



OPERATION OF THE PHENIX HYDRAULIC SYSTEM

procedure name

PHENIX Procedure No. PP-2.5.5.2-01

Revision: D

Date: 6/23/2016

Hand Processed Changes

<u>HPC No.</u>	<u>Date</u>	<u>Page Nos.</u>	<u>Initials</u>
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Approvals

[Signature] 6/23/16
 PHENIX SE & I Date

[Signature] 6/23/16
 Cognizant Scientist/Engineer Date
 /Activity Manager

[Signature] 6/23/16
 PHENIX QA/Safety Date



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LETTER	DESCRIPTION	DATE	AUTHOR	APPROVED BY	CURRENT OVERSIGHT
A	First Issue (Reviewed 6/6/07 and determined to be up to date)	5/12/1999	n/a	(2 unintelligible, P. Kroon, W. Lenz, Y. Makdisi	D. Lynch
B	Sections 4.1 and 4.2 revised to remove references to obsolete SAC and SEAPPM. Section 4.5 changed "...two technicians..." to "...two technicians including the operator..." to clarify ambiguity.	11/9/2009	Corrections made by D.Lynch	D. Lynch, P. Giannotti, R. Pisani	D. Lynch
C	3 year review with no changes to content. New rev letter and date	6/4/2013	Update made by D.Lynch	D. Lynch, P. Giannotti, R. Pisani	D. Lynch
D	3 year review with no changes to content, except corrected type setting problems and page numbering per HPC. New rev letter and date	6/23/2016	Update made by D.Lynch	D. Lynch, P. Giannotti, R. Pisani	D. Lynch

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1.0 Purpose & Scope

The purpose of this procedure is to instruct PHENIX personnel in the operation of the hydraulic system for movement of the carriages, magnets, and shield wall in both the Building 1008 Interaction Region (IR) and Assembly Hall (AH).

The scope of this procedure covers the various modes of hydraulic cylinder operation in terms of positional control and speed of travel. Instructions are provided for the three different sets of cylinders (6", 4", and 2.5" bore) which are utilized within PHENIX.

This procedure does not include information relative to mechanical connection of the hydraulic cylinders to the carriages, magnets, or shield wall; these directions are covered in other internal procedures (PHENIX Procedures No. PP-2.5.5.1-01 and 2.5.5.2-02). This procedure does not include instructions for the detector subsystems which may require disconnection or securing prior to any movement. This is left to each individual subsystem to prepare and integrate into an overall procedure for "Preparing PHENIX Detector Subsystems for Hydraulic System Operation".

2.0 Responsibilities

- 2.1 All operations shall be performed under the direction of the PHENIX designated Cognizant Engineer.
- 2.2 Operation of the hydraulic system controls shall be performed by authorized personnel only.

3.0 Prerequisites

- 3.1 Training: All personnel involved in this procedure shall have reviewed the operation of the hydraulic system and be fully knowledgeable about the way in which the various components are mounted to and move on the rails.
- 3.2 Due to the component value, as well as the inherent personnel risk involved in operating a high-pressure hydraulic system, this procedure and all relevant BNL safety guidelines must be strictly adhered to. In accordance with BNL policy, any individual may cease operations if they in any way feel unsafe or if they believe unsafe procedures are being followed. Such a complaint shall be reviewed by the cognizant engineer, and if necessary, by BNL ES & H Services.

4.0 Precautions

- 4.1 All personnel involved in this procedure must have a current PHENIX Awareness Training Certificate (SAC).
- 4.2 All personnel involved in this procedure shall wear safety shoes during all operations.
- 4.3 Safety glasses must be worn when connecting or disconnecting potentially pressurized hydraulic lines. The hydraulic pump motor must be turned off when connecting or disconnecting hydraulic lines.
- 4.4 All personnel involved in this procedure shall be aware of the location of the hydraulic system “Emergency Stop” button and wall-mounted circuit breaker.
- 4.5 A minimum of two technicians, including the hydraulic system operator, must be present during any of these operations, with their sole focus being on the moving components.
- 4.6 Operators shall ensure that personnel do not stand close enough to the rails so as to endanger themselves. Other technicians working in Bldg. 1008, and all visitors, shall be cautioned as to the hazards involved. If appropriate, areas can be cordoned-off and Bldg. 1008 closed to other traffic.

