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REMEDIAL ACTION CONTRACT (RAC)
CONTRACT NO. N62472-94-D-0398
DELIVERY ORDER NO. 0009

UPDATED OPERATION AND MAINTENANCE MANUAL
GROUNDWATER TREATMENT BUILDING
NAVAL AIR WARFARE CENTER
TRENTON, NEW JERSEY

June 1998

Prepared for
U.S. Navy Northern Division

Revision	Date	Prepared by	Approved by	Pages Affected
0	6/29/98	D. Kopcow, P.E.	A. Holcomb, P.E., C.I.H.	All

The following changes, along with the attached pages, are meant to supersede the information contained in the Operation and Maintenance (O&M) Manual for Interim Remedial Groundwater Treatment System, prepared by OHM Remediation Services Corp., dated September 8, 1995 and/or the Updated O&M Manual for Interim Remedial Groundwater Treatment System, prepared by FWENC, dated February 5, 1997.

Volume 1

Section 1: 13 new extraction wells have been added to the extraction well system in addition to the existing extraction well 15BR. They all operate in the same manner as 15BR. Electrical as-builts, well installation details, and pump details have all been previously submitted. The new wells include:

22BR
5BR
BRP-2
20BR
31S
48BR
41BR
16BR
4BR
BRP-1
29BR
8BR
45BR

In addition, the West Ditch Sump has been piped into the groundwater treatment system. Currently, five wells are operating for a total of 60 gpm in addition to the West Ditch Sump:

15BR - 15 gpm
48BR - 15 gpm
41BR - 10 gpm
20 BR - 15 gpm
45BR - 5 gpm

Volume 2

No changes.

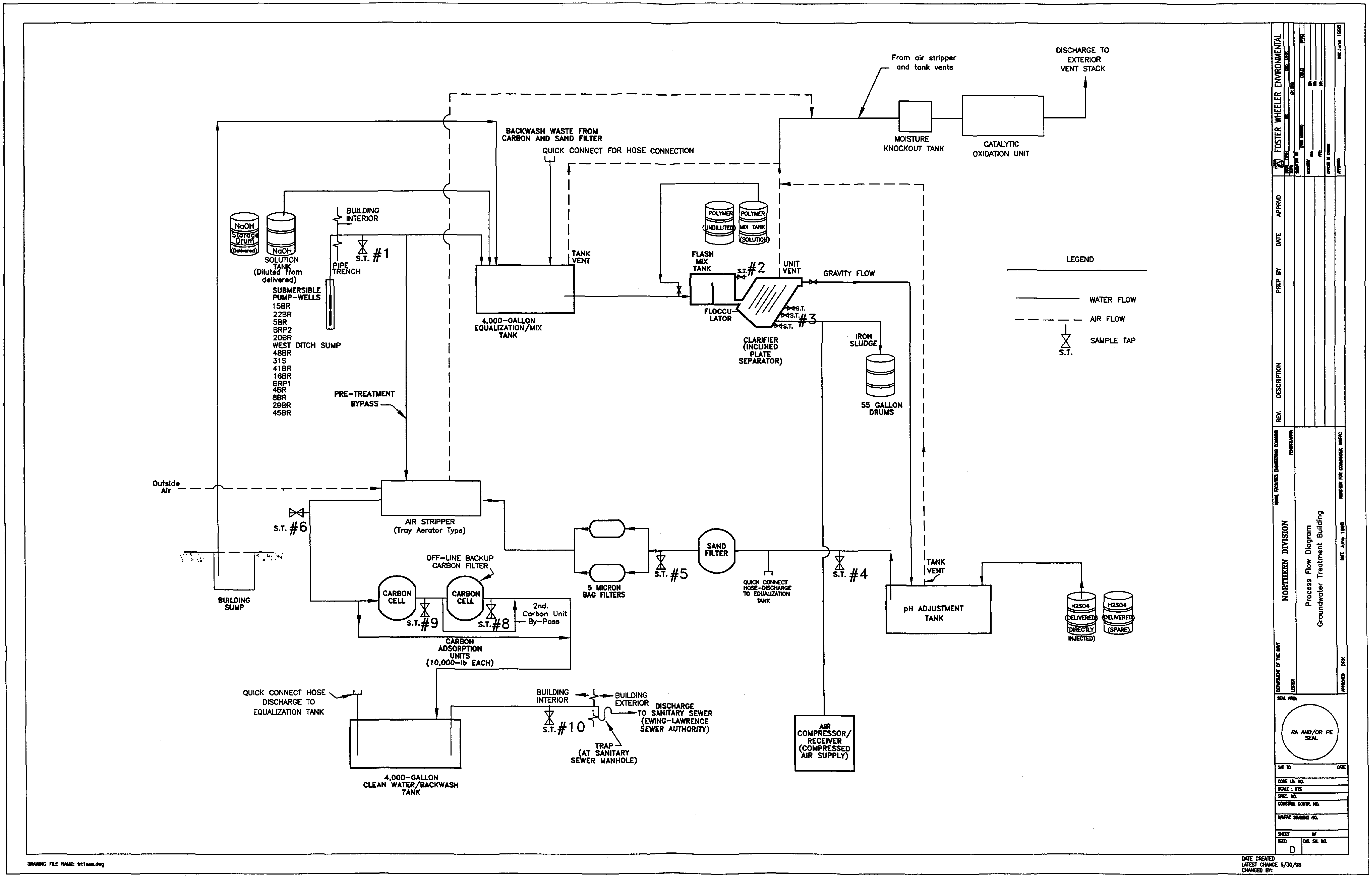
Volume 3

No changes.

Volume 4

Appendix T: Add attached as-built drawings for system modification.

Appendix V: Add attached O&M Manuals for Goulds Pumps, Ampco Pumps, ABB Instrumentation Process Indicators, Integral Orifice Flow Elements, Pressure Transmitters, and Sparling Instruments Magnetic Flowmeters



DISCHARGE TO EXTERIOR VENT STACK
From air stripper and tank vents
MOISTURE KNOCKOUT TANK
CATALYTIC OXIDATION UNIT
BACKWASH WASTE FROM CARBON AND SAND FILTER
QUICK CONNECT FOR HOSE CONNECTION
NaOH Storage Drum (Delivered)
NaOH SOLUTION TANK (Diluted from delivered)
BUILDING INTERIOR
PIPE TRENCH
S.T. #1
TANK VENT
4,000-GALLON EQUALIZATION/MIX TANK
POLYMER (UNDILUTED)
POLYMER MIX TANK (SOLUTION)
FLASH MIX TANK
S.T. #2
UNIT VENT
GRAVITY FLOW
FLOCCU-LATOR
S.T. #3
CLARIFIER (INCLINED PLATE SEPARATOR)
IRON SLUDGE
55 GALLON DRUMS
SUBMERSIBLE PUMP-WELLS
15BR
22BR
5BR
BRP2
20BR
WEST DITCH SUMP
48BR
31S
41BR
16BR
BRP1
4BR
8BR
29BR
45BR
PRE-TREATMENT BYPASS
LEGEND
WATER FLOW
AIR FLOW
S.T. SAMPLE TAP
Outside Air
AIR STRIPPER (Tray Aerator Type)
S.T. #6
BUILDING SUMP
OFF-LINE BACKUP CARBON FILTER
CARBON CELL
CARBON CELL
S.T. #9
S.T. #8
2nd. Carbon Unit By-Pass
CARBON ADSORPTION UNITS (10,000-lb EACH)
5 MICRON BAG FILTERS
S.T. #5
SAND FILTER
QUICK CONNECT HOSE-DISCHARGE TO EQUALIZATION TANK
S.T. #4
TANK VENT
pH ADJUSTMENT TANK
H2SO4 (DELIVERED) (DIRECTLY INJECTED)
H2SO4 (DELIVERED) (SPARE)
QUICK CONNECT HOSE DISCHARGE TO EQUALIZATION TANK
4,000-GALLON CLEAN WATER/BACKWASH TANK
BUILDING INTERIOR
BUILDING EXTERIOR
S.T. #10
DISCHARGE TO SANITARY SEWER (EWING-LAWRENCE SEWER AUTHORITY)
TRAP (AT SANITARY SEWER MANHOLE)
AIR COMPRESSOR/ RECEIVER (COMPRESSED AIR SUPPLY)
FOSTER WHEELER ENVIRONMENTAL
REV. DESCRIPTION PREP BY DATE APPRVD
DATE June 1998
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
NORTHERN DIVISION
PENNSYLVANIA
Process Flow Diagram
Groundwater Treatment Building
DATE June 1998
APPROVED DRK
NORTHDIV FOR COMMANDER, NAVFAC
SEAL AREA
RA AND/OR PE SEAL
SAT TO
DATE
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SCALE : NTS
SPEC. NO.
CONSTRN. CONTR. NO.
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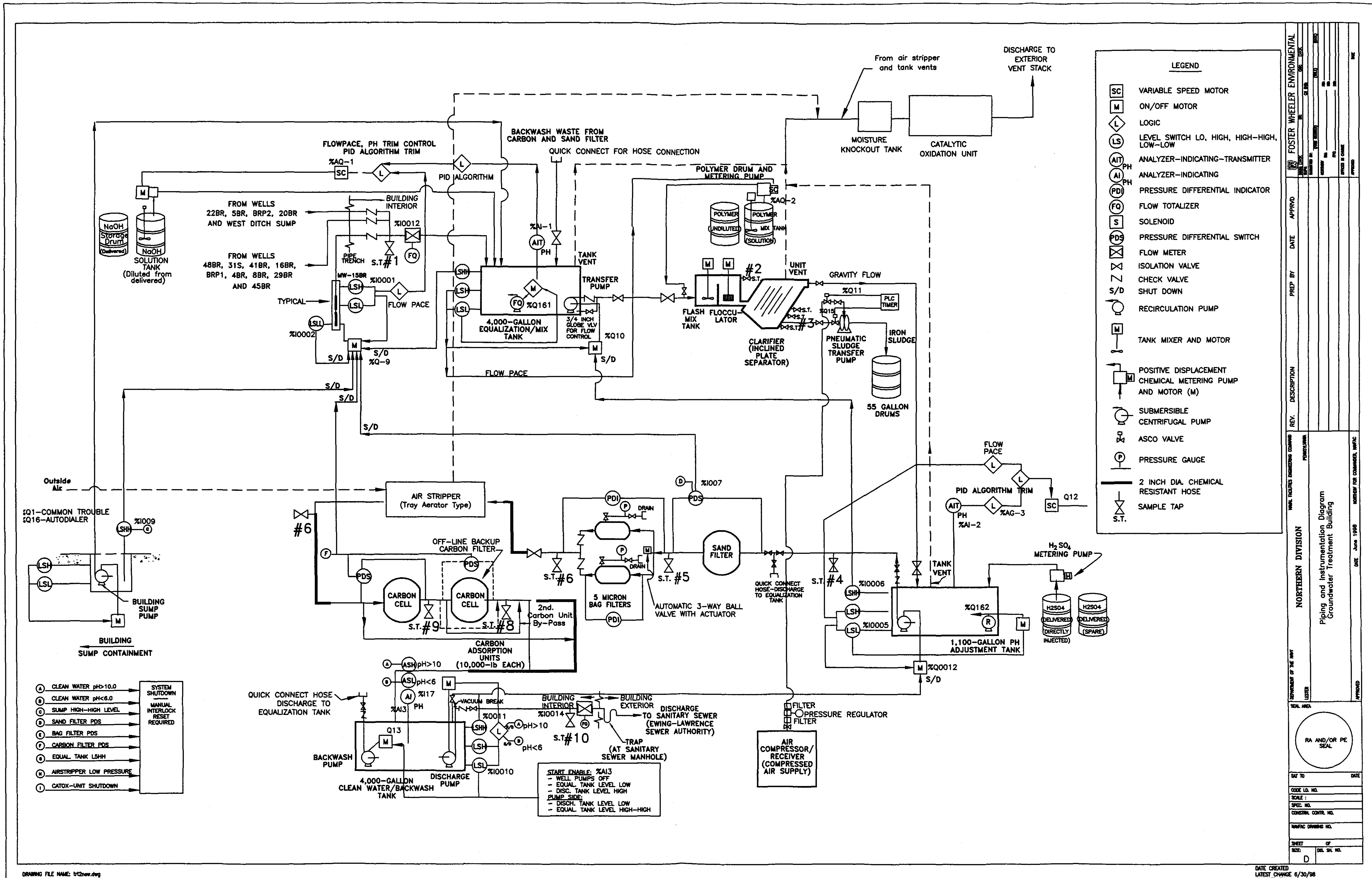

FLOWPACE, PH TRIM CONTROL
PID ALGORITHM TRIM
BACKWASH WASTE FROM CARBON AND SAND FILTER
QUICK CONNECT FOR HOSE CONNECTION
PID ALGORITHM
From air stripper and tank vents
DISCHARGE TO EXTERIOR VENT STACK
MOISTURE KNOCKOUT TANK
CATALYTIC OXIDATION UNIT
POLYMER DRUM AND METERING PUMP
NaOH Storage Drum (Delivered)
NaOH SOLUTION TANK (Diluted from delivered)
FROM WELLS 22BR, 5BR, BRP2, 20BR AND WEST DITCH SUMP
FROM WELLS 48BR, 31S, 41BR, 16BR, BRP1, 4BR, 8BR, 29BR AND 45BR
BUILDING INTERIOR
PIPE TRENCH
TYPICAL
MW-15BR
FLOW PACE
4,000-GALLON EQUALIZATION/MIX TANK
TANK VENT
TRANSFER PUMP
3/4 INCH GLOBE VLV FOR FLOW CONTROL
FLASH MIX TANK
FLOCCULATOR
UNIT VENT
GRAVITY FLOW
CLARIFIER (INCLINED PLATE SEPARATOR)
PNEUMATIC SLUDGE TRANSFER PUMP
PLC TIMER
IRON SLUDGE
55 GALLON DRUMS
Outside Air
AIR STRIPPER (Tray Aerator Type)
%Q1-COMMON TROUBLE
%Q16-AUTODIALER
BUILDING SUMP PUMP
BUILDING SUMP CONTAINMENT
OFF-LINE BACKUP CARBON FILTER
CARBON CELL
CARBON CELL
2nd. Carbon Unit By-Pass
CARBON ADSORPTION UNITS (10,000-lb EACH)
5 MICRON BAG FILTERS
AUTOMATIC 3-WAY BALL VALVE WITH ACTUATOR
SAND FILTER
QUICK CONNECT HOSE-DISCHARGE TO EQUALIZATION TANK
FLOW PACE
PID ALGORITHM TRIM
H2SO4 METERING PUMP
H2SO4 (DELIVERED) (DIRECTLY INJECTED)
H2SO4 (DELIVERED) (SPARE)
1,100-GALLON PH ADJUSTMENT TANK
QUICK CONNECT HOSE DISCHARGE TO EQUALIZATION TANK
BACKWASH PUMP
4,000-GALLON CLEAN WATER/BACKWASH TANK
DISCHARGE PUMP
VACUUM BREAK
BUILDING INTERIOR
BUILDING EXTERIOR
DISCHARGE TO SANITARY SEWER (EWING-LAWRENCE SEWER AUTHORITY)
TRAP (AT SANITARY SEWER MANHOLE)
FILTER
PRESSURE REGULATOR
AIR COMPRESSOR/RECEIVER (COMPRESSED AIR SUPPLY)
START ENABLE: %AI3
- WELL PUMPS OFF
- EQUAL. TANK LEVEL LOW
- DISC. TANK LEVEL HIGH
PUMP SIDE:
- DISCH. TANK LEVEL LOW
- EQUAL. TANK LEVEL HIGH-HIGH
A CLEAN WATER pH>10.0
B CLEAN WATER pH<6.0
C SUMP HIGH-HIGH LEVEL
D SAND FILTER PDS
E BAG FILTER PDS
F CARBON FILTER PDS
G EQUAL. TANK LSHH
H AIRSTRIPPER LOW PRESSURE
I CATOX-UNIT SHUTDOWN
SYSTEM SHUTDOWN
MANUAL INTERLOCK RESET REQUIRED
LEGEND
SC VARIABLE SPEED MOTOR
M ON/OFF MOTOR
L LOGIC
LS LEVEL SWITCH LO, HIGH, HIGH-HIGH, LOW-LOW
AIT ANALYZER-INDICATING-TRANSMITTER
AI ANALYZER-INDICATING
PDI PRESSURE DIFFERENTIAL INDICATOR
FQ FLOW TOTALIZER
S SOLENOID
PDS PRESSURE DIFFERENTIAL SWITCH
FLOW METER
ISOLATION VALVE
CHECK VALVE
S/D SHUT DOWN
RECIRCULATION PUMP
TANK MIXER AND MOTOR
POSITIVE DISPLACEMENT CHEMICAL METERING PUMP AND MOTOR (M)
SUBMERSIBLE CENTRIFUGAL PUMP
ASCO VALVE
PRESSURE GAUGE
2 INCH DIA. CHEMICAL RESISTANT HOSE
S.T. SAMPLE TAP
FOSTER WHEELER ENVIRONMENTAL
NORTHERN DIVISION
Piping and Instrumentation Diagram Groundwater Treatment Building
June 1998
RA AND/OR PE SEAL
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COMMANDER 150 User Guide
Universal Process Indicator

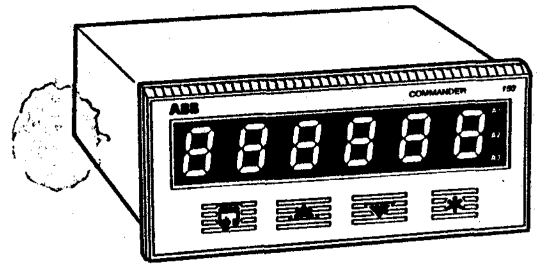

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ABB Instrumentation

ABB

Warning.
An instruction that draws attention to the risk of injury or death.

Note.
Clarification of an instruction or additional information.

Caution.
An instruction that draws attention to the risk of damage to the product, process or surroundings.

Information.
Further reference for more detailed information or technical details.

Although **Warning** hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **Warning** and **Caution** notices.

Information in this manual is intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of Technical Communications Department, ABB Instrumentation.

Health and Safety
To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

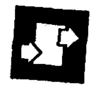
GETTING STARTED

This manual is divided into 5 sections which contain all the information needed to install, configure, commission and operate the COMMANDER 150. Each section is identified clearly by a symbol as shown below.

Displays and Controls
- Displays and function keys
- LED Indication
- Error Messages

Operator Mode (Level 1)
- Operator menus for:
  - *Standard Indicator*
  - *Totalizer/Batch Controller*
  - *Maximum/Minimum/Average Indicator*

Set Up Mode (Level 2)
- Alarm trip points
- Totalizer functions



Configuration Mode (Levels 3 and 4)
- Accessing the configuration levels
- Level 3
  - Hardware assignment and input type
  - Alarm types and hysteresis
  - Operator functions and totalizer setup
  - Digital input and serial communications
- Level 4
  - Ranges and passwords

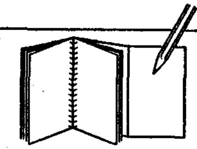
Installation
- Siting
- Mounting
- Electrical connections

Symbol Identification and Section Contents

CONTENTS

1 DISPLAYS AND FUNCTION KEYS

Information.
The fold-out page inside on the back cover of this manual shows all the frames in the programming levels. Space is provided on the page for writing the programmed setting or selection for each frame.



1.1 *Introduction – Fig. 1.1*

The COMMANDER 150 front panel display, function keys and LED indicators are shown in Fig. 1.1.

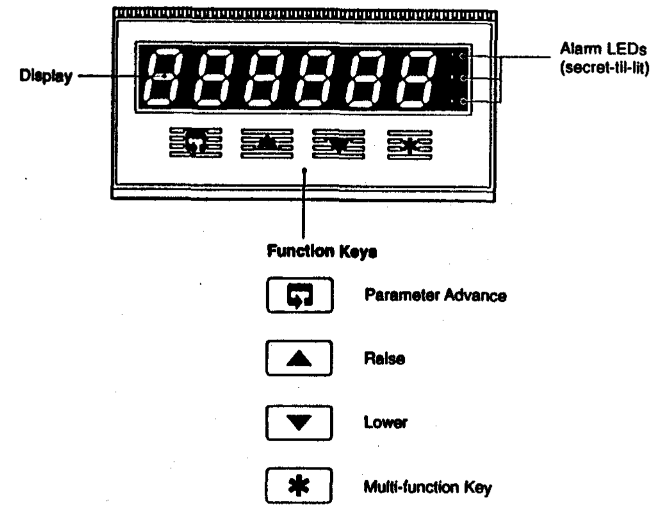


Fig. 1.1 Front Panel Display, Function Keys and Indicators

1.2 Use of Function Keys – Fig. 1.2

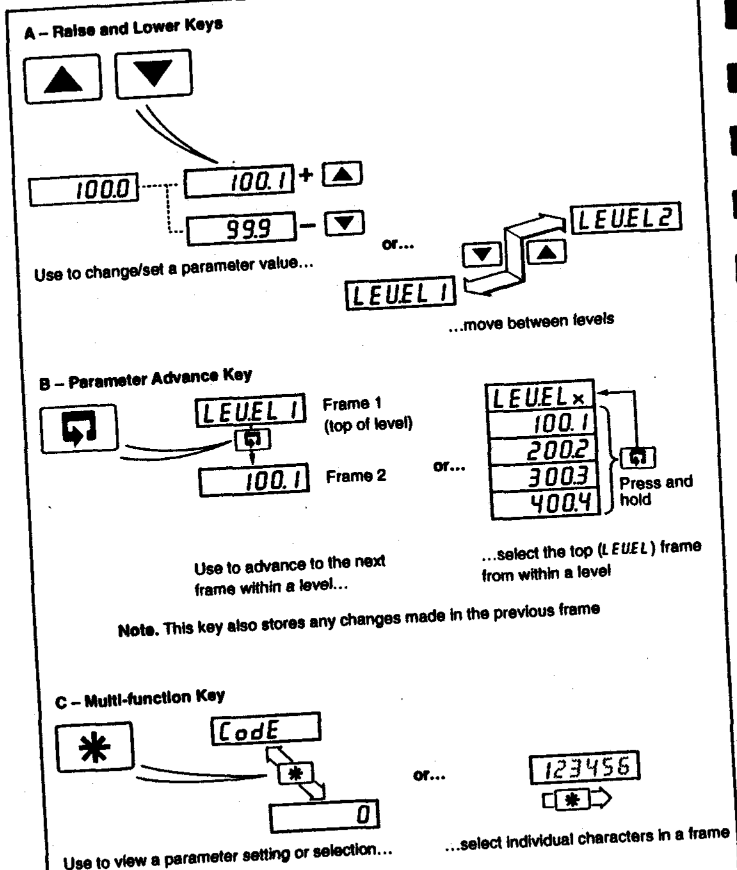
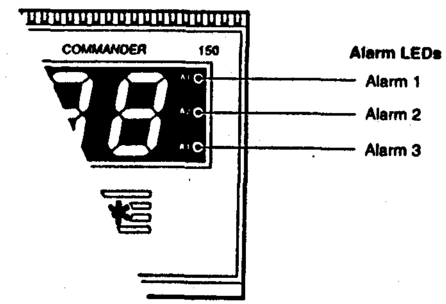


Fig. 1.2 Use of Function Keys

1.3 LED Alarms and Indicators



LED Status

All Flashing

- Indicator is in the configuration mode – see Section 4.2.

A1, A2 and A3

- Flashes when Alarm is active (off when inactive).
- Lit constantly when Alarm 1 is an active latched alarm which has been acknowledged

Fig. 1.3 LED Alarms and Indicators

1.4 Error Messages

Display	Error/Action	To Clear Display
CAL.Err	**Calibration error** Turn mains power off and on again (if the error persists contact the Service Organization).	Press the [▲] key
CFG.Err	**Configuration error** The configuration and/or setup data for the instrument is corrupted. Turn mains power off and on again (if error persists, check configuration/setup settings).	Press the [▲] key
A.d. Err	**A to D Converter Fault** The analog to digital converter is not communicating correctly.	Contact the Service Organization
-9999	**Process Variable Over/Under Range**	Restore valid input
OPt.Err	**Option board error** Communications to the option board have failed.	Contact the Service Organization

2.1 Introduction

Operator Mode (Level 1) is the normal day-to-day mode of the COMMANDER 150.

Frames displayed in level 1 are determined by the indicator functions which are selected during configuration of the instrument – see Section 4.

[*] **Note.** Only the operating frames relevant to the configured functions are displayed in Operator Mode.

The three indicator functions are:

- **Standard Indicator** – page 8
- **Indicator with Totalization** – page 9
- **Indicator with Max./Min./Average** – page 11

2.2 Operating Page – Standard (Level 1)

`2 145.3`

Process Variable

`2 145.3` Normally displayed in engineering units.

`27.6` To view the process variable in electrical units, press the [▼] key.

`UN-ACK.`*1 **Global Alarm Acknowledge (latch alarms only)**

[▲] [▼] `UN-ACK.` – alarm unacknowledged
`ACK.` – acknowledged

`CodE`

Security Code

Enter the correct code to access the setup level (Level 2).

`------` [▲] [▼] [0 to 9999]

`LEVEL 1`

Level 1

[*] **Note.** To select to this frame from anywhere in this level, press the [↺] key for a few seconds.

*1 Only displayed if there is an active latch alarm.

2.3 Operating Page – Totalizer (Level 1)

These frames are only displayed if the totalizer function is enabled in the configuration level – see Section 4.3.3

`2 145.3`*1

Process Variable

To view the input value (in electrical units) press the [▼] key.

`ACK.-n`

Global Alarm Acknowledge (latch alarms only)

[▲] [▼] `UN-ACK.` – alarm unacknowledged
`ACK.` – acknowledged

`123456`*1

Totalizer Value

When this frame is selected the current counter status is displayed (`t-GO` or `t-StOP`).

`rSt-n`

Stop/Start

[▲] [▼] `t-GO` – start totalizer
`t-StOP` – stop totalizer

Reset

[▲] [▼] `rSt-y` – reset totalizer
`rSt-n` – *do not reset totaliser*

To reset the totalizer, select `rSt-y.` then press the [*] key.

Continued on next page.

*1 Totalizer stop/go and reset from these frames can be disabled– see Section 4.3.3.
A digital input can also be used to start/stop or reset the totalizer – see Section 4.3.4

2.3 Operating Page – Totalizer (Level 1)

`PrESEt`

Preset Total
This is the value the batch total is set to when it is reset

`000000` — Select Digit — ▲ ▼ •1 [000000 to 999999 flow units]

`PrEdEt` •2

Predetermined Total
When the predetermined total is reached the batch total is reset (with wrap on) or stops (wrap off), depending on the wrap setting – see Section 3.2.

`999999` — Select Digit — ▲ ▼ •1 [000000 to 999999 flow units]

`CodE`

Security Code
Enter the correct code to access the setup level.

`------` — ▲ ▼ [0 to 9999]

`LEUEL`

Level 1

✱ **Note.** To select to this frame from anywhere in this page, press the ⮌ key for a few seconds.

•1 The predetermined value should be greater than the preset value when the totalizer is counting up and lower than the preset value when the totalizer is counting down.

•2 Only displayed if enabled in the configuration level – see Section 4.3.3.

2.4 Operating Page – Max./Min./Average Functions (Level 1)

✱ **Note.** It is possible to have totalizer and maths functions together.

`2 145.3`

Process Variable
To view the input value (in electrical units) press the ▼ key.

`Un-ACK.`

Global Alarm Acknowledge (latch alarms only)

▲ ▼ `Un-ACK.` – alarm unacknowledged
`ACK.` – acknowledged

`A 140.5` •1

Average Value
This is the mean average value of the process variable input, since the average was reset.

`rSt-n` — ▲ ▼
`rSt-Y` – reset
`rSt-n` – do not reset

To reset the average value, select `rSt-Y` then press the ✱ key.

`H 150.2`

Continued on next page.

•1 This frame can be disabled – see Section 4.3.3.

The average value is reset automatically on power-up and can also be reset from a digital input – see Section 4.3.4.

The reset function in this frame can be disabled – see Section 4.3.3.

...2.4 Operating Page – Maths Functions (Level 1)

H 150.2 •1

rSt-n

Maximum Value
This is the maximum value of the process variable since the maximum was reset.

rSt-y – reset
rSt-n – do not reset

To reset the maximum value, select rSt-y then press the [✱] key.

L 130.8 •1

rSt-n

Minimum Value
This is the minimum value of the process variable since the minimum was reset.

rSt-y – reset
rSt-n – do not reset

To reset the minimum value, select rSt-y then press the [✱] key.

CodE

Security Code
Enter the correct code to access the setup level.

[0 to 9999]

LEUEL 1

Level 1

[✱] **Note.** To select to this frame from anywhere in this page, press the [↺] key for a few seconds.

•1 This frame can be disabled – see Section 4.3.3.

The average value is reset automatically on power-up and can also be reset from a digital input – see Section 4.3.4.

The reset reset function in this frame can be disabled – see Section 4.3.3.

3.1 Introduction

To access the Setup Level (Level 2) the correct password must be entered in the security code frame (CodE) in Level 1– see Fig. 3.1.

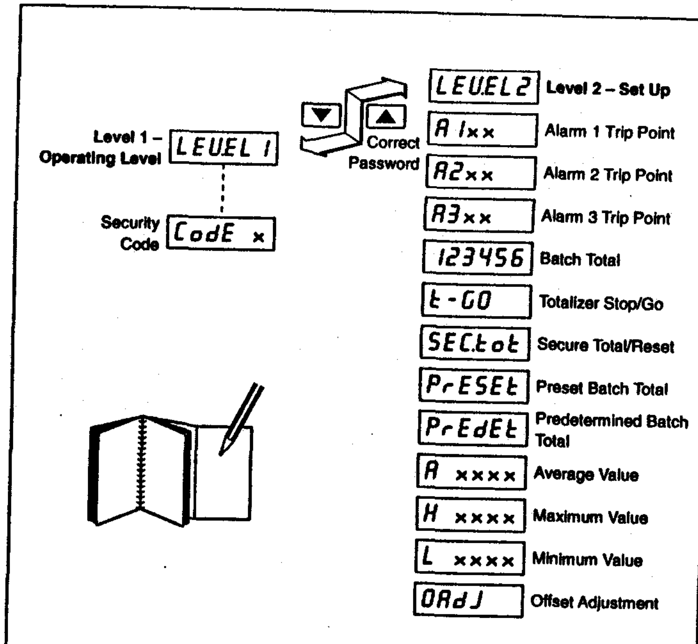
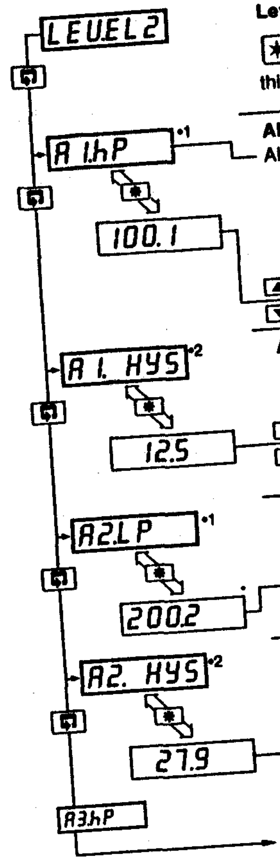


Fig. 3.1 Accessing the Setup Level (Level 2)

3.2 Setup Level (Level 2)



Level 2

Note. To select to this frame from anywhere in this level, press the [key] key for a few seconds.

Alarm 1 Trip Point

Alarm type:

- A1.hP = High process alarm
- A1.LP = Low process alarm
- A1.HL = Latched high process alarm
- A1.LL = Latched low process alarm

[In engineering units]

Alarm 1 Hysteresis Value

[In engineering units]

Alarm 2 Trip Point

Alarm type

[In engineering units]

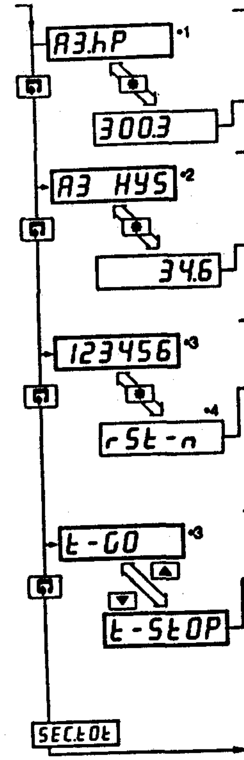
Alarm 2 Hysteresis Value

[In engineering units]

Continued on next page.

•1 Not displayed if the alarm is disabled ('None' selected) – see Section 4.3.2.

•2 Only displayed if custom alarm hysteresis is selected – see section 4.3.2



Alarm 3 Trip Point

Alarm type

[In engineering units]

Alarm 3 Hysteresis Value

[In engineering units]

Totalizer Value

- rSt-Y – reset
- rSt-n – do not reset

To reset the maximum value, select rSt-Y then press the [key] key.

Totalizer Stop/Go

- t-GO – start totalizer
- t-StOP – stop totalizer

Setting to t-GO starts the totalizer counting towards the predetermined value. Setting to t-StOP holds the totalizer at its present value.

Continued on next page

•1 Not displayed if the alarm is disabled ('NONE' selected) – see section 4.3.2

•2 Only displayed if custom alarm hysteresis is selected – see section 4.3.2

•3 Only displayed if enabled in the *Configuration Level* – see section 4.3.3

•4 A digital input can also be used to reset the batch total.

...3.2 Set Up Level (Level 2)

SECtOt [1]

Secure Total
The secure total is independent of the batch total value. When 999999 or 000000 is reached, the total is reset and then continues counting.

456789 – **Total**

Reset

rSt-n
- rSt-Y – reset totalizer
- rSt-n – do not reset totaliser

To reset, select rSt-Y then press the [✱] key.

PrESEt [2]

Preset Batch Total
This is the value the batch total is set to when it is reset.

000000 – [000000 to 999999]

PrEdEt [2]

Predetermined Batch Total
When this value is reached the batch total either resets (with wrap on) or stops (wrap off) – see Section 4.3.3.

999999 – [000000 to 999999]

A 140.5

Continued on next page.

•1 Only displayed if enabled in the Configuration Level – see Section 4.3.3.

•2 The preset value must be lower than the predetermined value when counting up, and greater than the predetermined value when counting down.

...3.2 Set Up Level (Level 2)

A 140.5 [1]

Average Value
This is the mean average value of the process variable input since the average was reset.

rSt-n
- rSt-Y – reset
- rSt-n – do not reset

To reset, select rSt-Y then press the [✱] key.

H 150.2 [2]

Maximum Value
This is the maximum value of the process variable since the maximum was reset.

rSt-n
- rSt-Y – reset
- rSt-n – do not reset

To reset, select rSt-Y then press the [✱] key.

L 130.8 [2]

Minimum Value
This is the minimum value of the process variable since the minimum was reset.

rSt-n
- rSt-Y – reset
- rSt-n – do not reset

To reset , select rSt-Y then press the [✱] key.

OAdJ

Offset Adjustment
An offset can be applied to the process variable input to enable spot calibration or the removal of system errors.

1.0 – [±10% of engineering range]

•1 The average value is reset automatically on power-up and can also be reset from a digital input – see Section 4.3.4.

•2 The maximum and minimum values are reset automatically on power-up and can also be reset from a digital input – see Section 4.3.4.

4.1 Introduction

The Configuration Mode comprises two levels (3 and 4) as shown in Fig. 4.2.

Configuration level 3 is divided into four frames. For most simple applications it is only necessary to set up the parameters in the first frame.

> **Note.**
> When in the configuration level:
> - All the l.e.d. indicators flash.
> - All relays and logic outputs are turned off.
> - The analog output reverts to 0% (4mA) output level.

4.2 Accessing the Configuration Mode – Fig. 4.1

To access the Configuration Mode set the security switch to the 'Configure' position (levels 1 and 2 cannot be accessed from this setting). When the configuration parameters are programmed, reset the security switch to the 'Normal' position and the Operating page is displayed automatically.

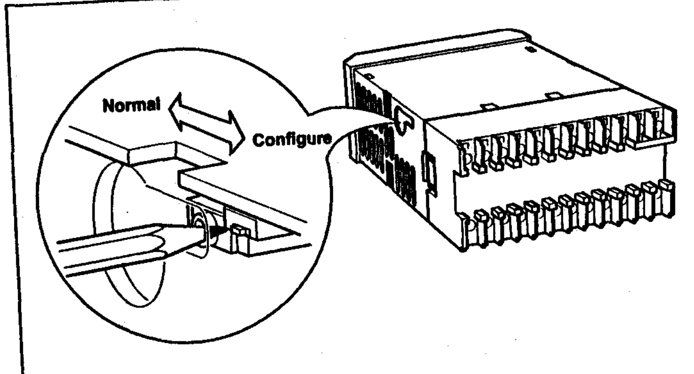


Fig. 4.1 Accessing the Configuration Mode

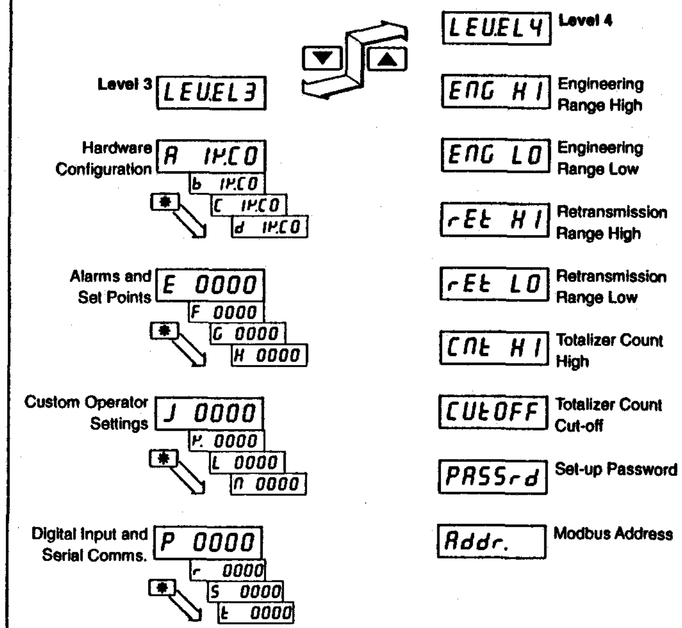
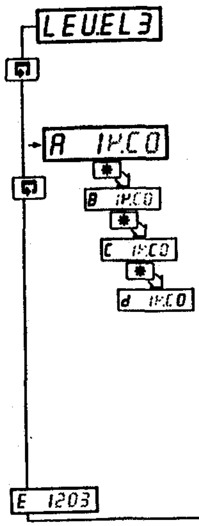


Fig. 4.2 Configuration Levels

4.3 Basic Hardware and Configuration (Level 3) – Fig. 4.3

4.3.1 Hardware Assignment and Input Type



Level 3

Note. To select to this frame from anywhere in this level, press the key for a few seconds.

'ABCD' Settings
The first character (A, B, C or D) identifies the parameter to be changed. The current setting is indicated by a flashing letter. Parameter options are shown in Fig. 4.3.

- A = Hardware configuration
- b = Input type and range
- C = Temperature units
- d = No. of decimal points

Note 1. The temperature ranges default to their maximum values when the input type is changed.

Note 2. For custom settings contact the local distributor.

Continued on page 22.

Information.
Count High Calculation

$$\text{Convert flow rate into units/sec} = \frac{\text{actual engineering flow rate}}{\text{flow range time units (in seconds)}}$$

$$\text{Count High} = \frac{\text{units/sec}}{\text{counter factor}}$$ resultant must be >0.001 and <99.999pps.

Counter factor is the engineering value of the least significant digit shown on the totalizer display – see Section 4.3.3.

Totalizer Count Pulse

The totalizer count pulse is on for a preset time of 250ms and off for a minimum of 250ms.

A IP.CO **A – Hardware Configuration**

50Hz/60Hz		Relay 1 Source	Relay 2* Source	Relay 3* Source	Logic O/P Source	Analog O/P Source
1	A	Alarm 1	Alarm 2	Alarm 3	TCP**	PV
2	b	Alarm 1	Alarm 2	Alarm 3	TWP**	PV
3	C	TCP**	Alarm 1	Alarm 2	TWP**	PV
4	D	TWP**	Alarm 1	Alarm 2	TCP**	PV
5	E	Alarm 1	Alarm 2	Alarm 3	TCP**	PV Average
U		Custom	Custom	Custom	Custom	Custom

TCP = Totalizer Count Pulse TWP = Totalizer Wrap Pulse PV = Process Variable

* Only available if the appropriate option board is fitted.
** Pulse energizes assigned relay

b IP.CO **B – Input Type and Range Configuration**

Display		Display	
b	THC Type B	1	0 to 20 mA
E	THC Type E	2	4 to 20 mA
J	THC Type J	3	0 to 5 V
K	THC Type K	4	1 to 5 V
n	THC Type N	6	0 to 50 mV
r	THC Type R	7	4 to 20 mA (square root linearise)
S	THC Type D	U	Custom Configuration
t	THC Type T		
P	PT100 RTD		

C IP.CO **C – Temperature Units**

Display	Temperature Units
C	Degrees C*
F	Degrees F*
0	No temperature units

* Temperature inputs only

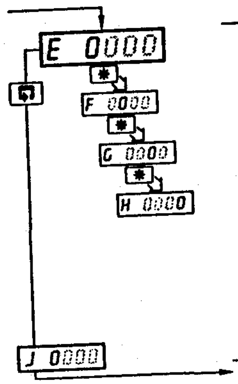
d IP.CO **D – Process Variable Display Decimal Places**

Display	
0	xxxx
1	xxx . x
2	xx . xx
3	x . xxx
4	x . xxxx

Fig. 4.3 Hardware Configuration and Input/Output Ranges

4.3.2 Alarms – Figs. 4.4 and 4.5

Note. Relays assigned to alarms are de-energized in the alarm state.



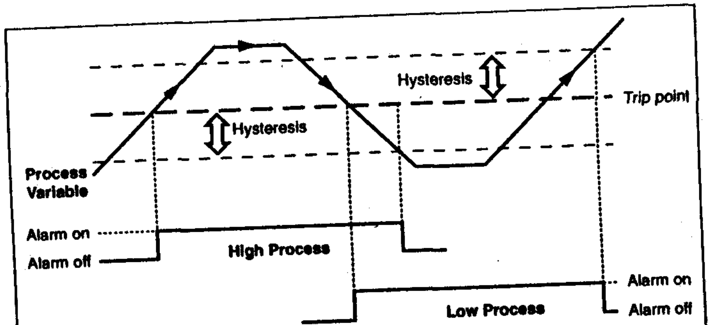
'EFGH' Settings

The first character (E, F, G or H) identifies the parameter to be changed. The current setting is indicated by a flashing letter. Parameter options are shown in Fig. 4.5.

E = Alarm 1 type
F = Alarm 2 type
G = Alarm 3 type
H = Alarm hysteresis

Note. For custom settings contact the local distributor.

Continued on page 24.



Information.
For latch alarms the relay remains de-energised until acknowledged in Level 1 (or by a digital input)

Fig. 4.4 Alarm Action

E 0000 E – Alarm 1 Type

Display	
0	None
1	High Process
2	Low Process
3	High Latch
4	Low Latch

F 0000 F – Alarm 2 Type

Display	
0	None
1	High Process
2	Low Process
3	High Latch
4	Low Latch

G 0000 G – Alarm 3 Type

Display	
0	None
1	High Process
2	Low Process
3	High Latch
4	Low Latch

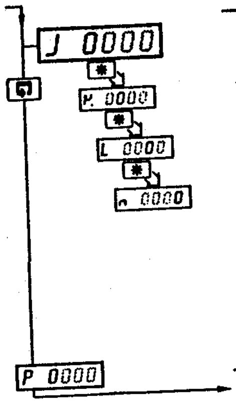
h 0000 H – Alarm Hysteresis

Display		
0	None	
1	0.1%	Value in % of engineering range
2	0.2%	
3	0.5%	
4	1.0%	
5	2.0%	
6	5.0%	
U	Custom	Value in engineering units *

Note. When custom alarm hysteresis is selected, the alarm hysteresis values are set individually in the **Set Up Level** – See section 3.2

Fig. 4.5 Alarm Setup

4.3.3 Operator Functions and Totalizer Set Up – Fig. 4.6



'JKLN' Settings

The first character (J, K, L or N) identifies the parameter to be changed. The current setting is indicated by a flashing letter. Parameter options are shown in Fig. 4.6.

- J = Totalizer set-up
- K = No. of decimal places for totalizer
- L = Operator level frame enable
- n = Operator level functions enable/disable

[*] **Note.** For custom settings contact the local distributor.

Continued on page 26.

