAY. Turn the alignment tool slowly clockwise until display reaches 1.0% methane and note the following:

a. Amber "LOW" LED flashes.

b. "Monitor-Cut-Off Relay" still energized (contacts closed).

Continue turning alignment tool slowly clockwise until display reaches 2.0% methane and note the following:

a. Red "HIGH" LED "ON" - Amber "LOW" LED flashes.

b. "Monitor-Cut-Off-Relay" de-energized (contacts open).

Continue to turn alignment tool slowly clockwise observing the display moving until 4.0% methane. No change in LED "ALARM" DISPLAY or "Monitor-CutOff-Relay" will be noted.

Turn alignment tool counterclockwise until display reaches 1.0% methane and note the following:

a. No change in LED alarm display.

b. "Monitor-Cut-Off-Relay" remains de-energized (contacts open).

Continue to turn alignment tool counterclockwise, adjust display to 0.0% methane - Red "HIGH" LED "ON", amber LED "OFF", "Monitor-Cut-Off-Relay" de-energized. Continue turning counterclockwise until both "%METHANE" digits are blank. Note that the decimal point continues to be displayed. This is the power "ON" indication at the controller.

GENERAL MONITORS

INSTALLATION CHECKOUT (cont'd)

1.0% METHANE "LOW" & 2.0% METHANE "HIGH" SET POINT TEST (cont'd)

at the controller. Turn the "ZERO" potentiometer clockwise until "0.0" is displayed constantly by "% METHANE" DISPLAY.

Depress "RESET" push button momentarily, then release and note the following:

a. "% METHANE" DISPLAY "0.0".

b. "ALARM" DISPLAY is "OFF".

c. "Monitor-Cut-Off-Relay" energized (contacts closed).

MALFUNCTION CUT-OFF TEST

The following test requires access to the sensor housing. If the sensor housing is located near cutting head boom or other movable parts of the mining machine, insure that all personnel safety precautions are observed.

Remove cover from the sensor housing. Remove the black sensor wire from the terminal strip and note the following:

a. "% METHANE" DISPLAY "0.0".

b. MALF Red LED is "ON".

c. "Monitor-Cut-Off-Relay" de-energized (contacts open).

Reconnect black wire and note the following:

a. "% METHANE" DISPLAY "0.0".

b. MALF Red LED is "OFF".

c. "Monitor-Cut-Off-Relay" energized (contacts closed).

NOTE: Controller unit may indicate "HIGH" ALARM if sensor is disconnected long enough to cool down. If this occurs reset "HIGH" ALARM by depressing "RESET" push button momentarily.

Inspect wiring connections at the terminal strip inside the sensor housing. Insure that they conform with applicable System Connection Diagram and that all terminal screws are tight.

Reinstall sensor housing cover, tighten cover set screw and install safety wire.

GENERAL MONITORS

INSTALLATION CHECKOUT (cont'd)

MINING MACHINE OPERATION CUT-OFF TEST

Assure that controller housing Cover Panel, Neoprene Bumper/Seal and sensor housing cover are properly installed and safety wired, where required.

Observing all necessary safety precautions, turn "ON" all mining machine switches for pumps, cutting heads, headlights, loading arms, etc., that would normally be "ON" during mining operations.

Depress "TEST" push button located on control indicator panel until display reads above "2.0%" methane, then release push button and note the following:

a. Mining Machine - All machine circuits are de-energized including headlights. Machine shuts down completely except for main power.

b. "% METHANE" DISPLAY reads "0.0%".

c. RED LED "HIGH" ALARM "ON".

Turn all mining machine switches "OFF" except for main power.

CAUTION: Do not reset "HIGH" ALARM before turning mining machine switches "OFF".

Reset of "HIGH" ALARM with mining machine switches "ON" may cause serious damage to the Monitor-Cut-Off-relay or control indicator.

Reset "HIGH" ALARM by momentarily depressing "RESET" push button and note the following:

a. "% METHANE" DISPLAY reads "0.0.

b. All ALARM displays "OFF.

Turn "ON" any mining machine switch to insure that power has been restored to the miner.

Installation check-out tests are now complete. Miner may be operated in a normal manner.