5.0 Procedure

5.1 System Description

5.1.1 The hydraulic system consists of the following major components:

- A) “Giddings & Lewis PiC 900” programmable industrial computer
- B) “Nematron” operator interface
- C) “Rex Roth” hydraulic power unit & associated valves
- D) ”Sheffer” cylinders with “Temposonics” feedback transducers

Figure (1) indicates the interconnection between these devices. The PiC contains a program to control the motion of the cylinders. The feedback devices built into the cylinders provide information that allows for accurate positioning of the load being moved

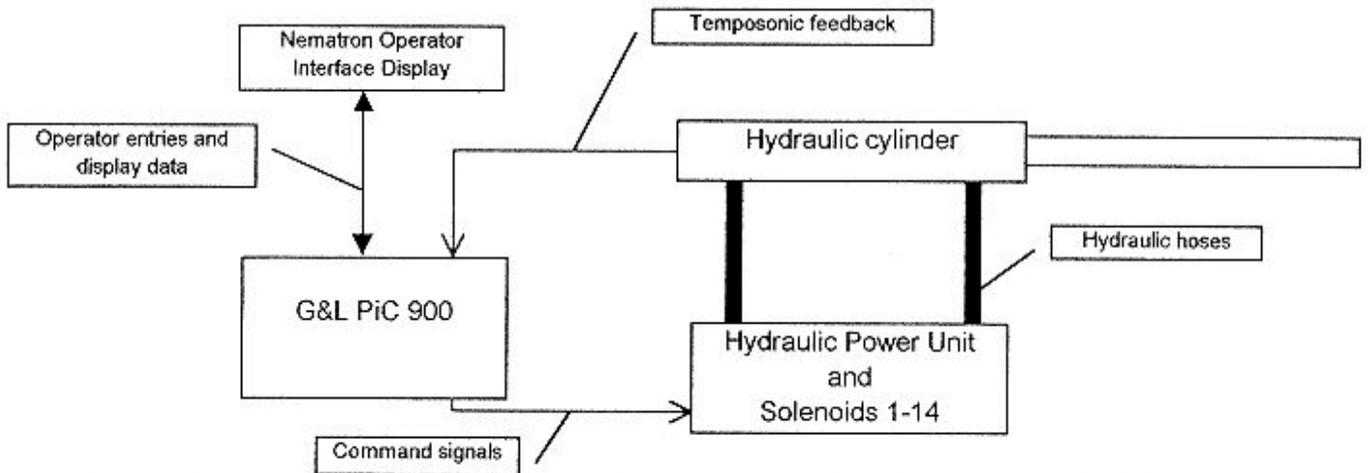


Figure 1

Prior to start-up, each Temposonics position sensor (thus, each cylinder) has specific parameters which must be set using the “BCD” programming switches located inside the PiC control console. Programming via these switches is described in detail in the “MK292 Digital Output Module Users Manual” (Reference 7.2). Input parameters for each cylinder are summarized in the table below:

Bore (inches)	Serial Number	Installed Location	Number of Recirculations	Gradient (nS/inch)	Resolution (inches)	Range (inches)
6	1610356	MMS-West	4	8.9550	.002	70
6	1610357	As Required	4	8.9990	.002	70
6	1610358	MMS-East	4	8.9585	.002	70
6	1610359	As Required	4	9.0477	.002	70
4	17123271	As Required	2	9.0132	.002	40
4	17123272	As Required	2	9.0294	.002	40
2.5	17123273	S.E. Carriage	2	9.0428	.002	40
2.5	17123274	N.W.Carriage	2	9.0222	.002	40
2.5	17123275	N.E. Carriage	2	9.0411	.002	40
2.5	17123276	S.W.Carriage	2	9.0387	.002	40

TEMPOSONICS PROGRAMMING NOTES:

Note 1: *The MK292 Users Manual (Reference 7.2), states that in programming each of these various parameters, the operator should:*

- A) Hold the programming (toggle) switch in Position #2 until the “xx” LED begins to flash (~3 sec.).*
- B) Enter the parameter value using BCD switches S1 – S6.*

CLARIFICATION:

It is necessary that the programming (toggle) switch be held in Position #2 WHILE each parameter is input, and not released until that parameters data has been completely entered.