J 0000 **J – Totalizer Setup**

Display	
0	Off
1	Count Up, Wrap Off
2	Count Up, Wrap On
3	Count Down, Wrap Off
4	Count Down, Wrap On

K 0000 **K – Totalizer Display Decimal Places**

Display	
0	xxxxxx
1	xxxxx.x
2	xxxx.xx
3	xxx.xxx
4	xx.xxxx
5	x.xxxxx

L 0000 **L – Operator Level Frame Enable**

Display	Max/Min Values Displayed	Average Value Displayed	Preset/Predetermined Values Displayed
0	No	No	No
1	Yes	No	No
2	Yes	Yes	No
3	No	Yes	Yes
4	No	No	Yes
5	Yes	No	Yes
6	Yes	Yes	Yes

This frame determines which frames appear in the operating page (level 1)

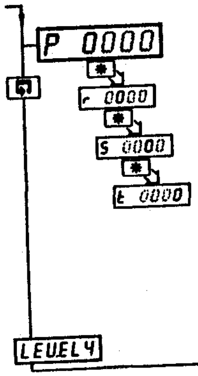
n 0000 **N – Operator Level Math Function & Totaliser Control Enable**

Display	Totalizer Stop/Go	Totalizer Reset	Max./Min./Average
0	No	No	No
1	Yes	No	No
2	No	Yes	No
3	Yes	No	Yes
4	No	Yes	Yes
5	Yes	Yes	Yes

This frame determines which functions the operator can control

Fig. 4.6 Totalizer Setup and Operator Functions

4.3.4 Digital Input and Serial Communications – Figs. 4.7 and 4.8



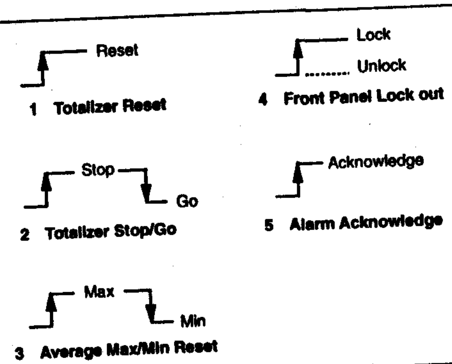
'PRST' Settings

The first character (P, R, S or T) identifies the parameter to be changed and the current setting is indicated by a flashing letter. Parameter options are shown in Fig. 4.8.

- P = Digital input function
- r = Analog input filter
- S = Serial communications configuration
- t = Serial communications parity

Note. For custom settings contact the local distributor.

Continued on page 28.



Information.
Digital input options 1, 2, 3 and 5 are edge-triggered to enable the front panel keys to change the function when the digital input is operational.

Fig. 4.7 Digital Function Configuration

P 0000 **P – Digital Input Function**

Display	
0	None
1	Totalizer Reset
2	Totalizer Stop/Go
3	Average, Max/Min Reset
4	Front Panel Lockout
5	Alarm Acknowledge

r 0000 **R – Analog Input Filter**

Display	
0	0 seconds
1	1 second
2	2 seconds
5	5 seconds
A	10 seconds
B	20 seconds
C	40 seconds
D	60 seconds

S 0000 **S – Serial Communication Configuration**

Display	Baud Rate, 2/4 Wire
0	Off
1	2400, 2 Wire
2	2400, 4 Wire
3	9600, 2 Wire
4	9600, 4 Wire

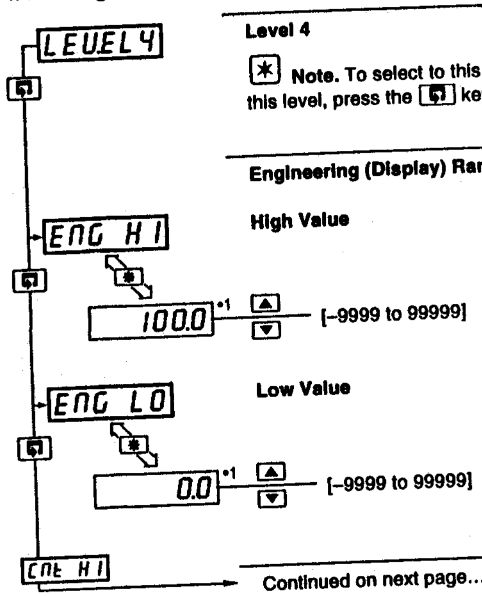
t 0000 **T – Serial Communication Parity**

Display	
0	None
1	Odd
2	Even

Note. Settings for options P, S and T are only available if the appropriate option board is fitted.

Fig. 4.8 Digital Function and Serial Communications Configuration

4.4 Ranges and Passwords (Level 4)



Level 4

Note. To select to this frame from anywhere in this level, press the key for a few seconds.

Engineering (Display) Range

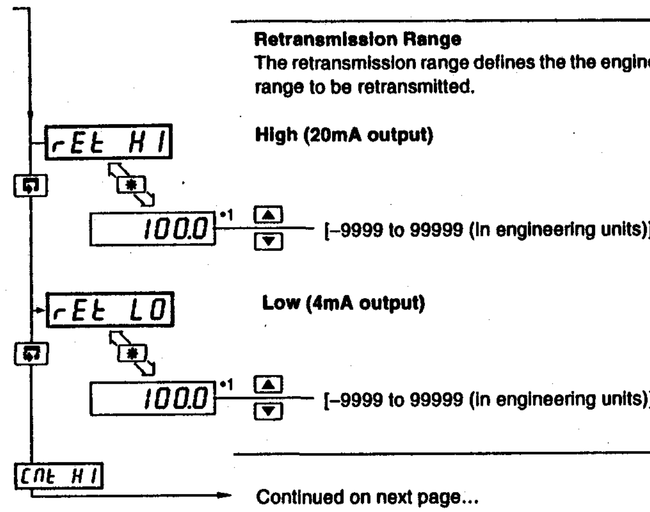
High Value

Low Value

Continued on next page...

*1 The engineering range high and low values are automatically set to the maximum allowed value when thermocouple or RTD is selected in the configuration level – see Section 4.3.1. This value can be modified if required.

...4.4 Ranges and Passwords (Level 4)



Retransmission Range

The retransmission range defines the the engineering range to be retransmitted.

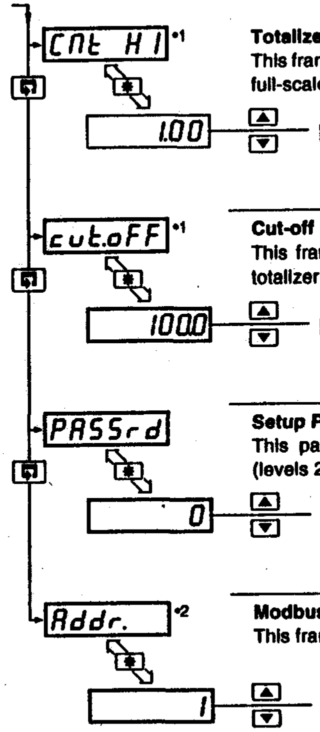
High (20mA output)

Low (4mA output)

Continued on next page...

*1 The retransmission range high and low values are automatically set to the maximum allowed value when thermocouple or RTD is selected in the configuration level – see Section 4.3.1. This value can be modified if required.

...4.4 Ranges and Passwords (Level 4)



Totalizer Count High
This frame determines the count corresponding to the full-scale input.

Cut-off
This frame sets the lowest flow value at which the totalizer is to stop counting.

Setup Password
This password enables access to the setup level (levels 2).

Modbus Address
This frame sets the Modbus address.

•1 Only displayed if enabled in the configuration level – see Section 4.3.3.

•2 Only available if the appropriate option board is fitted.

5.1 Siting – Figs. 5.1 and 5.2

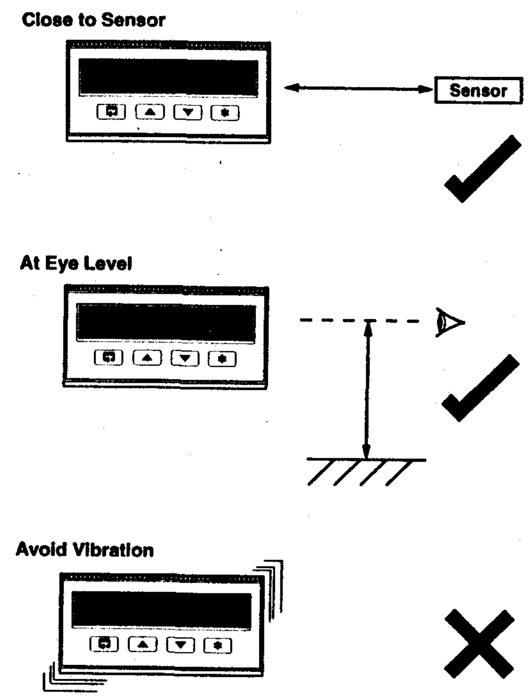


Fig. 5.1 Siting – General Requirements

...5.1 Siting – Figs. 5.1 and 5.2

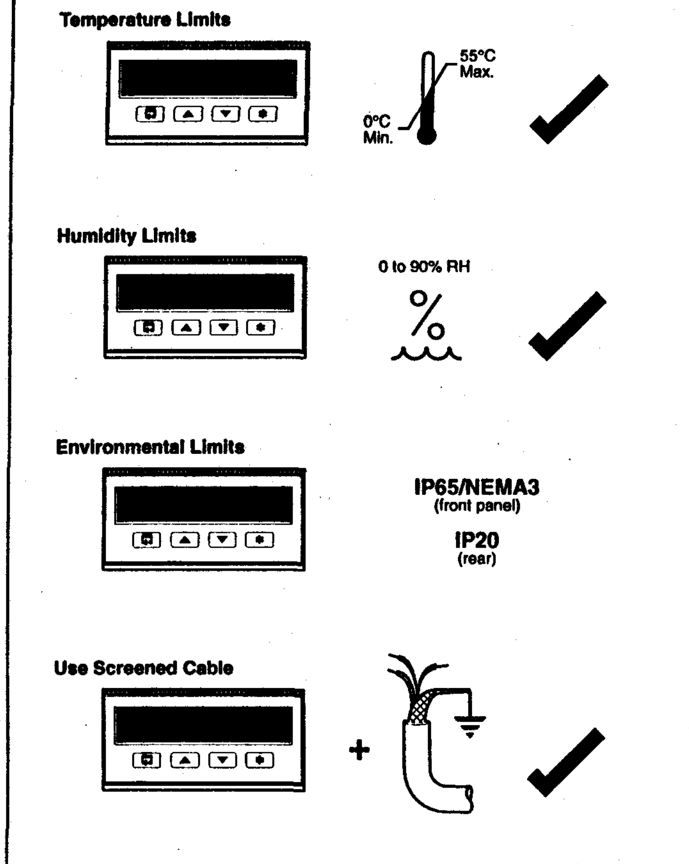


Fig. 5.2 Environmental Requirements

5.2 Mounting – Figs. 5.3 and 5.4

The instrument is designed for panel mounting (see Fig. 5.4). Overall dimensions are shown in Fig. 5.3.

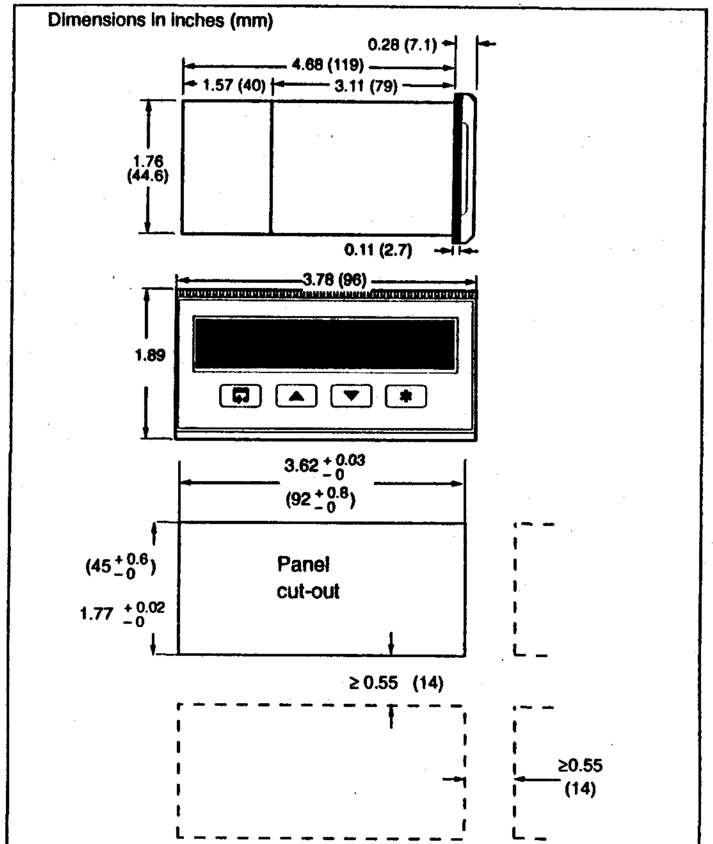


Fig. 5.3 Overall Dimensions

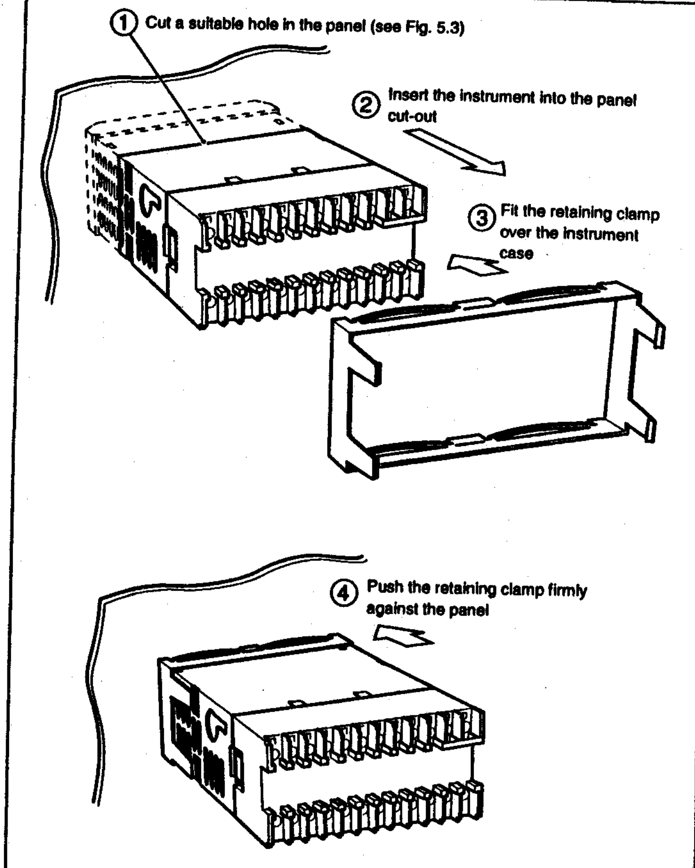


Fig. 5.4 Mounting Details

EC Directive 89/336/EEC

In order to meet the requirements of the EC Directive 89/336/EEC for EMC regulations, this product must not be used in a non-industrial environment.

5.3 Electrical Connections – Fig. 5.5 (overleaf)

⚠ **Warning.** Before making any connections, ensure that the power supply, any powered control circuits and high common mode voltages are switched off.

[*] **Note.** If it is not possible to avoid strong electrical and magnetic fields, screened cables within earthed metal conduit must be used.

5.4 Relays, Arc Suppression and Outputs

5.4.1 Relay Contact Ratings

Relay contacts are rated at:

115/230V AC at 5A (non-inductive)

250V DC 25W max.

5.4.2 Arc Suppression

Arc suppression components are fitted to relays 2 and 3 only. If relay 1 is required to switch inductive loads, fit the arc suppression components supplied.

5.4.3 Logic Output

18V DC at 20mA

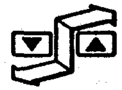
Min load 900Ω

Isolated from Analog Input (not isolated from Retransmission O/P).
Dielectric strength: 500V d.c. for 1 minute.

5.4.4 Control or Retransmission Analog Output

Max. load 15V (750Ω at 20mA)

Isolated from Analog Input (not isolated from Logic O/P).
Dielectric strength: 500V d.c. for 1 minute.



LEVEL3

A IP.CO

A_ B_ C_ D_

E 0000

E_ F_ G_ H_

J 0000

J_ K_ L_ N_

P 0000

P_ R_ S_ T_

LEVEL4

ENG HI _______

ENG LO _______

rEt HI _______

rEt LO _______

CNt HI _______

CUtOFF _______

PASSrd _______

Addr. __

IM/C150 Issue 7

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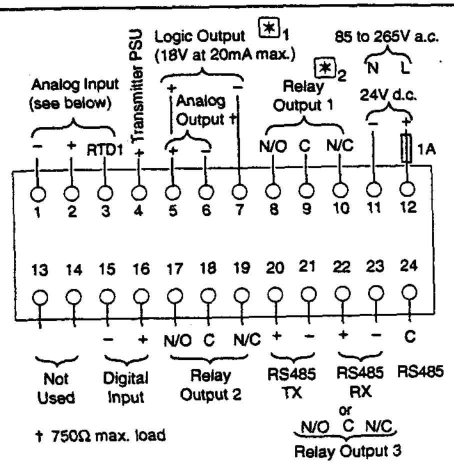


✱ **Note 1.** The Analog Output and Logic Output use a common positive terminal, capable of driving both outputs simultaneously.

✱ **Note 2.** Fit arc suppression components if switching inductive loads.

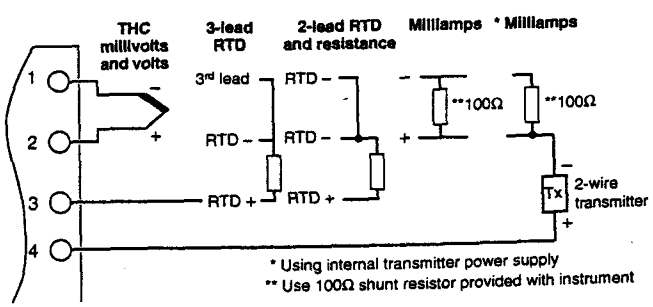


Fig. 5.5 Electrical Connections

Customer Support

ABB Instrumentation provides a comprehensive after sales service via a Worldwide Service Organization. Contact one of the following offices for details on your nearest Service and Repair Centre.

United Kingdom
ABB Kent-Taylor Limited
Tel: +44 (0)1480 475321
Fax: +44 (0)1480 217948

United States of America
ABB Instrumentation Inc.
Tel: +1 716 292 6050
Fax: +1 716 273 6207

Italy
ABB Kent-Taylor SpA
Tel: +39 (0) 344 58111
Fax: +39 (0) 344 56278

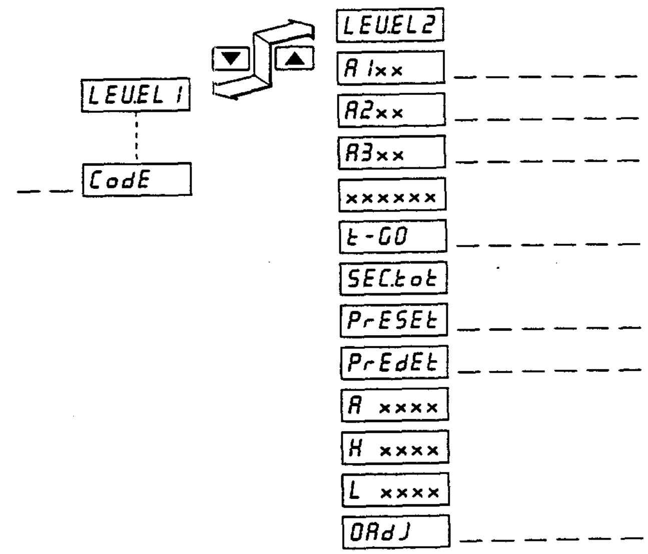
Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification. Periodic checks must be made on the equipment's condition.

In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of operating and maintenance records relating to the alleged faulty unit.

CUSTOMER SETUP LOG



Instrument Serial Number: ____________

Product Code: C 1 5 0 / _ _ _ _ / _ _ _

LIMITED WARRANTY

This warranty applies to all water systems pumps and related accessories manufactured and/or supplied by Goulds Pumps, Inc.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the buyer or any subsequent owner during the warranty period. The

GOULDS PUMPS, INC.
WATER TECHNOLOGIES GROUP
SENECA FALLS, NEW YORK 13148

4"– 60 Hz Submersible Pump Installation and Operation Instructions

page 2

Directives d'installation et de fonctionnement des pompes submersibles 60 Hz de 4 po

page 17

Instalación de la bomba sumergible de 60 Hz y 4" e Instrucciones de Operación

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Table of Contents

Owner's Information

Model Number: ______________________

Serial Number: ______________________

Dealer: ______________________

Dealer Telephone #: ______________________

Date of Purchase: ______________________

Installation: ______________________

SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

This is a **SAFETY ALERT SYMBOL.** When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

⚠ DANGER Warns of hazards that **WILL** cause serious personal injury, death or major property damage.

⚠WARNING Warns of hazards that **CAN** cause serious personal injury, death or major property damage.

⚠CAUTION Warns of hazards that **CAN** cause serious personal injury or major property damage.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED

PUMPING HAZARDOUS LIQUIDS OR FLAMMABLE GASES CAN CAUSE FIRE, BURNS OR DEATH.

DESCRIPTION AND SPECIFICATIONS

Goulds 4" submersible centrifugal pumps are for use in 4" (102 mm), or larger, diameter wells. Assembled pump/motor units purchased from the factory are UL® and CSA listed. All Franklin Electric motors are UL® recognized and CSA listed.

NOTICE: INSPECT UNIT FOR DAMAGE AND REPORT ALL DAMAGE TO THE CARRIER OR DEALER IMMEDIATELY.

Wiring and Grounding

⚠WARNING

Hazardous voltage can shock, burn or cause death

⚠ Install, ground and wire according to local and National Electrical Code requirements.

⚠ Install an all leg disconnect switch near the pump.

⚠ Disconnect and lockout electrical power before installing or servicing pump.

⚠ Electrical supply **MUST** match pump's nameplate specifications. Incorrect voltage can cause fire, damage to the motor and voids warranty.

⚠ Motors equipped with automatic thermal protection open the motor's electrical circuit when a thermal overload exists. This can cause the pump to start unexpectedly and without warning.

NOTICE: POWER CABLE SIZING MUST CONFORM TO LOCAL AND NATIONAL CODES AND STANDARDS.

- The use of wire size smaller than that provided in the National Electric Code could damage the motor and will void the warranty.
- Use only copper wire to motor and to ground. The ground wire must be at least as large as the wires to the motor. Wires should be color coded for ease of maintenance.

⚠WARNING
Hazardous Voltage

FAILURE TO PERMANENTLY GROUND THE PUMP, MOTOR AND CONTROLS BEFORE CONNECTING TO ELECTRICAL POWER CAN CAUSE SHOCK, BURNS OR DEATH.

"WARNING" Reduced risk of electrical shock during operation of this pump requires the provisions of acceptable grounding.

This pump is provided with a means for grounding. To reduce the risk of electrical shock from contact with adjacent metal parts, bond supply box to the pump-motor-grounding means and to all metal parts accessible at the well head, including metal discharge pipes, metal well casing, and the like, by means of:

1. an equipment-grounding conductor at least the size of the well-cable conductors, or the equivalent, that runs down the well with the well cable and
2. a clamp, a weld or both if necessary, secured to the equipment-grounding lead, the equipment-grounding terminal, or the grounding conductor on the pump housing. The equipment-grounding lead, if one is provided, is the conductor that has an outer surface of insulation that is green with or without one or more yellow strips. – UL 778

MOTOR CABLE INSTALLATIONS

1. Prepare the motor cable by stripping off ½" (13 mm) of the end of each conductor's insulation.

NOTICE: FOLLOW THE SPLICE KIT MANUFACTURER'S INSTRUCTIONS.

2. Where cables are spliced or connected to the motor leads, splices MUST be water tight. Commercially available potting or heat shrink kits may be used, if allowed by local or federal regulations.

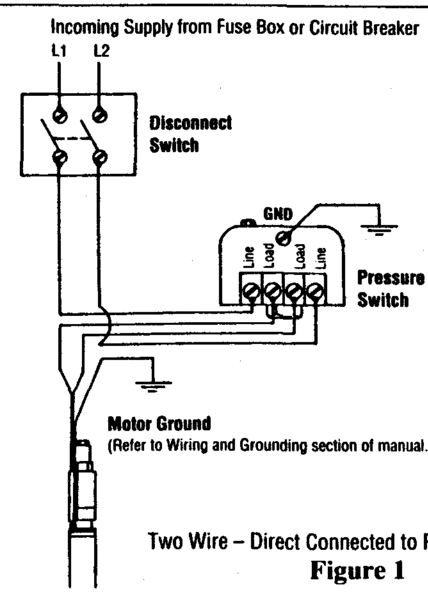
NOTICE: FOR MOTORS 5 HP AND LARGER, SPLICE CONNECTIONS MUST BE SOLDERED USING ONLY ROSIN CORE SOLDER.

3. *To ensure proper sealing, immerse splice in a metal container filled with water* for ten minutes, then take a resistance reading between the metal container and the cable conductor. Resistance should read 2 megohms or higher. Redo splice as required.
4. Complete the electrical connections to the pressure switch, contactor, control box or starter as indicated in Figure 1, 2, 3, or 4.
5. Affix motor information and submersible pump decals to the appropriate location.

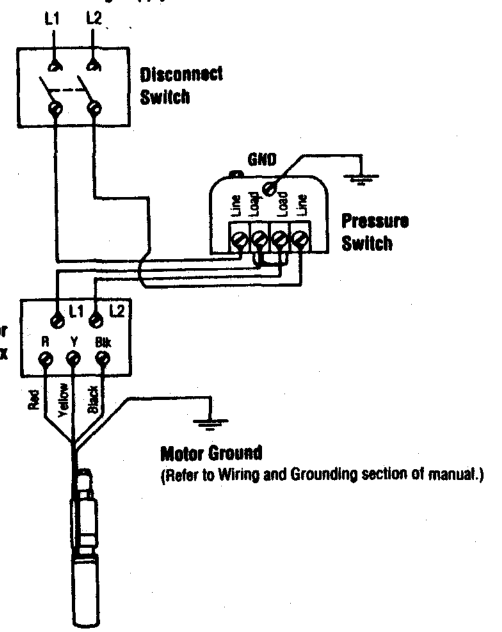
NOTICE: FOLLOW THE MOTOR CONTROL AND PRESSURE SWITCH MANUFACTURER'S INSTRUCTIONS CAREFULLY.

- Two wire motors do not require a control box. See Figure 1. Three wire, single phase motors require a control box. See Figure 2.
- Refer to "Technical Data" section of this manual for circuit breaker or fuse sizing.

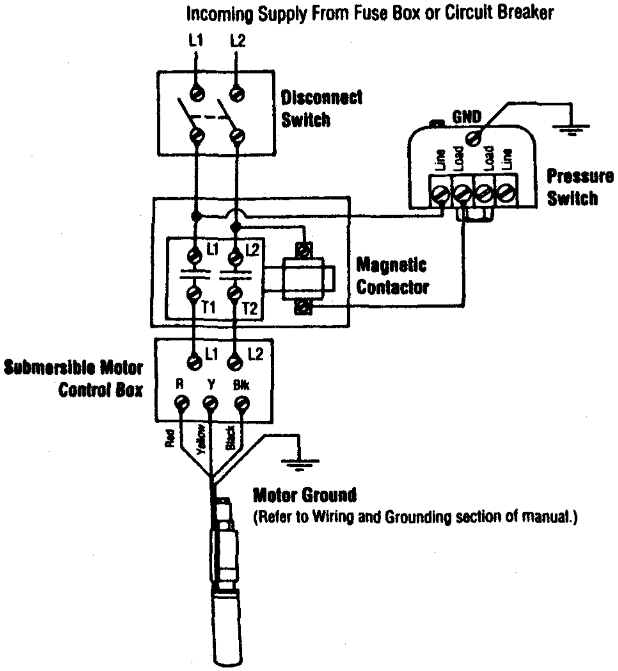
SINGLE PHASE MOTORS



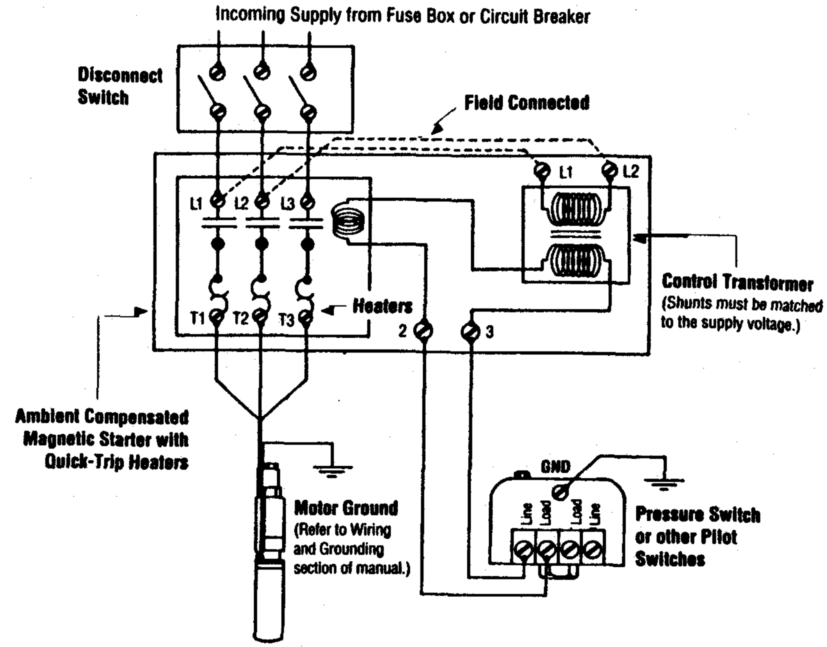
Two Wire – Direct Connected to Pressure Switch
Figure 1



Three Wire – Direct Connected to Pressure Switch
Figure 2



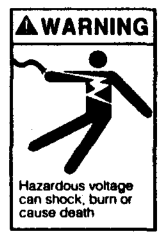
Three Wire – Connected through Magnetic Contactor
Figure 3



Three Phase Connections
Figure 4

GENERATOR OPERATION

- For externally regulated generator kilovolt amperes (KVA) ratings see Table 1. Electrical voltage, frequency, phase and ampacity, **MUST** match that shown on the motor nameplate, or pump control box.



FAILURE TO USE A MANUAL OR AUTOMATIC TRANSFER SWITCH WHEN GENERATOR IS USED AS STANDBY OR BACKUP CAN CAUSE SHOCK, BURNS OR DEATH.

Table 1

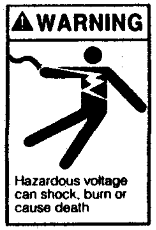
Minimum Generator Rating	Pump Motor Horsepower							
	⅓	½	¾	1	1½	2	3	5
KVA	1.9	2.5	3.8	5.0	6.3	9.4	12.5	18.8
KW	1.5	2.0	3.0	4.0	5.0	7.5	10.0	15.0

NOTE: For best starting of two-wire motors, minimum generator ratings 50% higher than shown are recommended.

NOTICE: FOLLOW THE GENERATOR MANUFACTURER'S INSTRUCTIONS CAREFULLY.

Pump Installation

NOTICE: PROTECT ALL PIPING, FITTINGS AND WATER SYSTEM COMPONENTS FROM FREEZING.



DO NOT LIFT, CARRY OR HANG PUMP BY THE ELECTRICAL CABLE. DAMAGE TO THE ELECTRICAL CABLE CAN CAUSE SHOCK, BURNS OR DEATH.

- Lower the pump into the well using the discharge pipe. A safety cable may be attached to the pump's discharge head lifting eye for added security. **DO NOT** use electrical cable to raise and lower unit. **DO NOT** damage electrical cables while raising and lowering unit.

Piping

- System piping **MUST** conform to all local and national plumbing codes and practices.
- To maximize the discharge flow, discharge piping should be at least 1" (25 mm) diameter. Keep the discharge pipe as short as possible and avoid unnecessary fittings.

NOTICE: MODELS GS AND SB ARE ASSEMBLED WITH **LEFT HAND THREADS**, HOLD THE PUMP WITH A WRENCH ON THE DISCHARGE HEAD WHILE INSTALLING THE DISCHARGE PIPE OR CONNECTOR.

- Ensure that the pump and motor are free to rotate by turning the shaft by hand.
- Connect drop pipe to pump and lower pump into well.
- Using waterproof plastic electrical tape, fasten the electrical cable to the drop pipe at approximately ten foot intervals.
- The pump **MUST** be submerged at all times for proper operation.
- Final setting must be within the pump's recommended operating range.

NOTICE: PROVIDE SUITABLE SAFEGUARDS TO PREVENT OVER PUMPING OF THE WELL. USE ONLY APPROVED DEVICES.

- Follow applicable local health codes for sealing the well and for providing an adequate power cable exit.

Tank Installation

FAILURE TO INSTALL A PROPERLY SIZED PRESSURE RELIEF VALVE CAN CAUSE PROPERTY DAMAGE, PERSONAL INJURY OR DEATH.

- If pump is to be operated with an open discharge, a discharge valve **MUST** be installed. Before startup, open this valve approximately ⅓ of the way, then start the pump. **SLOWLY** open the valve until the desired flow rate is achieved. Final setting **MUST** be within the pump's recommended operating range.

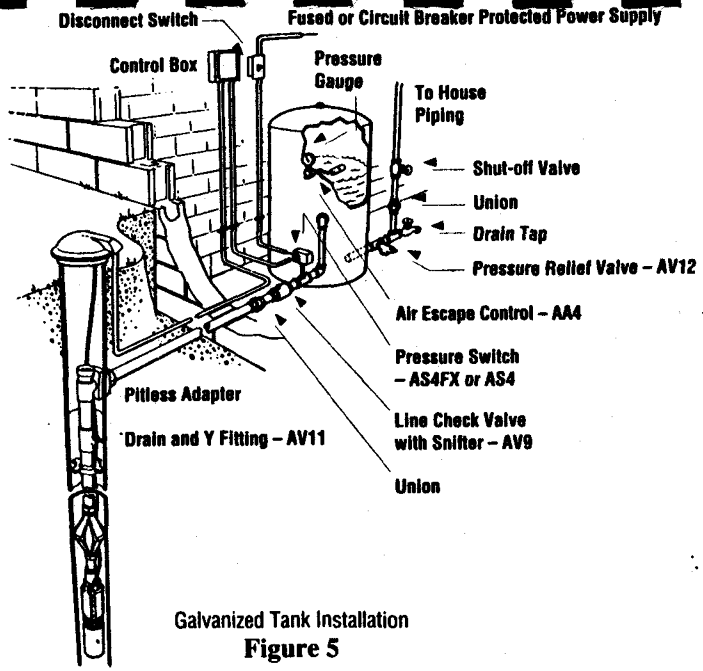
GALVANIZED TANKS

- An air charging system is required when using a Goulds' galvanized tank, or equivalent. The Goulds' system requires an AV11 – Drain and "Y" valve, an AA4 – Air Escape Control, and an AV9 – Line Check with a AA10 Snifter Valve.
- The distance between the AV9 and the AV11 determines the volume of the air charge to the tank. When the pump shuts off, the Snifter Valve on the AA4 will open to atmosphere. The AV11 will bleed the water between the AV9 and the AV11 back to the well. When the pump restarts, the air between the AV9 and AV11 will be forced into the tank. Excess tank air will automatically be bled to atmosphere by the AA4. See Table 2 for the required distance setting between the AV9 and the AV11, and Figure 5 for location and installation of required fittings and system components.

APPROXIMATE DRAIN FITTING SETTING

Tank Capacity	Distance Drain and "Y" Fitting BELOW the Line Check
42 gallon (9.5 m³/hr)	7 feet (2.1m)
82 gallon (18.6 m³/hr)	10 feet (3m)
120 gallon (27.3 m³/hr)	15 feet (4.6m)
220 gallon (50 m³/hr)	15 feet (4.6m)
315 gallon (71.5 m³/hr)	20 feet (6.1m)
525 gallon (119 m³/hr)	20 feet (6.1m)

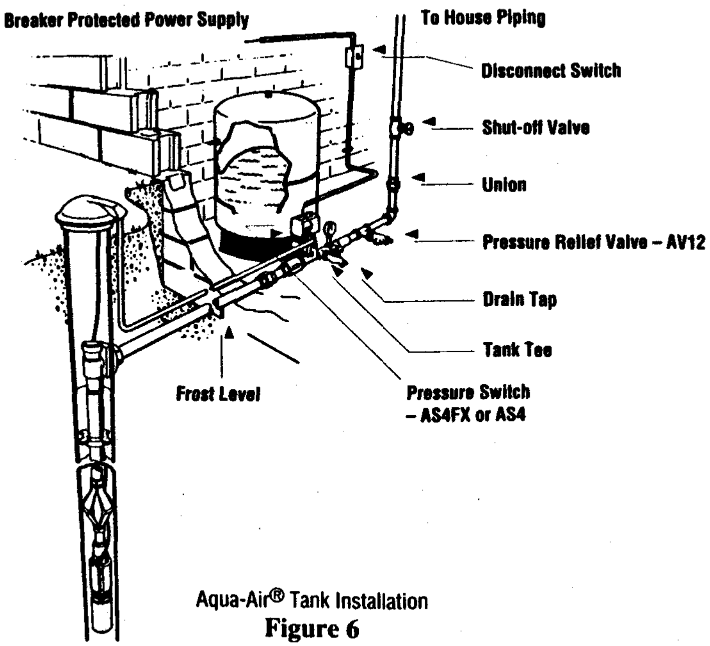
Table 2



Galvanized Tank Installation
Figure 5

AQUA-AIR® TANKS

NOTICE: TANK PRE-CHARGE PRESSURE CHANGES MUST BE MADE USING THE AIR VALVE ON TOP OF THE TANK.



Aqua-Air® Tank Installation
Figure 6

NOTICE: WITH NO WATER IN THE TANK, PRE-CHARGE MUST BE SET TO 2 PSIG (13.8 kPa) BELOW THE SYSTEM "CUT-IN" PRESSURE.

- See Figure 6 for location and installation of required fittings and system components.

Operation

PUMP OPERATION IN LAKES, SWIMMING POOLS, OR OTHER OPEN BODIES OF WATER CAN CAUSE SHOCK, BURNS OR DEATH.

Before operation, recheck the following items:
a) ALL electrical connections and grounds
b) Appropriate system shut-off valve settings
c) Appropriate pressure relief valve and check valve installations.

SINGLE PHASE MOTORS

1. Open one discharge line faucet and run the pump for one minute.
2. Close the faucet. The pump should stop when the system pressure reaches the pressure switch "cut-out" setting.
3. While observing the pressure gauge, open the faucet and note the gauge pressure reading when the pump starts.
4. Following the pressure switch manufacturer's instructions, adjust the pressure switch as required.

THREE PHASE MOTORS

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING SERVICE CAN CAUSE SHOCK, BURNS OR DEATH.

NOTICE: **THREE PHASE INSTALLATIONS AND CURRENT UNBALANCE CHECKS SHOULD ONLY BE PERFORMED BY A QUALIFIED ELECTRICIAN.**

1. Check rotation.
2. Check for current imbalance.
3. Install "K" Type overload protection if using NEMA starters, or set adjustable overloads to match motor nameplate amps.

- Current Readings at Startup:

Phase 1: ______________________________

Phase 2: ______________________________

Phase 3: ______________________________

- The motor bearings are lubricated internally. No other motor or pump maintenance is required or possible.

Technical Data

MOTOR INSULATION RESISTANCE READINGS [1]

Normal Ohm/Megohm readings, ALL motors, between all leads and ground

Condition of Motor and Leads	OHM Value	Megohm Value
New motor, without power cable	20,000,000 (or more)	20.0
Used motor, which can be reinstalled in well	10,000,000 (or more)	10.0
Motor in well – Readings are power cable plus motor		
New motor	2,000,000 (or more)	2.0
Motor in reasonably good condition	500,000 to 2,000,000	0.5 – 2.0
Motor which may be damaged or have damaged power cable *Do not pull motor for these reasons*	20,000 to 500,000	0.02 – 0.5
Motor definitely damaged or with damaged power cable *Pull motor and repair*	10,000 to 20,000	0.01 – 0.02
Failed motor or power cable *Pull motor and repair*	Less than 10,000	0 – 0.01

[1] Courtesy of Franklin Electric Company

SINGLE PHASE – 60 HZ MOTOR SPECIFICATIONS

Type	Goulds Motor Model	Franklin Motor Model	HP	Volts	Hz	S.F.	Rated Input Amps²	Max S.F. Load Amps²	Line to Line¹ Resistance M = Main S = Start	Circuit Breaker/ Fuse Amps Std	Circuit Breaker/ Fuse Amps Delay	Control Box
4" Two Wire	S03932	2445020	1/3	115	60	1.75	8.0	9.2	1.4 – 1.8	25	10	N/R
	S03942	2445030	1/3	230	60	1.75	4.0	4.6	6.0 – 7.4	15	5	N/R
	S04932	2445040	1/2	115	60	1.60	10.0	12.0	1.0 – 1.3	30	15	N/R
	S04942	2445050	1/2	230	60	1.60	5.0	6.0	4.2 – 5.2	15	7	N/R
	S05942	2445070	3/4	230	60	1.50	7.2	8.4	3.0 – 3.6	25	10	N/R
	S06942	2445081	1	230	60	1.40	8.2	9.8	2.2 – 2.7	25	12	N/R
	S07942	2445091	1 1/2	230	60	1.30	10.6	13.1	1.5 – 1.9	35	15	N/R
4" Three Wire	S03930	2145024	1/3	115	60	1.75	Y = 8.0 B = 8.0 R = 0.0	Y = 9.2 B = 9.2 R = 0.0	M = 1.4 – 1.8 S = 6.5 – 7.9	25	10	00033
	S03940	2145034	1/3	230	60	1.75	Y = 4.0 B = 4.0 R = 0.0	Y = 4.6 B = 4.6 R = 0.0	M = 6.0 – 7.4 S = 26.1 – 32.0	15	5	00034
	S04930	2145044	1/2	115	60	1.60	Y = 10.0 B = 10.0 R = 0.0	Y = 12.0 B = 12.0 R = 0.0	M = 1.0 – 1.3 S = 4.1 – 5.1	30	15	00043
	S04940	2145054	1/2	230	60	1.60	Y = 5.0 B = 5.0 R = 0.0	Y = 6.0 B = 6.0 R = 0.0	M = 4.2 – 5.2 S = 16.7 – 20.5	15	7	00044
	S05940	2145074	3/4	230	60	1.50	Y = 7.2 B = 7.2 R = 0.0	Y = 8.4 B = 8.4 R = 0.0	M = 3.0 – 3.6 S = 11.0 – 13.4	25	10	00054
	S06940	2145081	1	230	60	1.40	Y = 8.2 B = 8.2 R = 0.0	Y = 9.8 B = 9.8 R = 0.0	M = 2.2 – 2.7 S = 10.1 – 12.3	25	12	00064
4" Three Wire with RunCap	S07940	2243001	1 1/2	230	60	1.30	Y = 10.0 B = 9.9 R = 1.3	Y = 11.6 B = 11.0 R = 1.3	M = 1.5 – 2.3 S = 6.2 – 12.0	30	15	00074
	S08940	2243011	2	230	60	1.25	Y = 10.0 B = 9.3 R = 2.6	Y = 13.2 B = 11.9 R = 2.6	M = 1.6 – 2.3 S = 5.2 – 7.15	30	15	00084
	S09940	2243027	3	230	60	1.15	Y = 14.0 B = 12.2 R = 4.7	Y = 17.0 B = 14.5 R = 4.5	M = 0.9 – 1.5 S = 3.0 – 4.9	45	20	00094
	S10940	2243037	5	230	60	1.15	Y = 23.0 B = 19.1 R = 8.0	Y = 27.5 B = 23.2 R = 7.8	M = 0.68 – 1.0 S = 2.1 – 2.8	70	30	00104

[1] M = Main Winding – Black to Yellow, S = Start Winding – Red to Yellow

[2] Y = Yellow lead – line amps, B = Black lead – main winding amps, R = Red lead, start or auxiliary winding amps

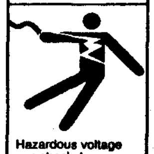
THREE PHASE 60 HZ MOTOR SPECIFICATIONS

Goulds Motor Model	Franklin Motor Model	HP	Volts	Hz	S.F.	Rated Input Amps	Max S.F. Load Amps	Line to Line Resistance	Circuit Breaker/Fuse Amps Std	Circuit Breaker/Fuse Amps Delay	Furnas® US/15 Starter	Furnas® US/15 Heater
S04978	2345014	½	200	60	1.6	2.8	3.7	6.64 – 7.3	10	5	BD	K32
S04970	2345114	½	230	60	1.6	2.3	2.9	9.5 – 10.4	8	4	BG	K29
S04975	2345213	½	460	60	1.6	1.2	1.6	38.4 – 41.6	4	2	BH	K21
S05978	2345024	¾	200	60	1.5	3.7	4.7	4.66 – 5.12	12	6	BD	K36
S05970	2345124	¾	230	60	1.5	3.3	4.1	7.24 – 7.84	11	5	BG	K33
S05975	2345223	¾	460	60	1.5	1.6	2.0	27.8 – 30.2	5	3	BH	K23
S06978	2345031	1	200	60	1.4	4.5	5.7	4.1 – 4.5	14	6	BD	K39
S06970	2345131	1	230	60	1.4	3.9	4.8	5.2 – 5.6	12	6	BG	K36
S06975	2345231	1	460	60	1.4	2.0	2.4	21.2 – 23.0	6	3	BH	K26
S07978	2345041	1½	200	60	1.3	6.1	7.3	2.4 – 3.4	20	9	BD	K43
S07970	2345141	1½	230	60	1.3	5.2	6.3	3.2 – 4.1	20	8	BG	K41
S07975	2345241	1½	460	60	1.3	2.6	3.1	11.3 – 15.0	15	4	BH	K29
S07979	2345341	1½	575	60	1.3	2.1	2.5	17.6 – 23.4	15	3	BE	K27
S08978	2343051	2	200	60	1.25	7.7	9.3	1.9 – 2.4	25	10	BD	K50
S08970	2343151	2	230	60	1.25	6.7	8.1	2.4 – 3.0	20	10	BG	K49
S08975	2343251	2	460	60	1.25	3.4	4.0	9.7 – 12.0	15	5	BH	K33
S08979	2343357	2	575	60	1.25	2.7	3.2	15.1 – 18.7	15	4	BE	K29
S09978	2343067	3	200	60	1.15	10.9	12.5	1.3 – 1.7	35	14	CD	K54
S09970	2343167	3	230	60	1.15	9.5	10.9	1.8 – 2.2	30	15	CG	K52
S09975	2343267	3	460	60	1.15	4.8	5.5	7.0 – 8.7	15	7	BH	K37
S09979	2343367	3	575	60	1.15	3.8	4.4	10.9 – 13.6	15	6	BE	K33
S10978	2343077	5	200	60	1.15	18.3	20.5	0.70 – 0.94	50	24	DD	K61
S10970	2343177	5	230	60	1.15	15.9	17.8	0.93 – 1.2	45	20	DG	K60
S10975	2343277	5	460	60	1.15	8.0	8.9	3.6 – 4.4	25	10	BH	K49
S10979	2343377	5	575	60	1.15	6.4	7.1	5.6 – 6.9	20	8	BE	K42
S119874	2343087	7½	200	60	1.15	26.5	30.5	0.46 – 0.57	80	35	ED	K68
S119704	2343187	7½	230	60	1.15	23.0	26.4	0.61 – 0.75	70	30	EG	K67
S119754	2343287	7½	460	60	1.15	11.5	13.2	2.4 – 3.4	35	15	CH	K55
S119794	2343387	7½	575	60	1.15	9.2	10.6	3.5 – 5.1	30	12	CE	K52

Courtesy of Franklin Electric Company

Troubleshooting

⚠WARNING



DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY SERVICE. FAILURE TO DO SO CAN CAUSE SHOCK, BURNS OR DEATH.