GENERAL MONITORS

THE IMPORTANCE OF CALIBRATION OF MINE METHANE MONITORING SYSTEMS

To be assured that your Methane Monitoring System is capable of functioning in a proper manner, be aware that it can only be fully tested by applying gas to the sensor. While the monitor is provided with a "Test" switch, the switch only checks the electronic readout and shut-down portions of the system, whereas gassing the sensor, checks the sensor splash/dust guard, readout and machine shut-down. Only through this checkout method are you assured that the monitor will provide a safe condition should a large release of methane occur in the mine workings, so check the system often.

Now that you are assured that machine shut-down occurs with a high methane gas concentration, it is necessary to check and calibrate the accuracy of the Methane Monitoring System. MSHA regulations, CFR 30, Part 27.24 states that machine shut-down must occur at a gas concentration of 2.0 volume percent methane and at all higher concentrations in the mine atmosphere. The calibration function serves to adjust the instrument's electronic circuitry including the readout portion to a calibration gas of a known concentration, and thus assure that shut-down does occur at 2.0 volume percent.

The selection of the proper concentration for the calibration gas is based on using a level of gas which is equivelant to 50% of the "Lower Explosive Limit" (LEL) for methane. The LEL for methane is 5 volume percent therefore the calibration gas should be 2.5 volume percent. Actually any concentration between 2.2 to 3.0 percent can be used. The actual concentration in volume percent will be marked on the "Cal Gas" label. This is the value that is to be used when setting the potentiometer during the calibration procedure. After zeroing the monitor with the zero potentiometer, the span "Pot" will be adjusted until the readout reads the exact value of the "Cal Gas". The monitor's electronic circuiitry is now set to the calibration value and its linerity will thus provide accurate readout from zero thru five percent.

GENERAL MONITORS

THE IMPORTANCE OF CALIBRATION OF MINE METHANE MONITORING SYSTEMS (cont'd)

The above provides you with information on why it is important to properly calibrate your monitor. It is most important that each step in calibration be followed as outlined in the calibration section of this manual.

Please remember that the methane monitor's job is to detect methane and to automatically shut down coal mining machinery if a dangerous methane atmosphere is present. Coal mining machinery is always well covered with coal and coal dust. The sensor's splash/dust guard screen always dirty and partially clogged. A good safety measure is to clean or replace the screens before starting your shift. A clogged screen completely eliminates methane detection and removes one of your prime safety devices. Stay safe by allowing the methane sensor to breathe and sense gas. It can prevent gas ignitions. It can save your life.

GENERAL MONITORS

CALIBRATION

The Model 420d Controller with its digital presentation provides readout display to one tenth of one percent. This is far greater resolution than available from a meter presentation, and therefore greater reason to use extreme care in the calibration of sensors. After calibrating the sensor, allow it to return to a "ZERO" reading then regas the sensor to assure repeatability. Careless calibration will cause a difference in readings of a few tenths which can be unacceptable to an MSHA inspector should he check your calibration.

Always calibrate the sensor with its splash/dust guard in place. Before calibration, be sure the outer screen is clean and free of all contamination. The screen should be inspected at least once each shift and cleaned or replaced as necessary.

The calibration of the Mine Methane Monitor system must be performed with the system power "ON". "% METHANE" DISPLAY must show the decimal point to indicate power "ON", "ALARM" DISPLAY "OFF", and the system must not be locked in "HIGH" ALARM. If system is "cold" allow at least three minutes "warm-up" before proceeding with the calibration.

Calibration of the Model 420d Mine Methane Monitor system is best accomplished using General Monitors' Portable Purge Calibrator, P/N 14-00-150, NMSC P/N 8080 1327. The calibrator consists of a methane/air gas bottle, valve, regulator, gauge, length of plastic tubing and a special plastic calibration cup which fits over the sensor splash/dust guard. The gas bottle has been filled with a known percent of methane gas which is marked on the bottle label. Percent of methane gas will vary between 2.25% and 2.75% methane. Instructions for use of the Portable Purge Calibrator are printed on the bottle label. These instructions are repeated here in greater detail. Calibration requires access to the sensor and sensor housing. Observe all personnel safety precautions when working near movable parts of the mining machine.