Note 2: *When inputing the zero/null offset using the BCD switches, these values should be entered as “zero” with the cylinders fully withdrawn (unless for some reason the operator prefers to read some intermediate cylinder position as “zero”).*

- 5.1.3 Cylinders are designated as “Cylinder #1” (tagged RED) and “Cylinder #2 (tagged BLUE). Hoses are also tagged with either one or two red or blue stripes for ease of identification. Hose connections must be made as follows:

Connect the hose tagged with one red band between the forward (clevis) end of Cylinder #1 and the top-most hydraulic connector beneath valve SV8 on the rear of the hydraulic power unit.

Connect the hose tagged with two red bands between the rear (stationary) end of Cylinder #1 and the bottom-most hydraulic connector beneath valve SV8 on the rear of the hydraulic power unit..

Connect the hose tagged with one blue band between the forward (clevis) end of Cylinder #2 and the top-most hydraulic connector beneath valve SV10 on the rear of the hydraulic power unit.

Connect the hose tagged with two blue bands between the rear (stationary) end of Cylinder #2 and the bottom-most hydraulic connector beneath valve SV10 on the rear of the hydraulic power unit.

- 5.1.4 Each cylinder has a signal cable terminating in a “J”-style connector. These two cables tie-in to a single cable which connects to the JB1/JB2 connection on the lower right side of the PiC control console.

- 5.1.5 Attach “Signal Cable C” to the top of the hydraulic pump unit power box at one end and to the “Hydraulic Power Unit Connector” located on the lower right-hand side of the PiC console at the other.
- 5.1.6 If operation in the **Full-Manual** mode is desired, the control knob located inside the hydraulic power unit control box must be set to either EXTEND or RETRACT (as opposed to its normal **Automatic** setting). This disables the computer command over the flow control valves (SV-7, 8, 9, 10), which then must be operated by hand while watching the positional readout on the Nematron display.

5.2 Operating Instructions

- 5.2.1 Turn-on the power switch on the rear of the PiC control console. The Nematron display screen will energize and indicate that the system is going through a series of self-tests, culminating in the initial system “Set-up” screen:

= **In. ---- CYL1**
 = **In. ---- CYL2**
1) FAST JOG 2) SLW JOG
3) AUTO 8) SLOW 9) FAST

The small red light on top of the auxiliary control box on the left-hand side of the hydraulic power unit will light if the system is in the **Automatic** mode and remain dark if in the **Full-Manual** mode (see Section 5.1.6).

Nematron Display Screen Notes:

- (1) *The blue SCREENS key returns you to the initial set-up screen.*
- (2) *The blue ALARMS key should give a screen read-out of: “There are no alarms to display; there have been no alarm conditions.”*
- (3) *The blue SELECT key should give no response.*
- (4) *The blue UPLOAD key is only used if uploading programming into the PiC.*
- (5) *The HELP key is not connected to any source of help.*
- (6) *The MENU and F() keys offer access to the same screens as do the blue keys, described above.*

- 5.2.2 Press the E-STOP RESET button. It should light-up, along with the STOP CYCLE button.
- 5.2.3 On the hydraulic power unit, turn the power on and depress the START button.
- 5.2.4 Select an operating mode from the Set-up screen menu.

Set-up Screen Menu Selection Notes:

- (1) **FAST JOG** – *Fast jogging is a method of moving one or both cylinders at the maximum speed available. For the 6-inch bore cylinders, operating singly, this speed is approximately 30-inches per minute (extend) and 50-inches per minute (retract). Speeds are roughly half as fast when both cylinders are jogged simultaneously. During fast jog, cylinder motion is not coordinated, so they may not stay in the same relative position. This mode should only be used when the cylinders are not connected to any load.*
- (2) **SLOW JOG** – *Slow jogging allows either cylinder to be jogged slowly for precise alignment. During slow jog, the cylinder motion is not coordinated. Speed for the 6-inch bore cylinders is 1-2 inches per minute.*
- (3) **AUTO** – *Auto is used to move both cylinders simultaneously while maintaining their relative position. The auto mode offers two types of movement: **MANUAL** and **AUTO-ABSOLUTE**. The **MANUAL** mode allows the cylinders to be moved slowly, remaining in synchronization, so long as the operator keeps his finger on the START CYCLE pushbutton. The **AUTO-ABSOLUTE** mode allows the operator to choose an end position to which the cylinders will go, stopping automatically. Speed of the 6-inch bore cylinders in the (slow) **AUTO** mode, whether **MANUAL** or **AUTO-ABSOLUTE** is less than 1" per minute.*
- (4) **SLOW** – *Slow is the default setting for speed control. Making this selection from the menu is not necessary.*
- (5) **FAST** – *Selecting FAST from the set-up menu will allow the cylinders to be operated at fast speed (3-inches per minute for the 6-inch cylinders) while in the **AUTO** mode.*

CAUTION: While under load, the 2.5"-bore cylinders may not be operated in any AUTOMATIC mode (Auto-Manual, Auto-Absolute, Slow or Fast speed). In order to maintain proper speed control when under load, they may only be operated in the Full-Manual mode, per Step 5.1.6.