Symptom	Probable Cause	Recommended Action
PUMP MOTOR NOT RUNNING	1. Motor thermal protector tripped a. Incorrect control box b. Incorrect or faulty electrical connections c. Faulty thermal protector d. Low voltage e. Ambient temperature of control box/starter too high f. Pump bound by foreign matter *g. Inadequate submergence*	1. Allow motor to cool, thermal protector will automatically reset a – e. Have a qualified electrician inspect and repair, as required f. Pull pump, clean, adjust set depth as required *g. Confirm adequate unit submergence in pumpage*
	2. Open circuit breaker or blown fuse	2. Have a qualified electrician inspect and repair, as required
	3. Power source inadequate for load	3. Check supply or generator capacity
	4. Power cable insulation damage 5. Faulty power cable splice	4 – 5. Have a qualified electrician inspect and repair, as required
LITTLE OR NO LIQUID DELIVERED BY PUMP	1. Faulty or incorrectly installed check valve	1. Inspect check valve, repair as required
	2. Pump air bound	2. Successively start and stop pump until flow is delivered
	3. Lift too high for pump	3. Review unit performance, check with dealer
	4. Pump bound by foreign matter	4. Pull pump, clean, adjust set depth as required
	5. Pump not fully submerged	5. Check well recovery, lower pump if possible
	6. Well contains excessive amounts of air or gases	6. If successive starts and stops does not remedy, well contains excessive air or gases
	7. Excessive pump wear	7. Pull pump and repair as required
	8. Incorrect motor rotation – three phase only.	8. Reverse any two motor electrical leads

Directives d'installation et de fonctionnement des pompes submersibles 60 Hz de 4 po

Table des Matières

SUJET **PAGE**

Fiche du Consommateur

Numéro du modèle : ______________________

Numéro de série : ______________________

Détaillant : ______________________

N° de téléphone du détaillant : ______________________

Date de l'achat : ______________________

Installation : ______________________

DIRECTIVES DE SÉCURITÉ

AFIN D'ÉVITER TOUTE BLESSURE GRAVE OU POUVANT ENTRAÎNER LA MORT, OU TOUT DOMMAGE MATÉRIEL IMPORTANT, LIRE ET SUIVRE LES DIRECTIVES DU MANUEL ET DES ÉTIQUETTES APPOSÉES SUR LA POMPE.

CE MANUEL COMPREND TOUTES LES DIRECTIVES REQUISES POUR L'INSTALLATION ET L'UTILISATION DE CETTE POMPE. TOUJOURS LE GARDER PRÈS DE LA POMPE.

LIRE ATTENTIVEMENT TOUTES LES DIRECTIVES ET MESURES DE SÉCURITÉ AVANT D'EFFECTUER TOUT TRAVAIL D'INSTALLATION OU D'ENTRETIEN DE CETTE POMPE.

LAISSER LES ÉTIQUETTES APPOSÉES SUR LA POMPE.

Ce symbole signifie **EXTRÊMEMENT DANGEREUX.** Lorsque ce symbole apparaît sur la pompe ou dans le manuel, lire tout autre symbole signalant des risques de blessures ou de dommages matériels.

⚠ DANGER Indique qu'il y a des **RISQUES** de blessures graves, de mort ou de dommages matériels importants.

⚠ AVERTISSEMENT Indique la **POSSIBILITÉ** de blessures graves, de mort ou de dommages matériels importants.

⚠ ATTENTION Indique la **POSSIBILITÉ** de blessures ou de dommages matériels.

REMARQUE : DONNE DES DIRECTIVES IMPORTANTES À SUIVRE ATTENTIVEMENT.

LE POMPAGE DE LIQUIDES INFLAMMABLES PEUT CAUSER DES INCENDIES, DES BRÛLURES OU LA MORT.

DESCRIPTION ET SPÉCIFICATIONS

Les pompes centrifuges submersibles de 4 po de Goulds sont destinées aux puits d'un diamétre de 102 mm (4 po) et plus. Ces appareils pompe/moteur assemblés en usine sont catalogués par UL® et CSA. Tous les moteurs Franklin Electric sont reconnus par UL® et catalogués par CSA (ACNOR).

REMARQUE : INSPECTER L'APPAREIL ET, DANS LE CAS DE DOMMAGES, EN AVISER LE TRANSPORTEUR OU LE DÉTAILLANT IMMÉDIATEMENT.

Câblage et Mise à la Terre

AVERTISSEMENT

⚠ Effectuer l'installation, la mise à la terre et le câblage en conformité avec les normes des codes de l'électricité régional et national.

⚠ Un coupe-circuit doit être installé près de la pompe.

⚠ Débrancher la pompe et couper l'alimentation électrique avant de faire l'installation ou l'entretien de la pompe.

⚠ L'alimentation électrique doit correspondre aux spécifications de la pompe. Une tension inadéquate pourrait causer un incendie ou des dommages au moteur et annulerait ainsi la garantie.

⚠ Les moteurs munis d'une protection thermique automatique peuvent ouvrir le circuit électrique du moteur lors d'une surcharge thermique. Ceci pourrait entraîner le démarrage soudain du moteur.

REMARQUE : LE CALIBRE DU CÂBLE DOIT ÊTRE CONFORME AUX NORMES DES CODES RÉGIONAL ET NATIONAL.

- Un fil plus petit que le calibre recommandé par le *National Electric Code* pourrait endommager le moteur et annulerait ainsi la garantie.
- N'utiliser que les fils de cuivre appropriés pour le câblage du moteur et la mise à la terre. Le fil de mise à la terre doit être de même calibre que les fils reliés au moteur. Pour faciliter l'entretien, les fils doivent respecter un code de couleurs.

⚠ AVERTISSEMENT Haute tension

AFIN D'ÉVITER TOUT RISQUE D'ÉLECTROCUTION, DE BRÛLURES OU DE MORT, LA MISE À LA TERRE DE L'ÉQUIPEMENT DOIT ÊTRE PERMANENTE.

"AVERTISSEMENT" Afin de réduire les risques d'électrocution, lorsque la pompe est en marche, la mise à la terre doit être conçue de façon adéquate.

Cette pompe comprend tous les éléments requis pour la mise à la terre. Afin de réduire les risques d'électrocution lors d'un contact avec des pièces métalliques à découvert, connecter les éléments de mise à la terre à la boîte d'alimentation et à toutes les parties métalliques accessibles à la tête du puits (tuyaux métalliques de refoulement, chemise métallique du puits, etc.). Le conducteur de mise à la terre doit être de même calibre que les conducteurs du câble du moteur. Ce conducteur doit être acheminé dans le puits avec les autres câbles et raccordé (à l'aide d'une attache, d'une soudure ou les deux si nécessaire), aux éléments de mise à la terre (borne, fil ou conducteur) de l'équipement. Le fil de mise à la terre de l'équipement (si fourni) est celui dont l'isolant est vert avec ou sans rayures jaunes.

INSTALLATION DU CÂBLE COURT DU MOTEUR

1. Dénuder l'extrémité de chaque conducteur du câble court en enlevant 13 mm (½ po) d'isolant.

REMARQUE : SUIVRE LES DIRECTIVES INCLUSES DANS LE NÉCESSAIRE D'ÉPISSAGE DU FABRICANT.

2. À l'endroit où les câbles sont épissés ou connectés aux fils du moteur, l'épissure doit être étanche à l'eau. Les nécessaires de collage ou d'épissage par chaleur que l'on retrouve sur le marché peuvent être utilisés s'ils sont approuvés par les codes régional et fédéral.

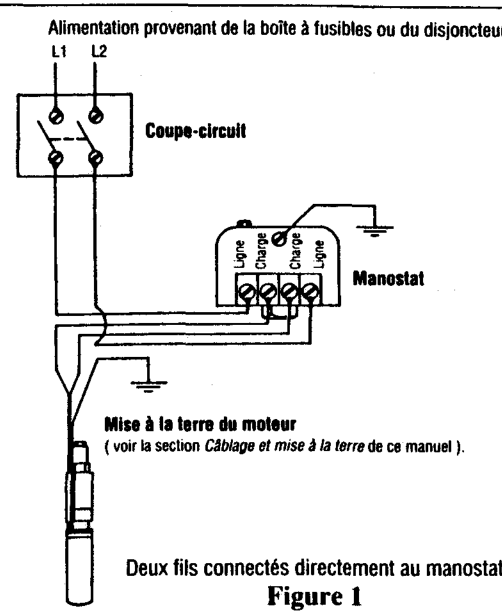
REMARQUE : POUR LES MOTEURS DE 5 CV OU PLUS, LES CONNEXIONS DOIVENT ÊTRE EFFECTUÉES À L'AIDE DE JOINTS À BRASER RÉSINEUX SEULEMENT.

3. Pour vérifier l'étanchéité du joint, immerger l'épissure dans un contenant métallique rempli d'eau pendant 10 minutes. Mesurer ensuite la résistance entre le contenant métallique et le conducteur du câble. La résistance devrait être de 2 mégohms ou plus. Refaire l'épissure si nécessaire.
4. Faire les connexions électriques au manostat, au contacteur, à la boîte de réglage ou au démarreur comme montré aux figures 1, 2, 3 et 4.
5. Apposer les étiquettes du moteur et de la pompe à l'endroit approprié.

REMARQUE : SUIVRE ATTENTIVEMENT LES DIRECTIVES DU FABRICANT DU MANOSTAT ET DE LA BOÎTE DE RÉGLAGE.

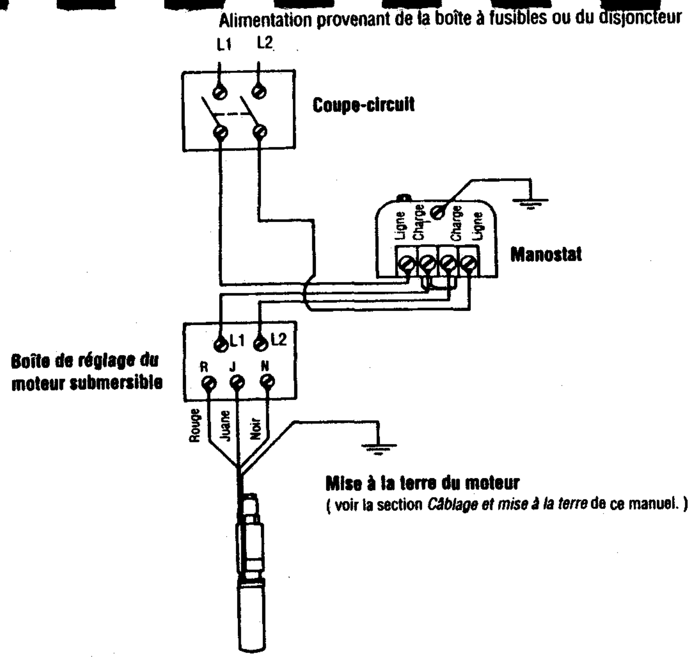
- La boîte de réglage n'est pas requise pour les moteurs à deux fils (voir figure 1). Par contre, cette boîte est requise pour les moteurs monophasés à trois fils (voir figure 2).
- Pour le calibre du disjoncteur et des fusibles, voir la section *Notes techniques* de ce manuel.

MOTEURS MONOPHASÉS



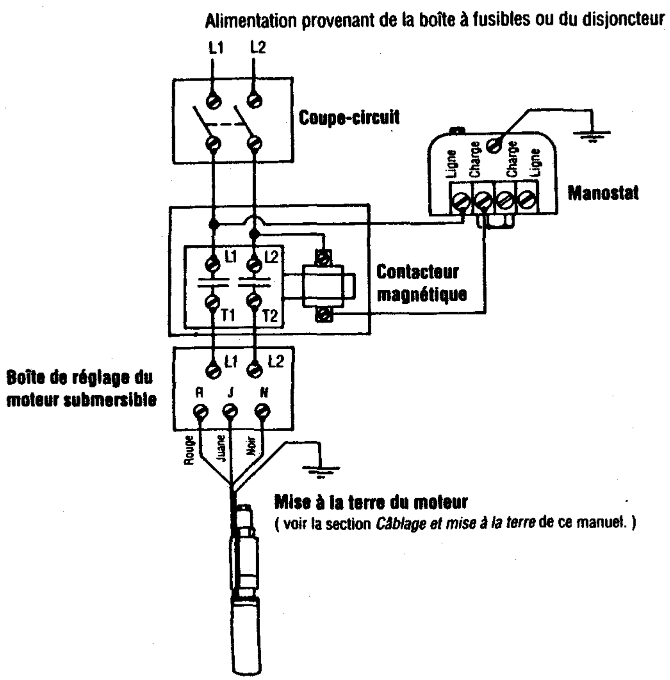
Deux fils connectés directement au manostat

Figure 1



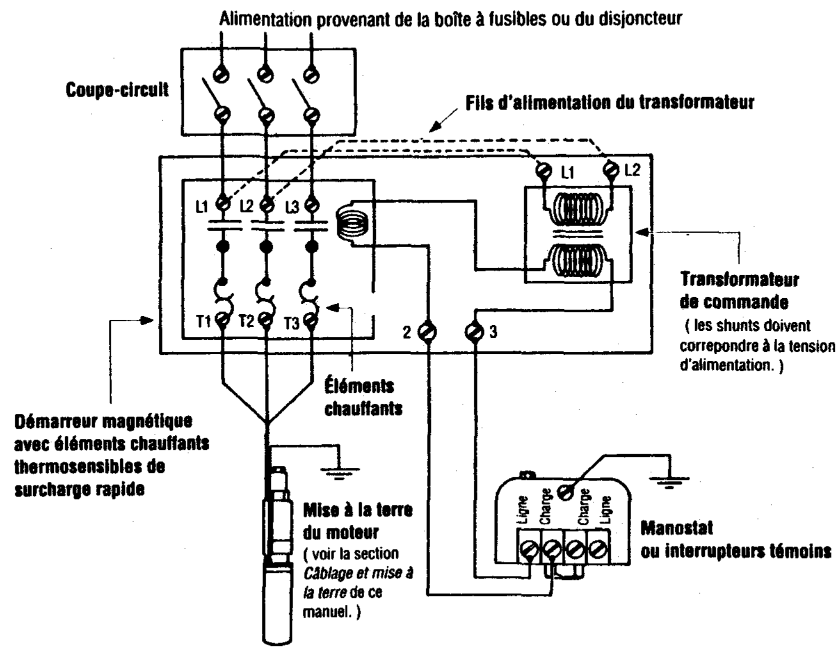
Trois fils connectés directement au manostat

Figure 2



Trois fils connectés au contacteur magnétique

Figure 3



Connexion à trois phases

Figure 4

FONCTIONNEMENT DE LA GÉNÉRATRICE

- Pour la capacité nominale en KVA (kilovolts ampères) de la génératrice à réglage extérieur, voir le tableau 1. La tension électrique, la fréquence, la phase et la capacité en ampères **DOIVENT** correspondre à celles de la plaque signalétique du moteur ou de la boîte de réglage.

AFIN D'ÉVITER TOUT RISQUE D'ÉLECTROCUTION, DE BRÛLURES OU DE MORT, UN INTERRUPTEUR MANUEL OU AUTOMATIQUE EST REQUIS LORSQUE LA GÉNÉRATRICE EST UTILISÉE COMME RÉSERVE OU DÉPANNAGE.

Tableau 1

Puissance nominale minimale de la génératrice	Puissance du Moteur							
	⅓	½	¾	1	1½	2	3	5
KVA	1,9	2,5	3,8	5,0	6,3	9,4	12,5	18,8
KW	1,5	2,0	3,0	4,0	5,0	7,5	10,0	15,0

NOTA: pour un meilleur démarrage des moteurs à 2 fils, il est recommandé d'utiliser une génératrice de puissance nominale minimale de 50% supérieure à celle qui est indiquée.

REMARQUE : SUIVRE ATTENTIVEMENT LES DIRECTIVES DU FABRICANT DE LA GÉNÉRATRICE.

Installation de la Pompe

REMARQUE : PROTÉGER DU GEL TOUS LES TUYAUX, LES RACCORDS ET LES COMPOSANTS DU SYSTÈME.

NE PAS SOULEVER, TRANSPORTER OU SUSPENDRE LA POMPE PAR LE CÂBLE ÉLECTRIQUE. DES DOMMAGES AU CÂBLE POURRAIENT ENTRAÎNER DES ÉLECTROCUTIONS, DES BRÛLURES OU LA MORT.

- Descendre la pompe dans le puits au moyen du tuyau de refoulement. Par mesure de sécurité, on peut attacher un câble de sécurité à l'anneau de levage fixé à la tête de refoulement de la pompe. **NE PAS** utiliser le câble électrique pour descendre ou retirer la pompe. Prendre soin de **NE PAS** endommager le câble électrique pendant le déplacement de la pompe.

Tuyauterie

- La tuyauterie du système **DOIT** être conforme aux normes et pratiques des codes régional et national.
- Afin d'optimiser le débit de refoulement, le diamètre minimal de la tuyauterie de refoulement doit être de 25 mm (1 po). Le tuyau de refoulement doit être le plus court possible et comporter un minimum de raccords.

AVIS : LES MODÈLES GS ET SB SONT MUNIS DE RACCORDS FILETÉS À GAUCHE. RETENIR LA TÊTE DE REFOULEMENT DE LA POMPE AVEC UNE CLÉ POUR POSER LE RACCORD OU LE TUYAU DE REFOULEMENT.

- S'assurer que la pompe et le moteur tournent librement en faisant tourner l'arbre à la main.
- Raccorder le tuyau de branchement à la pompe et faire descendre la pompe dans le puits.
- A l'aide d'un ruban isolant en plastique étanche à l'eau, fixer le câble électrique au tuyau de branchement à environ tous les trois mètres (10 pi).
- La pompe **DOIT** être submergée en tout temps pour fonctionner correctement.
- La position finale doit être conforme à la plage de positionnement recommandée pour la pompe.

REMARQUE : SUIVRE LES MESURES DE SÉCURITÉ REQUISES POUR ÉVITER QUE LA POMPE NE VIDE TROP LE PUITS. N'UTILISER QUE DES DISPOSITIFS APPROUVÉS.

- Suivre les règles de santé régionales en ce qui concerne la fermeture étanche du puits et la sortie appropriée du câble électrique.

Installation du Réservoir

L'INSTALLATION D'UNE SOUPAPE DE DÉCHARGE NON APPROPRIÉE POURRAIT ENTRAÎNER DES DOMMAGES MATÉRIELS, DES BLESSURES OU LA MORT.

- Si la pompe doit fonctionner avec une évacuation libre, une soupape de décharge **DOIT** être installée. Avant le démarrage, ouvrir cette soupape d'environ ⅓ de tour puis démarrer la pompe. Ouvrir la soupape **LENTEMENT** jusqu'à l'obtention du débit désiré. La position finale **DOIT** être conforme à la plage de positionnement recommandée pour la pompe.

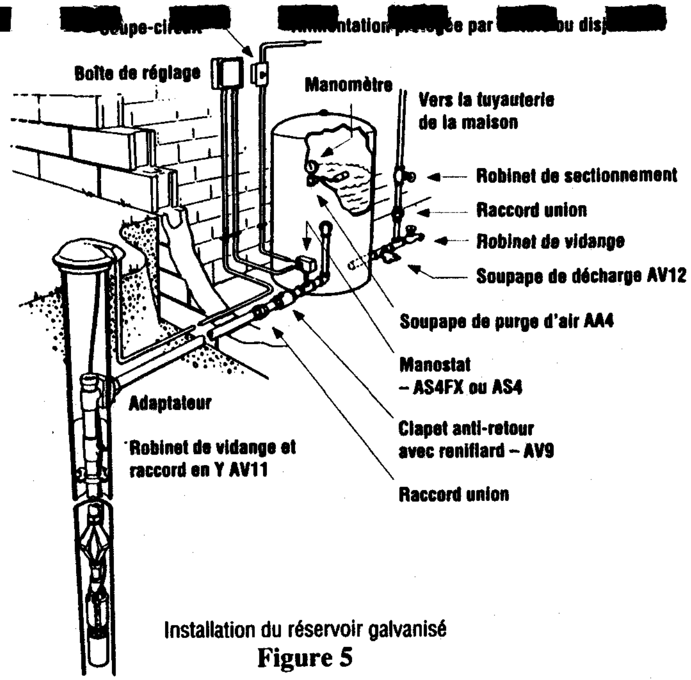
RESÉRVOIRS EN ACIER GALVANISÉ

- Un système de chargement en air est nécessaire avec les réservoirs galvanisés de Goulds ou équivalents. Le système Goulds requiert une soupape de vidange et un raccord en Y, une commande d'échappement d'air ainsi qu'un clapet de retenue et un reniflard.
- L'écart entre le clapet de retenue, la soupape de vidange et le raccord en Y détermine le volume d'air servant de charge au réservoir. Lorsque la pompe s'arrête, le reniflard de la commande d'échappement d'air s'ouvre et crée une mise à l'air libre. La soupape de vidange et le raccord en Y évacuent alors dans le puits l'eau emprisonnée entre le clapet de retenue, la soupape et le raccord. Quand la pompe se remet en marche, l'air se trouvant alors entre le clapet, la soupape et le raccord est refoulé dans le réservoir. L'excédent d'air du réservoir est évacué automatiquement par la commande d'échappement d'air. Voir le tableau 2 pour l'espace requis entre le clapet de retenue, la soupape de vidange et le raccord en Y. Voir aussi la figure 5 pour le positionnement des composants et des raccords nécessaires pour le système.

RÉGLAGE APPROXIMATIF DES RACCORDS DE VIDANGE

Capacité du réservoir	Distance ENTRE la soupape de vidange (et le raccord en Y) et le clapet de retenue.
9,5 m³/hr (42 gal)	2,1 m (7 pi)
18,6 m³/hr (82 gal)	2 m (10 pi)
27,3 m³/hr (120 gal)	4,6 m (15 pi)
50 m³/hr (220 gal)	4,6 m (15 pi)
71,5 m³/hr (315 gal)	6,1 m (20 pi)
119 m³/hr (525 gal)	6,1 m (20 pi)

Tableau 2

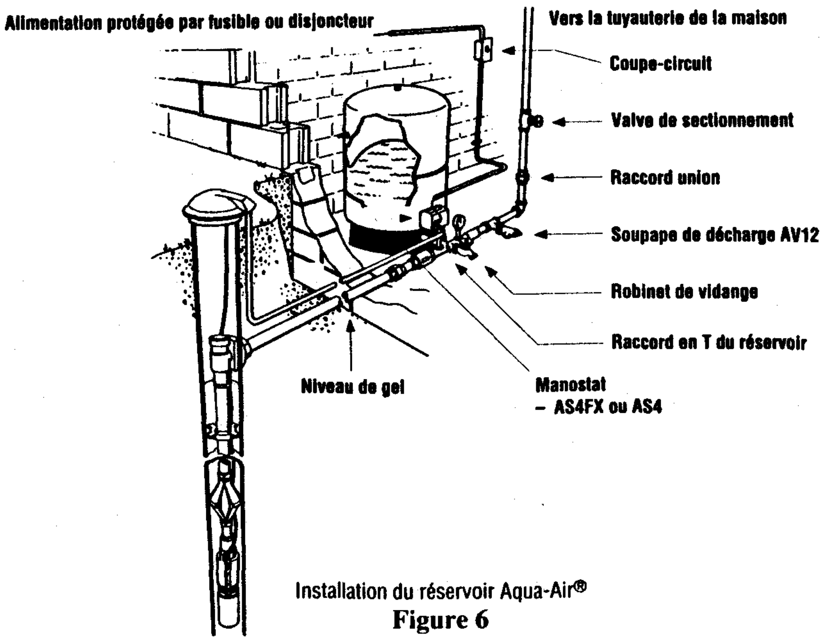


Installation du réservoir galvanisé

Figure 5

RÉSERVOIRS AQUA AIR®

AVIS: LA PRESSION DE PRÉCHARGEMENT DU RÉSERVOIR SE RÈGLE À L'AIDE DE LA VALVE SITUÉE SUR LE DESSUS DU RÉSERVOIR.



Installation du réservoir Aqua-Air®

Figure 6

[redacted]EM[redacted]UE :[redacted]SQU[redacted]'Y[redacted]S D'[redacted]DAN[redacted]RÉS[redacted]OIR,[redacted] LA PRÉ-CHARGE DOIT ÊTRE RÉGLÉE À 13,8 kPa (2PSIG) EN DESSOUS DE LA PRESSION DE BRANCHEMENT.

- Pour l'installation des composants du système et des raccords, voir la figure 6.

Fonctionnement

L'UTILISATION DE LA POMPE DANS UN LAC, UNE PISCINE OU AUTRES PLANS D'EAU POURRAIT ENTRAÎNER UNE ÉLECTROCUTION, DES BRÛLURES OU LA MORT.

Avant l'utilisation, vérifier les points suivants :

a) Toutes les connexions électriques et les mises à la terre
b) Les points de réglage du robinet de sectionnement (vanne d'arrêt) du système.
c) L'installation de la soupape de décharge et du clapet anti-retour

MOTEURS MONOPHASÉS

1. Ouvrir un robinet de décharge et faire tourner la pompe pendant une minute.
2. Fermer le robinet. La pompe devrait s'arrêter lorsque la pression du système atteint le réglage du manostat.
3. Tout en observant le manomètre, ouvrir le robinet et faire la lecture du manomètre lorsque la pompe démarre.
4. Selon les directives du fabricant du manostat, régler le mansostat.

MOTEURS TRIPHASÉS

RISQUES D'ÉLECTROCUTION, DE BRÛLURES OU DE MORT SL LA POMPE N'EST PAS DÉBRANCHÉE ET L'ALIMENTATION NON COUPÉE AVANT DE PROCÉDER À L'ENTRETIEN.

REMARQUE : L'INSTALLATION À TROIS PHASES ET LA VÉRIFICATION DU COURANT DOIVENT ÊTRE EFFECTUÉES PAR UN ÉLECTRICIEN QUALIFIÉ.

1. Vérifier le sens de rotation.
2. Vérifier s'il y a déséquilibre de courant.
3. Poser un limiteur de surcharge de type K sur les moteurs à démarreur NEMA ou mettre les limiteurs de surcharge réglables à la valeur d'intensité indiquée sur la fiche signalétique du moteur.

Lecture du courant au démarrage :

1re phase : ______________________________

2e phase : ______________________________

3e phase : ______________________________

- Les roulements du moteur doivent lubrifiés à l'intérieur. Aucun autre entretien n'est requis pour la pompe ou le moteur.

Notes Techniques

LECTURES DE RÉSISTANCE DE L'ISOLANT DU MOTEUR[1]

Lectures normales ohm/megohm, TOUS les moteurs, entre chaque fil et la mise à la terre

État du moteur et des fils	Valeur en ohms	Valeur en mégohms
Nouveau moteur sans câble d'alimentation	20 000 000 (ou plus)	20,0
Moteur usagé pouvant être réinstallé dans le puits	10 000 000 (ou plus)	10,0
Moteur dans le puits - Lectures du câble d'alimentation et du moteur		
Nouveau moteur	2 000 000 (ou plus)	2,0
Moteur relativement en bon état	500 000 à 2 000 000	0,5 – 2,0
Moteur pouvant être endommagé ou ayant un câble endommagé. *Ne pas retirer le moteur pour cette raison*	20 000 à 500 000	0,02 – 0,5
Moteur endommagé ou ayant un câble endommagé. *Retirer le moteur et réparer*	10 000 à 20 000	0,01 – 0,02
Panne du moteur ou du câble électrique. *Retirer le moteur et réparer*	Moins de 10 000	0 – 0,01

[1] Données fournies par Franklin Electric Company

MONOPHASE – SPÉCIFICATIONS MOTEUR 60 HZ

Type	Numéro de produit Goulds	Modèle de moteur Franklin	CV	Volts	Hz	S.F.	Alimentation nominale Ampères[2]	Charge S.F. Max Ampères[2]	Ligne à ligne[1] Résistance M = Principale S = Démarreur	Ampères disjoncteur/fusible Std	Ampères disjoncteur/fusible Retard	Boîte de réglage
4 po à deux fils	S03932	2445020	⅓	115	60	1,75	8,0	9,2	1,4 – 1,8	25	10	N/R
	S03942	2445030	⅓	230	60	1,75	4,0	4,6	6,0 – 7,4	15	5	N/R
	S04932	2445040	½	115	60	1,60	10,0	12,0	1,0 – 1,3	30	15	N/R
	S04942	2445050	½	230	60	1,60	5,0	6,0	4,2 – 5,2	15	7	N/R
	S05942	2445070	¾	230	60	1,50	7,2	8,4	3,0 – 3,6	25	10	N/R
	S06942	2445081	1	230	60	1,40	8,2	9,8	2,2 – 2,7	25	12	N/R
	S07942	2445091	1½	230	60	1,30	10,6	13,1	1,5 – 1,9	35	15	N/R
4 po à trois fils	S03930	2145024	⅓	115	60	1,75	J = 8,0 N = 8,0 R = 0,0	J = 9,2 N = 9,2 R = 0,0	M = 1,4 – 1,8 S = 6,5 – 7,9	25	10	00033
	S03940	2145034	⅓	230	60	1,75	J = 4,0 N = 4,0 R = 0,0	J = 4,6 N = 4,6 R = 0,0	M = 6,0 – 7,4 S = 26,1 – 32,0	15	5	00034
	S04930	2145044	½	115	60	1,60	J = 10,0 N = 10,0 R = 0,0	J = 12,0 N = 12,0 R = 0,0	M = 1,0 – 1,3 S = 4,1 – 5,1	30	15	00043
	S04940	2145054	½	230	60	1,60	J = 5,0 N = 5,0 R = 0,0	J = 6,0 N = 6,0 R = 0,0	M = 4,2 – 5,2 S = 16,7 – 20,5	15	7	00044
	S05940	2145074	¾	230	60	1,50	J = 7,2 N = 7,2 R = 0,0	J = 8,4 N = 8,4 R = 0,0	M = 3,0 – 3,6 S = 11,0 – 13,4	25	10	00054
	S06940	2145081	1	230	60	1,40	J = 8,2 N = 8,2 R = 0,0	J = 9,8 N = 9,8 R = 0,0	M = 2,2 – 2,7 S = 10,1 – 12,3	25	12	00064
4 po à trois fils avec RunCap	S07940	2243001	1½	230	60	1,30	J = 10,0 N = 9,9 R = 1,3	J = 11,6 N = 11,0 R = 1,3	M = 1,5 – 2,3 S = 6,2 – 12,0	30	15	00074
	S08940	2243011	2	230	60	1,25	J = 10,0 N = 9,3 R = 2,6	J = 13,2 N = 11,9 R = 2,6	M = 1,6 – 2,3 S = 5,2 – 7,15	30	15	00084
	S09940	2243027	3	230	60	1,15	J = 14,0 N = 12,2 R = 4,7	J = 17,0 N = 14,5 R = 4,5	M = 0,9 – 1,5 S = 3,0 – 4,9	45	20	00094
	S10940	2243037	5	230	60	1,15	J = 23,0 N = 19,1 R = 8,0	J = 27,5 N = 23,2 R = 7,8	M = 0,68 – 1,0 S = 2,1 – 2,8	70	30	00104

[1] Bobinage Principal – Noir à Jaune, Bobinage Démarreur – Rouge à jaune

[2] J = Fil jaune – amp. ligne, N = Fil noir – amp. bobinage principal, R = Fil rouge, amp. démarreur ou bobinage auxiliaire.

TRIPHASÉ – SPÉCIFICATIONS MOTEUR 60 HZ

Numéro de produit Goulds	Modèle de moteur Franklin					Alimentation nominale	Charge S.F. Max	Ligne à ligne	Ampères disjoncteur/fusible		Furnas® US/15	
		CV	Volts	Hz	S.F.	Ampères[2]	Ampères[2]	Résistance	Std	Retard	Démarrage	Elément chauffant
S04978	2345014	½	200	60	1,6	2,8	3,7	6,64 – 7,3	10	5	BD	K32
S04970	2345114	½	230	60	1,6	2,3	2,9	9,5 – 10,4	8	4	BG	K29
S04975	2345213	½	460	60	1,6	1,2	1,6	38,4 – 41,6	4	2	BH	K21
S05978	2345024	¾	200	60	1,5	3,7	4,7	4,66 – 5,12	12	6	BD	K36
S05970	2345124	¾	230	60	1,5	3,3	4,1	7,24 – 7,84	11	5	BG	K33
S05975	2345223	¾	460	60	1,5	1,6	2,0	27,8 – 30,2	5	3	BH	K23
S06978	2345031	1	200	60	1,4	4,5	5,7	4,1 – 4,5	14	6	BD	K39
S06970	2345131	1	230	60	1,4	3,9	4,8	5,2 – 5,6	12	6	BG	K36
S06975	2345231	1	460	60	1,4	2,0	2,4	21,2 – 23,0	6	3	BH	K26
S07978	2345041	1½	200	60	1,3	6,1	7,3	2,4 – 3,4	20	9	BD	K43
S07970	2345141	1½	230	60	1,3	5,2	6,3	3,2 – 4,1	20	8	BG	K41
S07975	2345241	1½	460	60	1,3	2,6	3,1	11,3 – 15,0	15	4	BH	K29
S07979	2345341	1½	575	60	1,3	2,1	2,5	17,6 – 23,4	15	3	BE	K27
S08978	2343051	2	200	60	1,25	7,7	9,3	1,9 – 2,4	25	10	BD	K50
S08970	2343151	2	230	60	1,25	6,7	8,1	2,4 – 3,0	20	10	BG	K49
S08975	2343251	2	460	60	1,25	3,4	4,0	9,7 – 12,0	15	5	BH	K33
S08979	2343357	2	575	60	1,25	2,7	3,2	15,1 – 18,7	15	4	BE	K29
S09978	2343067	3	200	60	1,15	10,9	12,5	1,3 – 1,7	35	14	CD	K54
S09970	2343167	3	230	60	1,15	9,5	10,9	1,8 – 2,2	30	15	CG	K52
S09975	2343267	3	460	60	1,15	4,8	5,5	7,0 – 8,7	15	7	BH	K37
S09979	2343367	3	575	60	1,15	3,8	4,4	10,9 – 13,6	15	6	BE	K33
S10978	2343077	5	200	60	1,15	18,3	20,5	0,70 – 0,94	50	24	DD	K61
S10970	2343177	5	230	60	1,15	15,9	17,8	0,93 – 1,2	45	20	DG	K60
S10975	2343277	5	460	60	1,15	8,0	8,9	3,6 – 4,4	25	10	BH	K49
S10979	2343377	5	575	60	1,15	6,4	7,1	5,6 – 6,9	20	8	BE	K42
S119874	2343087	7½	200	60	1,15	26,5	30,5	0,46 – 0,57	80	35	ED	K68
S119704	2343187	7½	230	60	1,15	23,0	26,4	0,61 – 0,75	70	30	EG	K67
S119754	2343287	7½	460	60	1,15	11,5	13,2	2,4 – 3,4	35	15	CH	K55
S119794	2343387	7½	575	60	1,15	9,2	10,6	3,5 – 5,1	30	12	CE	K52

Données fournies par Franklin Electric Company

Dépannage

⚠ AVERTISSEMENT

Haute tension. Risques d'électrocution, de brûlures ou de mort.

RISQUES D'ÉLECTROCUTION, DE BRÛLURES OU DE MORT SL LA POMPE N'EST PAS DÉBRANCHÉE ET L'ALIMENTATION NON COUPÉE AVANT DE PROCÉDER À L'ENTRETIEN.

Symptôme	Cause probable	Action recommandée
LE MOTEUR DE LA POMPE NE FONCTIONNE PAS	1. Protection thermique du moteur déclenchée	1. Laisser refroidir le moteur pour que la protection thermique se réenclenche.
	a. Boîte de réglage non appropriée b. Connexions électriques non appropriées ou défectueuses c. Protection thermique défectueuse d. Tension basse e. Température ambiante de la boîte de réglage/démarreur trop élevée	a – e. Faire appel à un électricien qualifié pour l'inspection et la réparation.
	f. Pompe bloquée par des corps étrangers	f. Retirer la pompe, la nettoyer et régler le niveau de profondeur approprié.
	g. Submersion insuffisante de la pompe	*g. S'assurer que la submersion de la pompe* est adéquate.
	2. Disjoncteur ouvert ou fusible grillé	2. Faire appel à un électricien qualifié pour l'inspection et la réparation.
	3. Alimentation inadéquate pour la charge	3. Vérifier l'alimentation ou la capacité de la génératrice.
	4. Isolant du câble d'alimentation endommagé 5. Épissure du câble électrique défectueuse	4 – 5. Faire appel à un électricien qualifié pour l'inspection et la réparation.
PEU OU PAS DE LIQUIDE POMPÉ	1. Clapet anti-retour défectueux ou installation inadéquate.	1. Vérifier le clapet anti-retour et réparer.
	2. Air dans la pompe.	2. Démarrer et arrêter la pompe de façon successive jusqu'à ce que le liquide sorte.
	3. Montée trop haute pour la pompe.	3. Revoir la capacité de l'appareil consulter votre détaillant.
	4. Pompe bloquée par des corps étrangers.	4. Retirer la pompe, la nettoyer et régler le niveau de profondeur approprié.
	5. Submersion insuffisante de la pompe.	5. Vérifier le puits et descendre la pompe si nécessaire.
	6. Puits contenant des quantités excessives d'air et de gaz.	6. Si les démarrages et arrêts successifs ne corrigent pas la situation, c'est qu'il y a trop d'air et de gaz dans le puits.
	7. Pompe trop usée.	7. Retirer la pompe et réparer.
	8. Mauvaise rotation du moteur – 3 phases seulement.	8. Inverser deux conducteurs du moteur.

Instalación de la bomba sumergible de 60 Hz y 4" e Instrucciones de Operación

Índice

Información del Propietario

Número de modelo: ____________________

Número de serie: ____________________

Agente: ____________________

No. telefónico del agente: ____________________

Fecha de compra: ____________________

Instalación: ____________________

INSTRUCCIONES DE SEGURIDAD

PARA EVITAR LESIONES CORPORALES SERIAS O FATALES, O DAÑOS MAYORES A LA PROPIEDAD, LEA Y SIGA TODAS LAS INSTRUCCIONES DE SEGURIDAD CONTENIDAS EN EL MANUAL Y REFERENTES A LA BOMBA.

ES INTENCIÓN QUE ESTE MANUAL ASISTA EN LA INSTALACIÓN Y EL FUNCIONAMIENTO DE ESTA UNIDAD Y EL MISMO SE DEBE MANTENER CON LA BOMBA.

EXAMINE BIEN TODAS LAS INSTRUCCIONES Y ADVERTENCIAS ANTES DE REALIZAR CUALQUIER TRABAJO EN ESTA BOMBA.

MANTENGA TODAS LAS CALCOMANÍAS DE SEGURIDAD.

Este es un **SÍMBOLO DE ALERTA DE SEGURIDAD.** Cuando usted vea este símbolo en una bomba o en el manual, busque una de las siguientes palabras de señal y esté alerta a las lesiones corporales potenciales o daños a la propiedad.

PELIGRO Advierte los peligros que **CAUSARÁN** serias lesiones corporales, la muerte, o daños mayores a la propiedad.

ADVERTENCIA Advierte los peligros que **PUEDEN** causar serias lesiones corporales, la muerte o daños mayores a la propiedad.

PRECAUCIÓN Advierte los peligros que **PUEDEN** causar lesiones corporales o daños a la propiedad.

AVISO: INDICA INSTRUCCIONES ESPECIALES QUE SON MUY IMPORTANTES Y QUE SE DEBEN SEGUIR.

BOMBEAR LÍQUIDOS PELIGROSOS O GASES INFLAMABLES PUEDE CAUSAR INCENDIOS, QUEMADURAS O LA MUERTE.

DESCRIPCIÓN Y ESPECIFICACIONES

Las bombas centrífugas sumergibles de 4" de Goulds son para uso en pozos de 4" (102 mm) de diámetro o más grandes. Las unidades montadas de motor/bomba compradas de fábrica están en la lista de UL®. Todos los motores son reconocidos por UL® y están en la lista de CSA.

AVISO: INSPECCIONE LA UNIDAD PARA VER SI TIENE DAÑOS Y AVISE INMEDIATAMENTE TODO DAÑO AL TRANSPORTISTA O AL AGENTE.

Instale, conecte a tierra y alambre de acuerdo a los requerimientos del Código Eléctrico Nacional y local.

Instale un interruptor de separación de todos los circuitos cerca de la bomba.

Desconecte y bloquee la energía eléctrica antes de instalar o dar servicio a la bomba.

El suministro de energía **DEBE** *coincidir con las especificaciones* de la placa del fabricante de la bomba. La tensión incorrecta puede causar incendios, daños al motor y anular la garantía.

Los motores equipados con protección térmica automática abren el circuito eléctrico del motor cuando existe una sobrecarga térmica. Esto puede causar que la bomba arranque *inesperadamente* y *sin aviso.*

AVISO: EL DIMENSIONAMIENTO DEL CABLE DE ENERGÍA DEBE ESTAR CONFORME A LAS NORMAS Y LOS CÓDIGOS NACIONALES Y LOCALES.

- El uso de un alambre de tamaño menor que el indicado en el Código Eléctrico Nacional puede dañar el motor y anular la garantía.
- Use sólo alambres de cobre al motor y a tierra. El alambre a tierra debe ser por lo menos del tamaño de los alambres al motor. Los alambres deben ser de los colores de código para facilitar el mantenimiento.

ADVERTENCIA Tensiones peligrosas

NO CONECTAR A TIERRA PERMANENTEMENTE LA BOMBA, EL MOTOR Y LOS CONTROLES ANTES DE CONECTAR LA ENERGÍA ELÉCTRICA PUEDE CAUSAR CHOQUES, QUEMADURAS O LA MUERTE.

"ADVERTENCIA" Para reducir el riesgo de choques eléctricos durante el funcionamiento de esta bomba se requiere la disposición de la conexión a tierra aceptable.

Esta bomba se proporciona con un medio de conexión a tierra. Para reducir el riesgo de choque eléctrico por contacto con las partes metálicas adyacentes, adhiera la caja de alimentación al medio de conexión-a-tierra a la bomba-motor y a todas las partes metálicas accesibles en el cabezal del pozo, incluyendo las tuberías metálicas de descarga, la tubería metálica de revestimiento, y similares, por medio de:

1. un conductor de conectar a tierra el equipo, por lo menos del tamaño de los conductores del cable del pozo, o su equivalente, que va abajo en el pozo con el cable del pozo, y
2. una abrazadera, una soldadura o ambas si es necesario, asegurada al hilo a tierra del equipo, al terminal a tierra del equipo o al conductor a tierra de la envoltura de la bomba. El hilo a tierra del equipo, si se provee uno, es el conductor que tiene una superficie exterior de aislamiento que es verde, con o sin una o más franjas amarillas – UL 778.

INSTALACION DEL CABLE CORTO DE FABRICA DEL MOTOR

1. Prepare el cable corto del motor pelando ½" (13 mm) del extremo del aislamiento de cada conductor.

AVISO: SIGA LAS INSTRUCCIONES DEL FABRICANTE DEL KIT DE EMPALME.