CALIBRATION (cont'd)

Check controller unit "% METHANE" DISPLAY. It should read "0.0%" methane. If necessary, adjust display to "0.0%" methane by turning the "ZERO" potentiometer. NOTE: "% METHANE" DISPLAY must be set to "0.0" methane in "clean air" (no methane). To check for "clean air" close end of the splashguard by placing calibration cup (with tubing hole plugged) over screened opening for about one minute. If display does not change with sensor closed off, air is "clean". If display decreased in reading, air contains small percentage of methane and meter must be "ZEROED" with the calibration cup. Connect length of plastic tubing, one end to outlet of gas bottle regulator or flowmeter and the other end to the plastic cup. The cup fits over the sensor with the splashguard installed. Calibration should only be performed with the splashguard installed.

Open valve on gas bottle until gauge indicates bottle pressure. To be assured there is adequate gas flow for calibration, check the flowmeter (with flowmeter in a vertical position) for 420 ml/min.

"% METHANE" DISPLAY on controller indicator will begin to increase. When display reads "1.0%" methane note the following:

a. Amber LED flashes to indicate "LOW" ALARM.

b. "Monitor-cut-off-relay" energized (contacts closed).

When a "% METHANE" DISPLAY reads "2.0%" Methane note the following:

a. Red LED also comes "ON" to indicate "HIGH" ALARM.

b. "Monitor-cut-off-relay" de-energized (contacts open).

GENERAL MONITORS

CALIBRATION (cont'd)

Wait several seconds for "% METHANE" DISPLAY to stabilize. Display should indicate the percent of methane shown on the bottle label.

If necessary, adjust the "% METHANE" DISPLAY to indicate the percent of methane shown on bottle label as follows:

Insert the small alignment tool into the hole marked "SPAN" on face plate, locate the slotted screwhead in the hole. Turn "SPAN" potentiometer clockwise to increase the display, or counterclockwise to decrease the display.

Close the valve on gas bottle by turning valve clockwise and remove plastic cup from sensor.

"% METHANE" DISPLAY will decrease to "0.0%" methane. "HIGH" ALARM LED will remain "ON".

Reset "HIGH" ALARM by momentarily depressing "RESET" push button, note the following:

a. "% METHANE" DISPLAY reads "0.0".

b. "Monitor-Cut-Off-Relay" energized (contacts closed).

"% METHANE" DISPLAY should stabilize at "0.0%" methane within 30 seconds. If "0.0%" reading has changed, readjust "ZERO" and repeat calibration procedure.

NOTE: If it was necessary to "ZERO" display with sensor closed off, use the same procedure to recheck "ZERO".

Reinstall window assembly on control indicator housing and reinstall Neoprene Bumper/Seal by stretching into position.

GENERAL MONITORS

METHANE MONITOR INSTALLATION RECORD

Initial installation of a Model 420d Methane Monitor system on any mining machine must be reported to the MSHA office. The last two pages of this manual's appendix are forms which may be removed and submitted as indicated. One copy is sent to the MSHA Approval and Certification Center, Triadelphia, WV. The other is sent to the District Office of MSHA for the district in which the mine is located.

Fill in the blanks with the appropriate information; mining machine manufacturer, type of machine, serial number, MSHA approval number and machine operating voltage. Sketch in the location of the sensor heads on the two views of the mining machine. Note the National Mine Service Co. System Part No. (8083-). Remove the proper drawing from the manual and attach to the form letter.

Sign the installation and calibration blanks and submit to the MSHA office.

GENERAL MONITORS

PERMISSIBILITY CHECKLIST

for

MODEL 420d MINE METHANE MONITORINT SYSTEM

1. ( ) Check condition of all system conduit for damage by cuts or tears.

2. ( ) Check all cable clamps for tightness.

3. ( ) Check power supply packing glands for security. Lock screw or safety wire in place.

4. ( ) Check power supply permissible box cover clearance with .005" feeler gauge which should not enter.

5. ( ) Check readout module for window security.

6. ( ) Check methane sensor for contamination on dust guard. Remove and clean dust guard at least every 8 hours of operation.

7. ( ) Check sensor housing lid for security. Safety wire should be in place.

8. ( ) Check methane high alarm shutdown. Apply calibration gas (2.5% methane in air) to the sensor to verify operation of the Cut-off Relay. When readout module displays "2.0" methane, high alarm light is "on" and Cut-off Relay should be de-energized (contacts open).