5.2.5 Selecting (1) **FAST JOG** in Step 5.2.4 results in the following display:

Enter Passcode:
>

5.2.5.1 Input the 4-digit passcode and press the ENTER key. The display now reads:

SELECT CYLINDER
1 = CYL1 2 = CYL2
3 = BOTH CYLINDERS
CANCEL TO ABORT

5.2.5.2 Select either 1, 2, or 3, depending upon which cylinder(s) you wish to jog. The display now reads:

← EXTEND FAST
→ RETRACT SLOW
= In. - CYL1
= In. - CYL2

***Note:** Operators should be aware that the hydraulic power unit will be noticeably noisier when operating in the retract mode as compared with the extend mode. The retract pressure is 3000 psi vs. only 1700 psi for extend.*

5.2.5.3 Select whether you want to extend or retract by pressing the arrow keys on the bottom of the Nematron display.

5.2.5.4 Press and hold the START CYCLE pushbutton on the console. The cylinder(s) will extend or retract at fast-jog speed until the pushbutton is released.

5.2.6 Selecting (2) **SLW JOG** in Step 5.2.4 results in the following display:

Cyl 1 <1> extend
<2> retract
Cyl 2 <3> extend
<4> retract

5.2.6.1 Press and hold keyboard key number 1, 2, 3, or 4 and the associated cylinder will either extend or retract. Only one cylinder can be operated at a time. When the operator removes his finger from the

key, the hydraulic unit disengages.

The hydraulic unit will continue to pump once the cylinder is fully extended or retracted, but cylinder motion will cease.

If operating in the retract mode, and the Nematron display reaches “zero” before the cylinder bottoms-out, the positional counter will start counting upward again.

5.2.7 Selecting (3) **AUTO** in Step 5.2.4 results in the following display:

SELECT MODE
1) MANUAL
2) AUTO-ABSOLUTE

5.2.7.1 Selecting **MANUAL** then results in the following screen:

→ RETRACT
← EXTEND

= In. - CYL1
= In. - CYL2

5.2.7.2 Select whether you want to extend or retract the cylinders by pressing the arrow keys on the bottom of the Nematron display.

5.2.7.3 Press and hold the **START CYCLE** pushbutton on the console. The cylinders will extend or retract at slow speed until the pushbutton is released.

5.2.7.4 Selecting **AUTO-ABSOLUTE** in Step 5.2.7 results in the following screen:

ABSOLUTE MOVES
= In. - CYL1
= In. - CYL2
➤ REQ'D POS.

5.2.7.5 Input the desired position for Cylinder #1 and press **ENTER**. Cylinder #1 is the “master” and Cylinder #2 the “slave”, so that the sensors will start and stop the hydraulic action based upon the

Cylinder #1 positional reading, with Cylinder #2 moving in concert.

5.2.7.6 Press the **START CYCLE** pushbutton on the console. The cylinders will move, and remain in the same relative position, until Cylinder #1 reaches the required position.

Note 1: *Cylinder movement in the auto-absolute mode can be halted at any time by pressing the **STOP CYCLE** pushbutton. Pressing the **START CYCLE** button will then resume cylinder motion precisely where it left off.*

Note 2: *Pressing **E-STOP** will stop the cylinders and shut down the hydraulic pump. To restart after an **E-STOP**, pull the **E-STOP** pushbutton out, press the **RESET** pushbutton, and restart the hydraulic power unit.*

5.2.8 Selecting (8) **SLOW** in Step 5.2.4 will yield no response. Slow is the default setting for speed control and its specific selection is not required.

5.2.9 Selecting (9) **FAST** in Step 5.2.4 will allow the cylinders to be operated at fast speed while in the **AUTO-ABSOLUTE** mode. The screen will request that you enter a passcode:

Enter Passcode:

>

After entering the four-digit passcode, the original set-up screen will Return (see Step 5.2.1), from which the selection of **AUTO** can be made.