2. Donde los cables están empalmados o conectados a los terminales del motor, los empalmes **DEBEN** ser estancos al agua. Se pueden usar las envolturas de resina líquida o autoencogibles térmicos disponibles comercialmente, si las regulaciones locales o federales lo permiten.

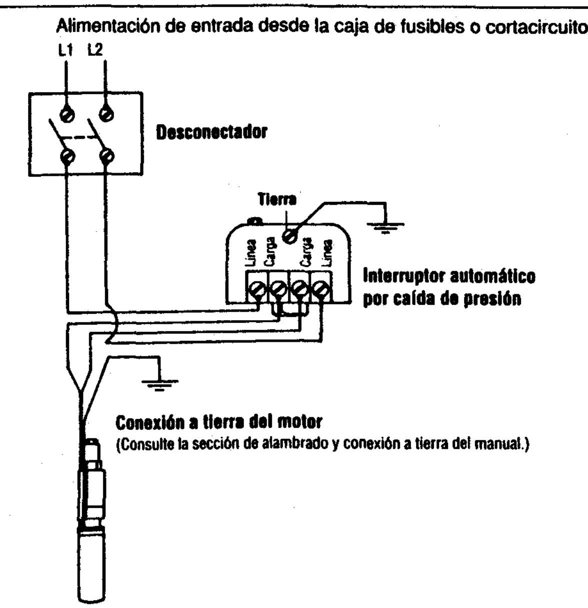
AVISO: LAS CONEXIONES DE EMPALME EN LOS MOTORES DE 5 HP Y MÁS GRANDES DEBEN SER SOLDADAS USANDO SOLAMENTE LA SOLDADURA DE NÚCLEO ROSIN.

3. Para asegurar una estanqueidad adecuada, sumergir el empalme en un recipiente metálico lleno de agua, por 10 minutos. Luego haga una lectura de la resistencia entre el agua y el conductor de cable. La resistencia debe leer 2 megaohmios o más. Vuelva a hacer el empalme si se requiere.
4. Complete las conexiones eléctricas al interruptor automático por caída de presión, contactor, caja de control o al arrancador, como se indica en la figura apropiada abajo.
5. Pegue las calcomanías de información al motor y a la bomba sumergible, en el lugar apropiado.

AVISO: SIGA CUIDADOSAMENTE LAS INSTRUCCIONES DEL FABRICANTE DEL INTERRUPTOR AUTOMÁTICO POR CAÍDA DE PRESIÓN Y DE CONTROL DEL MOTOR.

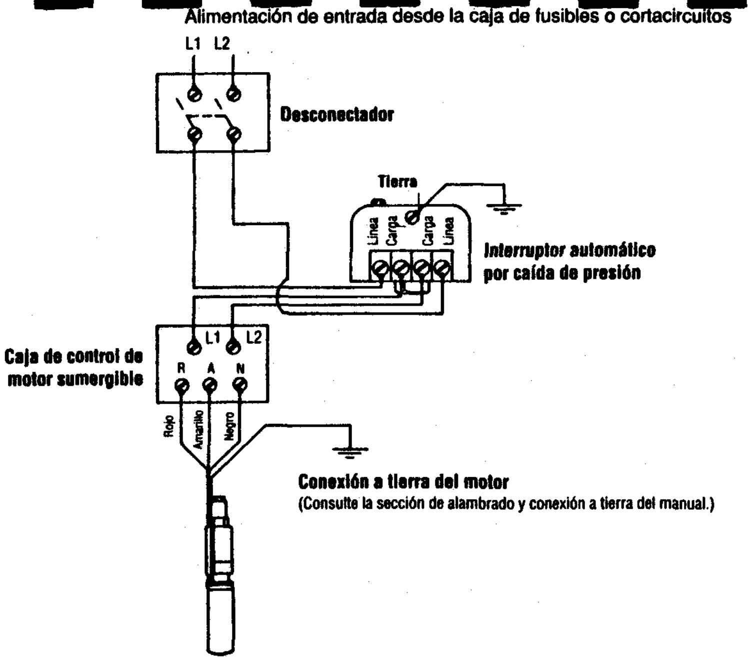
- Los motores de dos alambres no requieren una caja de control. Vea la Figura 1. Los motores monofásicos de tres alambres, requieren una caja de control. Vea la Figura 2.
- Consulte la sección de "Datos Técnicos" de este manual para el dimensionamiento del interruptor de circuitos o del fusible.

MOTORES MONOFÁSICOS



Dos alambres – Conexión directa al interruptor automático por caída de presión.

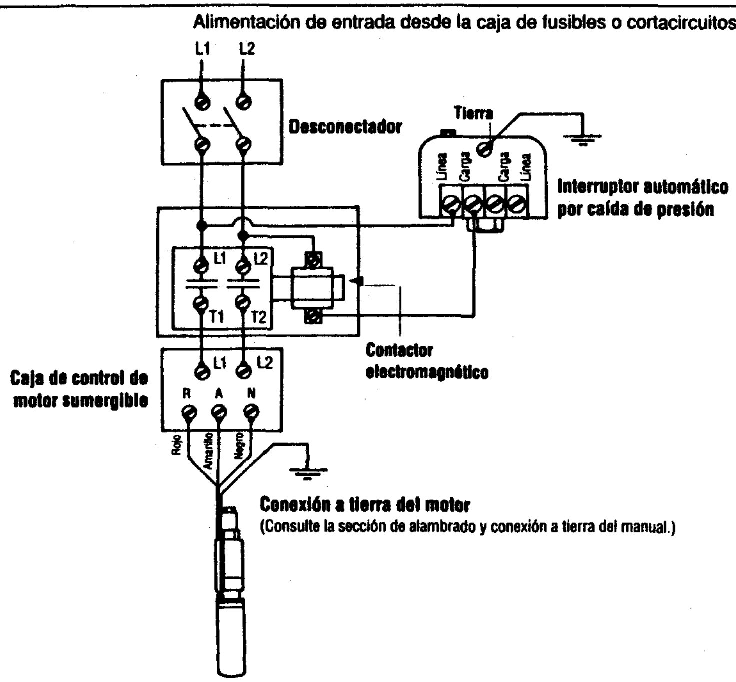
Figura 1



Tres alambres – Conectado directo al interruptor automático por caída de presión.

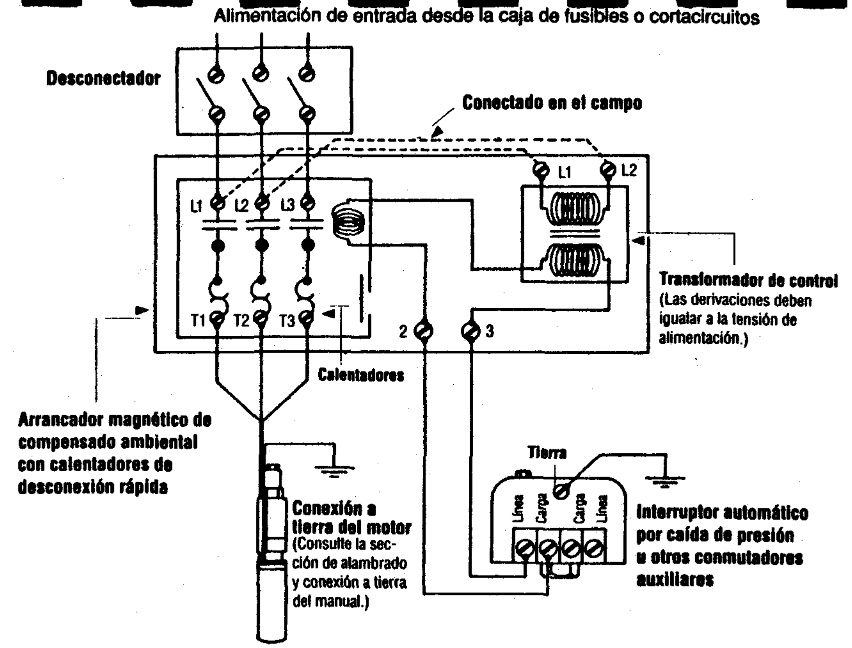
Figura 2

MOTORES TRIFÁSICOS



Tres alambres – Conectados a través del contactor electromagnético.

Figura 3



Conexiones trifásicas

Figura 4

FUNCIONAMIENTO DEL GENERADOR

- Para los generadores regulados externamente las clasificaciones de kilovoltio-amperios (KVA), vea la Tabla 1. La tensión eléctrica, frecuencia, fase y capacidad nominal de amperios **DEBEN** igualar las que se muestran en la placa de fabricante del motor, o la caja de control de la bomba.

LA FALLA DE USAR UN CONMUTADOR DE TRANSFERENCIA AUTOMÁTICO O MANUAL CUANDO SE USA EL GENERADOR COMO AUXILIAR O RESERVA, PUEDE CAUSAR CHOQUES, QUEMADURAS O LA MUERTE.

Tabla 1

Capacidad nominal mínima del generador.	Caballos de fuerza del motor de la bomba							
	⅓	½	¾	1	1½	2	3	5
KVA	1,9	2,5	3,8	5,0	6,3	9,4	12,5	18,8
KW	1,5	2,0	3,0	4,0	5,0	7,5	10,0	15,0

NOTA: Para el mejor arranque de los motores de dos alambres se recomienda que la capacidad nominal mínima del generador sea 50% superior a las indicadas.

AVISO: CUIDADOSAMENTE SIGA LAS INSTRUCCIONES DEL FABRICANTE DEL GENERADOR.

Instalación de la Bomba

AVISO: PROTEJA CONTRA LA CONGELACIÓN TODAS LAS TUBERÍAS, ACCESORIOS Y COMPONENTES DEL SISTEMA DE AGUA.

NO IZE, LLEVE O CUELGUE LA BOMBA DE LOS CABLES ELÉCTRICOS. EL DAÑO A LOS CABLES ELÉCTRICOS PUEDE CAUSAR CHOQUES, QUEMADURAS O LA MUERTE.

- Baje la bomba en el pozo usando el tubo de descarga. Se puede colocar un cable de seguridad a la argolla de izaje de la cabeza de descarga de la bomba, como seguro adicional. **NO** use el cable eléctrico para elevar o bajar la unidad. **NO** dañe los cables eléctricos mientras al levantar o bajar la unidad.

Tuberías

- La tubería del sistema **DEBE** estar conforme a todas las prácticas y códigos de plomería local y nacional .
- Para maximizar el flujo de descarga, la tubería de descarga debe ser por lo menos de 1" (25 mm) de diámetro. Mantenga la tubería de descarga tan corta como sea posible y evite los accesorios innecesarios.

AVISO: LOS MODELOS GS Y SB SE ENSAMBLAN CON **ROSCA IZQUIERDA.** SOSTENGA LA BOMBA CON UNA LLAVE EN EL CABEZAL DE DESCARGA MIENTRAS INSTALA LA TUBERÍA DE DESCARGA O EL CONECTOR.

- Asegúrese de que la bomba y el motor puedan girar libremente, haciendo girar el eje a mano.
- Conecte el tubo de aire a la bomba y baje la bomba en el pozo.
- Usando cinta aislante plástica sumergible, sujete el cable eléctrico al tubo de aire, a intervalos de 10 pies aproximadamente.
- La bomba **DEBE** estar sumergida en todo momento para que funcione bien.
- El ajuste final debe estar dentro del margen de funcionamiento recomendado de la bomba.

AVISO: PROPORCIONE LAS SALVAGUARDIAS ADECUADAS PARA IMPEDIR EL BOMBEO EXCESIVO DEL POZO. USE SÓLO DISPOSITIVOS APROBADOS.

- *Siga los códigos de salud locales aplicables para sellar el pozo y proporcionar una salida adecuada del cable de energía eléctrica.*

Instalación del Tanque

LA FALLA DE INSTALAR UNA VÁLVULA DE ALIVIO DE PRESIÓN ADECUADAMENTE DIMENSIONADA PUEDE CAUSAR DAÑOS A LA PROPIEDAD, LESIONES CORPORALES O LA MUERTE.

- Si la bomba debe operar con una descarga abierta, se **DEBE** instalar una válvula de descarga. Antes de arrancar, abra esta válvula aproximadamente ⅓ del total, luego arranque la bomba. **LENTAMENTE** abra la válvula hasta que se alcance la medida del caudal deseado. El ajuste final **DEBE** quedar dentro de los parámetros recomendados de operación de la bomba. El ajuste final **DEBE** estar dentro del margen de funcionamiento recomendado de la bomba.

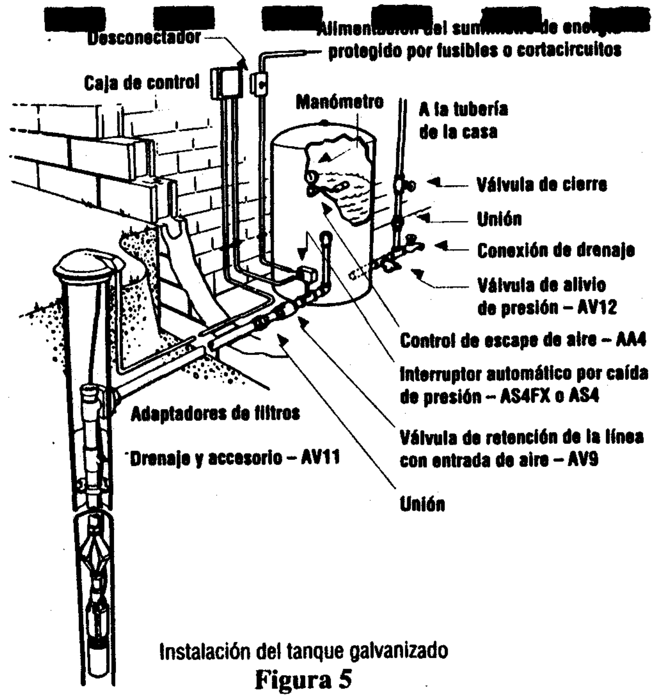
TANQUES GALVANIZADOS

- Cuando se usa un tanque galvanizado de Goulds o equivalente, se requiere un sistema de carga de aire. El sistema Goulds requiere un drenaje y un accesorio "Y", un control de escape de aire y una válvula de retención de la línea con válvula de alivio.
- La distancia entre la válvula de retención de la línea y el drenaje y el accesorio "Y" determinan el volumen de la carga de aire al tanque. Cuando la bomba se para, la válvula de alivio en el control de escape de aire se abrirá a la atmósfera. El drenaje y la el accesorio "Y" mandarán el agua entre la válvula de retención de la línea y el drenaje y el accesorio "Y", de vuelta al pozo. Cuando la bomba vuelva a arrancar, el aire entre la válvula de retención de la línea y el drenaje y el accesorio "Y" será forzado dentro del tanque. El exceso de aire del tanque se mandará automáticamente a la atmósfera por el control de escape de aire. Vea la Tabla 2 para el ajuste de la distancia requerida entre la válvula de retención de la línea y el drenaje y el accesorio "Y", y la Figura 5 para la ubicación e instalación de los accesorios requeridos y los componentes del sistema.

FIJACION APROXIMADA DE ACCESORIOS DE DRENAJE

Capacidad del tanque	Distancia del drenaje y el accesorio "Y" DEBAJO de la válvula de retención de la línea.
42 gal. (9,5 m³/hora)	7 pies (2,1 m)
82 gal. (18,6 m³/hora)	10 pies (3 m)
120 gal. (27,3 m³/horar)	15 pies (4,6 m)
220 gal. (50 m³/hora)	15 pies (4,6 m)
315 gal. (71,5 m³/hora)	20 pies (6,1 m)
525 gal. (119 m³/hora)	20 pies (6,1 m)

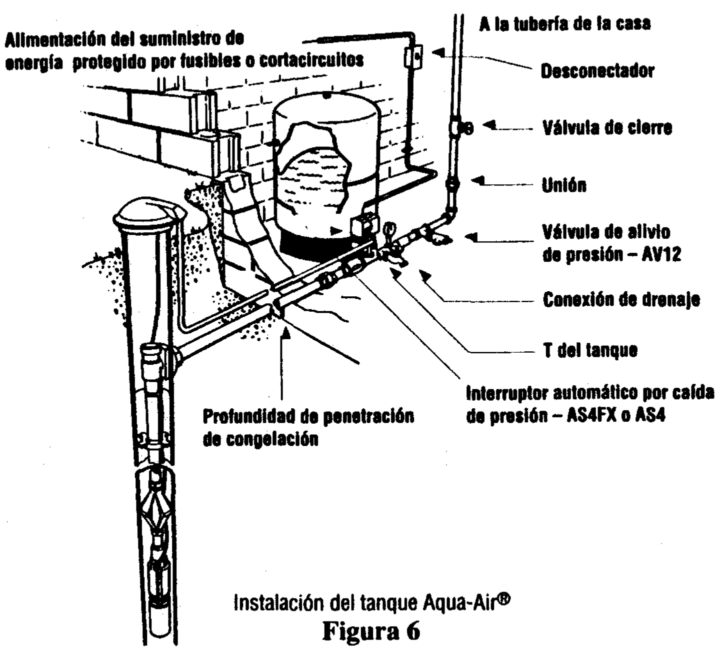
Tabla 2



Instalación del tanque galvanizado
Figura 5

TANQUES AQUA-AIR®

AVISO: LOS CAMBIOS DE PRESIÓN DE PRECARGA DEL TANQUE DEBEN HACERSE USANDO LA VÁLVULA DE AIRE EN LA PARTE SUPERIOR DEL TANQUE.



Instalación del tanque Aqua-Air®
Figura 6

AVI[illegible]IN [illegible] EN[illegible]TAN[illegible]LA [illegible]CAR[illegible]E DE[illegible]IJAR[illegible] LB/PULGADA CUADRADA DE MANÓMETRO (13,8 kPa) MENOS QUE LA PRESIÓN DE CONECTAR EL SISTEMA.

- Vea la Figura 6 para la localización e instalación de accesorios y componentes del sistema requeridos.

Operación

EL FUNCIONAMIENTO DE LA BOMBA EN LAGOS, PISCINAS U OTRAS EXTENSIONES DE AGUA PUEDE CAUSAR CHOQUES, QUEMADURAS O LA MUERTE.

Antes de poner en funcionamiento, vuelva a verificar los siguientes puntos:
- a) **TODAS** las conexiones eléctricas y conexiones a tierra
- b) Ajustes apropiados de la válvula de cierre del sistema.
- c) Instalaciones correctas de la válvula de alivio de presión y de la válvula de retención.

MOTORES MONOFÁSICOS

1. Abra un grifo de la línea de descarga y haga funcionar la bomba por un minuto.
2. Cierre el grifo. La bomba se debe parar cuando la presión alcanza la presión de desconectar fijada en el interruptor automático por caída de presión.
3. Mientras observa el manómetro, abra el grifo y note la lectura del manómetro cuando arranque la bomba.
4. Siguiendo las instrucciones del fabricante del interruptor automático por caída de presión, ajuste el interruptor según se requiera.

MOTORES TRIFASICOS

LA FALLA DE DESCONECTAR Y BLOQUEAR LA ENERGÍA ELÉCTRICA ANTES DE INTENTAR DAR SERVICIO PUEDE CAUSAR CHOQUES, QUEMADURAS O LA MUERTE.

AVISO: LAS VERIFICACIONES DE ROTACIÓN TRIFÁSICA Y DEL DESEQUILIBRIO DE CORRIENTE SE DEBEN REALIZAR SOLAMENTE POR UN ELECTRICISTA CALIFICADO.

1. Verifique el sentido de rotación.
2. Verifique el desequilibrio de corriente.
3. Instale el protector de sobrecarga tipo "K" si se usan arrancadores NEMA o regle las sobrecargas ajustables de acuerdo al amperaje del motor, el que se indica en la placa del fabricante.

Lecturas corrientes al arrancar:

1a. fase: __________

2a. fase: __________

3a. fase: __________

- Los cojinetes del motor están lubricados internamente. No se requiere ni es posible otro mantenimiento del motor o de la bomba.

Datos Técnicos

LECTURAS[1] DE RESISTENCIA DE AISLAMIENTO DEL MOTOR

Lecturas normales de ohmios/megaohmios, de TODOS los motores, entre todos los terminales y tierra

Condición del motor y conductores	Valor de ohmios	Valor de megaohmios
Motor nuevo, sin cable de energía eléctrica	20.000.000 (o más)	20,0
Motor usado, que se puede reinstalar en el área de contención	10.000.000 (o más)	10,0
Motor en área de contención – Las lecturas son del cable de energía eléctrica más el motor		
Motor nuevo	2.000.000 (o más)	2,0
Motor en condiciones razonablemente buenas	500.000 a 2.000.000	0,5 – 2,0
Motor que puede estar dañado o tiene el cable de energía eléctrica dañado *No retire el motor por estas razones*	20.000 a 500.000	0,02 – 0,5
Motor definitivamente dañado o con el cable de energía eléctrica dañado *Retire el motor y repare*	10.000 a 20.000	0,01 – 0,02
Falló el motor o el cable de energía eléctrica *Retire el motor y repare*	Menos de 10.000	0 – 0,01

[1] Cortesía de Franklin Electric Company

ESPECIFICACIONES DE MOTOR DE 60 HZ, MONOFÁSICO

Tipo	Número de catálogo Goulds	Modelo de motor Franklin	HP	Voltios	Hz	S.F.	Entrada nominal Amperios[2]	Carga de F.S. máx. Amperios[2]	*Línea a Línea*[1] Resistencia M = Principal S = Arranque	Amperios de fusible/cortacircuitos Estándar	Amperios de fusible/cortacircuitos Demora	Caja de control
4" de dos alambres	S03932	2445020	1/3	115	60	1,75	8,0	9,2	1,4 – 1,8	25	10	N/R
	S03942	2445030	1/3	230	60	1,75	4,0	4,6	6,0 – 7,4	15	5	N/R
	S04932	2445040	1/2	115	60	1,60	10,0	12,0	1,0 – 1,3	30	15	N/R
	S04942	2445050	1/2	230	60	1,60	5,0	6,0	4,2 – 5,2	15	7	N/R
	S05942	2445070	3/4	230	60	1,50	7,2	8,4	3,0 – 3,6	25	10	N/R
	S06942	2445081	1	230	60	1,40	8,2	9,8	2,2 – 2,7	25	12	N/R
	S07942	2445091	1 1/2	230	60	1,30	10,6	13,1	1,5 – 1,9	35	15	N/R
4" de tres alambres	S03930	2145024	1/3	115	60	1,75	A = 8,0 N = 8,0 R = 0,0	A = 9,2 N = 9,2 R = 0,0	M = 1,4 – 1,8 S = 6,5 – 7,9	25	10	00033
	S03940	2145034	1/3	230	60	1,75	A = 4,0 N = 4,0 R = 0,0	A = 4,6 N = 4,6 R = 0,0	M = 6,0 – 7,4 S = 26,1 – 32,0	15	5	00034
	S04930	2145044	1/2	115	60	1,60	A = 10,0 N = 10,0 R = 0,0	A = 12,0 N = 12,0 R = 0,0	M = 1,0 – 1,3 S = 4,1 – 5,1	30	15	00043
	S04940	2145054	1/2	230	60	1,60	A = 5,0 N = 5,0 R = 0,0	A = 6,0 N = 6,0 R = 0,0	M = 4,2 – 5,2 S = 16,7 – 20,5	15	7	00044
	S05940	2145074	3/4	230	60	1,50	A = 7,2 N = 7,2 R = 0,0	A = 8,4 N = 8,4 R = 0,0	M = 3,0 – 3,6 S = 11,0 – 13,4	25	10	00054
	S06940	2145081	1	230	60	1,40	A = 8,2 N = 8,2 R = 0,0	A = 9,8 N = 9,8 R = 0,0	M = 2,2 – 2,7 S = 10,1 – 12,3	25	12	00064
4" de tres alambres con capacitor de funcionamiento	S07940	2243001	1 1/2	230	60	1,30	A = 10,0 N = 9,9 R = 1,3	A = 11,6 N = 11,0 R = 1,3	M = 1,5 – 2,3 S = 6,2 – 12,0	30	15	00074
	S08940	2243011	2	230	60	1,25	A = 10,0 N = 9,3 R = 2,6	A = 13,2 N = 11,9 R = 2,6	M = 1,6 – 2,3 S = 5,2 – 7,15	30	15	00084
	S09940	2243027	3	230	60	1,15	A = 14,0 N = 12,2 R = 4,7	A = 17,0 N = 14,5 R = 4,5	M = 0,9 – 1,5 S = 3,0 – 4,9	45	20	00094
	S10940	2243037	5	230	60	1,15	A = 23,0 N = 19,1 R = 8,0	A = 27,5 N = 23,2 R = 7,8	M = 0,68 – 1,0 S = 2,1 – 2,8	70	30	00104

[1] M = Devanado principal – Negro a amarillo; S = Devanado de comienzo – Rojo a Amarillo.
[2] A = conductor amarillo – línea amperios. N = conductor negro – devanado principal amperios.
R = conductor rojo, arranque o devanado auxiliar amperios.

ESPECIFICACIONES DE MOTOR DE 60 HZ, TRIFÁSICO

Modelo de motor Goulds	Modelo de motor Franklin					Entrada nominal	Carga de F.S. máx.	Línea a Línea	Amperios de fusible/ cortacircuitos		Furnas® US/15	
		HP	Voltios	Hz	S.F.	Amperios²	Amperios²	Resistencia	Estándar	Demora	Arrancador	Calentador
S04978	2345014	½	200	60	1,6	2,8	3,7	6,64 – 7,3	10	5	BD	K32
S04970	2345114	½	230	60	1,6	2,3	2,9	9,5 – 10,4	8	4	BG	K29
S04975	2345213	½	460	60	1,6	1,2	1,6	38,4 – 41,6	4	2	BH	K21
S05978	2345024	¾	200	60	1,5	3,7	4,7	4,66 – 5,12	12	6	BD	K36
S05970	2345124	¾	230	60	1,5	3,3	4,1	7,24 – 7,84	11	5	BG	K33
S05975	2345223	¾	460	60	1,5	1,6	2,0	27,8 – 30,2	5	3	BH	K23
S06978	2345031	1	200	60	1,4	4,5	5,7	4,1 – 4,5	14	6	BD	K39
S06970	2345131	1	230	60	1,4	3,9	4,8	5,2 – 5,6	12	6	BG	K36
S06975	2345231	1	460	60	1,4	2,0	2,4	21,2 – 23,0	6	3	BH	K26
S07978	2345041	1½	200	60	1,3	6,1	7,3	2,4 – 3,4	20	9	BD	K43
S07970	2345141	1½	230	60	1,3	5,2	6,3	3,2 – 4,1	20	8	BG	K41
S07975	2345241	1½	460	60	1,3	2,6	3,1	11,3 – 15,0	15	4	BH	K29
S07979	2345341	1½	575	60	1,3	2,1	2,5	17,6 – 23,4	15	3	BE	K27
S08978	2343051	2	200	60	1,25	7,7	9,3	1,9 – 2,4	25	10	BD	K50
S08970	2343151	2	230	60	1,25	6,7	8,1	2,4 – 3,0	20	10	BG	K49
S08975	2343251	2	460	60	1,25	3,4	4,0	9,7 – 12,0	15	5	BH	K33
S08979	2343357	2	575	60	1,25	2,7	3,2	15,1 – 18,7	15	4	BE	K29
S09978	2343067	3	200	60	1,15	10,9	12,5	1,3 – 1,7	35	14	CD	K54
S09970	2343167	3	230	60	1,15	9,5	10,9	1,8 – 2,2	30	15	CG	K52
S09975	2343267	3	460	60	1,15	4,8	5,5	7,0 – 8,7	15	7	BH	K37
S09979	2343367	3	575	60	1,15	3,8	4,4	10,9 – 13,6	15	6	BE	K33
S10978	2343077	5	200	60	1,15	18,3	20,5	0,70 – 0,94	50	24	DD	K61
S10970	2343177	5	230	60	1,15	15,9	17,8	0,93 – 1,2	45	20	DG	K60
S10975	2343277	5	460	60	1,15	8,0	8,9	3,6 – 4,4	25	10	BH	K49
S10979	2343377	5	575	60	1,15	6,4	7,1	5,6 – 6,9	20	8	BE	K42
S119874	2343087	7½	200	60	1,15	26,5	30,5	0,46 – 0,57	80	35	ED	K68
S119704	2343187	7½	230	60	1,15	23,0	26,4	0,61 – 0,75	70	30	EG	K67
S119754	2343287	7½	460	60	1,15	11,5	13,2	2,4 – 3,4	35	15	CH	K55
S119794	2343387	7½	575	60	1,15	9,2	10,6	3,5 – 5,1	30	12	CE	K52

Cortesía de Franklin Electric Company

Investigación de Averías

ADVERTENCIA

Las tensiones peligrosas pueden causar choques, quemaduras o la muerte.

DESCONECTE Y BLOQUEE LA ENERGÍA ELÉCTRICA ANTES DE INTENTAR DAR NINGÚN SERVICIO. NO HACER ESTO PUEDE CAUSAR CHOQUES, QUEMADURAS O LA MUERTE.

Síntoma	Causa probable	Acción recomendada
EL MOTOR DE LA BOMBA NO FUNCIONA	1. El protector térmico del motor disparó a. Caja de control incorrecta b. Conexiones eléctricas incorrectas o defectuosas c. Protector térmico defectuoso d. Tensión baja e. Temperatura ambiente de la caja de control/arrancador demasiado alta f. Bomba atascada por materias extrañas g. Inmersión inadecuada	1. Deje que se enfríe el motor; el protector térmico se reajustará automáticamente a-e. Haga inspeccionar y reparar con un electricista calificado, según se requiera f. Retire la bomba, limpie, ajuste la profundidad fijada según se requiera g. Confirme que la inmersión de la unidad es adecuada
	2. Cortacircuitos abierto o fusible fundido	2. Haga inspeccionar y reparar con un electricista calificado, según se requiera
	3. Fuente de energía eléctrica inadecuada para la carga	3. Verifique el suministro o la capacidad del generador
	4. Aislamiento del cable de energía eléctrica dañado 5. Empalme del cable de energía eléctrica defectuoso	4 – 5. Haga inspeccionar y reparar con un electricista calificado, según se requiera
LA BOMBA ENTREGA POCO O NADA DE LÍQUIDO	1. Válvula de retención defectuosa o instalada incorrectamente	1. Inspeccione la válvula de retención y repare según se requiera
	2. La bomba está atascada por aire	2. Arranque y pare la bomba sucesivamente hasta que entregue flujo
	3. La altura de elevación es demasiado alta para la bomba	3. Examine el comportamiento de la unidad, verifique con el agente
	4. La bomba está atascada por materias extrañas	4. Retire la bomba, limpie, ajuste la profundidad fijada según se requiera
	5. La bomba no está totalmente sumergida	5. Verifique la recuperación del pozo, baje la bomba si es posible
	6. El pozo contiene cantidades excesivas de aire o gases	6. Si los arranques y paradas sucesivas no corrigen el problema, el pozo contiene excesiva cantidad de aire o gases
	7. Desgaste excesivo de la bomba	7. Retire la bomba y repare según se requiera.
	8. Rotación incorrecta de motor – trifásico solamente	*8. Invierta dos conductores eléctricos cualesquiera del motor*

LIMITED WARRANTY

This warranty applies to all water systems pumps and related accessories manufactured and/or supplied by Goulds Pumps, Inc.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the buyer or any subsequent owner during the warranty period. The warranty period shall exist for a period of twelve months from the date of installation or eighteen months from the date of manufacture, whichever period is shorter.

A consumer who believes that a warranty claim exists must contact the authorized Goulds dealer from whom the equipment was originally purhased and furnish complete details regarding the claim. The dealer is authorized to adjust any warranty claims utilizing Goulds Customer Relations Department and its distributor organization.

This warranty excludes: a) Labor, transportation and related costs incurred by the consumer to make the allegedly defective equipment available to the dealer for inspection, b) re-installation costs of repaired equipment, c) re-installation costs of replacement equipment, d) consequential damages of any kind, and e) reimbursement for loss caused by interruption of service. 4SUB.IOM (07/95)

GARANTIE LIMITÉE

Cette garantie s'applique à tous les systèmes de pompe et accessoires fabriqués ou vendus par Goulds Pumps, Inc.

Pendant la durée de la garantie, toute pièce défectueuse sera remplacée sans frais pour le premier acheteur et les acheteurs subséquents. La durée de la garantie est de douze mois à partir de la date d'installation ou de 18 mois à partir de la date de fabrication, selon la période la plus courte.

Le consommateur qui veut faire une réclamation doit communiquer avec le détaillant autorisé Goulds qui lui a vendu l'appareil et lui fournir tous les renseignements nécessaires pour sa réclamation. Le détaillant est habilité à s'occuper des réclamations en passant par le service à la clientèle de Goulds ou par son réseau de distribution.

Cette garantie ne couvre pas: a) les frais de port et de manutention ainsi que tout autre frais encouru par la livraison de l'appareil considéré défectueux au détaillant pour inspection, b) les coûts de réinstallation de l'appareil réparé, c) les coûts de réinstallation de l'appareil de rechange, d) tout dommage y afférent et e) le remboursement des pertes encourues par une interruption de service. 4SUB.IOM (07/95)

GARANTÍA LIMITADA

Esta garantía se aplica a todas las bombas de los sistemas de agua y de accesorios afines, fabricados y/o suministrados por Goulds Pumps Inc.

Cualquier pieza o piezas encontradas defectuosas, dentro del período de la garantía, serán reemplazadas sin cargo al comprador o a cualquier propietario subsiguiente, durante el período de la garantía. El período de garantía es de doce (12) meses a partir de la fecha de instalación, o dieciocho (18) meses a partir de la fecha de fabricación, de los dos, el período que sea más corto.

Un consumidor que crea que existe una reclamación de garantía debe comunicarse con el agente autorizado de Goulds, a quien le compró el equipo originalmente, y debe proporcionar los detalles completos acerca de la reclamación. El agente está autorizado a ajustar las reclamaciones de garantía utilizando el Departamento de Relaciones del Cliente de Goulds y su organización de distribuidores.

Esta garantía excluye: a) la mano de obra, transporte y los costos relacionados incurridos por el consumidor para poner a disposición del agente para la inspección, el equipo que se alega es defectuoso, b) los costos de reinstalación del equipo reparado, c) los costos de reinstalación del equipo reemplazado, d) los daños emergentes de cualquier clase que sean, y e) el reembolso por las pérdidas causadas por la interrupción del servicio. 4SUB.IOM (07/95)

Smart Pressure Transmitters
600T Series

Operating Instructions

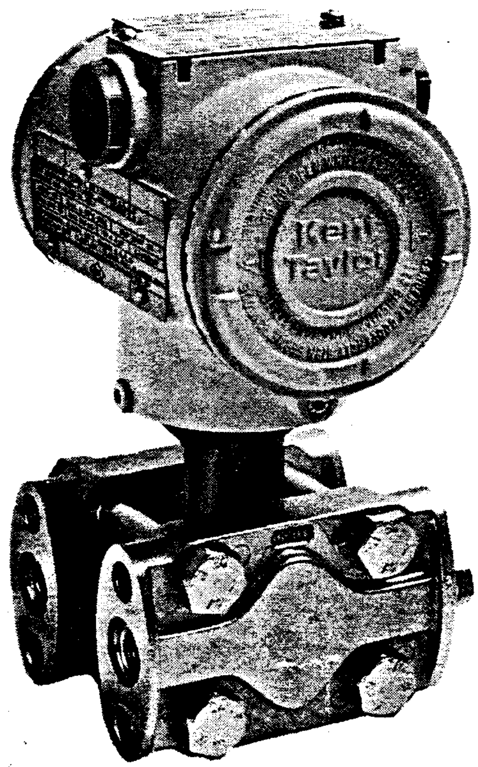


ABB Instrumentation

ABB KENT TAYLOR

BS EN ISO 9001
St Neots - Certificate No. Q5907
Stonehouse - Certificate No. FM 21106

Stonehouse - Certificate No. 0255

The Company

ABB Kent-Taylor is an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivaled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The NAMAS Calibration Laboratory No. 0255(B) is just one of the ten flow calibration plants operated by the Company, and is indicative of ABB Kent-Taylor's dedication to quality and accuracy.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.

2. Warning Labels on containers and packages must be observed.

3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.

4. Normal safety procedures must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.

5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.

6. When disposing of chemicals, ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual may be obtained from the Company address on the back cover, together with servicing and spares information.

Use of Instructions

Δ **Warning.** An instruction that draws attention to the risk of injury or death.

! **Caution.** An instruction that draws attention to the risk of the product, process or surroundings.

• **Note.** Clarification of an instruction or additional information.

i **Information.** Further reference for more detailed information or technical details.

Although Warning hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **Warning** and **Caution** notices.

Information in this manual is intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of the Technical Communications, ABB Kent-Taylor.

Licensing, Trademarks and Copyrights

Smart Deltapi K Series is a registered trademark of Asea Brown Boveri, Inc.

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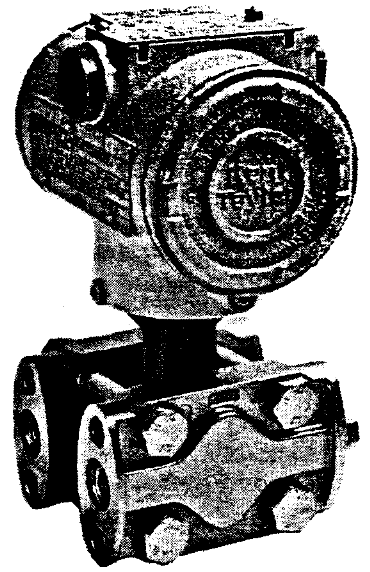
INTRODUCTION



The **600T** series is a modular range of field mounted, microprocessor based electronic transmitters, using a unique inductive sensing element. Accurate and reliable measurement of differential pressure, gauge and absolute pressure, flow and liquid level is provided, in even the most difficult and hazardous industrial environments.

The 600T Smart transmitters provide the added capability of bidirectional digital communication with the Hand Held Communicator model K-HT or with any remote transmitter interface supporting the HART® Protocol.

The communication protocol allows remote re-ranging, calibration and diagnostics without interferring with the normal 4 to 20 mA signal.

Transport
After final calibration, the instrument is packed in a carton (*), intended to provide protection from physical damage.

(*) Type 2 to ANSI/ASME N45.2.2-1978

Storage
The instrument does not require any special treatment if stored as despatched and within the specified ambient conditions level (*). There is no limit to the storage period, although the terms of guarantee remain as agreed with the Company and as given in the order acknowledgment.

Handling
The instrument does not require any special precautions during handling although normal good practice should be observed.

Product identification

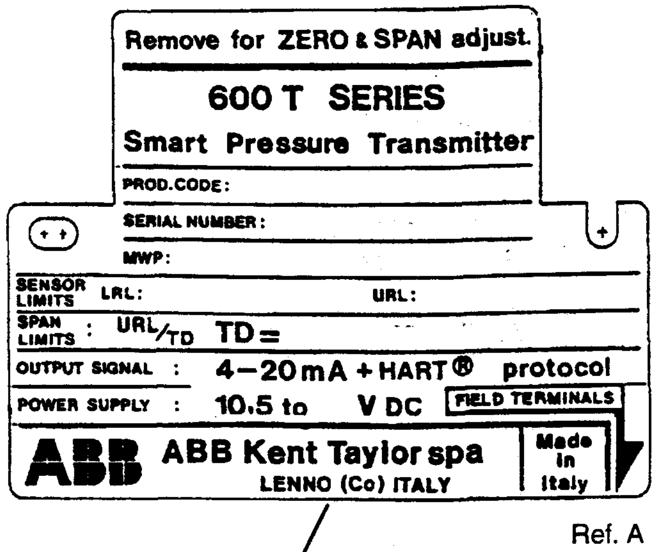
The instrument is identified by the data plates shown in Figure 1.

The Nameplate (ref . A) provides information concerning the code number, maximum working pressure, range and span limits , power supply and output signal. See code/specification sheet for detailed information. This plate also shows the transmitter serial number. **Please refer to this number when making enquiries.**

A dedicated label (Ref. B) is welded as standard to the primary unit, carrying specific details of the transducer (diaphragms material, fill fluid, range limit and identification number).

A Safety Marking plate (ref. C) is fitted when the transmitter is required to comply with hazardous area regulations, e.g. flameproof or intrinsic safety protection.

Additionally a wired-on type Tag plate (ref. D) provides the customer tag number and calibrated range.



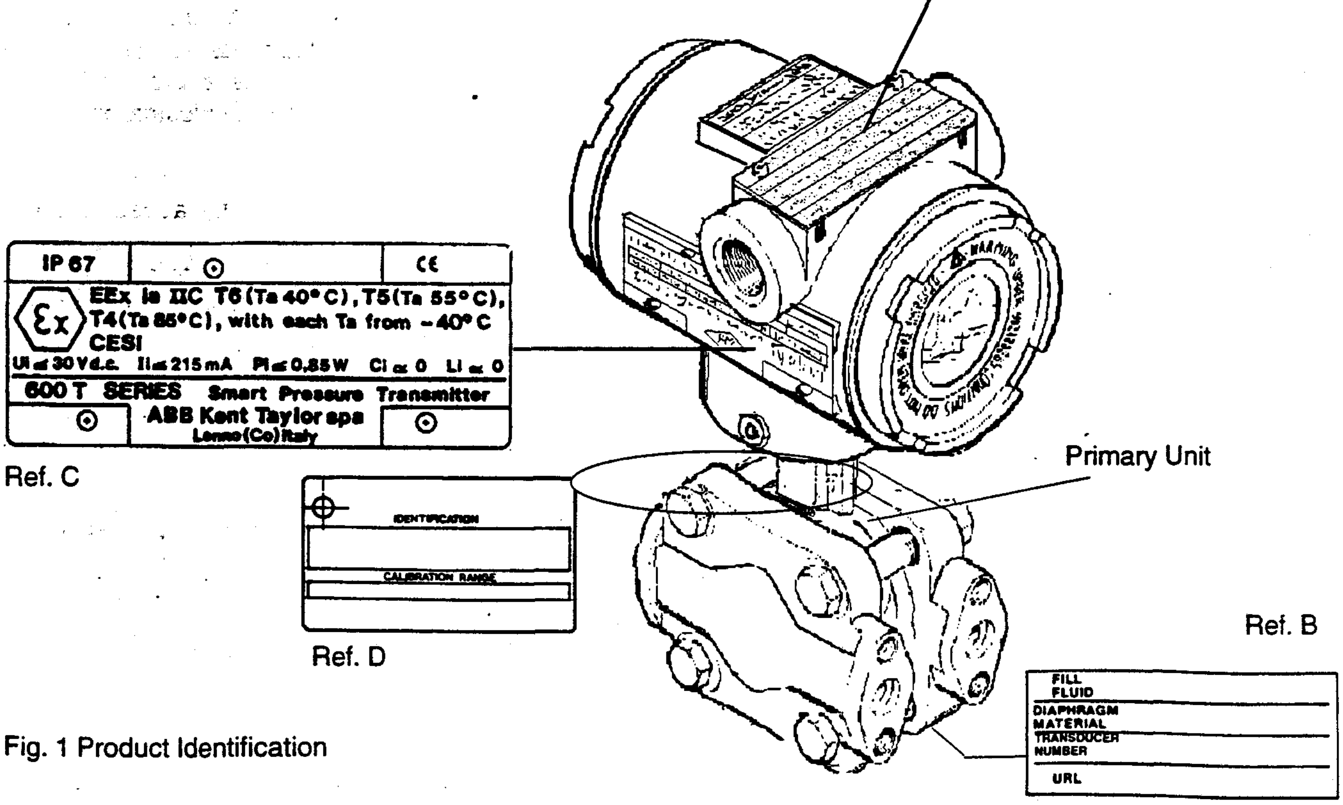


Fig. 1 Product Identification

Important - The instrument serial number must always be quoted when making enquiries.

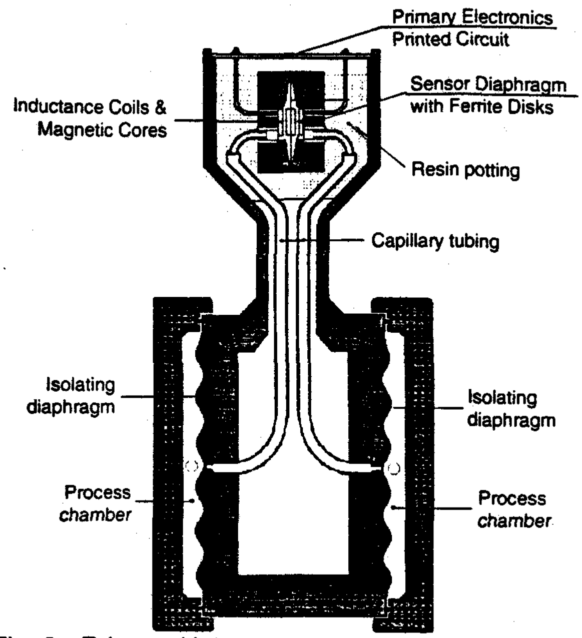


Fig. 2 - Primary Unit

PRINCIPLE OF OPERATION

The instrument consists of two functional units:
- Primary Unit
- Secondary Unit

The Primary Unit includes the process interface and the sensor, the Secondary Unit the electronics, the terminal block and the housing. The two units are mechanically coupled by a threaded joint.