9. ( ) Immediately upon engine shutdown prepare to calibrate methane monitoring system. Note "Calibration" section on Page 19 and follow this procedure.

10. ( ) Checklist complete. System is operational for 30 day period ending

Date:_____

GENERAL MONITORS

OPERATING INSTRUCTIONS

Before each shift, check the sensor head dust cover to assure that it is free of coal dust accumulation or other contamination which could prevent gas from reaching the sensor.

Turn "ON" the mining machine main power. The "% METHANE" DISPLAY on the control indicator unit will come "ON".

NOTE: If the system is "cold" the ALARM LED's will be activated as the methane display increases above 1.0 and 2.0%. Push "RESET" switch when it drops below 2.0%.

Turn "ON" one of the operating switches of the mining machine; headlights, pump or other convenient switch.

Depress the "TEST" push button located on the front panel of the control indicator until a reading in excess of "2.0% is displayed. The mining machine should cutoff and the "HIGH" ALARM Red LED is "ON".

Turn "OFF" all operating switches on the mining machine except the main power.

CAUTION: Do not reset "HIGH" ALARM before turning "OFF" mining machine switches. Reset of "HIGH" ALARM with mining machine switches "ON" may cause severe damage to the "Monitor-Cut-Off-Relay", or control indicator. Reset the "HIGH" ALARM by depressing the "RESET" push button momentarily. The Model 420d Mine Methane Monitor system is ready for opertion.

During mining or loading operations the Mine Methane Monitor system will continuously display the percent of methane at the monitoring point. If that percent of methane exceeds 1.0% the Amber LED will flash to indicate "LOW" ALARM and the mining machine will continue to operate. However, operation at a reduced pace until the "LOW" ALARM goes "OFF" may prevent a "HIGH" ALARM cutoff.

GENERAL MONITORS

OPERATING INSTRUCTIONS (cont'd)

If more than 2.0% methane is sensed at the monitoring point the mine methane monitor will latch in the Red "HIGH" ALARM LED and the mining machine will be cut-off. In that event turn "OFF" all operating switches on the mining machine except main power and wait for the "% METHANE" DISPLAY to indicate less than 1.0% methane. Reset the "HIGH" ALARM to normal by depressing the "RESET" push button momentarily, the "HIGH" ALARM LED will go "OFF".

CAUTION: Do not reset "HIGH" ALARM before turning "OFF" mining machine switches.

Restart mining machine and continue mining operations.

Should the Red MALF LED come "ON" during mining operation, the mining machine will be cut-off. The Red MALF LED display indicates a sensor circuit malfunction. This condition could be caused by sensor failure or a broken wire in the sensor head to the controller housing cable. Refer to the Servicing Section of this manual (See Page 27) for corrective repair.

GENERAL MONITORS

MAINTENANCE

SENSOR DUST COVERS

The sensor dust covers should be inspected at the start of each work shift by the mining machine operator. The operator will look for excessive dust accumulation or other contamination on the outside of the stainless steel mesh in the dust cover. Grease or oil leaking from the mining machine must not be allowed to accumulate. Crushed or broken dust covers must be replaced.

The sensor SS mesh dust covers should be removed and inspected on a regular daily schedule, or more often if operation conditions require it. The SS mesh dust cover can be removed by the screen pull tab from the sensor and the inside of the cover examined for evidence of contamination.

When the SS mesh dust cover is removed an additional fine mesh screen will be seen on the end of the sensor. This screen should be free of dirt.

Stainless steel mesh dust covers can be cleaned with a solvent such as naptha or equivalent. Blow out with an air nozzle and thoroughly dry. This cycle can be repeated indefinitely.

CAUTION: Do not install dust covers which have not been thoroughly dried or aired. Dust covers which contain wet residues of volatile or flammable solvents can cause false methane readings or "HIGH" ALARM.

CALIBRATION

Regulations require that the mine methane monitoring system be calibrated every 30 days. Calibration must be performed in accordance with the CALIBRATION Section of this manual. Operating experience in a particular mine or working area may indicate a requirement for calibration on a more frequent schedule.

Calibration must be performed if a sensor and/or control indicator unit are replaced for any reason.