5.2.9.1 Selecting 3) **AUTO** results in the following display:

SELECT MODE
3) **MANUAL**
4) **AUTO-ABSOLUTE**

5.2.9.2 Selecting **MANUAL** then results in the following screen:

→ **RETRACT**
← **EXTEND**
= **In. - CYL1**
= **In. - CYL2**

5.2.9.3 Select whether you want to extend or retract the cylinders by pressing the arrow keys on the bottom of the Nematron display.

5.2.9.4 Press and hold the START CYCLE pushbutton on the console. The cylinders will extend or retract at fast speed until the pushbutton is released.

5.2.9.5 Selecting **AUTO-ABSOLUTE** in Step 5.2.9.1 results in the following screen:

ABSOLUTE MOVES
= **In. - CYL1**
= **In. - CYL2**
➤ **REQ'D POS.**

5.2.9.6 Input the desired position for Cylinder #1 and press ENTER. Cylinder #1 is the “master” and Cylinder #2 the “slave”, so that the sensors will start and stop the hydraulic action based upon the Cylinder #1 positional reading, with Cylinder #2 moving in concert.

5.2.9.7 Press the START CYCLE pushbutton on the console. The cylinders will move, and remain in the same relative position, until Cylinder #1 reaches the required position.

5.3 Troubleshooting

PROBLEM	PROBABLE CAUSE	SUGGESTED SOLUTIONS
Hydraulic pump will not start	<ol style="list-style-type: none"> 1. 460-volt power is off 2. Disconnect switch on motor start is in the OFF position 3. E-STOP circuit is not reset 4. Blown fuse in motor starter enclosure 5. Overload relay tripped in motor starter 	<ol style="list-style-type: none"> 1. Turn-on 460-volt power 2. Turn-on disconnect switch 3. Press E-STOP RESET 4. Replace blown fuse 5. Press reset button on overload
E-STOP will not reset	<ol style="list-style-type: none"> 1. Disconnect on console is OFF 	<ol style="list-style-type: none"> 1. Turn-on disconnect switch
Console display does not come on	<ol style="list-style-type: none"> 1. Console disconnect is OFF 	<ol style="list-style-type: none"> 1. Turn-on disconnect switch
Console display comes on but indicates a communication problem	<ol style="list-style-type: none"> 1. Loose cable between monitor & PiC control 2. Switch on PiC control is off 	<ol style="list-style-type: none"> 1. Reconnect cable 2. Turn switch on
When start button is pressed none of the solenoids come on	<ol style="list-style-type: none"> 1. 24-volt power supply failure 2. Cable from console is disconnected 	<ol style="list-style-type: none"> 1. Power supply fuse is blown 2. Replace power supply 3. Connect cable
Position display is incorrect	<ol style="list-style-type: none"> 1. Temposonic connector is disconnected 2. 5-V or 24-V power supply failure 3. Counter card is faulty 4. Transducer is faulty 	<ol style="list-style-type: none"> 1. Reconnect feedback cable 2. Check fuses and power supply 3. Replace or recalibrate counter card 4. Replace transducer
Fast jog does not work	<ol style="list-style-type: none"> 1. Solenoids are not enabled 	<ol style="list-style-type: none"> 1. Check 24-Volt power supply 2. Check SV11-SV14
Slow moves do not work	<ol style="list-style-type: none"> 1. Solenoids are not enabled 	<ol style="list-style-type: none"> 1. Check 24-Volt power supply 2. Check SV3-SV6 3. Check rotary actuators SV7-SV10
Coordinated moves do not work properly	<ol style="list-style-type: none"> 1. Solenoids are not working as expected 	<ol style="list-style-type: none"> 1. Check all solenoids

6.0 Documentation

- 6.1 The operator will record the following information in the Bldg. 1008 logbook for each occasion that the system is used:

Date & Time Started
Name of Operator(s)
Description of Move
Date & Time Completed
Notes on Operation & Difficulties Encountered

7.0 References

- 7.1 “Hydraulic Control System Operation and Maintenance Manual”

In-Control Systems		T.H. Paris, Inc.
1612-B Locust Ave.	AND	107E Corporate Blvd.
Bohemia, N.Y. 11716		S. Plainfield, N.J. 07080

- 7.2 “Temposonics MK292 Digital Output Module Users Manual”

MTS Systems Corp., Sensors Division
3001 Sheldon Drive
Cary, North Carolina 27513

8.0 Attachments

None