The principle of operation of the Primary Unit is as follows. The process fluid (liquid, gas or vapor) exerts pressure onto the sensing diaphragm via flexible, corrosion-resistant isolating diaphragms, capillary tubing and the fill fluid (see Fig. 2). As the measuring diaphragm deflects in response to differential pressure changes, it simultaneously produces variations in the gap between two fixed magnetic circuits (comprising coil and ferrite core) positioned on both sides of the measuring diaphragm. As a result, the inductance of each coil changes.

The unit also includes a temperature sensor. The two inductance values L1 and L2, and the sensor temperature ST, combined in the primary electronics to provide a proprietary standard signal.

In the manufacturing process the sensor output characteristics are compared with reference pressures and temperatures: the "mapped" parameters are then stored in EEPROM # 1.

The measured values and the sensor parameters are transferred to the Secondary Unit, where a microprocessor computes precise primary output linearization, compensating for the combined effects of sensor non linearity, of static pressure and temperature changes.

In the secondary electronics EEPROM #2 stores specific transmitter information :
- non modifiable data such as the serial number, the UID (Unique Identifier), the manufacturer's name and production site, the hardware and software version of the electronics and of the communication protocol
- the modifiable data such as the final trimming and calibration ie., all data that can be changed by the user through the configurator devices.

The microprocessor also computes, as a function of the input range required, the 4 to 20 mA output signal and receives data from the internal modem to provide bidirectional digital communication with the configuration device, i.e. the Hand Held Terminal "Communicator" or P.C. "Configurator", using the HART* Protocol.

This protocol is based on the standard Bell 202 FSK (Frequency Shift Keying) with a ±.5 mA signal modulation superimposed on the 4 to 20 mA analog signal. As the energy balance added to the current loop is virtually zero and the frequency is very high compared to that of the process dynamic, the analog process signal remains undisturbed. Using a configuration device it is then possible to remotely modify the configuration of the transmitter, including the measuring range. It is also possible to read other transmitter data and diagnostic information. Limited rezeroing and respanning, comparable to that conventional analog transmitters is possible using the optional calibration device.

The sensor and all electronic parts are galvanically isolated from the transmitter body.

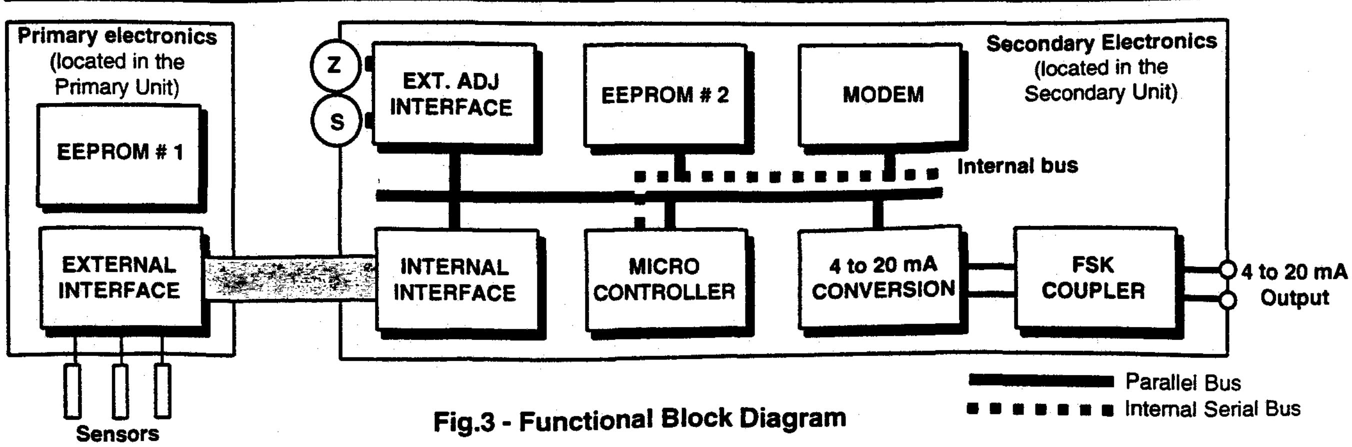


Fig.3 - Functional Block Diagram

INSTALLATION

WARNING
In order to ensure operator safety and plant safety it is essential that installation is carried out by suitably trained personnel according to the technical data provided in the specification for the relevant model.

The transmitter may be mounted on a horizontal or vertical 2-inch pipe (figg. 5) by means of the same mounting bracket (fig. 6).
Note: for other installation details see the relevant Addendum.

DANGER - For installation in Hazardous Areas, i.e. areas with danger of fire and/or explosion, irrespective of the protection mode used, the installation must carried out in accordance with local authority regulations. Ensure also that the temperature of the transmitter does not exceed the value indicated in the Safety Marking plate.

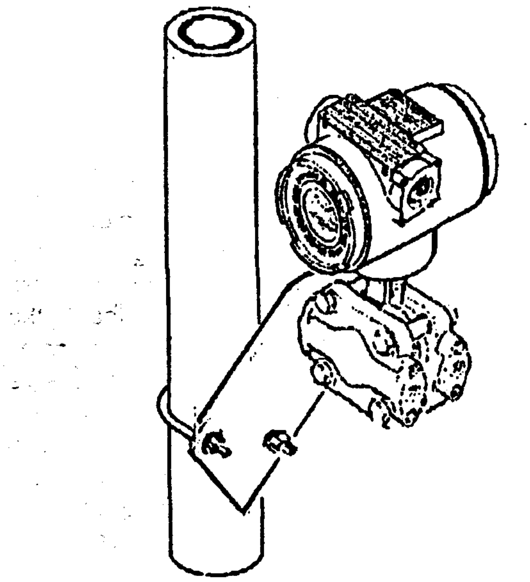


Fig. 5a - Mounting on 2" vertical pipe

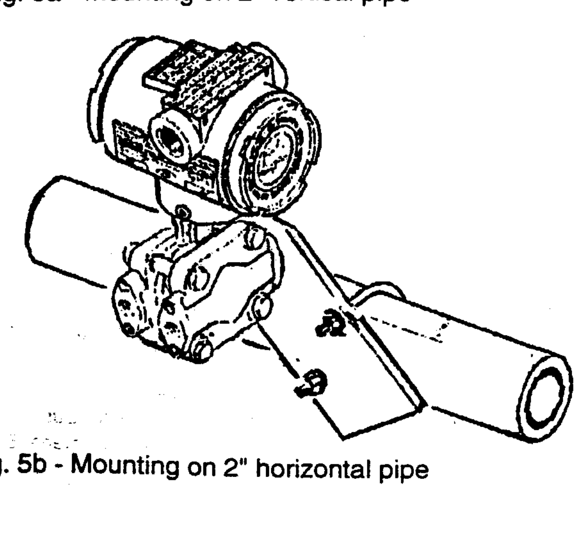


Fig. 5b - Mounting on 2" horizontal pipe

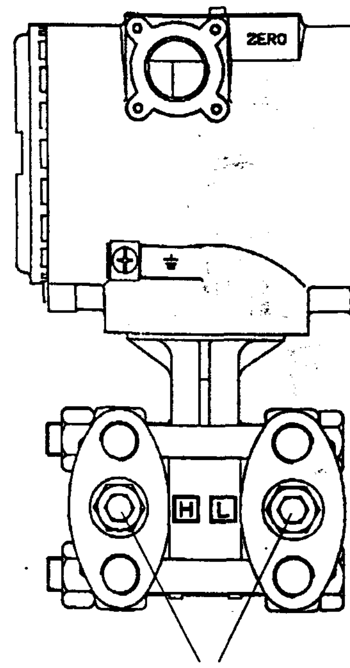


Fig. 4 - Process Connections
(Diff. Press. Transmitter)

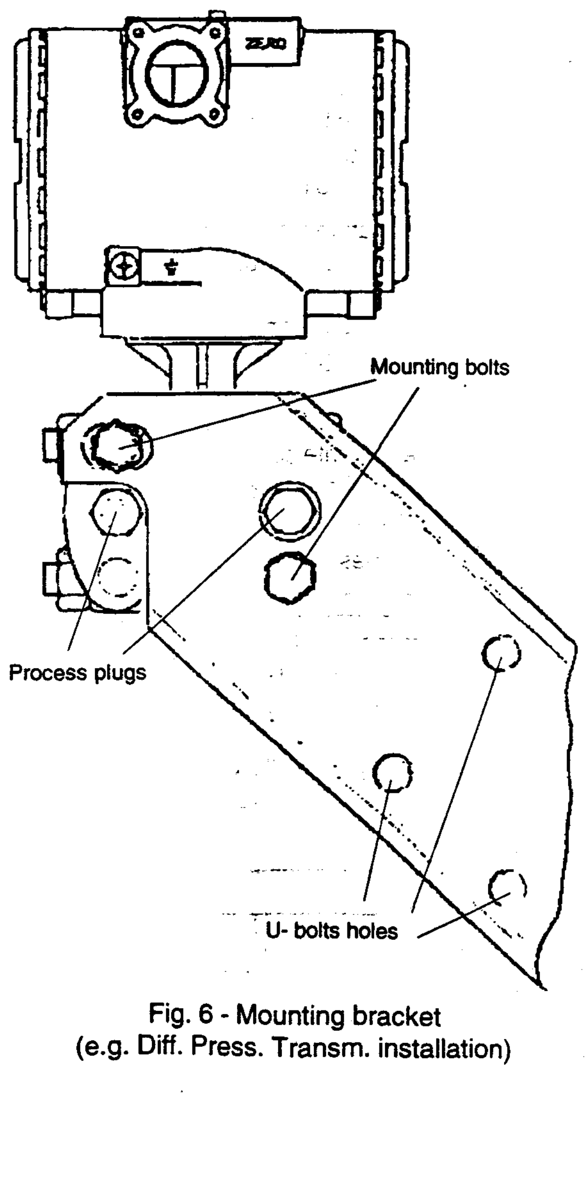


Fig. 6 - Mounting bracket
(e.g. Diff. Press. Transm. installation)

CAUTION - Proper location of the transmitter with respect to the process pipe will depend upon the service for which the instrument is used. **Care should be exercised to identify correct process connections.**

The secondary unit of the transmitter may be rotated through 360° approx. with respect to the primary unit without degrading performance or damaging the internal wiring. Do not force the primary unit to rotate; use the 2 mm Allen key supplied to unlock and lock the tang grub screw (see Fig. 7). This feature, obtained by unscrewing (one turn is sufficient) the Allen screw, is particularly useful for reaching optimum access to the electrical connections and visibility of the output indicator.

ELECTRICAL CONNECTIONS

DANGER - For installation in Hazardous Areas, i.e. areas with danger of fire and/or explosion, prior to making electrical connections, ensure compliance with safety information on the Safety Marking plate. Failure to comply with this warning can result in fire or explosion.
Signal terminals are located in a separate compartment of the secondary unit electronics housing. The housing incorporates two connection ports for cable glands or conduit fittings. They are protected with a temporary plastic plug for transit purpose which should be replaced with a suitable permanent plug in the unused port. Connections can be made by removing the cover (indicated in Fig. 7); first screw down the locking screw located below the cover, using a 3 mm Allen Key.

DANGER - For Hazardous Location installations, at least five (5) threads on both conduit fittings and permanent plug must be engaged in order for the transmitter to meet flameproof (explosion-proof) requirements.
The signal cable should be connected to the terminals marked respectively (+) and (-). If an internal output meter - either with analog or digital indication - is installed, it should be removed in order to make the connection, simply by pulling it out from its socket.
After the connections have been made, reinstall the output meter.
Note : refer to relevant addendum for details.
The power to the transmitter is supplied over the signal wiring and no additional wiring is required. The signal wiring does not need to be shielded but the use of a twisted pair is highly recommended. The cable shield should be grounded in one side only, to avoid dangerous earth paths. Normal practice is to ground in the control room side. In which case the field side of the screen should be adequately protected to avoid contact with metallic objects. Signal wiring may be ungrounded (floating) or grounded at any place in the signal loop, but for intrinsically safe installations the wiring and grounding must follow the specific rules for this technique. The transmitter case may be grounded or ungrounded: a ground connection is provided internally (in the terminal compartment) and externally.

Do not run the signal wiring in close proximity to power cable or high power equipment; use dedicated conduits or trays for signal wiring.

CAUTION - Do not connect the powered signal wiring to the mA signal testing terminals as this could damage the by-pass diode.

After the connections have been completed check the integrity of the cover O-ring, screw down the cover and secure it by unscrewing the safety screw.

CAUTION - *Unless absolutely necessary, avoid the removal on site of the protective cover which gives access to the electronic circuitry. Although the electronics are fully tropicalized they should not be subjected to humidity for long periods.*

DANGER - For Hazardous Location installations, at least eight (8) threads on each cover must be engaged in order for the transmitter to meet flameproof (explosion-proof) requirements.

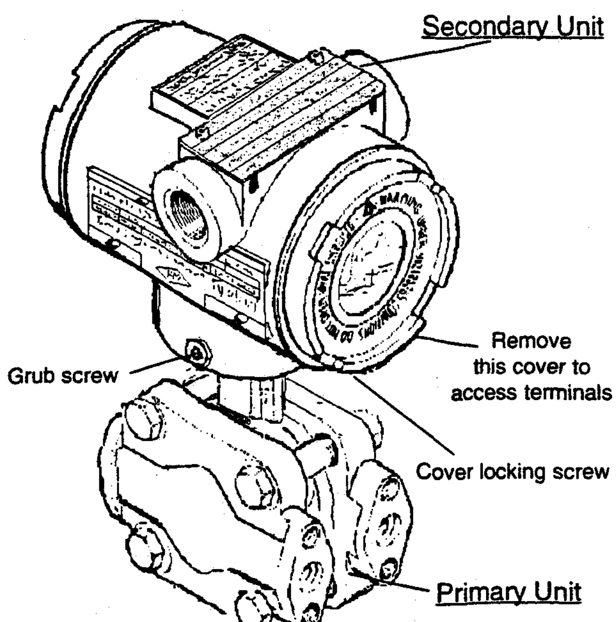


Fig. 7 - Location of the locking screws and terminals

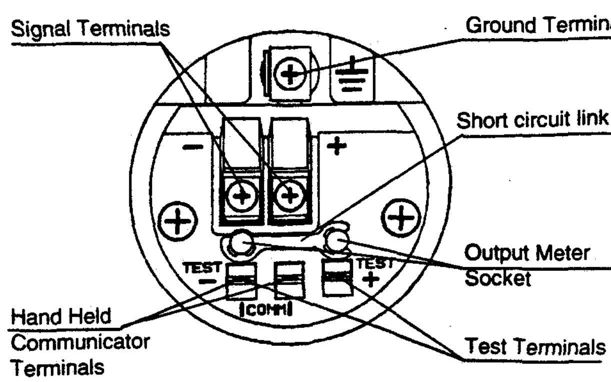


Fig. 8 - Terminals arrangements

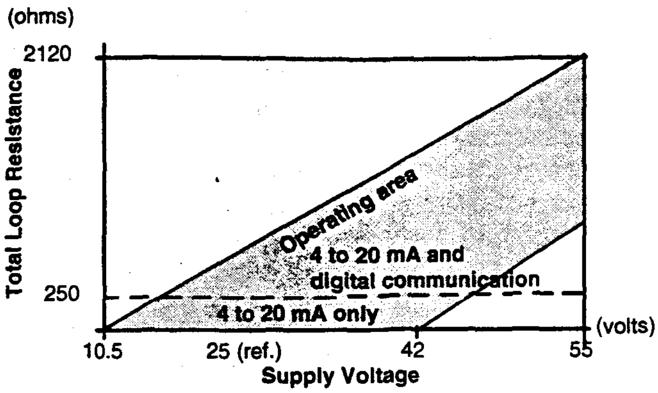
NOTE : If the use of the Hand Held Communicator is foreseen, resistance of 250 ohms minimum **must** be included in the current loop, between the power supply and the connection point of the model K-HT Hand Terminal, to allow the communication to operate.

ELECTRICAL REQUIREMENTS

The transmitter operates on a minimum voltage of 10.5 Vdc to a maximum of 55(*) Vdc and is protected against polarity inversion. If the optional surge protection is installed the minimum voltage increases to 11.6 Vdc.

The total loop resistance, including optional remote indicator line (max 15 ohm), is indicated in the figure and expression below.

$$R\ (k\Omega) = \frac{\text{Supply voltage - min. operating voltage (Vdc)}}{21}$$



The total loop resistance is the sum of the resistance of all elements of the loop, including wiring, conditioning resistor, safety barriers and additional indicators (excluding the equivalent resistance of the transmitter).

Where a configuration device, such as the Hand Held Communicator or a Modem is likely to be used, a resistance of 250 ohm minimum should be present between the power supply and the point of insertion of these devices, to allow communication.

Several types of safety barriers, either passive or active, can be satisfactorily used in conjunction with the Smart KT transmitter. Nevertheless, in case of use of active barriers, check with the supplier if the model is suitable for use with smart transmitters allowing the connection of the configuration devices in the "safe" or non-hazardous area.

(*) **WARNING - In some countries the maximum power supply voltage is limited to a lower value.** From 42 V. to 55 V. d.c. a load from 0 up to 620 ohm is requested (see the figure above).

RANGE AND SPAN CONSIDERATION

The Smart KT Transmitter Specification Sheets provide all information concerning the Range and Span limits in relation to the model and the sensor code.

The terminology currently used to define the various parameters is as follows:

URL : Upper Range Limit of a specific sensor. The highest value of the measured value that the transmitter can be adjusted to measure.

LRL : Lower Range Limit of a specific sensor. The lowest value of the measured value that the transmitter can be adjusted to measure.

URV : Upper Range Value. The highest value of the measured value to which the transmitter is calibrated.

LRV : Lower Range Value. The lowest value of the measured value to which the transmitter is calibrated.

SPAN : The algebraic difference between the Upper and Lower Range Values. The minimum span is the minimum value that can be used without degradation of the specified performance.

TURN DOWN RATIO : is the ratio between the maximum span and the calibrated span.

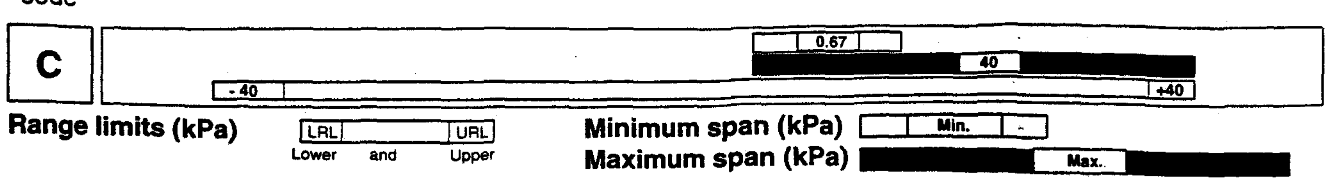
The transmitter can be calibrated with any range between the LRL and the URL with the following limitations:

LRL - LRV - (URL - CAL SPAN)
CAL SPAN • MIN SPAN
URV - URL

The figure below gives an example of the representation of the range and span limits included in all Specification Sheets.

Sensor code

RANGE AND SPAN LIMITS



CALIBRATION

Unlike conventional electronic transmitters, the use of a microprocessor and the presence of serial communications between the transmitter and the configuration device, allows the use of several different approaches in calibration and servicing.

Three different methods can be used to calibrate the Smart transmitter:

i) using the optional zero and span calibration screws in the transmitter secondary unit.
ii) using the Hand Held Communicator model K-HT.
iii) using the Personal Computer Configuration Software Package.

This manual describes only the first method; the others are described in the relevant Instruction Manuals. If the optional calibration screws are not fitted calibration must be by method ii) or iii).

Note: Unless otherwise specified the instrument is factory calibrated at maximum span with the LRV set to true zero. Instruments adjusted and tagged for a specific range will not require recalibration. Rezeroing of the transmitter may be required in order to compensate for zero shift arising from the installation.

Preliminary operation

Before commencing calibration ensure that:

i) the required span, the upper and lower range value (URV & LRV) are within the span and range limits (URL & LRL) indicated on the nameplate (please refer to "Range and Span" consideration on the previous page).

ii) the transmitter is properly powered and the electrical connections correctly made.

iii) the write (W) / write protect (P) link, located either on the electronics module (Fig.9a) or on the integral display (Fig.9b), is in position "W" (write allowed). Access to the link is gained by unscrewing the secondary unit housing cover at the opposite end to the terminal cover.

iv) the Upscale/Downscale link is positioned to the required function (Figs. 9a, 9b).

v) make the electrical connections, as indicated in Fig. 10. Connect a precision milliammeter as shown and **remove the short circuit link.**

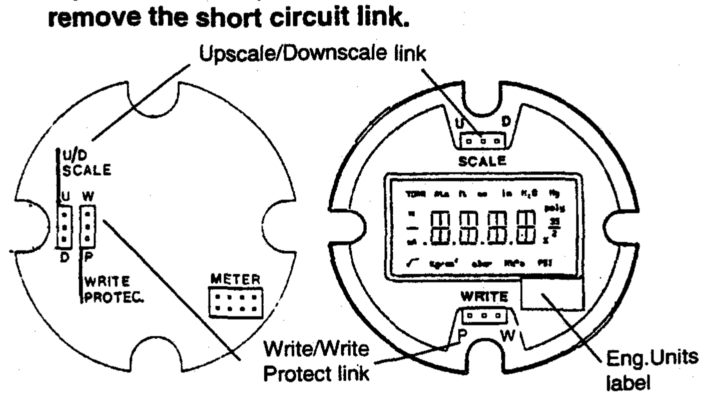


Fig. 9a Location of the links on the electronics

Fig. 9b Location of the links on the integral display

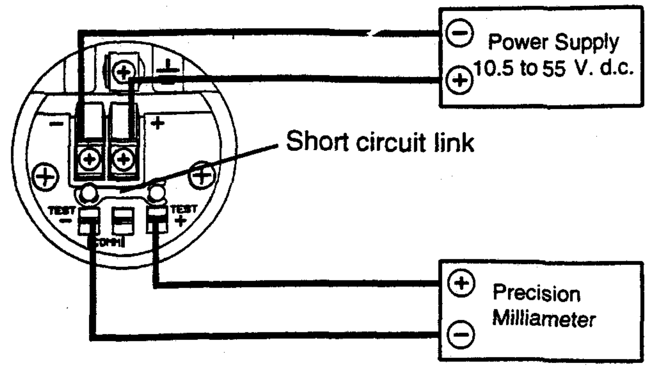


Fig. 10 - Calibration electrical connections

Set up an appropriate test rig in accordance with the required calibration. Figure 11 shows a complete test rig that can be selectively used to suit the calibration.

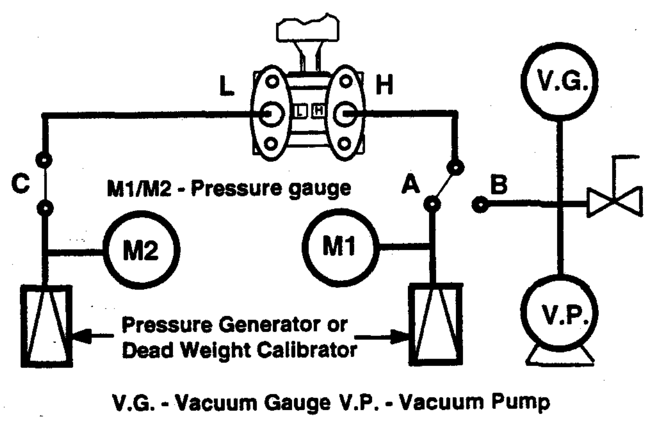


Fig. 11 - Calibration pressure connections

Note that calibration accuracy is strictly related to the accuracy of the test equipment: the use of a dead weight tester is highly recommended.

The zero and span calibration screws are located behind the Nameplate. To gain access slacken the nameplate screw and rotate 90° ; proceed in the reverse mode when the calibration procedure has been completed. Fig. 12 shows the calibration screws: they provide two large plastic heads that can rotate 90° in the direction indicated by the arrows, with spring-return to normal. The calibration screws can be removed after the calibration, to avoid improper use by inserting a screwdriver blade below the plastic flange and pulling out.

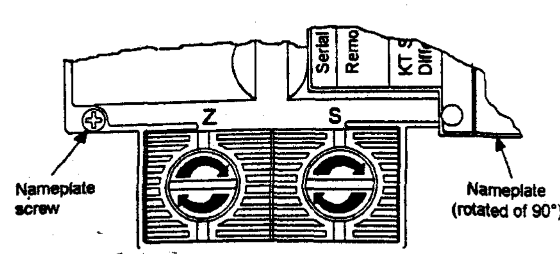


Fig. 12 - Top view of the calibration devices

Zero and span - true zero procedure

Differential pressure, gauge and level.

- Switch on the power supply.

- With no pressure applied to the transmitters, the value read on the digital milliammeter should be 4 mA ; if it is not turn the zero screw for at least 1 second. After this operation the reading should move to 4 mA: if no change occurs repeat the operation.

- Apply to the H (high) connection a pressure equal to the upper range value (URV) and allow time for the pressure to stabilize.

- Turn the span screw for at least 1 second: after this operation the reading on digital milliammeter should be 20 mA and the calibration procedure is complete. If no change occurs either the calibration procedure was not correctly performed or the span exceeds the limit; correct and repeat the operation.

Absolute pressure

- Switch on the power supply.

- Connect a vacuum source to the process connection and draw the maximum possible vacuum obtainable. The value read on the digital milliammeter should be 4 mA ; if it is not turn the zero screw for at least 1 second. After this operation the reading should move to 4 mA : if no change occurs repeat the operation.

- If the value of the calibration span (URV) is less than atmospheric pressure gently open the vent valve so increasing the pressure to the Upper Range Value. If the calibration span (URV) is greater than the atmospheric pressure then connect the pressure connection to a pressure source and generate a pressure corresponding to the URV. Allow time for the pressure to stabilize.

- Turn the span screw for at least 1 second: after this operation the reading on digital milliammeter should be 20 mA and the calibration procedure is complete. If no change occurs the calibration procedure was not correctly performed or the span exceeds the limit; correct and repeat the operation.

Zero suppression procedure

Differential pressure, gauge and level.

Two different methods (a) or (b) can be used :

a) After completion of the zero and span procedure above, apply to the H (high) connection a pressure equal to the pressure to be suppressed. Allow time for pressure stabilization and then turn the zero screw for at least 1 second. After this operation the digital milliammeter reading should be 4mA and the Upper Range Value automatically moved to a value equal to the sum of the pressure to be suppressed and the previous calibrated span.

b) Use the zero and span procedure above but apply pressures equal to the Lower Range Value (LRV) and then to Upper Range Value (URV), and turning, for at least 1 second, the zero and span screws respectively.

Absolute pressure

Use the zero and span procedure above but apply to the process connection absolute pressures equal to the Lower Range Value (LRV) and then to the Upper Range Value (URV), turning, for at least 1 second, the zero and span screws respectively.

Zero elevation procedure

Differential pressure and level

Two different methods (a) or (b) can be used :

a) After completion of the zero and span procedure above apply to the L (low) connection a pressure equal to the pressure to be elevated. Allow time for pressure stabilization and then turn the zero screw for at least 1 second. After this operation the digital milliammeter reading should be 4mA and the Upper Range Value (URV) is automatically moved to a value equal to the sum of the pressure to be elevated and the previous calibrated span.

b) Use the zero and span procedure above but apply pressures equal to the Lower Range Value (LRV) and then equal to the Upper Range Value (URV) and turning, for at least 1 second, the zero and span screws respectively. The LRV pressure will be applied to the L connection whereas the URV will be applied to the L or to the H connection depending upon the whether the range is all negative or crosses zero.

Gauge pressure

Apply to the process connection, pressures equal to the LRV and then equal to the upper range value (URV) and correspondingly turn the zero and span screws respectively.

NOTE - To prevent unauthorized calibration operation refit the write protection link in position P (Write Protect) (Figs 9a and 9b).

Note - If during the calibration procedure the readings on the digital milliammeter are , outside its inherent accuracy, output trimming of the transmitter may be requested. This operation can only be performed using the Hand Held Terminal Communicator or the Personal Computer Configurator. If this equipment is not available the transmitter should be returned to a Service Center for recalibration.

DISMANTLING AND REASSEMBLY

DANGER - Process fluids and/or pressure retained in the transmitter primary unit can cause severe injury and death or damage to the equipment.
Plant Safety Procedures must be followed when removing the instrument from service or when draining or venting.

CAUTION - Dismantling and reassembly should not be carried out on site because of the risk of damage to components and printed circuits as a result of adverse environmental conditions such as humidity, dust, etc. The dismantling and reassembly procedures given below should be carried out in the listed order to avoid instrument damage.

Required tools
2 mm Allen key
3 mm Allen key
Small Phillips screwdriver
Small flat-bladed screwdriver
17 mm spanner
17 mm torque wrench (*)

(*) Range > 20 Nm (15 foot lbs)

Dismantling

a) Screw down completely the cover locking screw, electronics side, using the 3 mm Allen key.
b) Unscrew and remove the cover
c) Unscrew the two fixing screws and remove the secondary electronic assembly
d) Unplug the sensor cable
e) Remove the grub screw using the 2 mm Allen key
f) Unscrew the housing taking care not to damage the sensor cable or the connector
g) Loosen and remove the four flange fixing bolts using a 17 mm. spanner.

Reassembly

Check that the "O" rings are not damaged : if in replace.

DANGER - Assembling flanges with incorrect fixing bolts and nuts and improper "O rings" can cause fracture or overstressing of bolts and release of pressurized process material. Use only official spare parts and do not exceed the specified torque limits. DO NOT REMOVE the "O ring" fitted in the sensor neck: it provides the housing a degree of protection.

a) Refit the flange fixing bolts with a torque of 20 Nm (15 ft lbs) using a 17 mm. torque wrench.

   1 Nm is equivalent to 0.738 ft lbs (8.85 in lbs)

b) Insert the sensor cable in its recess at the bottom of the housing.
c) Screw the housing down completely until the nesting of housing/sensor assy is reached, then unscrew by one complete turn maximum. Rotate the topwork in the desired position and lock it with the grub screw previously removed.
d) Plug the sensor cable to the secondary electronics. Fix the electronic circuit by its screws.
e) Refit the cover and tighten securely.

   DANGER - For Hazardous Location installations, at least eight (8) threads on the cover must be engaged in order to meet the flameproof (explosion-proof) requirements.

f) Unscrew the cover locking screw to secure the cover. This is **mandatory** to meet **"Flameproof requirements" for Hazardous Areas installation.**

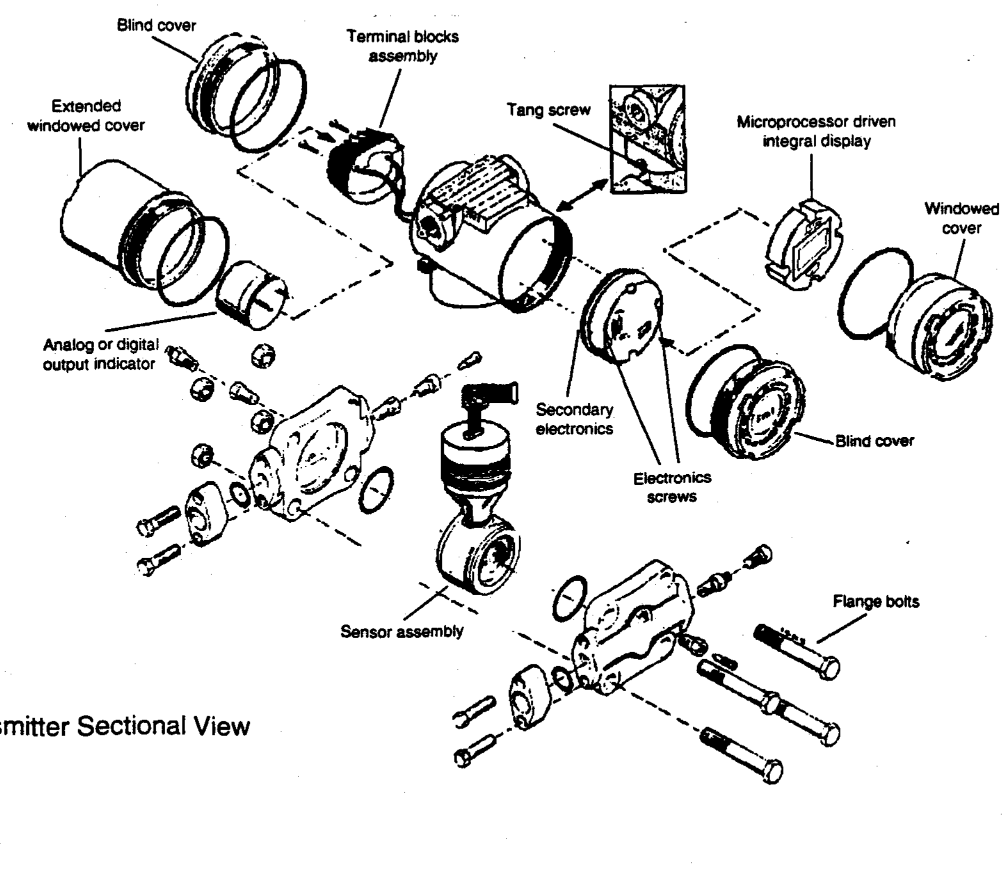


Fig. 13 - Transmitter Sectional View

Simple fault finding

This part is applicable only for a quick fault finding in the case that the Hand Held Terminal or the P.C. Configurator Package are not available.

If the transmitter does not appear to be working satisfactory, carry out the following fault finding checks before contacting your nearest Service Centre.

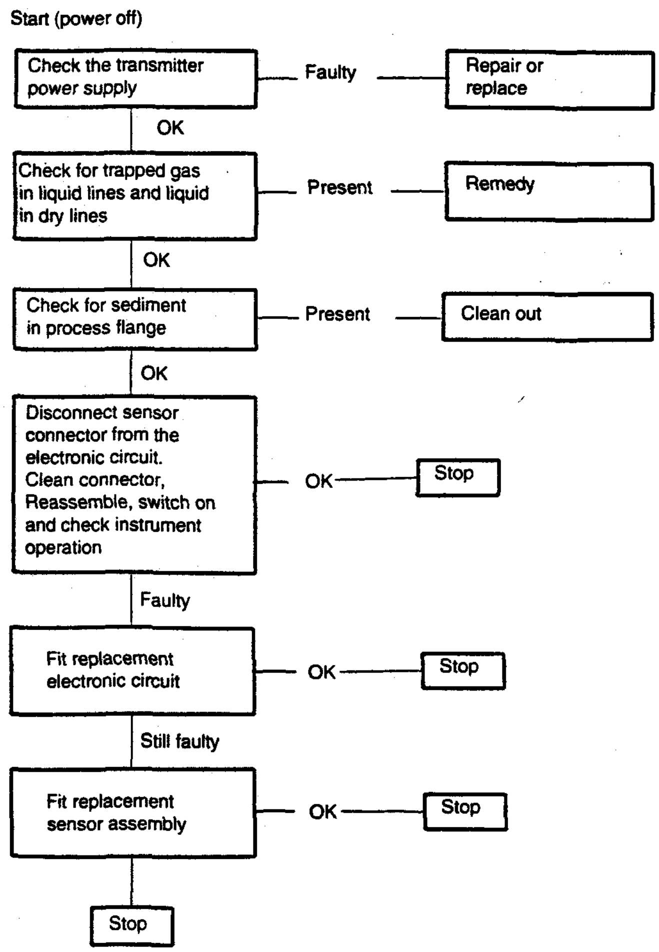
If the instrument is to be returned for repair, ensure that it is adequately packed using the original polystyrene box or high density chip foam: **the trouble sheet/returning form at page 11 should be sent with the instrument, filled in all its parts.** If the transmitter needs to be dismantled follow the procedures of the previous section.

WARNING : If the transmitter forms part of a control loop, the plant must be placed under local manual control while the instrument is examined or taken out of service. Take all precautions to avoid damages caused by pressure or dangerous fluids release.

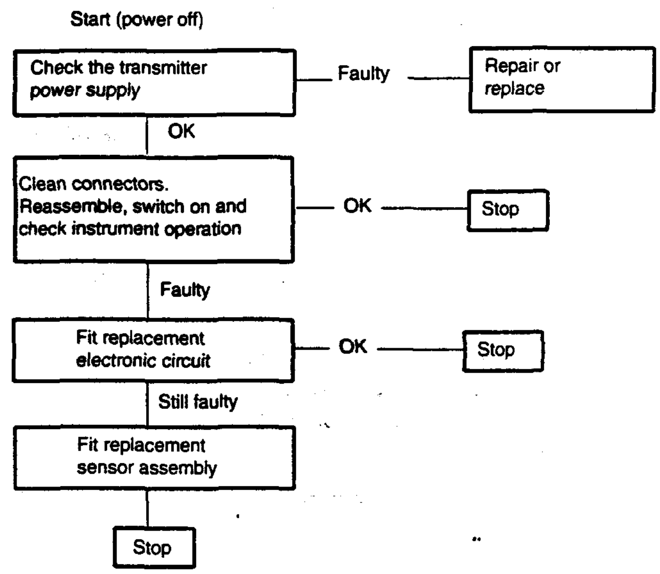
Equipment needed

Voltmeter , milliammeter (0 to 100 mA d.c.), solvent contact cleaner.

High, Low or Irregular Output



No output



TROUBLE SHEET

WARRANTY REPAIR ☐ ☐ REPAIR ORDER

Rejection or discrepancy reports — Copy attached ☐ Not available ☐

- IDENTIFICATION

Customer
Purchase order No.
Plant
Name of person to contact
Instrument tag No.
Model
Serial No.

- OPERATING CONDITIONS

Specify location, environmental conditions, type of service and approximate number of operating hours or date of installation if known.

- REASON FOR RETURN

Trouble found during : Installation ☐ Commissioning ☐ Maintenance ☐ At start up ☐ On service ☐

Shipping information for the return of the equipment

Material returned for factory repair, should be sent to the nearest ABB Kent -Taylor Service Center, transportation charges prepaid by the Purchaser.

Please enclose this sheet duly completed to cover letter and packing list

Date	Signature	Originator

"Meters" option

GENERAL DESCRIPTION

This option provides three different indications (meters) inside the transmitter housing. Two meters, "output meters", are mounted on the terminal block (field terminals) side; one is of "analog" type, the other is of "digital" type (LCD, 3 1/2 -digit). Both are operated by the output signal of the transmitter. The third meter, "integral display", is mounted on the electronics side: it is of "digital" type (LCD, 4-digit), microprocessor driven.

Analog output meter

The analog output meter provides a 90° scale indication. It has either a 0 to 100 linear scale or a 0 to 10 square root scale.

Analog Output Meter Calibration

The calibration of the analog type meter, only involves zeroing. Fig. 1 shows the location of the zero adjustment.

The calibration is quite simple using one of the following methods:

- with the loop unpowered adjust the zero screw to read exactly the **true zero** mark on the scale (Fig. 1).
- with the transmitter transmitting 4 mA adjust the zero screw to read exactly the **live zero** of the scale.

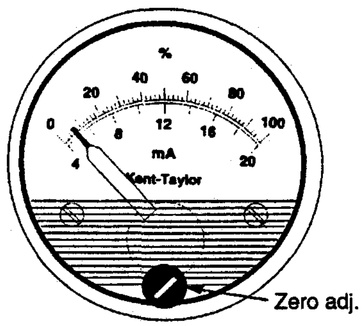


Fig. 1 - Analog meter adj.

Digital output meter

The digital output meter has a 3 1/2-digit, 10 mm (3/8 in) high liquid crystal display (LCD). The maximum count is 1999.

Digital Output Meter Calibration

The LCD digital type output meter can be calibrated, to indicate the output current, output as a percentage or the process value. Meter calibration may be accomplished during calibration of the transmitter or utilizing the capability of the Smart transmitter as a current generator. However the latter can be used only in conjunction with the Hand Held Communicator or a suitable P.C. based program.

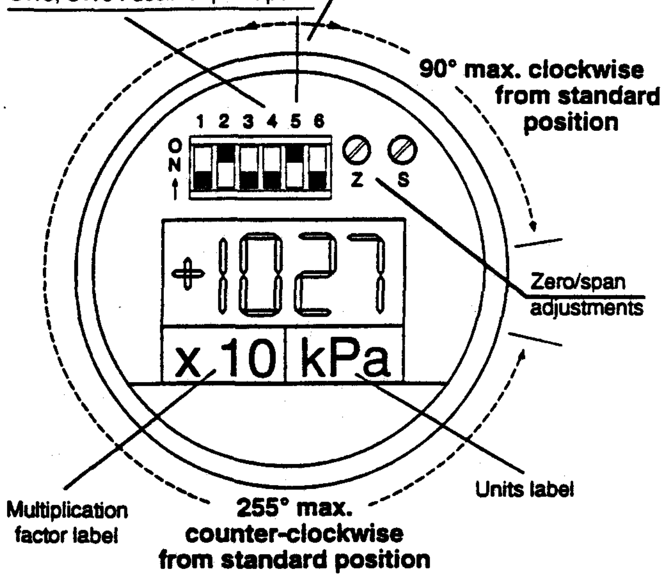


Fig. 2 - LCD output meter front view

The calibration can be performed in output current or percentage, or in process engineering units (see fig. 2).

Proceed as follows:

A) OUTPUT CURRENT (4÷20 mA)

1) The switches from SW1 to SW6 must be positioned as follows :
   ON - OFF - ON - OFF - ON - OFF
2) Set the output current of the current generator to 4 mA, reading it on the milliammeter or 1 V. on the DVM. Alternatively force, using the "Loop Test" procedure on the Hand Held Communicator, the output of your Smart transmitter to 4 mA.
3) Adjust the zero trimmer (Z) to read approximately 4.00
4) Set the output current to 19.9 mA, reading it on the milliammeter, or 4.975 V. on the DVM. Alternatively force the output of your Smart transmitter to 19.9 mA checking for this value in the Hand Held

Communicator.

5) Adjust the span trimmer (S) to read approximately 19.90.
6) Repeat the points 2) 3) to read exactly (± 0.1) 4.00
7) Repeat the points 4) 5) to read exactly (± 0.1) 19.90.
8) Fit the "mA" unit label in the right recess below the indication.

B) OUTPUT PERCENTAGE (0÷100%)

1) The switches from SW1 to SW6 must be positioned as follows :
   ON - OFF - ON - ON - OFF - ON
2) Set the output current of the current generator to 4 mA, reading it on the milliammeter or 1 V. on the DVM. Alternatively force, using the "Loop Test" procedure on the Hand Held Communicator, the output of your Smart transmitter to 4 mA.
3) Adjust the zero trimmer (Z) to read approximately 00.0
4) Set the output current to 20 mA, reading it on the milliammeter, or 5 V. on the DVM. Alternatively force the output of your Smart transmitter to 20 mA checking for this value in the Hand Held Communicator.
5) Adjust the span trimmer (S) to read approximately 100.0.
6) Repeat the points 2) 3) to read exactly (± 0.1) 00.0
7) Repeat the points 4) 5) to read exactly (± 0.1) 100.0.
8) Fit the "%" unit label in the right recess below the indication.

C) ENGINEERING UNITS

The switches must be positioned as follows:

SW1	SW2	For ZERO adjustment, between
OFF	OFF	-1999 ÷ -1000
OFF	ON	-1000 ÷ 0
ON	OFF	0 ÷ 1000
ON	ON	1000 ÷ 1999

SW3	SW4	For SPAN adjustment, between
ON	ON	50 ÷ 1000
ON	OFF	1000 ÷ 2000
OFF	ON	2000 ÷ 3000
OFF	OFF	3000 ÷ 3998

SW5	SW6	For DECIMAL POINT position, like
ON	OFF	4.00 ÷ 19.99
OFF	ON	40.0 ÷ 199.9
OFF	OFF	400 ÷ 1999

Then proceed as follows:

1) Set the output current of the current generator to 4 mA on the milliammeter or 1 V. on the DVM. Alternatively, using the "Loop Test" procedure on the Hand Held Communicator, force the output of your Smart transmitter to 4 mA.
2) Adjust the zero trimmer (Z) to read approximately the lower range value (LRV) on the digital meter.
3) Set the output current to 20 mA, on the milliammeter or 5 V. on the DVM. Alternatively force the output of the transmitter to 20 mA using the Hand Held Communicator.
4) Adjust the span trimmer (S) to read approximately the upper range value (URV) on the digital meter.
5) Repeat the points 1) 2) to read exactly (± 0.1) the LRV.
6) Repeat the points 3) 4) to read exactly (± 0.1) the URV.
7) Complete the calibration procedure by fitting the multiplication factor label (if any) in the left recess below the display and the engineering unit label in the right recess (see fig. 2).

Microprocessor Driven Integral Display (fig. 3)

This type of display is fitted in the Secondary Unit housing, connected directly to the electronics and secured by a "Snap-locking". Its primary use is the display of the transmitter's output. The variables displayed are software programmable and can be selected using the Hand Held Communicator or a suitable P.C. based program:

- Process Variable
- Percent of Range
- Process Variable + Percent of Range
- Process Variable + Output Current

When two variables are displayed they are shown alternating every two seconds. A Process Value outside the display limits (4 digits) will be shown as "9999" while a saturated output (>20 mA) will be shown as "E---". When square root or other output conditioning is activated the appropriate symbol is displayed.