GENERAL MONITORS

SERVICING

SENSOR REPLACEMENT

Insure that all "POWER" is "OFF".

Remove the dust cover by unscrewing from the sensor.

Cut safety wire and remove cover from sensor housing.

Loosen three terminal screws on sensor side of terminal block for the Black, Red and White sensor wires. Disconnect Black, Red and White sensor wires from terminal block.

Use a wrench on the hex flats of the sensor, unscrew sensor from sensor housing. Install new sensor by reversing above procedure. Install new or clean dust cover.

NOTE: Recalibration of the mine methane monitoring system is required after sensor replacement. Recalibrate per the CALIBRATION Section of this manual.

CONTROL-INDICATOR "ELECTRONIC MODULE" REMOVAL

The electronic circuitry for the Model 420d is contained in a plug-in enclosure module within the controller cast iron case. It may be removed by the following method:

a. Insure that all "POWER" is "OFF".

b. Remove the Neoprene Bumper/Seal.

c. Loosen the four screws retaining the Lexan Cover Panel. Remove the panel.

d. The metal removal bail is now exposed, laying on the instrument panel. It should be swung to a vertical position with reference to the instrument panel.

e. Slowly, pull the removal handle to disengage the electrical connector, then remove the enclosure from the cast iron case.

Due to the extensive use of logic circuitry in the Model 420d, it is not recommended that service be attempted by other than factory authorized National Mine

GENERAL MONITORS
SERVICING (cont'd)

CONTROL-INDICATOR "ELECTRONIC MODULE" REMOVAL (cont'd)

Service Company service shops. National Mine Service Company is equipped with special electronic test equipment specifically designed to trouble shoot the Model 420d. Exchange electronic modules are available, through National Mine Service Company, to minimize down time.

The "ELECTRONIC MODULE" is replaced in the controller cast iron case as follows:

a. Insure that all "POWER" is "OFF".

b. Care should be taken to properly orient the module with the controller case. This can be accomplished by noting the stepped bottom of the module and its off-set connector.

c. Carefully align the connector pins and "feel" for initial engagement. After connector engagement, press the module into final seated position.

d. Swing the handle down against the instrument panel.

e. Carefully remove all dust from the instrument panel and machined seal surface for the Lexan Cover Panel.

f. Before replacing the Lexan Cover Panel inspect its gasket to assure that it will maintain a tight water and dust seal.

g. Replace Lexan Cover Panel, tightening screws snugly.

h. Replace Neoprene Bumper/Seal carefully to further assure the case seal integrity.

i. The controller is now ready for operation.

j. Re-calibrate system if exchanged module is installed.

CONTROLLER ALARM SET POINT ADJUSTMENTS

Alarm set points are factory set at 1.0% methane for "LOW" ALARM and 2.0% methane for "HIGH" ALARM. The alarm set points may be lowered in increments of one-tenth of one percent when required for gassy mine applications. These adjustments should be made by National Mine Service Company Personnel.

GENERAL MONITORS

CAUTION & WARNING

All Model 420d systems have been tested and certified by Mine Safety and Health Administration (U. S. Dept. of Labor) and by Energy, Mines and Resources Canada. All Model 420d Power Supplies have a current limited output of 0.75 Amps at 8 VDC and are certified as intrinsically safe by both of the above agencies. Should repair be required, it is not permissible to change the values of any components in either the Power Supply or the Controller unit. Deviation, change or substitution of such components could violate the intrinsic safety of the monitoring system.

All servicing and repairs should be performed only by National Mine Service Co. factory authorized repair centers.

GENERAL MONITORS through engineering design, testing, manufacturing techniques and rigid quality control, delivers the finest gas detection systems available. The user is required by MSHA to establish a suitable maintenance program to keep the Methane Monitoring system operative.