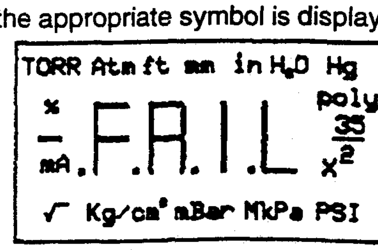


Fig. 3 - Microprocessor driven display

This display is also used for diagnostic messages occurring either during normal operation or during calibration of the transmitter operation. The diagnostics are displayed in two four letter words alternating every two seconds. Only the highest priority message will appear at any time. The following messages are pertinent to the calibration operations:

DSBL ZERO or **DSBL SPAN** : indicates an attempt to use the calibration devices while they are software disabled.
FAIL ZERO or **FAIL SPAN**: indicates that the input value exceeds the maximum allowed turndown or that the pressure input is outside of the sensor limits.
PASS ZERO or **PASS SPAN**: indicates that the zero or span calibration procedure has been correctly performed and accepted. The output will assume the expected value (4 or 20 mA).
FAIL or **EPR2 FAIL**: indicates a failed attempt to write in the EEPROM #2.

Meter Installation or replacement

DANGER - If the transmitter is not certified as Intrinsic Safety type, DO NOT REMOVE ANY COVER in areas classified as "HAZARDOUS LOCATIONS: CAN RESULTS IN HAZARD OF FIRE AND EXPLOSION". Contact your Safety Dpt. in order to establish correct installation procedure.

Analog or Digital Output Meter
To install (or to replace) the meter, use the following procedure:
1) If the transmitter is part of a control loop, put the loop in manual.
2) Remove the cover on the terminal block side; inside of which is affixed the label shown in Fig. 4.

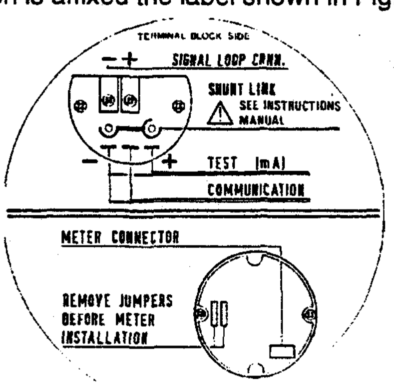


Fig. 4 - Cover Internal label

3) Remove the link shown on the label (and in Fig. 8 of the Transmitter Operating Manual) by pushing down at its left extremity and then its right. Alternatively it can be removed on the left side only in preparation for a further refit.
4) Plug the meter into the socket. The digital indication meter can rotate, for easy viewing, in 15° steps, 90° degree clockwise and 255° counterclockwise, as shown in figure 2. Further rotation causes damage to the meter stops or to the "banana" connections and should be avoided. Note that considerable effort must be applied for 15° rotation. The analog output meter can also rotate for easy viewing.
5) Check that the cover O-ring gasket is properly in place, screw on the extended windowed cover and tighten properly.

To remove the meter simply pull it out from the socket and fit a replacement following the above procedure.

CAUTION - If the meter is removed, ensure that it is replaced immediately by another one or with the proper link provided. **This operation is important for I.S. loop operation.**

Microprocessor Driven Integral Display
The Microprocessor Driven Integral Display can be installed simply by plugging it in to the connector provided in the secondary electronics (see fig. 9 of the Transmitter Operating Manual) and replacing the blind cover with a windowed one.

To provide easy viewing, the indicator can be installed in 4 different positions, in steps of 90°. The indicator is provided with 4 female connectors, equally spaced at 90°, while the secondary electronics is provided with one female connector, marked "METER". An 8 pin insert, supplied with the meter, should be positioned in order to connect the two female connectors with the indicator in the required position.

Proceed, with reference to the figure 9a & 9b of the Transmitter Operating Manual, as follows:

1) **Switch Off the transmitter power supply**
2) Remove the blind cover in the electronics side. Remove the write protect link and the upscale/downscale link, and transfer them to the corresponding positions in the link recesses located in front of the display. **Be sure to respect the previous positions.**
3) Fit the insert in to the electronics connector, place the indicator in the required position, check that the connectors match, and push, with both thumbs, until the two parts hook together.
4) Screw on the windowed cover.
5) Switch on the transmitter power supply

To replace a Microprocessor Driven Integral Display proceed as follows:

1) **Switch Off the transmitter power supply**
2) Remove the windowed cover in the electronics side. Unscrew the two fixing screws and remove the secondary electronic assembly. Unplug the sensor cable. Remove the write protect link and the upscale/downscale link, and fit in the corresponding position of the new unit. Lift gently the 4 plastic hooks and disengage the two units.

Proceed now as indicated at point 3) to 5) above.

"Surge Protection" option

General description

This option provides a built-in surge protection circuit. The surge protector is designed to dissipate large quantities of electrical energy which have been induced in a transmission line. The option is suitable to protect up to 2500 V (5 kA discharge current) of 8μs rise time/20μs decay to half value. These large quantities of energy can be induced in the signal transmission line by lightning discharge in the area or by nearby electrical equipment. The dissipation of this energy prevents damage to transmitter circuitry connected to the transmission line.
The surge protector will not protect the instrument in case of a direct lightning strike.

The surge protector board is located inside the terminal block of the transmitter (see drawing).
The circuit is designed to operate and recover automatically. It does not require periodic testing or adjustment.

Fitting procedure (refer to figures)

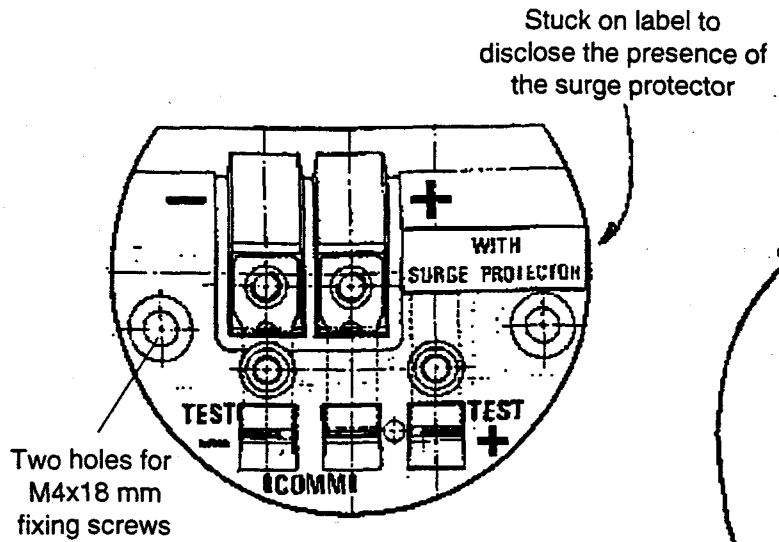
CAUTION : This procedure should not be carried out on the field site.

a) Remove the transmitter cover of the field connections side.
b) Unplug the built-in indicator, if present.
c) Unscrew the two Phillips screws (M 4 x 18 mm) which secure the terminal block and pull it off the housing.
d) Unscrew the two Phillips screws (M 3 x 6 mm) which fix the wire eyelet terminals of the two RF (radio frequency) filters, on the back of the terminal block. Retain the screws.
e) Fit properly the surge protector p.c. board and secure it by a self-tapping screw (M 2.9 x 6mm)
f) Secure the two +/- eyelet terminals to +/- threaded holes on the back of the terminal block, by the two Phillips screws (M 3 x 6 mm) previously removed.
g) Secure the two +/- wire eyelet terminals of the RF filters to the +/- threaded bushes of the p.c. board by two Phillips screws (M 3 x 6 mm).
h) Connect the wire eyelet terminal of the Surge Protector to the dedicated ground connection below terminal block, using a provided self tapping screw M4x8 mm and relevant washers.
i) Reinstall the terminal block and stick on the notice label in the proper position.
l) Plug the built-in indicator, if used.
m) Refit the cover.

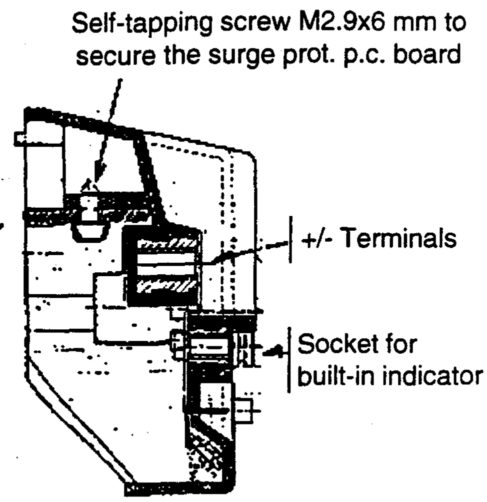
DANGER
The Surge Protector must not be used in I.S. and Type N European certified transmitters.

NOTE
The Surge Protector is suitably provided with the necessary installation screws and the notice label.
Adding the unit to an existing transmitter will affect the power supply requirement for a minimum added operating voltage of 1.6 V d.c.

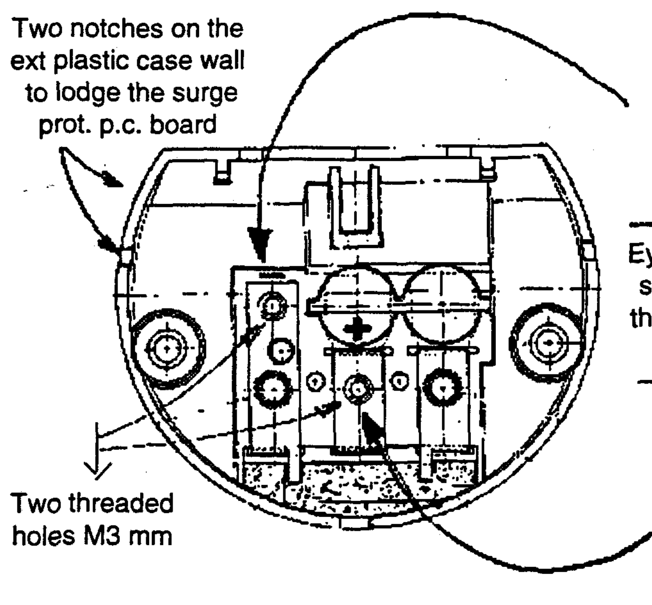
SURGE PROTECTOR



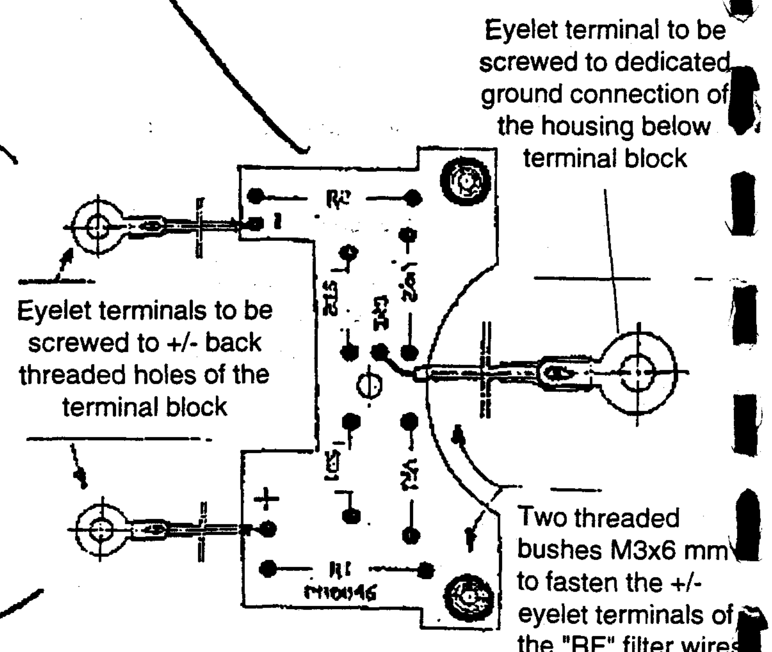
TERMINAL BLOCK
(Front view)



TERMINAL BLOCK
(Side Sect. View)



TERMINAL BLOCK
(Back view)



SURGE PROTECTOR
(P.C. Board)

Selectable output functions

General description

Differential Pressure Transmitters provide a selection of output functions, as follows:

Linear	for differential pressure or level measurements
Sq. Root (x)	for flow measurements using restriction type primary element, like orifice plate, integral orifice, Venturi or Dall tube and similar.
Sq. Root (x^3)	for open channel flow measurements using rectangular or trapezoidal weir
Sq. Root (x^5)	for open channel flow measurements using V-notch (triangular) weir.
Polynomial	for input linearization using a 5th-order polynomial function
Constant current	for loop or associated equipment test.

where |x| and output are in the range 0 to 1 (0% to 100%).

Figure 1 shows the Input/output relationships with the different Square Root Options applied.

These output functions can be activated using a Configuration Tool like the Model K-HT Hand Held Communicator, a HART Universal Communicator or a Personal Computer, carrying the Smart Configuration Program, connected to the transmitter via a Bell 202 modem (see the relevant Operating Instructions).

The output of the transmitter is actually the analog signal 4 to 20 mA and the digital signal read in engineering units on the integral display.

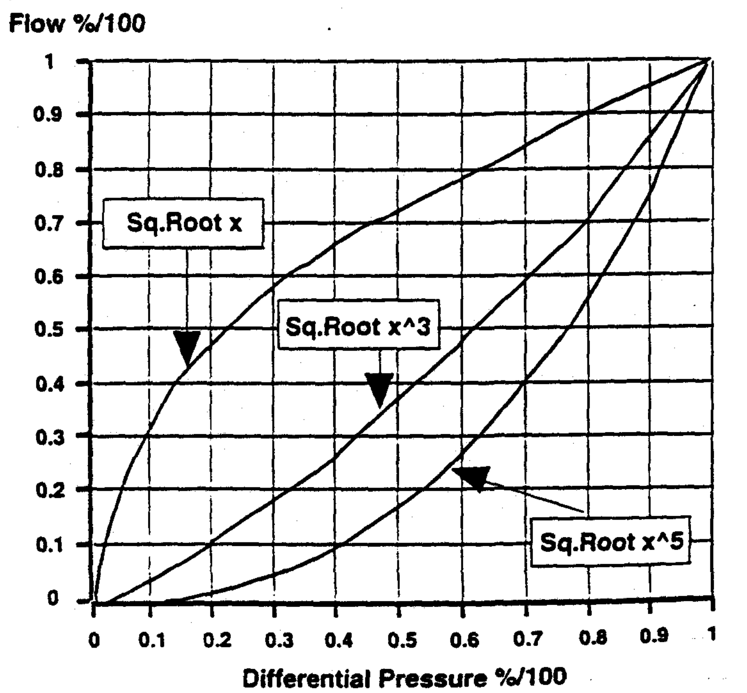


Figure 1. Input/Output Relationships with Different Square Root Options

1.0 Linear

Using this function, the relationship between the input (measured value), expressed in % of the calibrated span and the output is linear, e.g. at 0% input, corresponds 0% output (4mA), at 50% input corresponds 50% output (12mA) and at 100% input corresponds 100% output (20mA).

2.0 Square Root (x)

Using this function, the output (in % of the span) is proportional to the square root of the input signal in % of the calibrated span: the instrument, e.g., gives an analog output proportional to the rate of flow.

To avoid the extremely high gain with the input approaching zero, the transmitter output is linear with the input up to 4%, with a two options, in order to ensure a more stable output near zero. This also allows an easier zero adjustment and performs a reduced zero error for ambient temperature variations.
The two output options provided are:

a) when the input varies from 0% to 4% the output varies linearly from 0% to 20%. At input's values greater than 4% the output follows the applied transfer function. This is the default option.
b) when the input varies from 0% to 4% the output varies linearly from 0% to 4% too. At input's values greater than 4% the output jumps to 20% and then follows applied transfer function. To avoid transition problems a hysteresis of 4% of the output signal is applied when the output decrease below the 20%.

To convert from a pressure value within the calibrated span to a percent of flow, first express the pressure as a percent of calibrated span, then take the square root of this pressure percentage and multiply by 10.
Example : Transmitter calibrated 0÷400 mbar - with 196 mbar, pressure input, the percentage of flow is determined as follows:

$$\frac{196}{400} \times 100 = 49\% \text{ of calibrated pressure}$$

$$\sqrt{49} \times 10 = 70\% \textit{ of calibrated flow}$$

To convert from a percentage of the calibrated flow to the equivalent output current (see figure), first divide the percentage of flow by 100, then multiply this figure by the 16 mA adding also the live zero 4 mA.

$$\frac{70\% \text{ calibrated flow}}{100} \times 16 \text{ mA} + 4 \text{ mA d.c.} = 15{,}2 \text{ mA d.c.}$$

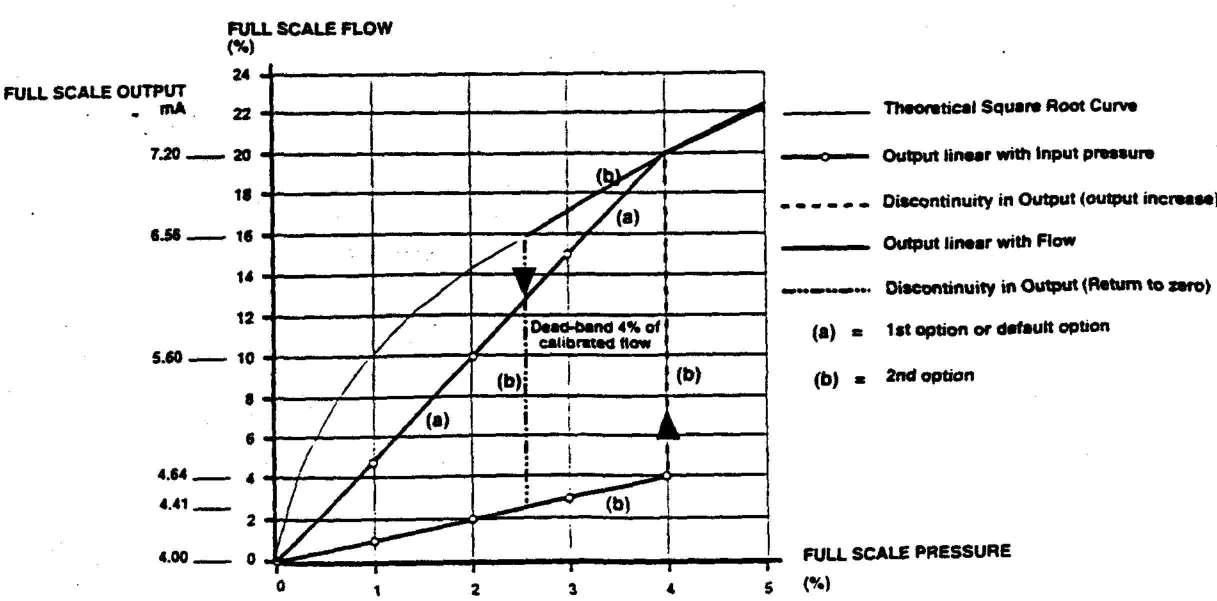


Fig. 2

3.0 Square Root (x^3)

This function, as mentioned before, can be used for open channel flow measurement using ISO 1438 rectangular weirs (Hamilton Smith, Kindsvater-Carter, Rehbock formulas) or trapezoidal weirs (Cippoletti formulas) (see Fig. 3a and 3b) and ISO 1438 Venturi flumes. In these types of devices the relationship between the flow and the developed head h (the differential pressure measured by the transmitter) is proportional to $h^{3/2}$ or square root of h^3. Other types of Venturi or Parshall flume do not follow this relationship.

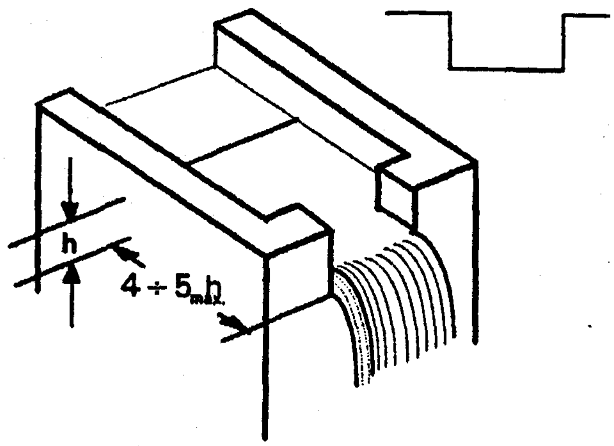


Fig. 3a - Rectangular weir

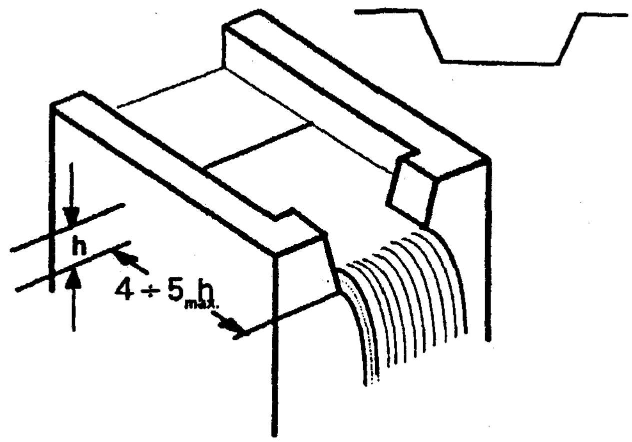


Fig. 3b - Trapezoidal weir

Using this function, the output (in % of the span) is proportional to the square root of the third power of the input signal in % of the calibrated span: the instrument, e.g., gives an output proportional to the rate of flow calculated using the above mentioned formulas.

4.0 Square Root (x^5)

This function can be used for open channel flow measurement using ISO 1438 V-notch (triangular) weirs (see Fig. 4) where the relationship between the flow and the developed head h (the differential pressure measured by the transmitter) is proportional to $h^{5/2}$ or square root of h^5.

Using this function, the output (in % of the span) is proportional to the square root of the fifth power of the input signal in % of the calibrated span: the instrument, e.g., gives an output proportional to the rate of flow calculated using the Kingsvater-Shen formula.

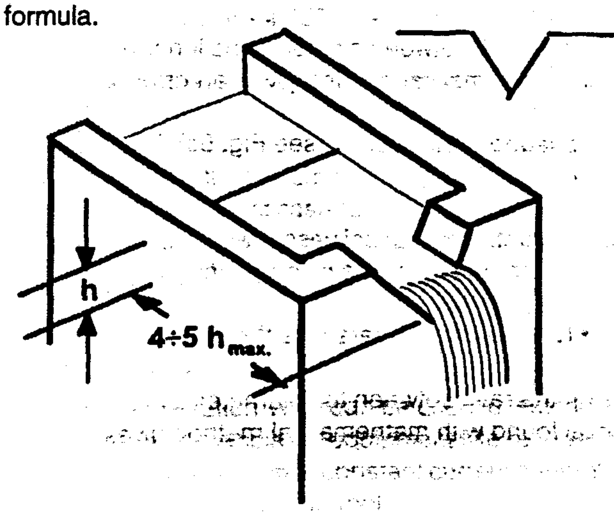


Fig. 4 - V-notch weir

5.0 Polynomial

The polynomial function, applied to the transmitter input (x) expressed in % of the calibrated span, has the following form:

$$Out = \pm A_0 \pm A_1(x) \pm A_2(x^2) \pm A_3(x^3) \pm A_4(x^4) \pm A_5(x^5)$$

where (x) and Out should be normalized in the range 0 to 1 for calculation purpose, with following Out meaning:

Out = 0 means Analog out 4 mA
Out = 1 means Analog out 20 mA

This function can be used for linearization purpose: the user can plot the characteristic curve of the input and find, using a mathematical method, the parameters of the polynomial that better approximate the plotted curve. Check, after the calculation, if the maximum error is compatible with the application. The following are some application examples.

5.1 Cylindrical vessel

Using the polynomial function applied to a level transmitter installed in a horizontal cylindrical vessel is possible to transmit the measure of level in term of partial volume. Some different cases should be considered:

a) Cylindrical vessel with flat ends (not often used. Fig. 5a). Transmitter measuring the whole vessel height.

The following polynomial gives the area of the circular section in relation to the height h (height of the liquid in the vessel).

$$Out = -0.02 + 0.297\,h + 2.83\,h^2 - 4.255\,h^3 + 3.5525\,h^4 - 1.421\,h^5$$

Being both the input h and the output Out normalized, i.e. in the range 0 to 1 (or 0% to 100%), the vessel diameter corresponding to a circular area equal to 1 (100%) will be "normalized" by a "K" factor of the following value :

$$K = 2 \bullet \sqrt{1/\pi} = 1.12838$$

The volume of the liquid contained in the vessel, at height = h will be

$$V = Out \bullet (d/1.12838)^2 \bullet L$$ where d = vessel diameter and L = vessel length.

The non conformity error is within 0.1% between 0.5% and 99.5% of h, 0.2% at 0% and 100%.

b) Cylindrical vessel with hemispherical ends (see Fig. 5b). Transmitter measuring the whole vessel height.

The same polynomial can be used also for the cylindrical vessel with hemispherical ends. To obtain the volume contained in the vessel can be used the following empirical formula:

$$V = Out \bullet (d/1.12838)^2 \bullet (L + 2/3\,d)$$

The non conformity error depends on the ratio between diameter and length of the vessel: for ratio •5 to 1 the error is -0.25%. The polynomial found with mathematical method gives an error of ±0.15%.

c) Cylindrical vessel with elliptical or pseudoelliptical ends (see Fig. 5c). Transmitter measuring the whole vessel height.

The same polynomial can be used also for the cylindrical vessel with elliptical or pseudoellipticall ends. To obtain the volume contained in the vessel can be used the following empirical formula:

$$V = Out \bullet (d/1.12838)^2 \bullet (L + 2/3\,m)$$ where m is the length of the minor ellipse axis (see Fig.5c)

The non conformity error depends on the ratio between the diameter and the length of the vessel: for ratio •5 to 1 the error is -0.25%. The polynomial found with mathematical method gives an error of ±0.15%.

5.2 Spherical tank

Spherical tank (see Fig.5d). Transmitter measuring the whole vessel height.

The following polynomial gives the volume of the spherical section in relation to the height h of the liquid in the tank.

$$Out = 3\,h^2 - 2\,h^3$$

This formula is geometrical and then his conformity is perfect.

Being both the input h and the output Out normalized, i.e. in the range 0 to 1 (or 0% to 100%), the sphere diameter D corresponding to a volume equal to 1 (100%) will be "normalized" by a "K" factor of the following value:

$$K = 2 \bullet \sqrt[3]{3/(4\,\text{þ})} = 1.2407$$

The volume of the liquid contained in the tank, at height = h will be

$$V = Out \bullet (D/1.2407)^3 \qquad \text{where } D = \text{sphere diameter}.$$

5.3 Cylindrical vessel and Spherical tank with partial level measurement

Cases a) to d) but with partial level measurement (Fig. 6)

In these cases two methods can be used:

1) Plot the changes in volume in relation to the level changes and, using a mathematical method, find the relevant polynomial.

2) Use the polynomial coefficients for cases a) to d) and calibrate the transmitter range to cover the full diameter of the vessel or tank: the changes in volume for the h changes between h_0 and h_{max} will be correct. Of course the transmitter will transmit, when the level is $-h_0$, the volume corresponding to h_0: the same apply for level $\bullet h_{max}$.
<u>All transmitted volumes are % of the total volume of the vessel.</u>

If it is required the partial volume starting from h_0 (i.e. the volume at $h_0 = 0$) then the A_0 coefficient should be equal to the polynomial solved for h_0 with negative sign: for example for $h_0 = 20\%$

$$A_0 = -0.02 + 0.297 \bullet 0.2 + 2.83 \bullet 0.2^2 - 4.255 \bullet 0.2^3 + 3.5525 \bullet 0.2^4 - 1.421 \bullet 0.2^5 = -0.14179$$

The polynomial coefficients for the example will be:

$$Out = \overset{A_0}{-0.14179} + \overset{A_1}{0.297}\,h + \overset{A_2}{2.83}\,h^2 - \overset{A_3}{4.255}\,h^3 + \overset{A_4}{3.5525}\,h^4 - \overset{A_5}{1.421}\,h^5$$

Note : The accuracy of all above numerical values can not be guaranteed..

<u>General notes for level measurement</u>
The level transmitter calibration is effected by the transmitter installation conditions, i.e. if the reference connection is empty (dry leg) or liquid filled (wet leg). In the first case (dry leg) the calibration in affected by the specific gravity of the measured liquid and the atmosphere above the liquid at process condition, whereas in the second case (wet leg), it is a affected by the specific gravity of the liquid in the connecting pipe(s).

6.0 Constant current

This output function, activated by a Configuration Tool, can be used to test the transmitter output, the integrity of the transmission loop and the calibration of associated equipment like receivers, recorders, etc.
When this function is activated the transmitter acts as a constant current generator: the user can select to transmit 4 mA, 20 mA or any value entered via the configuration tool.

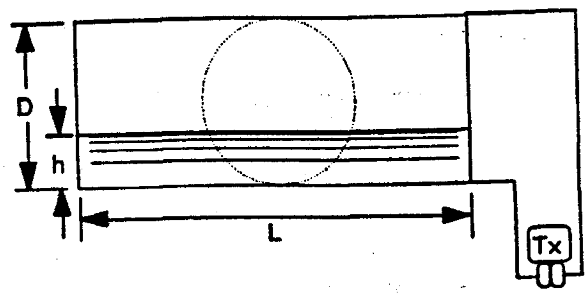


Fig. 5a

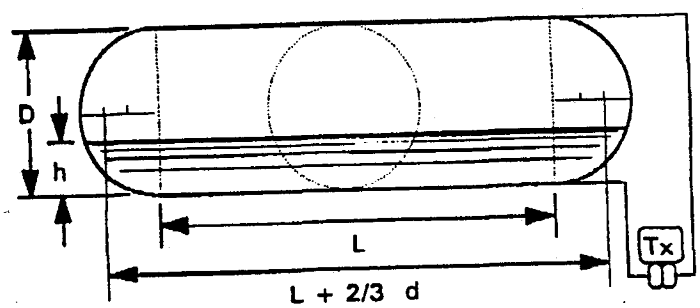


Fig. 5b

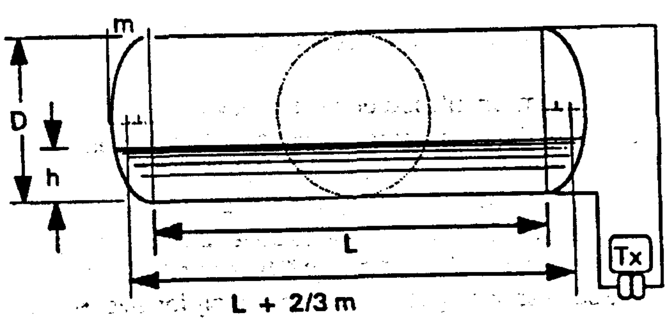


Fig. 5c

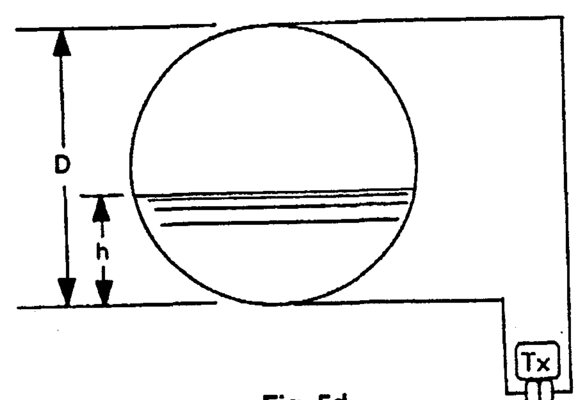


Fig. 5d

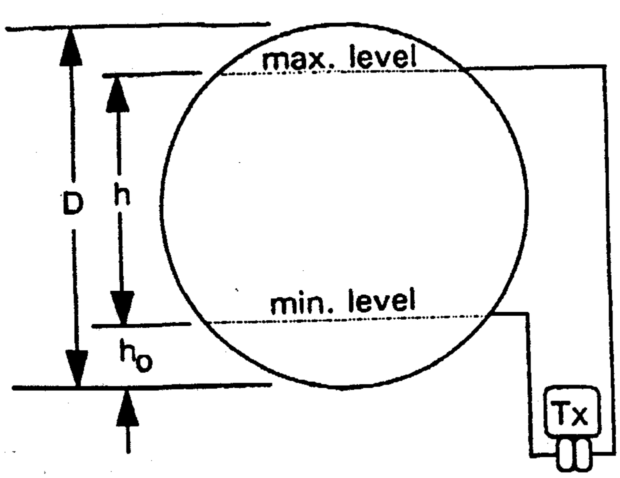


Fig. 6

Flange-mounted Transmitters

Flange-mounted transmitters are suitable for open or closed tank service. The process fluid may, or may not, be corrosive, viscous, dirty and with suspended solids; each case requires a proper transmitter.

Two models are available for tank service: 621L/N and 623D. The 621, which includes two main application variants L/N, is dedicated to Liquid Level measurement. The second, 623D, is marketed as a Differential Pressure transmitter, but it is particularly suitable for Liquid Level measurement. The two flange-mounted transmitters are explained here:

Model 621 L/N

These Liquid Level Transmitters are mounted to a tank as shown in Figure 1. The ambient temperature of the transmitter mounting location must be between -40°C and +85°C (-40 and +185°F). The process temperature can instead be between -40°C and +320°C (-40 and +608°F). The process interface and fill fluid of the transmitter must be selected amongst the various options provided according to the specific range of temperature.

DANGER - For installation in Hazardous Areas, i.e. areas with danger of fire and/or explosion, irrespective of the protection mode used, the installation must carried out in accordance with local regulations. Ensure also that the temperature of the transmitter does not exceed the value indicated in the Safety Marking plate. In this connection, consider that process temperature above 85°C (185°F) requires derating the ambient limits by 1.5:1 ratio.

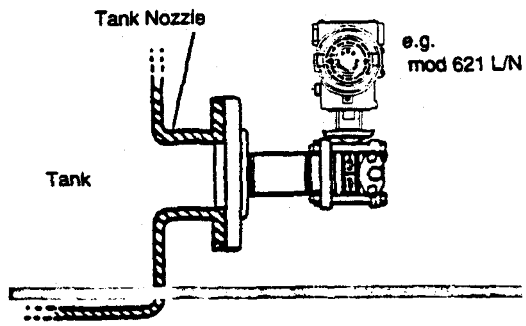
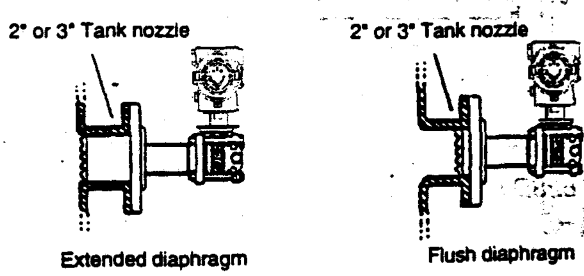


Figure 1 - Liquid level transmitter - Installation

The 621 L/N liquid level transmitter has been designed to connect to a flanged tank nozzle, or similar ANSI (DIN) fitting. Standard connections for 2/3-inch Class 150/300/600 flanges, and equivalent DIN, are available.



Flush and extended diaphragm options are also available, Figure 2. The flush diaphragm is suitable for applications where the process is free of suspended solids. The extended diaphragm eliminates the pocket at the transmitter connection and is typically used for slurries and viscous liquids.

Figure 2 - Liquid level transmitter - Diaphragm options

It is recommended that the liquid level transmitter be mounted with the process diaphragm vertical and with the housing above the primary transducer. Operation is not affected by mounting in other positions, however, some rezeroing may be required.

The transmitter is insensitive to level changes over the lower half of the diaphragm, so it is important to locate the transmitter datum line with the center line of the tank nozzle. The nozzle also must be located so that the minimum level is always at or above the datum line.

The liquid level transmitters can be used to measure liquid level in either open or closed (pressurized) tanks. The model 621L is specifically dedicated to open tanks, whereas the model 621N is for closed tanks.

In open tank applications, mounting the transmitter on the tank nozzle provides the Hi side process connection, with the LO side being vented to atmosphere. The hydraulic head pressure acting against the process diaphragm is a direct measurement of the liquid level. The effect of atmospheric pressure is canceled because this pressure is applied to both sides of the transmitter.

A recommended open tank installation is shown in Figure 3.

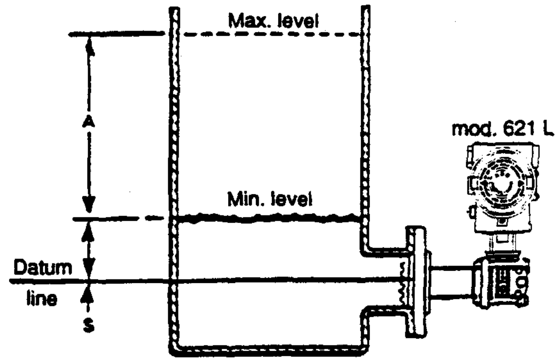


Figure 3 - Liquid level transmitter 621L in Open tank installation

In the closed tank application, Figure 4, the effect of tank pressure is canceled by connecting the Hi side and LO side of the primary transducer to the tank. The HI side connection is made by mounting the transmitter on the tank nozzle. A compensating leg connects to the LO side near the top of the tank. It is important to ensure that this leg is either completely free of liquid (dry leg) or completely filled to a constant level (wet leg).

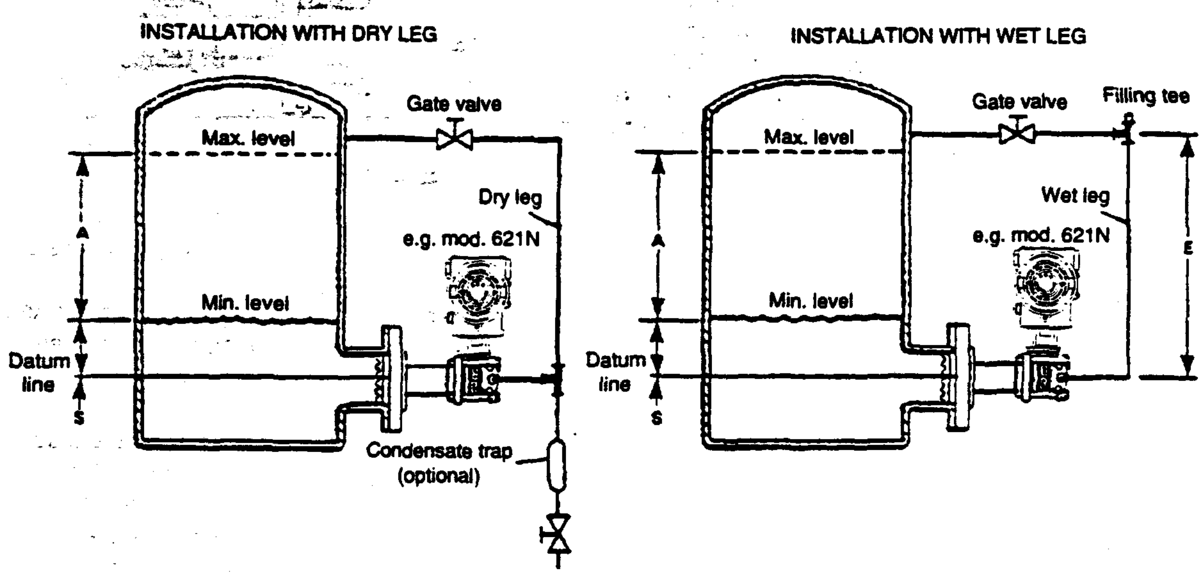
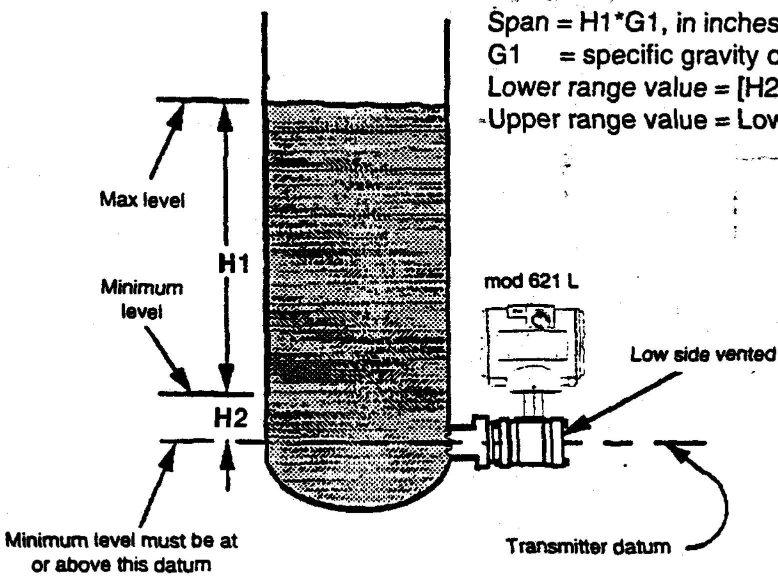


Figure 4 - Liquid level transmitter 621N / 623D in closed tank installation

For a better understanding, three applications of liquid level measure are shown, as follows:

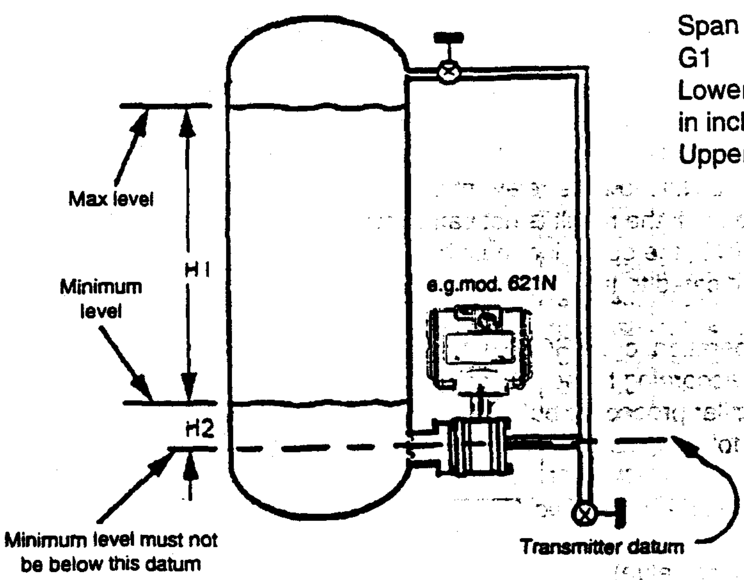
Application no. 1 Liquid Level Open Tank Using a Flange-Mounted Transmitter 621L

Span = H1*G1, in inches w.g. if H1 is in inches
G1 = specific gravity of the process liquid
Lower range value = [H2*G1], in inches w.g. if H2 is in inches
Upper range value = Lower range value + span

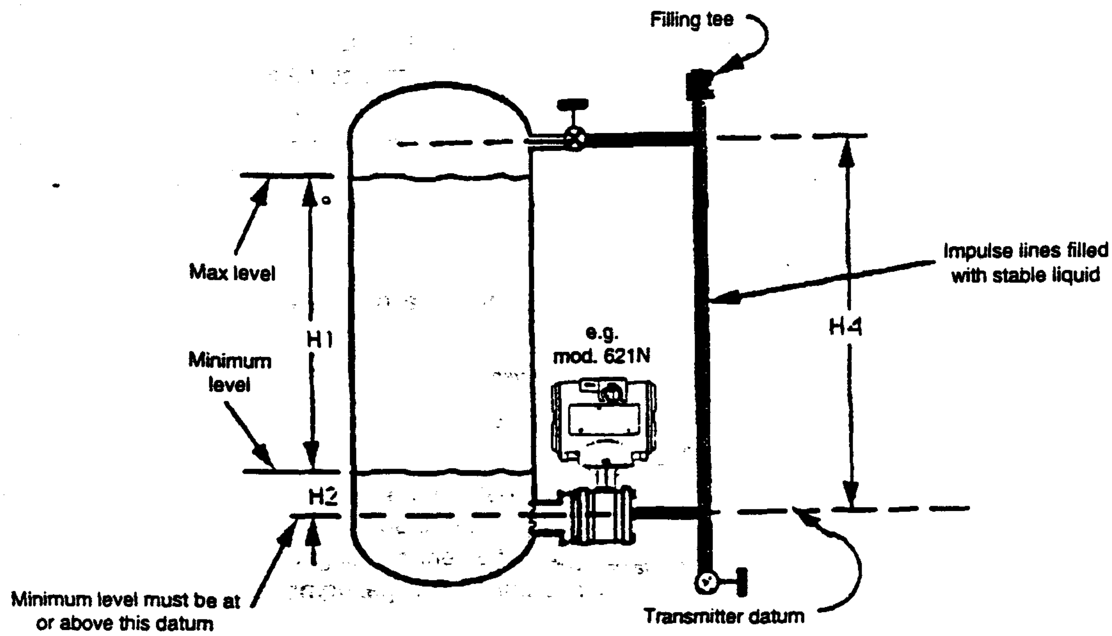


Application no. 2: Liquid Level - Closed Tank
Using a Flange-Mounted Transmitter 621N / 623D (No Condensable Vapors)

Span = H1 *G1, in inches w.g. if H1 is in inches
G1 = specific gravity of the process liquid
Lower range value = [H2*G1], in inches w.g. if H2 is in inches
Upper range value = Lower range value + span



Application no. 3: Liquid Level - Closed Tank
Using a Flange-Mounted Transmitter mod. 621N / 623D and a Wet Leg (With Condensable Vapors)



Span = H1*G1, in inches w.g. if H1 is in inches
Lower range value = [H2*G1]-[H4*Gw], in inches w.g. if H2 and H4 are in inches
Upper range value = Lower range value + span
Gl = specific gravity of process liquid
Gw = specific gravity of liquid in wet leg

Sensor Trimming

If a sensor trimming operation is requested for 621L/N, follow the relevant procedure of the Hand Held Communicator (K-HT) and PC Software instructions. If the result is not satisfactory after having carried out either the ZERO TRIMMING or the FULL TRIMMING, the operation must be repeated with a special variation for these transmitters. This special procedure dedicated to the model 621L/N, is as follows:

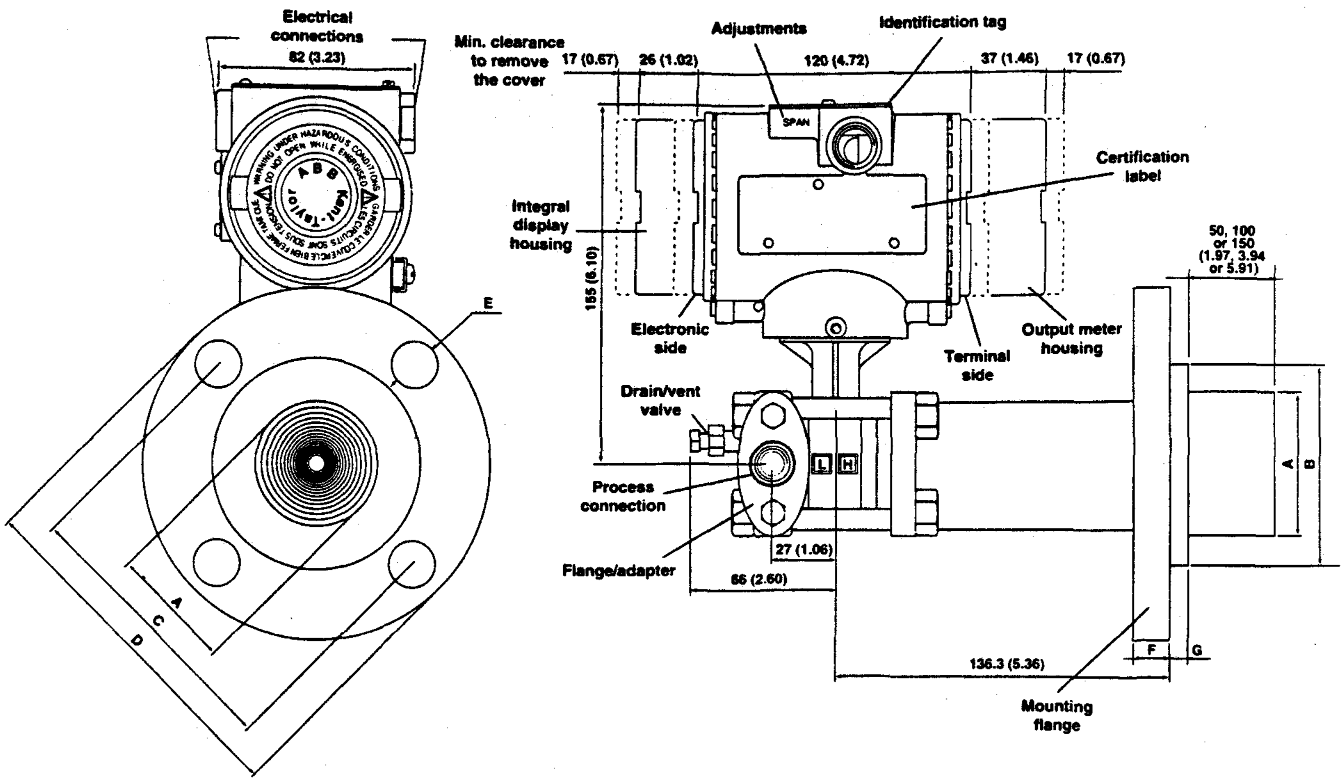
a) LOW TRIM (low value) for FULL TRIM operation, or ZERO TRIM, only.
A standard operation must be performed according to the procedure. If the result is not satisfactory *the operation must be repeated with a similar procedure* but with a new value which has to be entered. This value must be calculated, as follows, taking in consideration the error with reversed sign:

new **V** entered = **V** applied - (**V** displayed - V applied)* (*) error

- 1 st Example: Trimming at 10 mbar (applied value)
If the displayed value (via HART) after the first operation, is 10.2 mbar, then the error is +0.2 (10.2 - 10).
The new value to be therefore entered is 9.8 mbar (10 - 0.2).

- 2nd Example: *Trimming at true zero* (0 mbar)
If the displayed value (via HART) after the first operation, is -0.5 mbar, the operation must be repeated entering + 0.5 mbar.

Note: The LOW TRIM and ZERO TRIM operations affect the span as they do not change the upper range value previously set. So a high trimming operation according to point **b,** is highly recommended.



RATING	SIZE	A flush	A extended	B	C	D	E	No.of holes	F	G
ANSI 150 R.F.	2"	60 (2.36)	48 (1.89)	92 (3.62)	120.6 (4.75)	152.5 (6.0)	20 (0.79)	4	19.1 (0.75)	9.5 (0.37)
ANSI 150 R.F.	3"	89 (3.50)	73 (2.87)	127 (5.0)	152.4 (6.0)	190.5 (7.5)	20 (0.79)	4	23.8 (0.94)	9.5 (0.37)
ANSI 300 R.F.	2"	60 (2.36)	48 (1.89)	92 (3.62)	127 (5.0)	165 (6.50)	20 (0.79)	8	22.3 (0.88)	9.5 (0.37)
ANSI 300 R.F.	3"	89 (3.50)	73 (2.87)	127 (5.0)	168.2 (6.62)	209.5 (8.25)	22.3 (0.88)	8	28.5 (1.12)	9.5 (0.37)
ANSI 600 R.F.	2"	60 (2.36)	48 (1.89)	92 (3.62)	127 (5.0)	165 (6.50)	20 (0.79)	8	25.4 (1.0)	9.5 (0.37)
ANSI 600 R.F.	3"	89 (3.50)	73 (2.87)	127 (5.0)	168.2 (6.62)	209.5 (8.25)	22.3 (0.88)	8	31.8 (1.25)	9.5 (0.37)
DIN ND 16 FORM C	DN 50	60 (2.36)	48 (1.89)	102 (4.02)	125 (4.92)	165 (6.50)	18 (0.71)	4	20 (0.79)	9.5 (0.37)
DIN ND 16 FORM C	DN 80	89 (3.50)	73 (2.87)	138 (5.43)	160 (6.30)	200 (7.87)	18 (0.71)	8	20 (0.79)	9.5 (0.37)
DIN ND 40 FORM C	DN 50	60 (2.36)	48 (1.89)	102 (4.02)	125 (4.92)	165 (6.50)	18 (0.71)	4	20 (0.79)	9.5 (0.37)
DIN ND 40 FORM C	DN 80	89 (3.50)	73 (2.87)	138 (5.43)	160 (6.30)	200 (7.87)	18 (0.71)	8	24 (0.94)	9.5 (0.37)
DIN ND 64 FORM E	DN 50	60 (2.36)	48 (1.89)	102 (4.02)	135 (5.31)	180 (7.09)	22 (0.87)	4	26 (1.02)	9.5 (0.37)
DIN ND 64 FORM E	DN 80	89 (3.50)	73 (2.87)	138 (5.43)	170 (6.69)	215 (8.46)	22 (0.87)	8	28 (1.10)	9.5 (0.37)
DIN ND 100 FORM E	DN 50	60 (2.36)	48 (1.89)	102 (4.02)	145 (5.71)	195 (7.68)	26 (1.02)	4	28 (1.10)	9.5 (0.37)
DIN ND 100 FORM E	DN 80	89 (3.50)	73 (2.87)	138 (5.43)	180 (7.09)	230 (9.05)	26 (1.02)	8	32 (1.26)	9.5 (0.37)

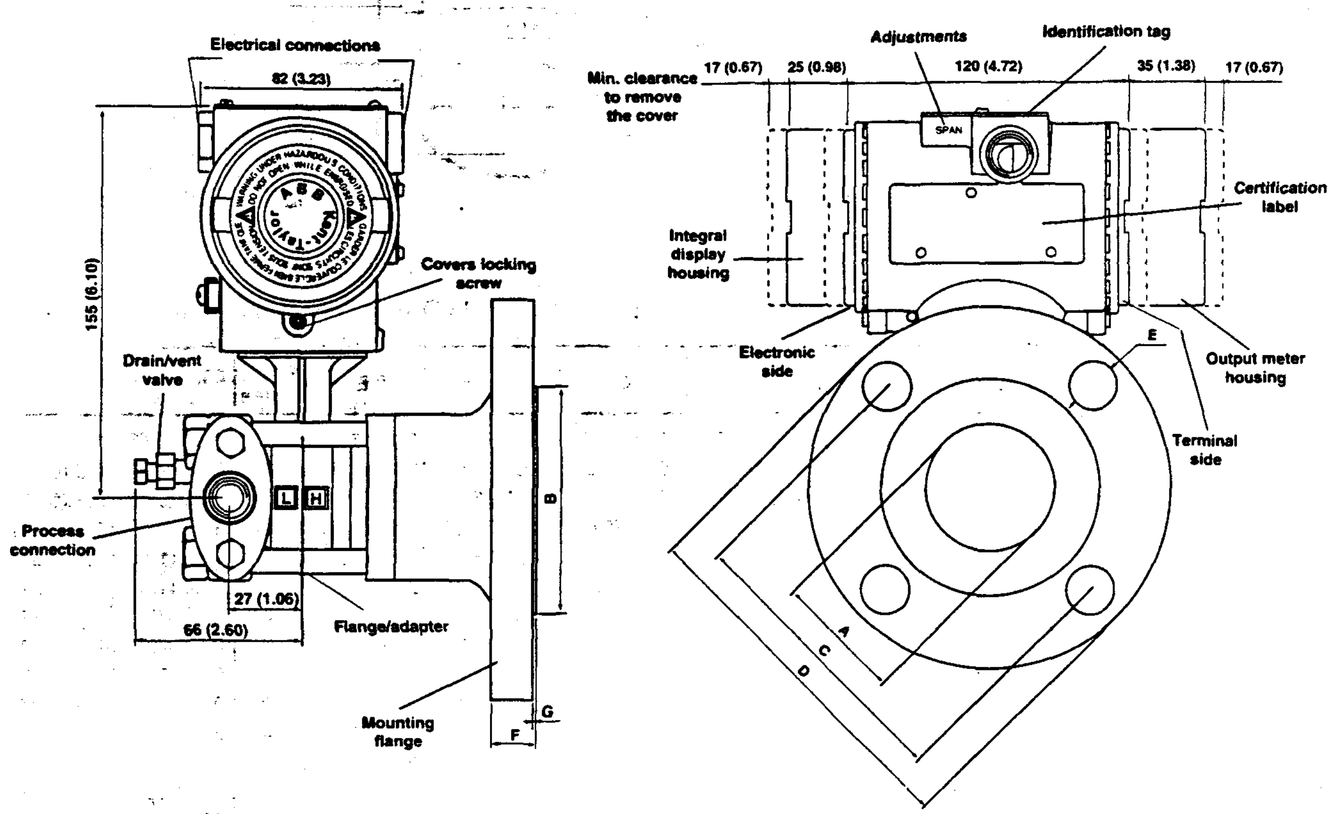
b) HIGH TRIM (high value) for FULL TRIM operation.
A standard operation must be performed according to the procedure. If the result is not satisfactory the operation must be repeated with a procedure similar to that shown at point a above. (new calculated value with error taken with reversed sign).

Model623D

This model, as already said, is suitable for liquid level measurement. Thefluid, in this case, must be clean, free of solids and not viscous. This is becausethe process diaphragm is recessed relative to the flange face.

The model 623D has been designed to connect to a flanged tank nozzle, or similar ANSI (DIN) fiffing. Standard connections for 2/3-inch Class 150/300, and equivalent DIN, are available (see Figures 1 and 2). This model is specifically dedicated to closed (pressurized) tanks (see Figure 4 and Applications no. 2 and no. 3).

Mounting recommendations are like those of model 621L/N.

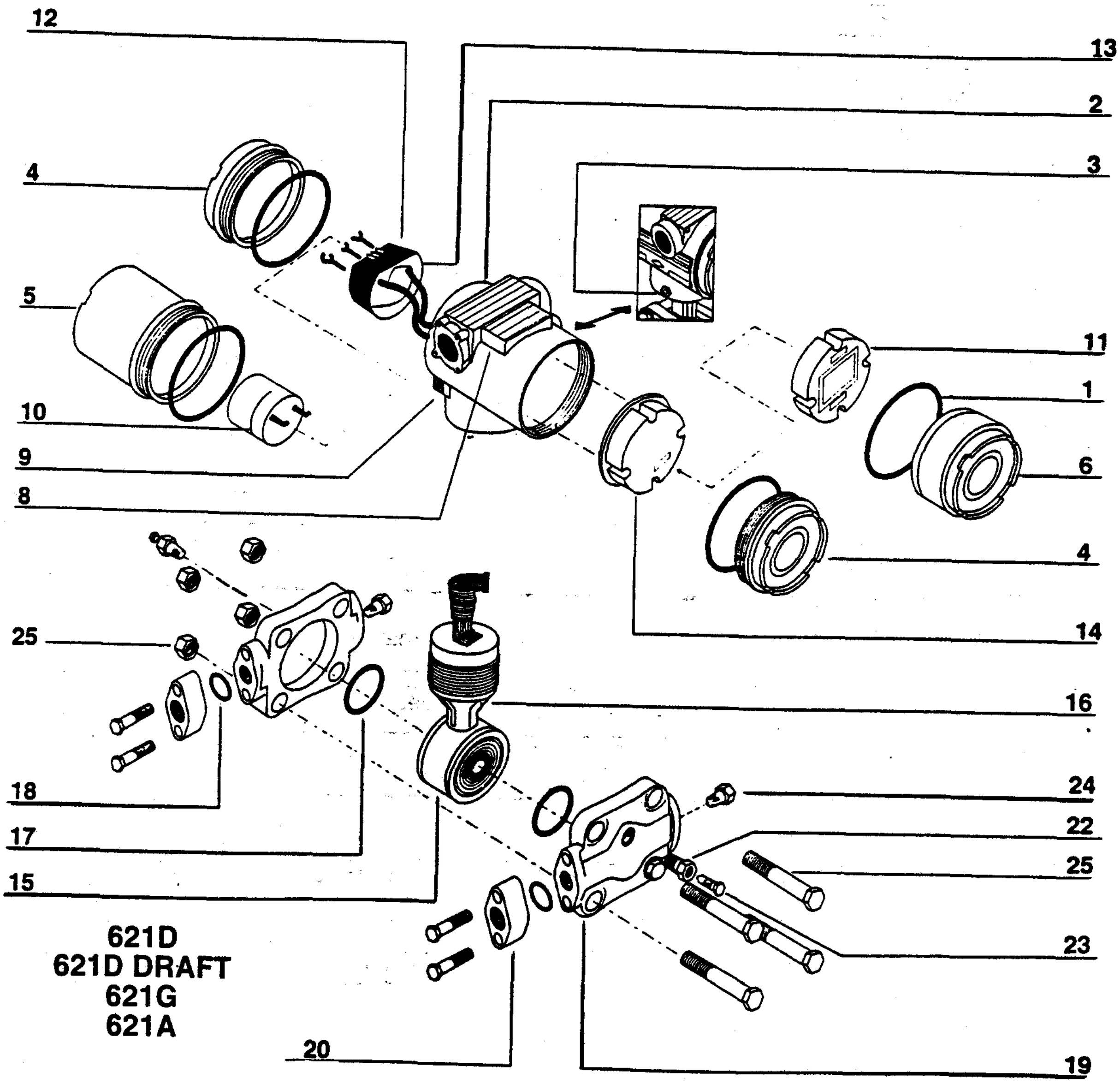


RATING	SIZE	A	B	C	D	E	No.of holes	F	G
ANSI 150 R.F.	2"	53 (2.09)	92 (3.62)	120.6 (4.75)	152.5 (6.0)	20 (0.79)	4	19.5 (0.77)	1.6 (0.07)
ANSI 150 R.F.	3"	77 (3.04)	127 (5.0)	152.4 (6.0)	190.5 (7.5)	20 (0.79)	4	24 (0.95)	1.6 (0.07)
ANSI 300 R.F.	2"	53 (2.09)	92 (3.62)	127 (5.0)	165 (6.50)	20 (0.79)	8	22.5 (0.89)	1.6 (0.07)
ANSI 300 R.F.	3"	77 (3.04)	127 (5.0)	168.2 (6.62)	209.5 (8.25)	22.3 (0.88)	8	29 (1.15)	1.6 (0.07)
DIN ND 16 FORM C	DN 50	53 (2.09)	102 (4.02)	125 (4.92)	165 (6.50)	18 (0.71)	4	20 (0.79)	3 (0.12)
DIN ND 16 FORM C	DN 80	77 (3.04)	138 (5.43)	160 (6.30)	200 (7.87)	18 (0.71)	8	20 (0.79)	2 (0.08)
DIN ND 40 FORM C	DN 50	53 (2.09)	102 (4.02)	125 (4.92)	165 (6.50)	18 (0.71)	4	20 (0.79)	3 (0.12)
DIN ND 40 FORM C	DN 80	77 (3.04)	138 (5.43)	160 (6.30)	200 (7.87)	18 (0.71)	8	24 (0.95)	2 (0.08)

The part numbers contained in this list are only for transmitters manufactured in the United States. Kits contain parts requirements for one transmitter. See page 9 for Dismantling and Reassembly instructions.

Recommended spares:

- one part of category **"A"** for every 25 transmitters.
- one part of category **"B"** for every 50 transmitters.

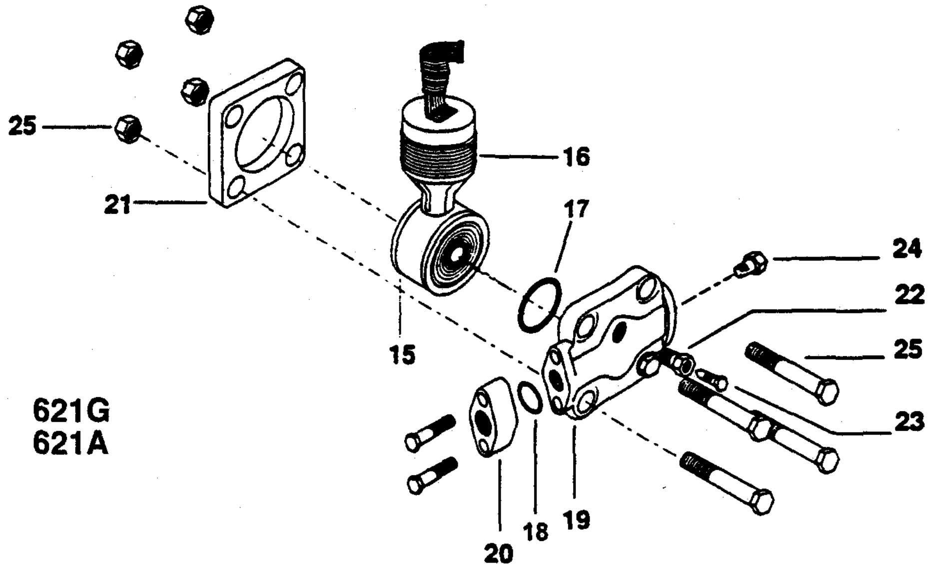


621D, 621D Draft, 621G, 621A Item Number Cross Reference List

Item no.	Description	Category	Part N	Qty. per tx
1	"O" rings for cover	B	DR0023	2
2	Electronics housing (includes items 3, 7, 8, and 9) -1/2" NPT			1
3	Tang Screw			
4	Blind cover **(NOTE 1)**		PN0106	2*
5	Windowed cover for LCD or analog output indicator		AN0077	1
6	Windowed cover for integral display		AN0086	1
8	zero and span local adjustment		AN0080	2
9	**KIT** external earth connection assembly		DR0022	1
10	**OUTPUT INDICATOR** (see below)	B		1
	analog 0/100% linear scale		EL0001	
	analog 0-10 square root scale		EL0002	
	LCD digital		AN0087	
11	Integral display (LCD digital uP driven)		DR0031	
12	**KIT**-Terminal block assembly	A	DR0005	1
13	**KIT**-Surge protector assembly **(NOTE 2)**	A	DR0024	1
14	Secondary electronics module	B	DR0026	1
15	Sensor assembly			
16	"O" ring			
17	**KIT**-Process flange "O" ring (see below)	B		1
	Viton		DR0009	
	PTFE		DR0032	
18	KIT-Flange adapter "O" ring (see below)	B		1
	Viton		DR0015	
	PTFE		DR0033	

Notes: 1. A total of (2) covers are required per transmitter. Item 4 may be used in conjunction with items 5 and 6.

2. Not available with 10th character 2, 4 or 5 electrical codes.



621G, 621A Item Number Cross Reference List

Item No.	Description	Catagory	Model	AISI 316L ss	Hast "C"	Monel 400	AISI 316L (Nace)	Qty
19	Process flange with 1/4" NPT							
20	**KIT**		621D	19S291J	19S291Z	19S291M	19S291J	
	flange adaptor		621G/A	19S292J	19S292Z	19S292M	19S292J	1
21	Blind flange							
22	Vent bushing		All	76P791J	76P465Z	76P465M	76P791J	1
23	Vent screw	A	All	9P2891J	9P1237Z	9P1237M	9P2891J	1
24	Plug		All	76P790J	76P464Z	76P464M	76S301J	1

Item no.	Description	Catagory	Model	AISI 316ss	Carbon steel	Alloy steel	Qty
25	**KIT:** bolts and nuts		621D/621G	155S1202	155S1200	155S1201	1
	for process flanges		621A	155S1205	155S1203	155S1204	1

Item no.	Description	Category	Stainless steel	Carbon steel	Qty.
	KIT: Standard bracket	**PENDING**	T6DXM2	T6DXM1	1
	KIT: Angle style mtg. bracket		T6DXM4	T6DXM3	1

This sheet applies only to transmitters installed in loops which are NOT Intrinsically Safe.

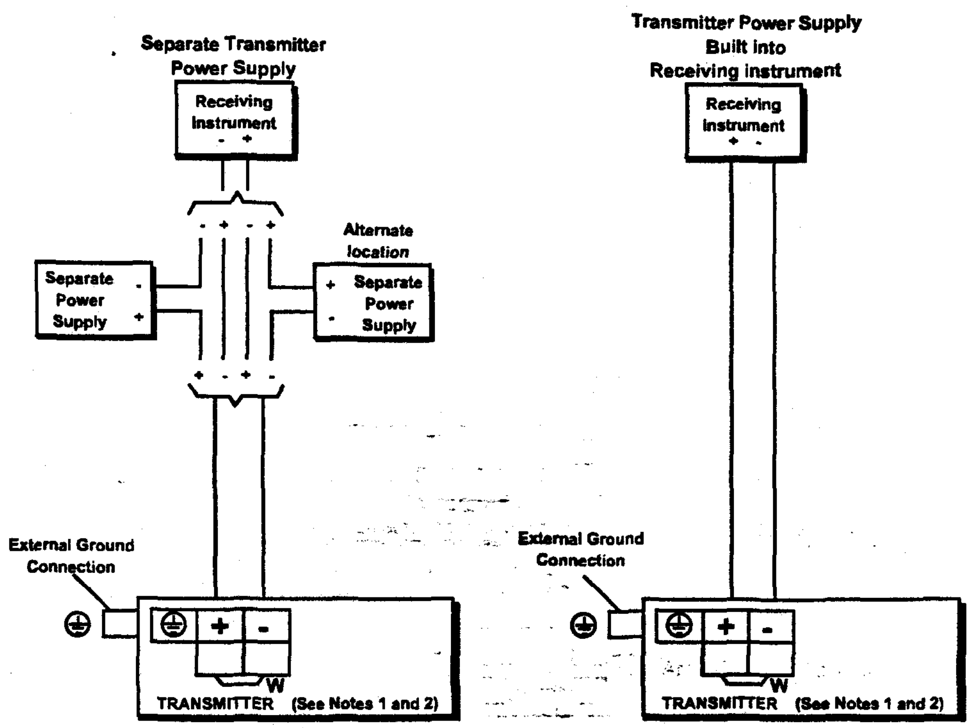
Drawing applies only to following Cat. Nos:

621	D*****7*****	
(631)	R	8
	G	
	P	
	A	
	V	
621	N******7****	
	L	8
	M	
	S	
623	D******7****	
(633)		8
624	G*****7****	
and	P	8
614	A	
	V	
622	D******7****	
		8

* Can be any digit

Note : digit meaning of
"7" = FM approval
"8" = CSA and FM combined approval

2-WIRE SYSTEM CONNECTIONS



Notes :

1. If transmitter has an internal output meter, jumper W is omitted.
2. Non-incendive component field wiring parameters V_{MAX}=55V dc, I_{MAX}=250 MA, C_i=0, L_i=0 for installation in non incendive circuits in Class I Division 2 Groups A,B,C,D hazardous locations. See National Electric Code section 501-4 (b) exception (Applies to FM Approval only)
3. Non-incendive equipment for installation in Class I Division 2 Groups A,B,C,D hazardous locations. See National Electric Code articles 500 and 501 and Canadian Electric Code Rules 18.150 through 154.
4. Use Listed dust tight seal at conduit entry for installation in Class II, III hazardous locations.

Output (2-wire transmitter) :
4 to 20 mA dc

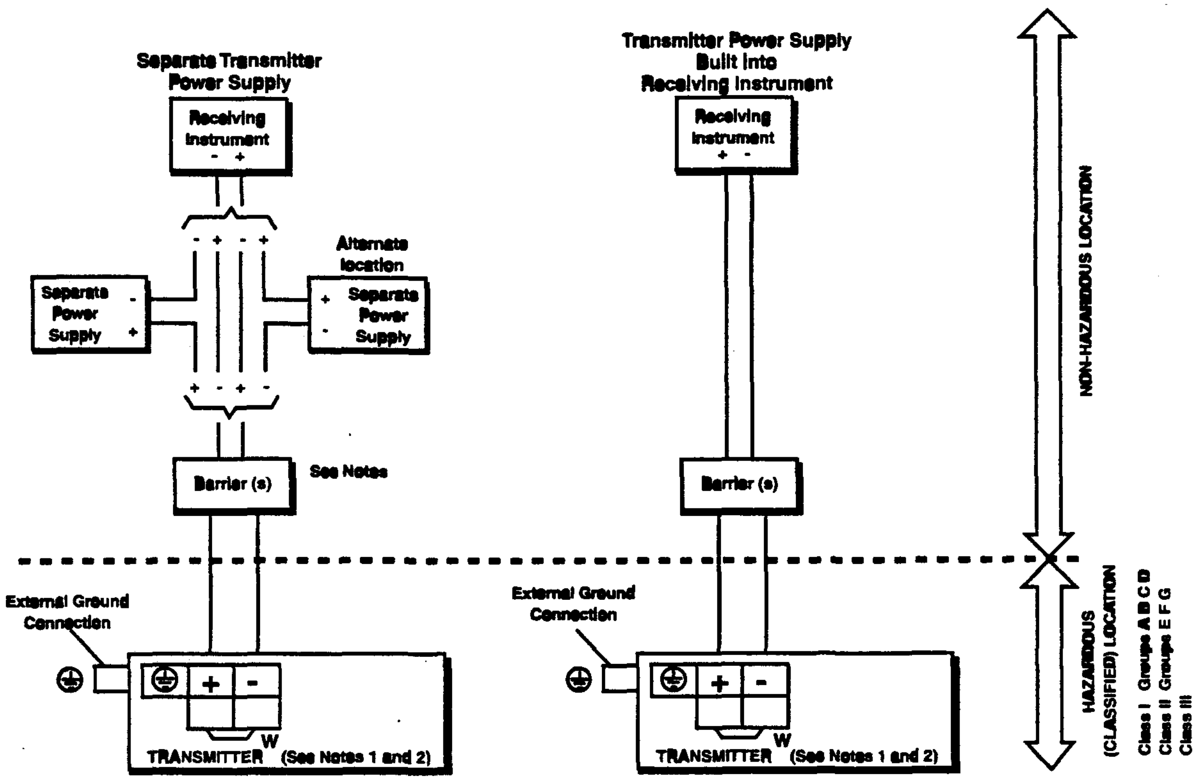
Power :
24V dc norminal
10.5V min, 55V max.

Not for Construction unless Certified

TITLE	DATE 12-5-1996
600 T Series **6XX Transmitters "Control drawing"**	No. **1H5-15-10064** **Sh 1 of 5**

This sheet applies only to FM Approved and CSA Certified transmitters installed in Intrinsically Safe Loops

KENT-TAYLOR 2-WIRE SYSTEM CONNECTIONS
(Refer to Sheet 3 for Approved Loop Configuration)



Output (Kent-Taylor 2-wire transmitter) : 4 to 20 mA dc

Power : 24V dc nominal, 10.5V min

Notes :

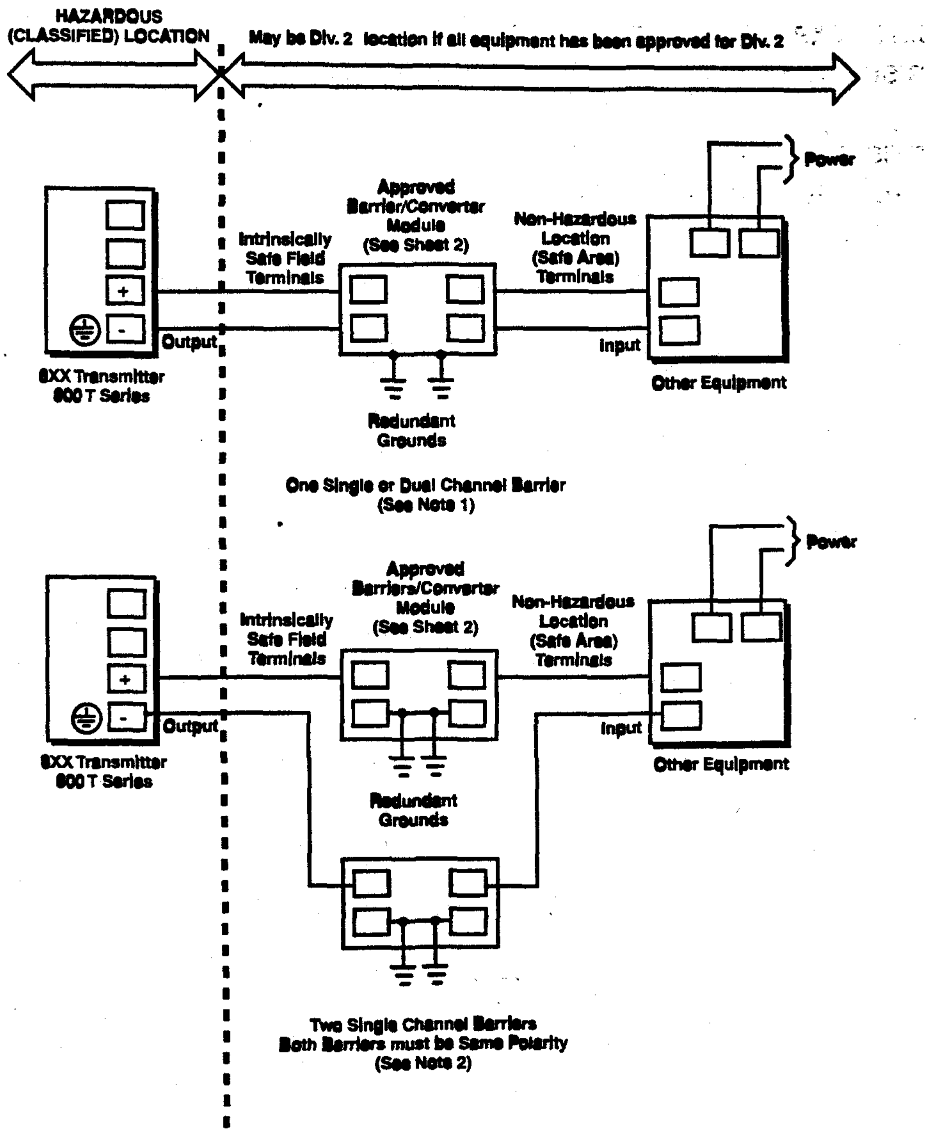
1. If transmitter has an internal output meter, jumper W is omitted
2. Maximum entity parameters for transmitter (FM approval only):
   V_{MAX} = 30V dc, I_{MAX} = 215 mA, Ci = 0, Li = 0.
   Barrier Voc or V_T => 6V.
3. For CSA Certification, use CSA Certified zener barriers: one barrier rated 28V 300 Ohm with or without one 28V/diode or 10V/47 Ohm return barrier.
4. Use Listed dust tight seal at conduit entry for installation in Class II, III hazardous locations.

TITLE		DATE	4-4-1994
	600 T Series 6XX Transmitters "Control drawing"	No.	**1H5-15-10064 Sh 2 of 5**

This sheet applies only to FM Approved and CSA Certified transmitters installed in Intrinsically Safe Loops

INTRINSIC SAFETY
APPROVED LOOP CONFIGURATION

Installation and wiring must be in accordance with information in Instruction Manual supplied with Barrier/Converter Module



Notes :

1. When one side of output barrier circuit can be grounded, use one single channel barrier. When neither side of output circuit can be grounded, use one dual channel barrier or two single channel barriers.
2. Return barrier must be either diode return or 10V 47 ohm

TITLE	600 T Series 6XX Transmitters "Control drawing"	DATE	4-4-1994
		No.	1H5-15-10064 Sh 3 of 5

This sheet applies only to CSA
Certified transmitters installed in Intrinsically Safe and
Non-Incendive Loops

- WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2
  and
  ADVERTISSEMENT - RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATÈRIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASS I, DIVISION 2

- Ex i INTRINSICALLY SAFE/SECURITÉ INTRINSEQUE WHEN CONNECTED PER AND WITH GROUP LIMITATION STATED HEREIN

- MAXIMUM AMBIENT TEMPERATURES BETWEEN 60°C AND 85°C ALLOWED ONLY IN CLASS I, GROUPS C, D; CLASS II, GROUPS E,F,G; AND CLASS III AREAS AND WHEN USED WITH CLASS I, GROUPS A,B RATED BARRIERS

- TRANSMITTER GROUND MUST BE AT SAME POTENTIAL AS BARRIER GROUND

ENTITY AND NON-INCENDIVE COMPONENT FIELD WIRING CONCEPTS

Entity Concept

Equipment which is FM approved for intrinsic safety may be connected to barriers based on the ENTITY CONCEPT. This concept permits interconnection of approved transmitters, meters and other devices in combinations which have not been specifically examined by FM, provided that the agency's criteria are met. The combination is then intrinsically safe if the entity concept is acceptable to the authority having jurisdiction over the installation.

The entity concept criteria are as follows :

> The intrinsically safe devices, other than barriers, must not be a source of power.
>
> The maximum voltage (V_{MAX}) and current (I_{MAX}), which the device can receive and remain intrinsically safe, must be equal to or greater than the voltage (V_{OC} or V_T) and current (I_{SC} or I_T) which can be delivered by the barrier.
>
> The sum of the maximum unprotected capacitance (C_i) for each intrinsically device and the interconnecting wiring must be less than the capacitance (C_A) which can be safely connected to the barrier.
>
> The sum of the maximum unprotected inductance (L_i) for each intrinsically device and the interconnecting wiring must be less than the inductance (L_A) which can be safely connected to the barrier.

The maximum entity parameters V_{MAX}, I_{MAX}, C_i and L_i for the 600T Series transmitter are listed on page 2 of this document.

The entity parameters V_{OC} or V_T, I_{SC} or I_T, C_A and L_A for barriers are provided by the barrier manufacturer.

Non-incendive Component Field Wiring concepts

The non-incendive field wiring concept is very similar to the entity concept except it allows devices approved with Non-incendive Component Field Wiring parameters to be installed in Class I Division 2 hazardous locations when connected to appropriate sources of power provided that the appropriate criteria are met. The combination is then safe if the concept is acceptable to the authority having jurisdiction over the installation.

The criteria are as follows :

> There must be only one source of power. The source may be an intrinsic safety barrier or it may be a device marked with Non-incendive Component Field Wiring parameters suitable for connection to non-incendive circuit components located in Division 2 hazardous locations.
>
> The maximum voltage (V_{MAX}) and current (I_{MAX}), which the device can receive and remain non-incendive, must be equal to or greater than the voltage (V_{OC} or V_T) and current (I_{SC} or I_T) which can be delivered by the source of power.
>
> The sum of the maximum unprotected capacitance (C_i) for each device and the interconnecting wiring must be less than the capacitance (C_A) which can be safely connected to the source of power.
>
> The sum of the maximum unprotected inductance (L_i) for each device and the interconnecting wiring must be less than the inductance (L_A) which can be safely connected to the source of power.

The Non-incendive Component Field Wiring parameters V_{MAX}, I_{MAX}, C_i and L_i for the 600T Series transmitter are listed on page 1 of this document.

The parameters, V_{OC} or V_T, I_{SC} or I_T, C_A and L_A, for the source of power are provided by the manufacturer of that equipment

PRODUCTS AND SERVICING

A Comprehensive Instrumentation Range

Sensors, transmitters and related instruments for flow, temperature, pressure, level and other process variables

Flowmeters
electromagnetic, ultrasonic, turbine, differential pressure, Wedge, rotary shunt, coriolis.

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electronic and pneumatic.

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sensors and transmitters, fiber optic systems.

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Level
sensors and controllers.

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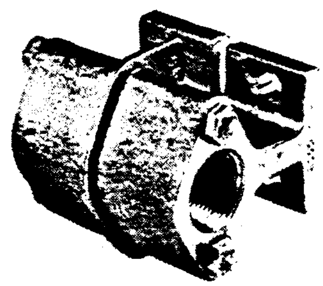
Facsimile (0344) 56278

Instructions for Integral Orifice Flow Element With Upstream and Downstream Piping and With Threaded Connections

IB-4H104
Issue 6
Feb 1991

1330L Z — — 1, 2, 4, 5, 6, 8 Model A
1330L Z — — 0 Model A



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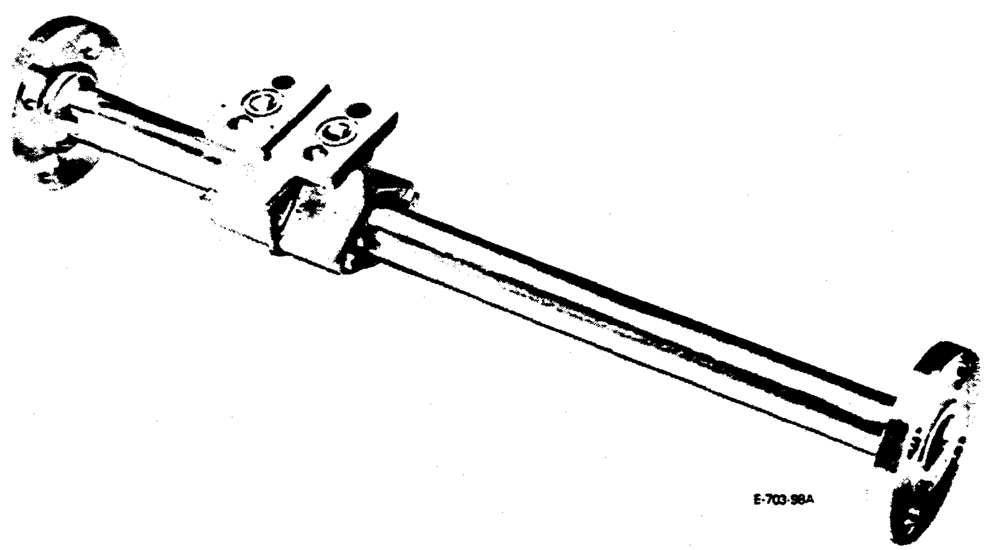

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ABB Instrumentation

NOTICE

Use of **DANGER, WARNING, CAUTION** and **NOTE**

This publication includes **DANGER, WARNING, CAUTION** and **NOTE** information where appropriate to point out safety related or other important information.

DANGER	- Hazards which will result in severe personal injury or death.
WARNING	- Hazards which could result in personal injury.
CAUTION	- Hazards which could result in equipment or property damage.
NOTE	- Alerts user to pertinent facts and conditions.

Although **DANGER** and **WARNING** hazards are related to personal injury, and **CAUTION** hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **DANGER, WARNING** and **CAUTION** notices.

TRADEMARKS

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SECTION 1
INTRODUCTION

1.1 DESCRIPTION

The ABB Kent-Taylor Integral Orifice Flow Elements are primary measuring elements which sense fluid flow and develop a differential pressure as a function of the volume flow rate. This differential pressure is measured by an ABB Kent-Taylor differential pressure transmitter. The differential pressure measurement can be related to volume flow rate by using either a calibration report for the specific element or a standard flow equation applying to all integral orifice elements. A calibration report based on an ABB Kent-Taylor Flow Laboratory calibration is supplied with the element when specified on the order. Refer to **3.2 Accuracy** and **3.3 Flow Equations.**

The element connects directly to a standard differential pressure transmitter with a 2-1/8 inch center-to-center distance between the high and low pressure ports. The ABB Kent-Taylor transmitters which accept these flow elements are available with either electronic or pneumatic output.

The elements are available with several different orifice bore diameters to provide the required differential pressures over a wide range of flow rates. The orifice plate is removable, permitting the orifice bore to be changed in the field if the process requirements change. Elements with threaded connections have an optional cleaning for use on oxygen service applications.

On elements with piping, the upstream and downstream piping is welded to the body of the element. The piping is available in either 1/2-inch, 1-inch, or 1-1/2-inch sizes, and the pipe sections have flanged end connections with several flange options available. The pipe sections provide the minimum straight pipe length required for accurate measurement. The material of the orifice body, pipe, and flanges is type 316 SST.

1.2 EXPLANATION OF SERIAL AND CATALOG NUMBERS

The serial number stamped on the data plate consists of the catalog number and a sequential identification number. The catalog number describes the construction of the element. An X before the catalog number indicates that the element has been built to meet a customer's special requirements.

Sample Serial No. 1330L Z 2 1 1 0 1 - 555 A

Catalog Number:

- Basic Catalog No. — 1330L
- Electrical Code — Z
- Pipe Size and Orifice Bore — 2 1
- Flange Connections — 1
- Material of Construction — 0
- Calibration — 1

Sequential Identification No. — 555

Model (Design Level) — A

BASIC CATALOG NUMBER
1330L - Integral Orifice Flow Element

ELECTRICAL CODE
Z - No Electrical Components

PIPE SIZE AND ORIFICE BORE
Refer to Table 1-1 for description of digits

FLANGE CONNECTIONS
0 - None
1 - Class 150 ANSI flanges
2 - Class 300 ANSI flanges
4 - BS 10 Table D flanges
5 - DIN ND10 flanges
6 - BS 10 Table H flanges
8 - DIN ND40 flanges
9 - Special

MATERIAL OF CONSTRUCTION
0 - Type 316 SST with Type 316 SST Orifice Plate
4 - Type 316 SST with Hastelloy C Orifice Plate

CALIBRATION
0 - Not Calibrated
1 - Water Calibration
9 - Special

EXAMPLE:
Serial number 1330LZ21101-555A identifies an integral Orifice Flow Element with upstream and downstream piping It has no electrical components (Z). The pipe size is 1 inch (2), the orifice bore in 0.020 inch (1) and the flange connection is Class 150 ANSI (1). The material of construction is Type 316 SST with Type 316 SST orifice plate (0) and the pipe section has been water calibrated (1). The sequential identification number is 555 and the design level is Model A.