1. MSHA requires the Methane Monitor to be checked for accuracy at least once each month. This requirement is satisfied by "CALIBRATING" the system and it is the only method of insuring proper system accuracy and operation. "CALIBRATION" is defined as the procedure of applying a known concentration of gas to the sensor while observing the monitor. The digital display will indicate the gas concentration and activate alarm indicators/circuits in direct relationship to gas concentration. "CALIBRATION" adjustments must be made if results are at variance (See CALIBRATION Section of this manual).
2. GENERAL MONITORS cautions, as with all equipment of this type, that high levels or long exposure to certain atmospheres will "poison" the sensor catalyst and eventually affect sensitivity. "Poison atmospheres" are: halides (compounds containing fluorine, chlorine, iodine or bromine), sul-

GENERAL MONITORS

CAUTION & WARNING (cont'd)

phur, silicone and lead. Use in this type of atmosphere requires "CALIBRATION" on a more frequent schedule.

3. GENERAL MONITORS' sensors and sensor housings are designed and tested for use in certain classes of hazardous atmosphere. Explosion-proof integrity cannot be maintained if sensors and sensor housing are operated in other than the "as designed" condition. Terminal access covers of sensor housings must be secured in place. Sensor housings must be installed in accordance with MSHA requirements.
4. Sensors are designed with screen covers which act as flame arrestors. Do not operate without screen in place.
5. The Model 420d controller has a "test" switch which checks out electronics only and gives no indication of the sensor condition chemically.
6. GENERAL MONITORS' gas detection systems are primarily SAFETY devices for the protection of personnel and facilities, and must be "always ready". With proper calibration, maintenance and installation, the system will provide continuous Mine Methane monitoring. The user will assume all liability for misuse of GENERAL MONITORS' gas detection systems by its employees or other persons.

GENERAL MONITORS

RECOMMENDED SPARE PARTS

CONTROLLER SECTION DRWG. NO. 20200

Description	GMI P/N	NMSC P/N	QTY.
Window Assembly	20193-1	8083-0219	1
Switch Plug Button	1800929-1	8080-0717	2
Sensor Cable 3 Cond. Shielded	1800842-7	8083-4096	25 ft.
Controller Cable 6 Cond x 16 AWG	20403	1920-4239	20 ft.
Control Module Assy. Manual Reset	20202-1	8083-0128	1
Control Module Assy. Automatic Reset	20202-2	8083-0144	1
Rubber Safety Guard	20024	8080-2853	1
MSHA Name Tag	20224		1
EMR (Canada) Name Tag	20229	8083-4336	1
Controller Assy. Automatic Reset	20457	8083-0284	

DOMESTIC SENSOR SECTION DRWG. NO. 1800823

Complete Assy. Sensor & Housing	* 10266-00-05	8080-1467	1
Sensor Housing	1800824-1	8080-1624	1
Sensor	10001-1	8080-1459	1
Dust Guard Assy. (1 cyl. & 1 screen)	10110	8080-3190	1
Splashguard Assy.	10117-1	8080-0204	1
Replaceable Screen Kit (12 screen)	10042	8080-2879	1
Splashguard Assy. (Optional)	* 10395-1	8080-0220	

* P/N change/addition June 1988

GENERAL MONITORS

RECOMMENDED SPARE PARTS (cont'd)

EXPORT SENSOR SECTION DRWG. NO. 20481

Description	GMI P/N	NMSC P/N	QTY.
Complete Assy. Sensor & Housing	20481	8083-4039	1
Sensor Housing	20482	8083-4021	1
Sensor	10058-1	8083-2256	1
NOTE: Dust guards same as with 1800823.			
POWER SUPPLY SECTION			
AC Power Supply 120,240,480,575 VAC	20147-1	8083-0169	1
Fuse 0.75 Amp 600V	951-106		2
Regulator Circuit Card Assy.	20162	8083-2421	1
Power Transformer	20170	8083-2009	1
Shut-down Contactor	945-033	8083-1910	1
NOTE: For Remote Control Units add:			
Remote Alarm Indicator Circuit Card Assembly.	20467		1
LOW DC Power Supply 64 or 128 VDC	20148	8083-0177	1
Fuse 0.75 Amp 600V	951-106		2
Regulator Circuit Card Assy.	20162	8083-2421	1
Inverter Circuit Card Assy.	20166	8083-2439	1
Shut-down Contactor	945-034	8083-1902	1

GENERAL MONITORS

RECOMMENDED SPARE PARTS (cont'd)

POWER SUPPLY SECTION (cont'd)

DESCRIPTION	GMI P/N	NMSC P/N	QTY.
HI DC Power Supply 150 to 550 VDC	20361	8083-0078	
Power Input Circuit Card Assy.	20428	8083-2447	1
Control Circuit Card Assy.	20430	8083-2454	1
Base Plate	20418	8083-3981	1
Fuse 0.75 Amp 600V	951-106		2
Inverter Transformer	20337	8083-1993	1
Shut-down Contactor	20437	8083-1928	1

GENERAL MONITORS

GENERAL MONITORS'S PART NO. TO NATIONAL MINE SERVICE'S PART NO. CONVERSION LIST

GMI P/N	NMSC P/N
* 420-01-00	8080-1053
1800801-1	8080-1491
1800801-5	8080-1673
1800802-1	8080-1665
1800804-1	8080-5245
1800805-1	8080-2788
1800806-1	8080-3901
1800809-1	8080-1350
1800810-1	8080-1632
1800810-3	8080-1640
1800811-1	8080-3927
1800812-1	8080-1434
1800812-3	8080-1426
1800813-1	8080-1392
1800814	8080-7753
1800815	8080-9122
1800817	8080-7670
1800818	8080-7779
1800820-1	8080-6524
1800820-3	8080-6540
1800822	8080-2861
* 10266-00-05	8080-1467
1800824	8080-1624
1800826-1	8080-1657
1800828	8080-1822
1800834	8080-3992
1800835	8080-6623
1800836	8080-1798
1800837	8080-1475
1800838	8080-0535
* 1800856	* 8080-3984
* 10395-1	* 8080-0220
* 925-057	8080-3943
10001-1	8080-1459
10042-1	8080-2879
10058	8083-2256
10110	8080-3190
10117	8080-0204
20024	8080-2853
20147-1	8083-0169
20147-2	8083-0151
20148	8083-0177
20162	8083-2421
20166	8083-2439
20169	8083-2330
20170	8083-2009
20171	8083-2348

* P/N change/ addition June 88

GMI P/N	NMSC P/N
20175	8083-1977
20176	8083-4088
20192	8083-0201
20193-1	8083-0219
* 20394	* 8083-4369
20196	8083-0235
20197	8083-0243
20199	8083-0250
20200	8083-0268
20202-1	8083-0128
20202-2	8083-0144
20210	8083-0300
20211	8083-0318
20213	8083-0326
20214	8083-0334
20216	8083-0342
20217	8083-0359
20219	8083-0367
20221	8083-0375
20222	8083-0383
20226	8083-0391
20337	8083-1993
20338	8083-2058
20347	8083-1985
20361	8083-0078
* 420D-02-04	8083-5002
20410	8083-5101
20413	8083-3973
20418	8083-3981
20419	8083-4062
20420	8083-4070
20428	8083-2447
20430	8083-2454
20437	8083-1928
20439	8083-4054
* 420D-01-00	8083-0110
* 420D-01-01	8083-0532
* 420D-01-02	8083-0490
* 420D-01-03	8083-0540
20457	8083-0284
* 10266-00-06	* 8080-2267
20482	8083-4021
20487-1	8083-0185
20487-2	8083-0193
20488	8083-1621
* 20373	* 8083-5135
20733	8083-5580
20736	8083-5622

GENERAL MONITORS

GENERAL MONITORS' PART NO. TO NATIONAL MINE SERVICE'S PART NO. CONVERSION LIST

GMI P/N	NMSC P/N		GMI P/N	NMSC P/N
20739	8083-5598		928-505	8083-1720
20744	8083-5614		928-516	8083-1738
20747-1	8083-5531		928-525	8083-1746
20752	8083-5556		928-526	8083-1761
20758	8083-5606		928-527	8083-1787
20761	8083-5572		928-528	8083-1779
915-028	8083-1068		928-529	8083-1753
915-033	8083-0839		928-607	8083-3916
915-039	8083-1118		931-001	8083-1837
915-042	8083-1019		931-002	8080-5500
915-049	8083-0847		931-019	8083-1829
915-050	8083-0854		931-020	8083-1811
915-054	8083-1001		931-036	8083-1845
915-055	8083-0987		931-300	8080-5005
915-102	8083-0896		931-302	8080-5039
915-106	8083-1035		931-306	8083-2116
915-120	8083-5153		931-311	8083-2215
915-125	8083-0961		931-316	8083-2124
915-130	8083-0904		931-322	8083-2132
915-134	8083-1076		931-324	8083-2140
915-140	8083-1043		931-332	8083-2298
915-144	8083-1084		931-339	8083-2157
915-146	8083-0912		931-345	8083-2165
915-147	8083-0920		931-346	8083-2306
915-150	8083-0938		931-350	8083-2199
915-151	8083-0995		931-351	8083-2207
915-155	8083-0946		931-353	8083-2173
915-156	8083-1050		931-357	8083-2280
915-165	8083-0979		931-417	8083-2181
921-042	8080-9932		939-003	8080-1558
921-043	8080-7555		939-004	8080-1566
921-044	8080-7571		939-006	8080-1541
921-045	8080-9049		939-007	8080-1533
921-046	8080-9023		939-008	8080-1525
921-111	8080-5948		939-011	8080-3406
921-122	8083-1373		939-013	8080-1509
921-123	8083-1381		945-002	8080-1376
921-126	8083-1399		945-009	8080-1384
921-152	8083-1407		945-015	8081-0344
921-154	8083-1415		945-028	8083-1936
921-332	8083-2371		945-033	8083-1910
921-333	8083-2363		945-034	8083-1902
921-334	8083-2397		945-035	8083-1894
921-342	8083-2355		947-002	8083-2611
921-343	8083-2389			
924-004	8083-1480			
928-307	8083-1688			
928-504	8083-1712			

GENERAL MONITORS

GENERAL MONITORS' PART NO. TO NATIONAL MINE SERVICE'S PART NO. CONVERSION LIST

GMI P/N	NMSC P/N
947-003	8083-2991
947-019	8083-2629
947-023	8083-3031
947-024	8083-2637
947-026	8083-2645
947-027	8083-2652
947-031	8083-3056
947-032	8083-2785
947-036	8083-2660
947-039	8083-2850
947-042	8083-2801
947-048	8083-2678
947-052	8083-3049
947-055	8083-2686
947-060	8083-2777
947-062	8083-2694
947-065	8083-2702
947-070	8083-2710
947-076	8083-2728
947-081	8083-2736
947-086	8083-2744
947-120	8080-8751
947-124	8080-8769
947-126	8083-3023
947-128	8080-8785
947-132	8080-8793
947-136	8080-8801
947-146	8083-2827
947-168	8080-8819
947-169	8080-8827
947-198	8080-5757
947-199	8080-5773
947-200	8080-8843
947-205	8083-2835
947-207	8083-3015
947-305	8083-2876
947-307	8083-2884
947-309	8083-2892
947-315	8083-2900
947-316	8083-2918
947-324	8083-2926
947-328	8083-2934
947-349	8083-2942
947-357	8083-2959
947-401	8080-8900
947-411	8080-8876
947-424	8083-2843
947-434	8083-2793

* P/N change or addition June 88

GMI P/N	NMSC P/N
947-435	8083-2868
947-443	8083-3007
947-452	8083-2819
947-501	8080-7894
947-507	8080-7902
947-532	8080-7910
947-539	8080-7928
947-552	8083-3155
947-563	8083-3163
* 947-526	8083-3171
* 947-529	* 8080-9437
947-566	8083-3197
947-569	8083-3205
948-005	8080-5336
948-010	8080-5369
948-014	8083-3445
948-017	8083-3619
948-019	8083-3627
948-102	8083-3544
948-103	8083-3585
948-104	8083-3452
* 948-107	8080-5708
948-112	8083-3551
948-115	8083-3601
948-117	8083-3593
948-118	8083-3577
948-126	8083-3569
948-206	8083-3460
948-207	8083-3650
948-211	8083-3726
948-212	8083-3668
948-213	8080-6086
948-216	8080-6185
948-224	8083-3718
948-225	8083-3700
948-229	8083-3692
948-230	8083-3684
948-231	8083-2041
948-232	8083-2033
948-241	8083-3676
948-315	8083-3486
948-316	8083-3494
948-317	8083-3502
951-042	8080-1806
* 951-115	8080-3919
951-403	8083-3932
951-404	8083-3940
* 960-000	8080-3430
960-304	8083-4237
* 960-315	* 8083-4260
* 960-326	