1.3 TECHNICAL CHARACTERISTICS

ACCURACY
Refer to Table 1-2

MAXIMUM WORKING PRESSURE (Elements with Threaded Connections)
1/2 and 1-inch Elements: 3000 psig (21 000 kPa)
1-1/2-inch Element: 1500 psig (10 500 kPa)

MAXIMUM WORKING PRESSURE (Elements with Piping)
Refer to Table 1-3

GASKET MATERIAL
Silicate Ceramic Filled TFE

MAXIMUM OPERATING TEMPERATURE
300°F (149°C)

Table 1-1. Description of Pipe Size and Orifice Bore Digits of the Catalog Number

Pipe Size and Orifice Bore Digit of Catalog No.	Pipe Size Inches	Orifices	
		Inches	mm
01	1/2	0.020	0.51
02	1/2	0.035	0.89
03	1/2	0.065	1.65
04	1/2	0.113	2.87
05	1/2	0.150	3.81
06	1/2	0.196	4.98
07	1/2	0.270	6.86
08	1/2	0.340	8.64
09	1/2	Special	-
11	1	0.150	3.81
12	1	0.270	6.86
13	1	0.612	15.54
21	1	0.020	0.51
22	1	0.035	0.89
23	1	0.065	1.65
24	1	0.113	2.87
25	1	0.196	4.98
26	1	0.340	8.64
27	1	0.500	12.70
28	1	0.735	18.67
29	1	Special	-
31	1-1/2	0.500	12.70
32	1-1/2	0.612	15.54
33	1-1/2	0.750	19.05
34	1-1/2	0.918	23.32
35	1-1/2	1.127	28.63
39	1-1/2	Special	-

Table 1-2. Accuracy

Orifice Bore Inches	Accuracy in % of Flow Rate	
	Calibrated With Water in ABB Kent-Taylor Flow Lab*	Uncalibrated
0.02 thru 0.065	±0.5	±5
0.113 thru 0.500	±0.5	±2
0.612 thru 1.127	±0.5	±1.5

*Curve supplied with each calibrated instrument

Table 1-3. Maximum Working Pressure

Catalog No.	Flanges	Max. Working Pressure at 100 F° (38 C°)	
		psig	kPa
1330LZ___0___	None		
1330LZ___1___	Class 150 ANSI	275	1900
1330LZ___2___	Class 300 ANSI	720	4900
1330LZ___4___	BS 10 Table D	100	700
1330LZ___5___	DIN ND10	140	980
1330LZ___6___	BS 10 Table H	500	3400
1330LZ___8___	DIN ND40	565	3900

1.4 IDENTIFICATION OF MATERIAL AND ORIFICE BORE

The element body material is stamped on the body as shown in Figure 1-1. The orifice material and bore size are stamped on the orifice plate.

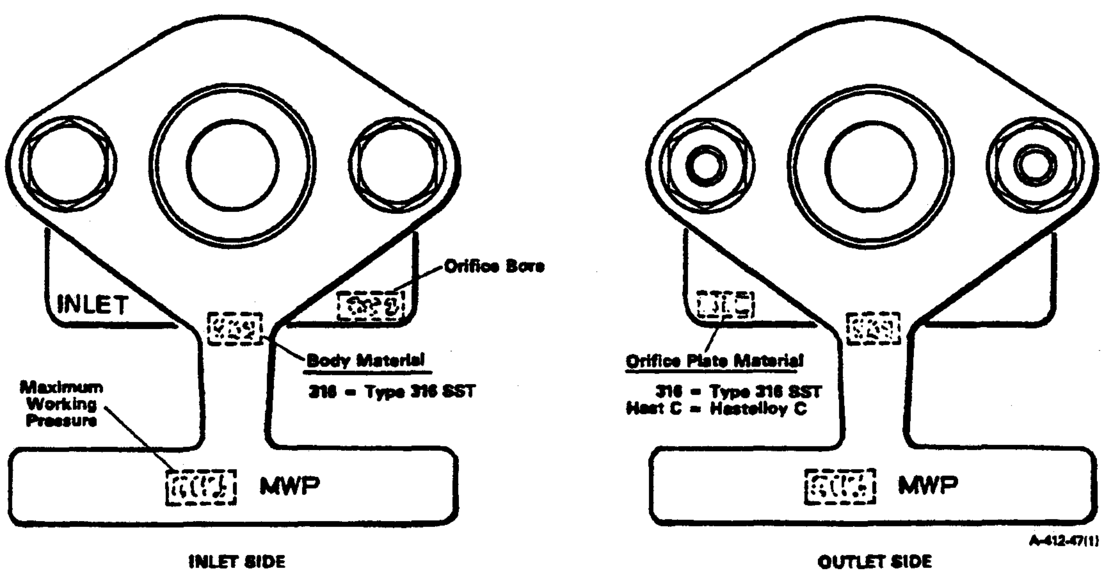


Figure 1-1. Identification Stamping

SECTION 2
INSTALLATION

2.1 SELECTING A MOUNTING LOCATION

2.1.1 General

The recommended mounting location for the element is on a horizontal plane as shown in Figure 2-1. This location allows the integrally mounted differential pressure transmitter to be mounted in its recommended vertical position.

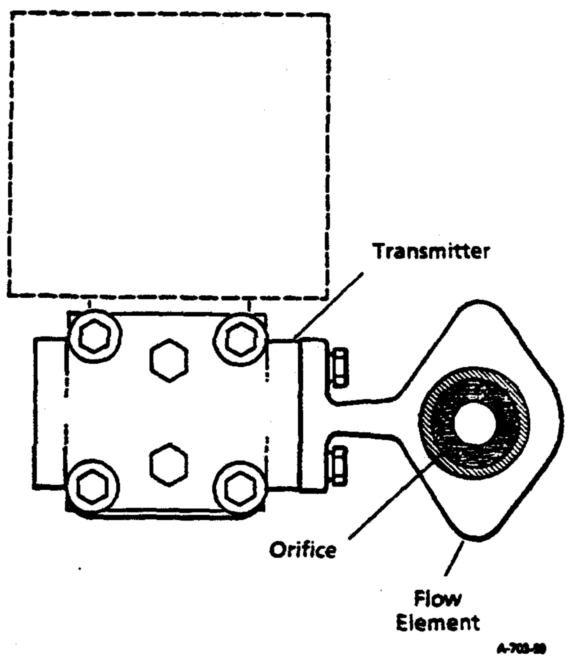


Figure 2-1. Horizontal Location of Flow Element

The element can be installed on a vertical plane as shown in Figure 2-2. However, care must be taken to ensure that the transmitter measuring element is properly vented. With the transmitter on its side, the lower flange cavity is difficult to vent. Gas bubbles in this chamber can cause excessive zero shifts. Routine zero checks can minimize, if not eliminate, this problem. In a vertical installation, the flow direction can be either up or down.

The required upstream and downstream straight pipe lengths are built into the element. No additional straight pipe run is required.

2.1.2 Straight Pipe Run Requirements

The integral orifice element with threaded connections must have a length of straight unrestricted pipe on the upstream and downstream side of the orifice inside the element. The recommended minimum straight length on the upstream side of the orifice depends on the pipe diameter, orifice diameter, and the fitting at the end of the straight run. Minimum upstream lengths are shown in Table 2-1. The recommended minimum length of downstream straight pipe run is 6 pipe diameters (6D) for all pipe fittings.

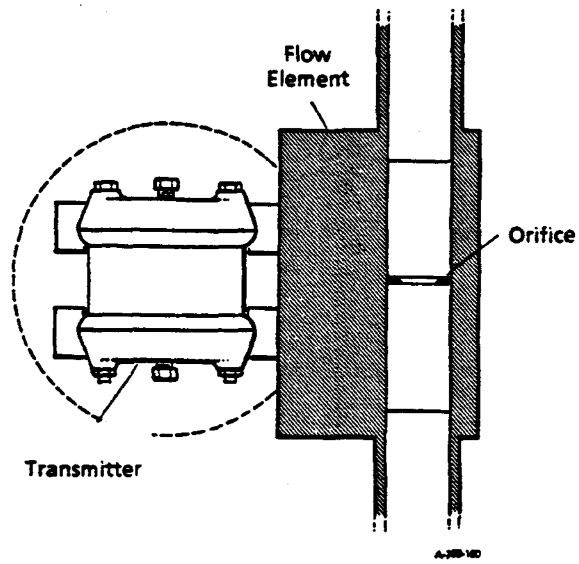


Figure 2-2. Vertical Location of Flow Element

Table 2-1. Minimum Upstream Straight Pipe Length Required for Various Flow Obstructions

Pipe Size (inches)	Orifice Diam. Inches	Minimum Straight Pipe Length – Inches			
		Tee or Elbow	Reducer or Expander	Valves or Regulators	2 Elbows on Different Planes
1/2	0.020 0.035 0.065	6D	8D	16D	14D
	0.113 0.150 0.196	7D	9D	19D	16D
	0.270 0.340	9D	10D	28D	22D
1	0.150 0.270	6D	9D	18D	16D
	0.020 0.035 0.065	6D	8D	14D	12D
	0.113 0.196 0.340	6D	8D	18D	16D
	0.500 0.612 0.735	12D	12D	19D	22D
1-1/2	0.500	6D	8D	18D	16D
	0.612	6D	8D	20D	17D
	0.750	7D	9D	24D	19D
	0.918	8D	10D	28D	22D
	1.127	13D	13D	36D	30D

D = 0.622 for 1/2-inch pipe size; 1.049 for 1-inch pipe size; 1.61 for 1-1/2-inch pipe size

2.2 INSTALLATION PRECAUTIONS FOR OXYGEN SERVICE ELEMENT

Elements with threaded connections have an optional cleaning for use on oxygen service applications. Integral orifice flow elements which have been specially cleaned for oxygen service are packed in protective plastic bags prior to shipment. To prevent possible contamination of the cleaned surfaces, do not remove the parts from the bags until the time of installation. Handle all specially cleaned parts with plastic (polyethylene) gloves. Do not contaminate these parts with oil, grease or any combustible material. If parts become contaminated, remove contamination with clean trichlorethylene.

All tools and equipment used for assembly and installation must be oil free and clean. To check cleaned surfaces and tools for possible contamination, use a long wave ultraviolet lamp.

When mounting the element in the process pipe line, do not use ordinary pipe dope or Teflon tape to seal process connections. The thread sealant must be approved for use in oxygen service. Seal process connections with Fluoramics, Inc. LOX-8 paste or equivalent.

CAUTION

When using Teflon tape, do not allow excess tape to protrude into the process stream. Excess tape can shred and break off, causing particle contamination inside the pipe.

2.3 MOUNTING AND DIFFERENTIAL PRESSURE CONNECTIONS

WARNING

Exceeding the maximum pressure rating of the element can cause personal injury and damage to equipment. Make sure that process pressure does not exceed pressure rating (MWP) stamped on data plate.

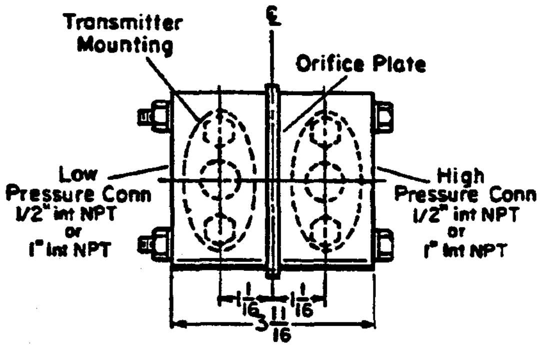
2.3.1 Elements with Threaded Connections

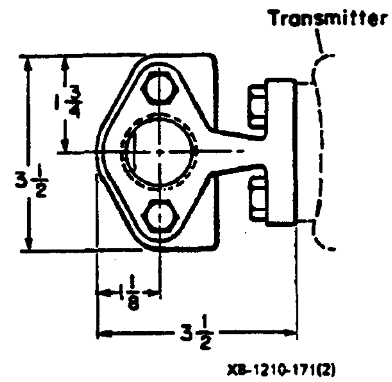
When mounting the element, be sure to orient it so that the flow enters from the side stamped INLET on the orifice plate, Figure 1-1. The high pressure port is on the inlet side of the element and must be connected to the high pressure side of the differential pressure transmitter.

WARNING

Maximum working pressure rating of element may be different than rating of transmitter. Exceeding the pressure rating can cause personal injury and damage equipment. Make sure that process pressure does not exceed lowest pressure rating of either the element or transmitter.

Mounting dimensions for the elements are shown in Figures 2-3 and 2-4. The element is supplied with two ring gaskets and four mounting screws for connection to a differential pressure transmitter at the high and low pressure ports.



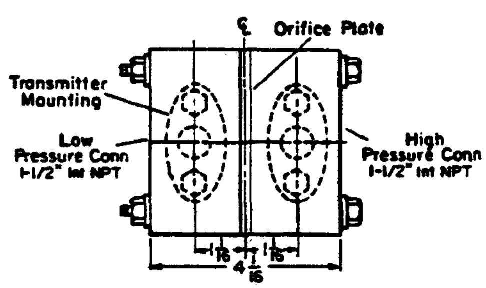


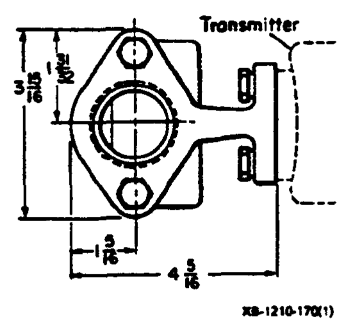
INCHES	mm
1-1/16	26.99
1-5/16	33.34
1-31/32	50.01
3-15/16	100.01
4-1/16	103.19
4-5/16	109.54

All dimensions in inches.

For reference only; not for construction.

Figure 2-3. Mounting Dimensions for 1/2 Inch and 1 Inch Elements





INCHES	mm
1-1/16	26.99
1-5/16	33.34
1-31/32	50.01
3-15/16	100.01
4-1/16	103.19
4-5/16	109.54

All dimensions in inches.

For reference only; not for construction.

Figure 2-4. Mounting Dimensions for 1-1/2 Inch Elements

Remove all plastic shipping plugs from the element ports. Remove any foreign matter from the mating surfaces of the element and transmitter. Position the ring gaskets in the grooves on the mating surfaces of the element. Connect the element to the transmitter using the four mounting bolts supplied. Be sure the high pressure side of the transmitter is connected to the **INLET** side of the element. Tighten the four mounting bolts to a torque of 250 to 300 inch-lbs (28.2 to 33.9 Nm).

Mount the assembled transmitter and flow element in the pipe line. Refer to the transmitter instructions for additional mounting information. A union connection is required in the process line to permit installation of the element.

NOTE

If it is more convenient, the flow element can be mounted in the pipe line before connecting the transmitter to the element.

2.3.2 Elements with Upstream and Downstream Piping

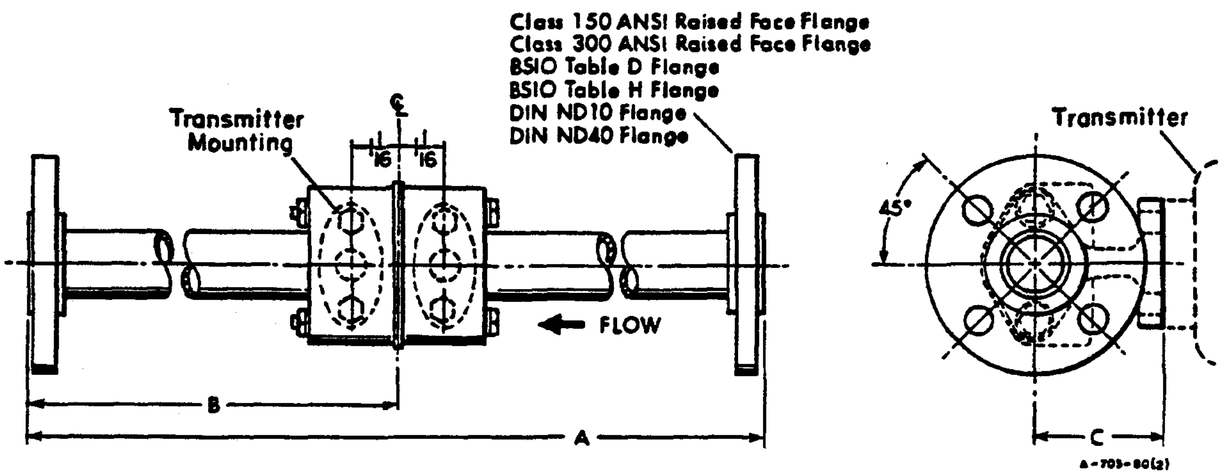
When mounting the element, be sure to orient it so that the flow will be in the direction indicated by the arrow shown in Figure 2-5. Flow must enter the element at the upstream end; this is the end with the longer pipe section. The high pressure port is on the upstream side of the element and must be connected to the high pressure side of the differential pressure transmitter.

A gasket must be inserted between each element flange and its mating process flange. The flange gaskets are to be supplied by the customer. These gaskets should be of a type which will withstand the maximum process temperature and pressure which will resist corrosive attack by the process fluid. Gaskets may be selected in accordance with ANSI Standard B16.5, using the Group 1 type for raised face flanges.

It is important that the flanges in the process pipe line be of the same class and type as the element flanges. The element flanges can be Class 150, Class 300, British Standard or DIN.

WARNING

Maximum working pressure rating of element may be different than rating of transmitter. Exceeding the pressure rating can cause personal injury and damage equipment. Make sure that process pressure does not exceed lowest pressure rating of either the element or transmitter.



Catalog No.	Pipe Size	A ±3/16	B	C
1330LZ0 – – – –	1/2	24	8	2-1/2
1330LZ1 – – – –	1	24	8	2-1/2
1330LZ2 – – – –	1	24	8	2-1/2
1330LZ3 – – – –	1-1/2	38	8	3

For reference only, not for construction.

All dimensions in inches.

INCHES	mm
3/16	4.76
1-1/16	26.99
2-1/2	63.50
3	76.20
8	203.20
24	609.20
38	965.20

Figure 2-5. Mounting Dimensions for Elements With Upstream and Downstream Piping

SECTION 3
OPERATION

3.1 STARTUP

Before any true transmitter zero reading can be taken it is necessary to establish that the process pipe and flow element are solid filled with process fluid and that there is no flow. A shut-off valve or control valve downstream from the element will facilitate this condition. Opening the valve for a short time will remove any gasses that are present in the system. It will also be necessary to purge air from the transmitter body by opening the vent valves on the high- and low-side flanges. Any air present in the transmitter body will cause a false zero reading.

3.1.1 Zero Check

With the flow element under full line pressure, at normal operating temperature and at zero flow, the transmitter output can be adjusted to an exact zero reading on the readout device. If possible, open the downstream valve for a few seconds and then close it. The readout device should return to a zero reading. If it does not, readjust the zero screw on the transmitter. Repeat this procedure two or three times to establish a true zero.

3.1.2 Span Check

In most cases it will not be possible to check for the correct span because this would require a field calibration. The transmitter associated with the flow element has been calibrated at the factory to agree with the calibration and/or calculation of the element.

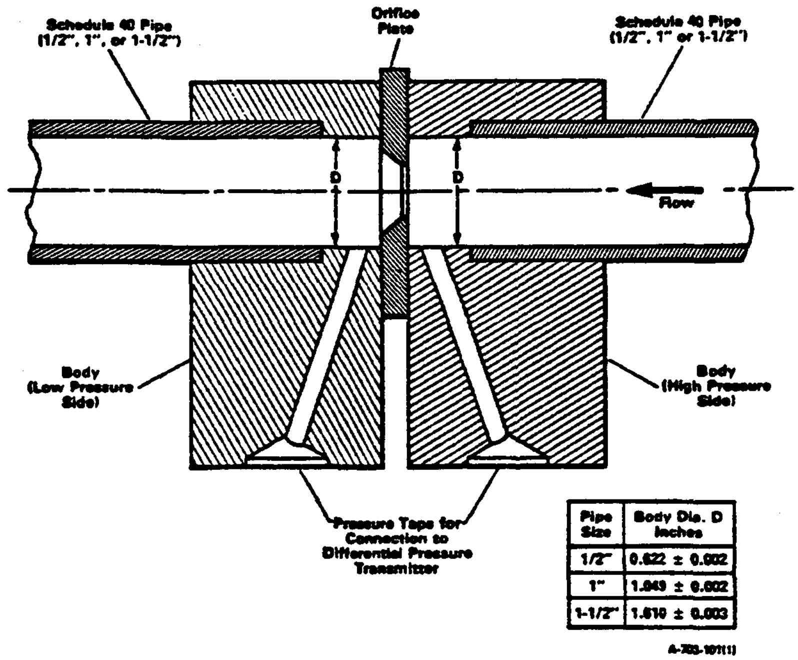
NOTE

A calibration report is supplied with each flow element that is calibrated in the ABB Kent-Taylor Flow Laboratory. Check the calibration report to see that the maximum differential of the element agrees with the differential span of the transmitter. If it does not, it will be necessary to recalibrate the transmitter. A flow data sheet with calculations is provided for flow elements that are not laboratory calibrated.

3.2 ACCURACY

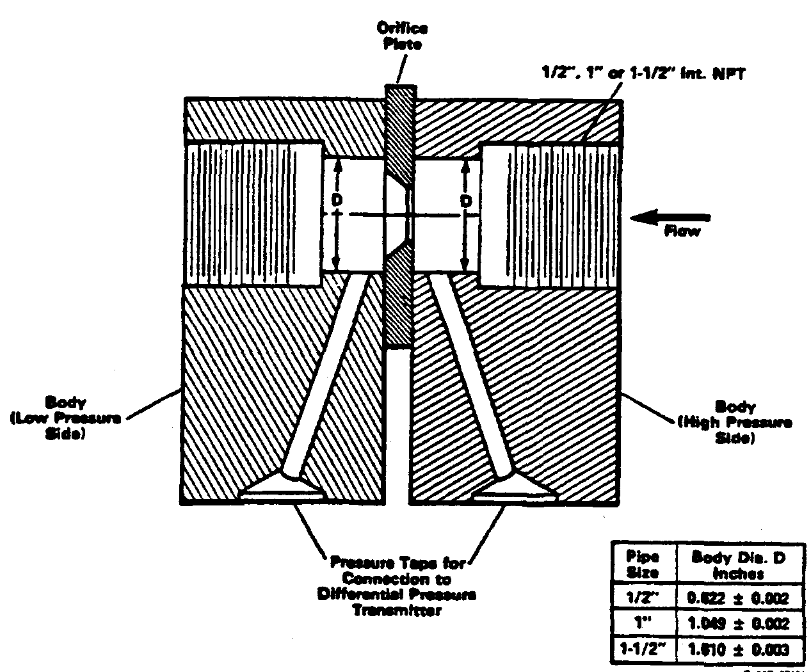
The body of the integral orifice assembly provides a precisely controlled diameter (D) adjacent to the orifice plate, Figures 3-1 and 3-2. For elements with piping,the pipe sections are Schedule 40 pipe with standard pipe manufacturing tolerances. The pipe tolerances do not affect accuracy because of the controlled body diameter.

All flow elements that are calibrated in the ABB Kent-Taylor Flow Laboratory are calibrated to ±0.5% of flow. The accuracy of uncalibrated flow elements may be 2 to 5% of flow span, depending on the type of element, pipe size and orifice size; refer to Table 1-2. Additional errors will occur if the process fluid density differs from the design value. The percent errors given do not include the inherent errors of the transmitter which are normally very small until flow rates fall below 30% of maximum flow (9% of maximum differential pressure).



Pipe Size	Body Dia. D Inches
1/2"	0.622 ± 0.002
1"	1.049 ± 0.002
1-1/2"	1.610 ± 0.003

Figure 3-1. Cross-Section View of Flow Element With Upstream and Downstream Piping



Pipe Size	Body Dia. D Inches
1/2"	0.622 ± 0.002
1"	1.049 ± 0.002
1-1/2"	1.610 ± 0.003

Figure 3-1. Cross-Section View of Flow Element With Threaded Connections

3.3 FLOW EQUATIONS

The standard flow equations for integral orifice elements are as follows:

Liquid Flow at flowing temperature

$$q = 5.668\ Fa\ K\ d^2 \sqrt{h\ g_f}$$

Liquid Flow at 60°F

$$q = \frac{5.668\ Fa\ K\ d^2}{gt} \sqrt{h\ g_f}$$

Gas Flow

$$Q = 7727\ Fa\ Fpv\ K\ d^2\ Y \sqrt{\frac{h\ P_f}{G\ T_f}}$$

Steam Flow

$$W = 359\ Fa\ K\ d^2\ Y \sqrt{\frac{h}{V}}$$

where q = Maximum flow rate, gallons/min
Q = Maximum flow rate, SCFH
W = Maximum flow rate, lbs/hr
Fa = Orifice expansion factor, Figure 3-3
K = Flow coefficient, Table 3-1
d = Orifice diameter, inches
h = Maximum differential pressure, inches of water
gf = Liquid specific gravity at flowing temperature
gt = Liquid specific gravity at 60°F
Fpv = Gas compressibility factor (normally 1)
Y = Gas expansion factor, Figure 3-4
Pf = Pressure of flowing fluid, psia
Tf = Temperature of flowing fluid, degrees Rankine (°F + 460)
G = Gas specific gravity
V = Specific volume of steam, cu ft/lb

3.4 METRIC CONVERSIONS

1 kPa = 0.1450 psi
1 bar = 14.50 psi
1 kg/cm^2 = 14.22 psi
1 mm Hg = 0.5357 inches of water
1 meter = 3.281 ft
1 cm = 0.3937 inches
1 liter = 0.2642 gals
1 Imp Gal = 1.201 gals
1 cu meter/sec = 35.32 cu ft/sec
1 kg/hr = 2.205 lbs/hr
°C = 5/9(°F − 32)

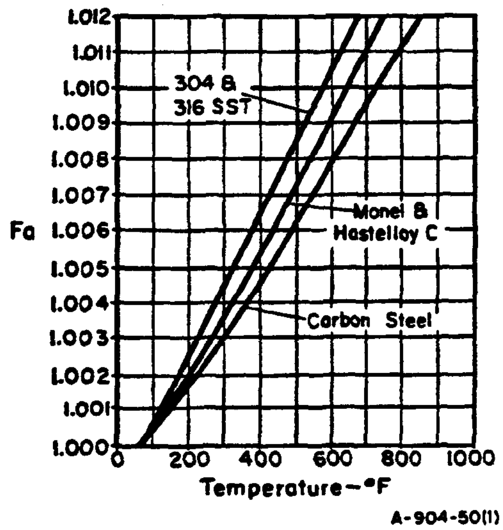
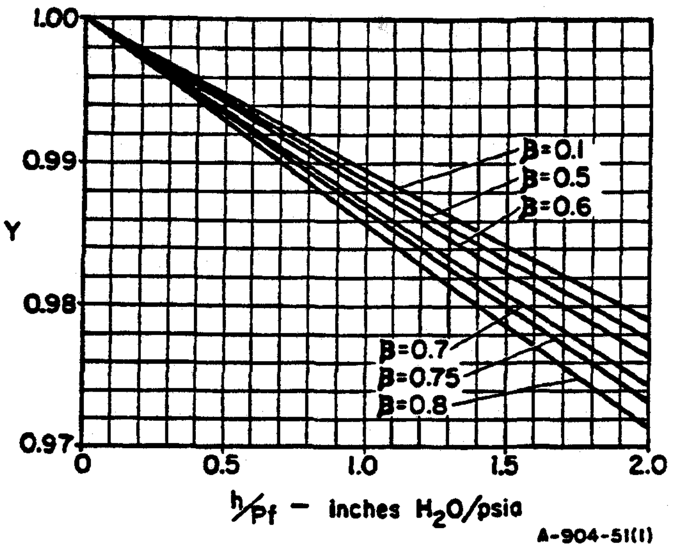


Figure 3-3. Orifice Expansion Factor

Table 3-1. Orifice Flow Coefficient

Pipe Size (Inches)	Orifice Bore (Inches)	Nominal Flow Coefficient K
1/2	0.020 0.035 0.065 0.113 0.150 0.196 0.270 0.340	0.670 0.642 0.628 0.612 0.608 0.608 0.619 0.642
1	0.150 0.270 0.020 0.035 0.065 0.113 0.196 0.340 0.500 0.612 0.735	0.604 0.604 0.645 0.635 0.620 0.605 0.603 0.605 0.630 0.666 0.715
1-1/2	0.500 0.612 0.750 0.917 1.127	0.611 0.614 0.623 0.650 0.714



Pipe Size (Inches)	Orifice Bore (Inches)	β
1/2	0.020	0.1
	0.035	0.1
	0.065	0.1
	0.113	0.2
	0.150	0.2
	0.196	0.3
	0.270	0.4
	0.340	0.5
1	0.150	0.1
	0.270	0.2
	0.020	0.1
	0.035	0.1
	0.065	0.1
	0.113	0.1
	0.196	0.2
	0.340	0.3
	0.500	0.5
	0.612	0.6
	0.735	0.7
1-1/2	0.500	0.3
	0.612	0.4
	0.750	0.5
	0.917	0.6
	1.127	0.7

Figure 3-4. Gas Expansion Factor

SECTION 4
MAINTENANCE

4.1 REMOVING ELEMENT FROM SERVICE

WARNING
Process pressure and material retained in the flow element can cause injury and damage to equipment. Standard plant safety procedures must be followed when removing the element from service.

Shut off the process pressure before loosening any bolts. Disconnect the transmitter from the element by removing the four mounting screws connecting the element to the transmitter flanges, then disconnect the element from the process pipe line.

4.2 CHANGING ORIFICE

The orifice can be changed by disassembling the element as shown in Figures 4-1 and 4-2. When installing the new orifice, be sure to orient it as shown in Figures 4-1 and 4-2. Use new gaskets to insure proper sealing.

WARNING
On 1-1/2-inch elements, be sure to use the hardened steel washers under the nuts and bolt heads to assure adequate bearing strength.

The correct body bolts, nuts, and mounting bolts must be used to maintain the specified pressure rating of the element. The identification code on the bolt heads and nuts must be as shown in Figures 4-1 and 4-2. Tighten body bolts to the following torque values:

1/2-inch and 1-inch Elements:
250 to 350 inch-lb (28.2 to 39.5 Nm)

1-1/2-inch element:
400 to 425 inch-lb (45.2 to 48 Nm)

NOTE
When reconnecting the element to the transmitter, use new gaskets and torque connecting screws as specified under **2.3 Mounting and Differential Pressure Connections.**

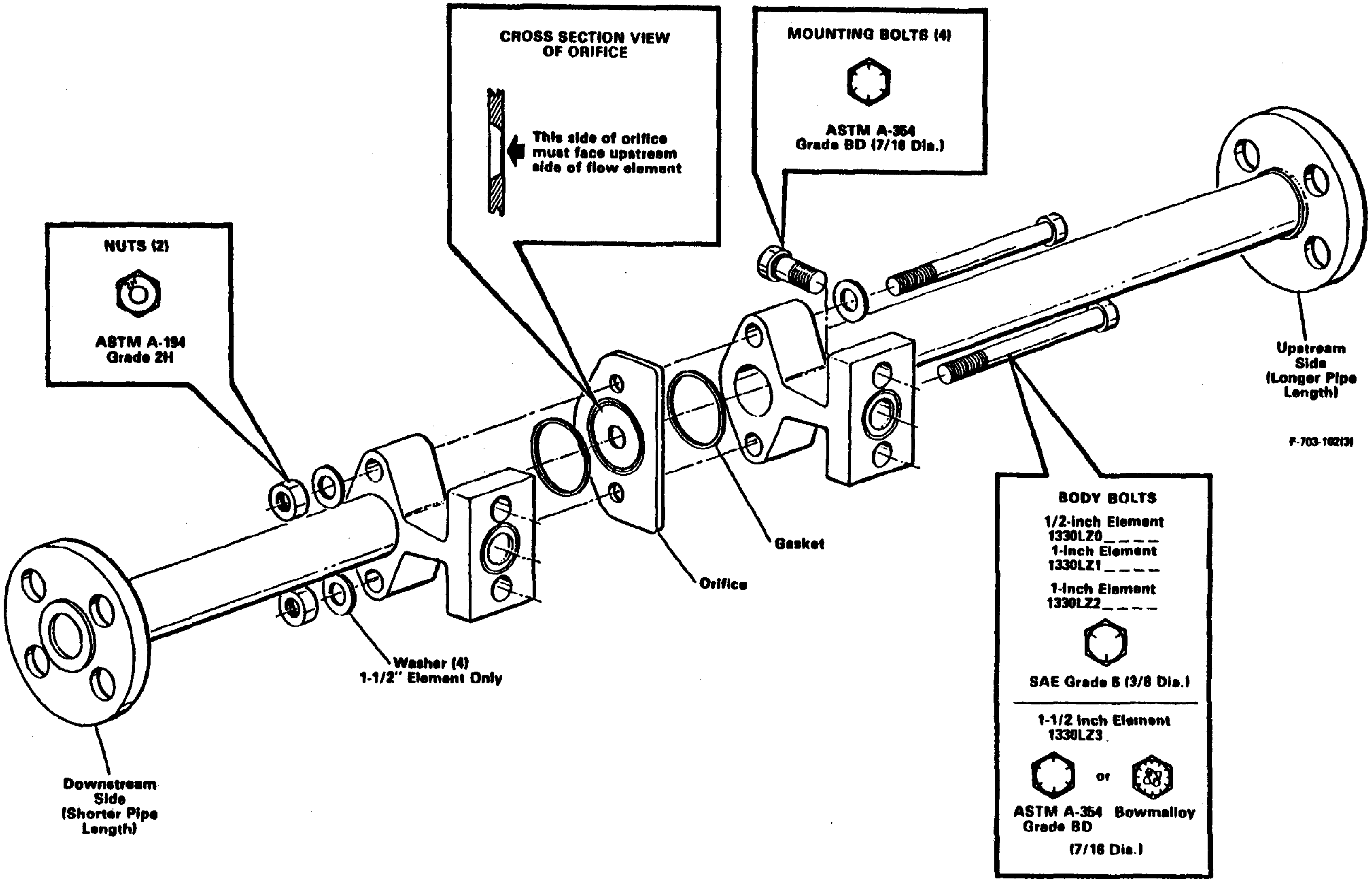


Figure 4-1. Exploded View of Flow Element with Upstream and Downstream Piping

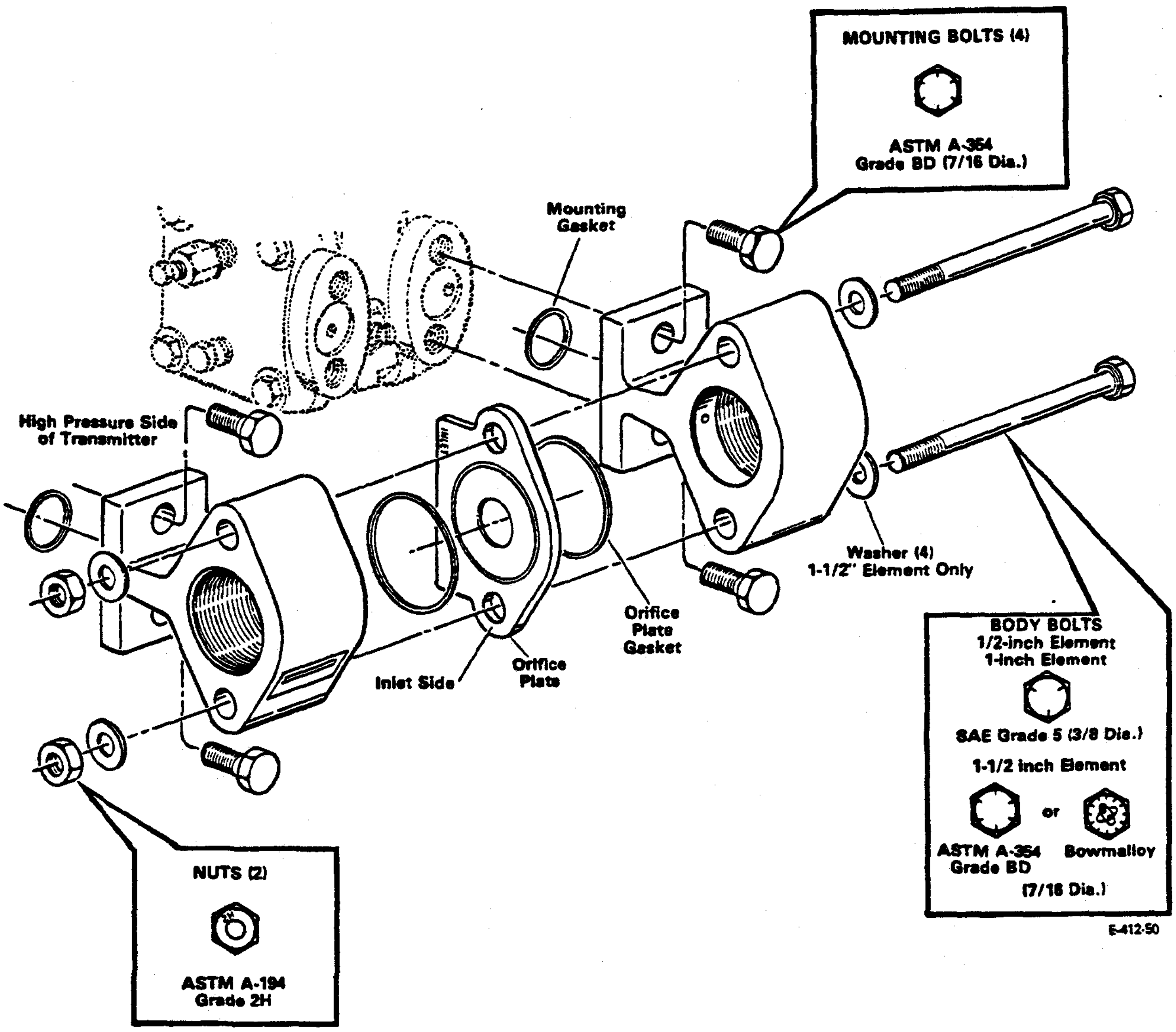


Figure 4-2. Exploded View of Flow Element With Threaded Connections

SECTION 5
PARTS LIST

5.1 ORDERING INFORMATION

When ordering parts, always specify the complete serial number of the instrument.

5.2 RECOMMENDED SPARE PARTS

A plus (+) sign before the item number indicates that the item is a recommended spare part.

5.3 PARTS AVAILABILITY

This parts list may contain parts that are not saleable. These parts are identified with an asterisk (*) in the part number column. They are listed and shown as required to provide a comprehensive breakdown of the assembly.

5.4 PARTS IDENTIFICATION

A dash (–) in the item number column indicates that the part is not illustrated in the referenced figure. A dash (–) in the part number column indicates there is no part identification available.

Some part descriptions have dots preceding them. These dots indicate that the parts are components of the assembly or subassembly (SA) which immediately proceeds them in the listing.

5.5 UNDERSCORE IDENTIFICATION

Underscores in place of characters in a catalog number (e.g. 1330LZ _ _ _ _ _A) indicate any character may apply. Refer to **1.2 Explanation of Serial and Catalog Numbers**. Underscores in place of characters in a part number (e.g. 127S932-_ _) indicate that more than one character may apply. The part number may be referenced to another page or section for selection of required characters.

5.6 PARTS LISTING

Refer to Figure 5-1.

Item	Part No.	Description	No. Req'd
1	3P1424	Protective Cover	1
2	6P_ _ _ _	Orifice Plate; refer to Table 5-1 for part numbers	1
3	9P1566	Element Mounting Bolt	4
4	9P1907-3	Body Mounting Bolt, Grade BD - 1330LZ2	2
4	9P1929-2	Body Mounting Bolt, Grade BD - 1330LZ3	2
5	22P958	Body Mounting Washer - 1330LZ3	4
6	27S_ _ _	Body and Flange, Downstream; refer to Table 5-2 for part numbers	1
7	27S_ _ _	Body and Flange, Upstream; refer to Table 5-2 for part numbers	1
8	32P803-1	Body Mounting Nut, Grade 2HB - 1330LZ2	2
8	32P818	Body Mounting Nut, Grade 2HB - 1330LZ3	2
9	43P900-1	Element Mounting Gasket	2
+10	43P900-8	Body Mounting Gasket - 1330LZ2	2
+10	43P900-13	Body Mounting Gasket - 1330LZ3	2
11	45P2296	Label	2
12	*	Data Plate	1
13	542M167	Protective Cover Retaining Nut, 7/16"-20	4

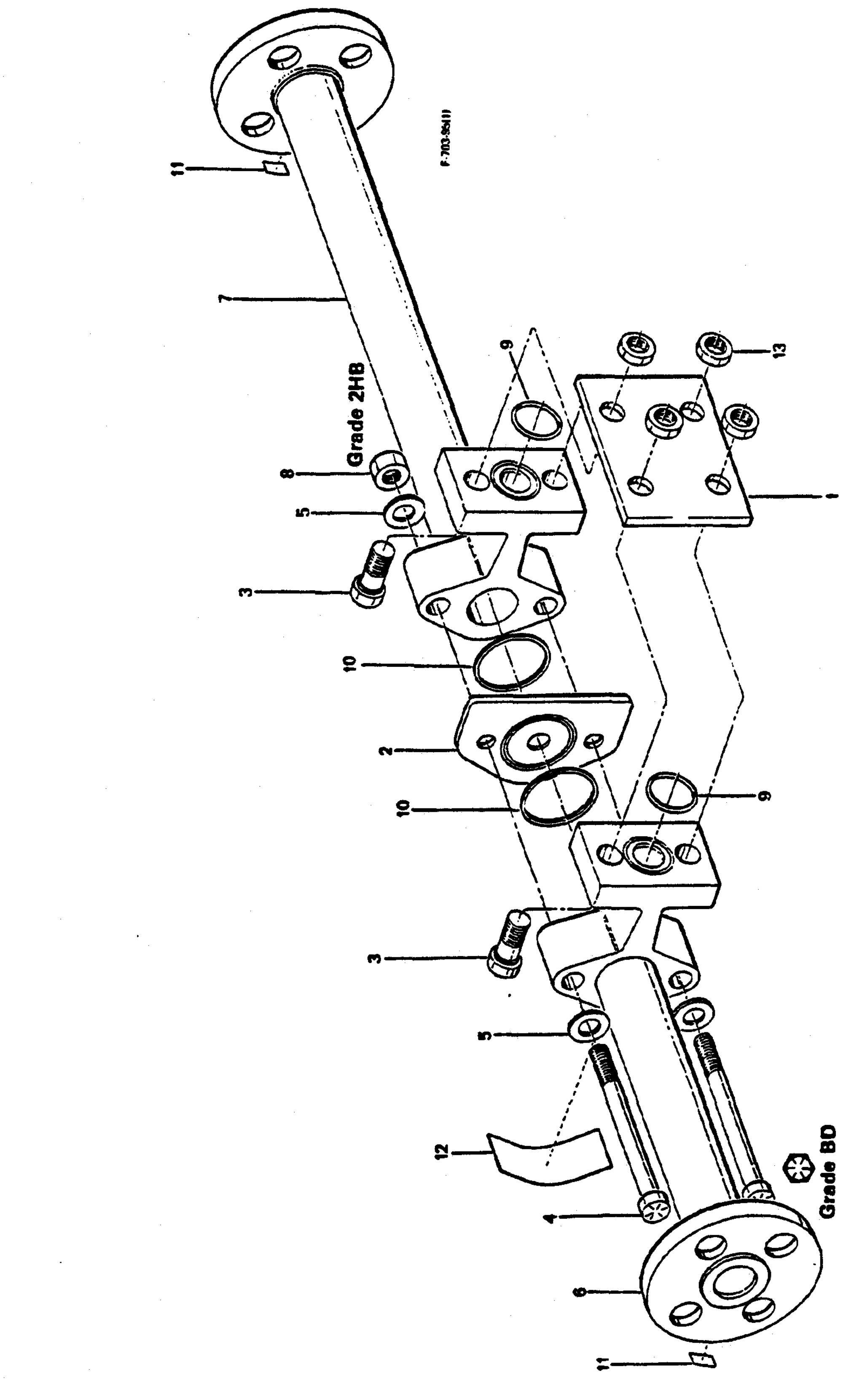


Figure 5-1. Integral Orifice Flow Element

Table 5-1. Part Numbers for Orifice Plates

	Catalog Number 1330LZ_ _ _ _ _ _			Part Number	Orifice Size (inches)	Orifice Size (mm)
1 Inch Pipe	2	1	0.2 3.4	6P2835J020 6P2835Z020	0.020	0.51
	2	2	0.2 3.4	6P2835J035 6P2835Z035	0.035	0.89
	2	3	0.2 3.4	6P2835J065 6P2835Z065	0.065	1.65
	2	4	0.2 3.4	6P2835J113 6P2835Z113	0.113	2.87
	2	5	0.2 3.4	6P2835J196 6P2835Z196	0.196	4.98
	2	6	0.2 3.4	6P2835J340 6P2835Z340	0.340	8.64
	2	7	0.2 3.4	6P2835J500 6P2835Z500	0.500	12.70
	2	8	0.2 3.4	6P2835J735 6P2835Z735	0.735	18.67
1-1/2 Inch Pipe	3	1	0.2 3.4	6P3396JA 6P3396ZA	0.500	12.70
	3	2	0.2 3.4	6P3396JB 6P3396ZB	0.612	15.54
	3	3	0.2 3.4	6P3396JC 6P3396ZC	0.750	19.05
	3	4	0.2 3.4	6P3396JD 6P3396ZD	0.918	23.32
	3	5	0.2 3.4	6P3396JE 6P3396ZE	1.127	28.63

Table 5-2. Part Numbers for Bodies and Flanges

	Catalog Number 1330LZ_ _ _ _ _ _		Part Number Downstream Item 6	Part Number Upstream Item 7
1 Inch Pipe	2	1	27S529SG01	27S529SG03
	2	2	27S529SG05	27S529SG07
	2	3	27S530SG01	27S530SG03
	2	4	27S530SG05	27S530SG07
	2	5	27S531SG01	27S531SG03
	2	6	27S531SG05	27S531SG07
1-1/2 Inch Pipe	3	1	27S529SG02	27S529SG04
	3	2	27S529SG06	27S529SG08
	3	3	27S530SG02	27S530SG04
	3	4	27S530SG06	27S530SG08
	3	5	27S531SG02	27S531SG04
	3	6	27S531SG06	27S531SG08

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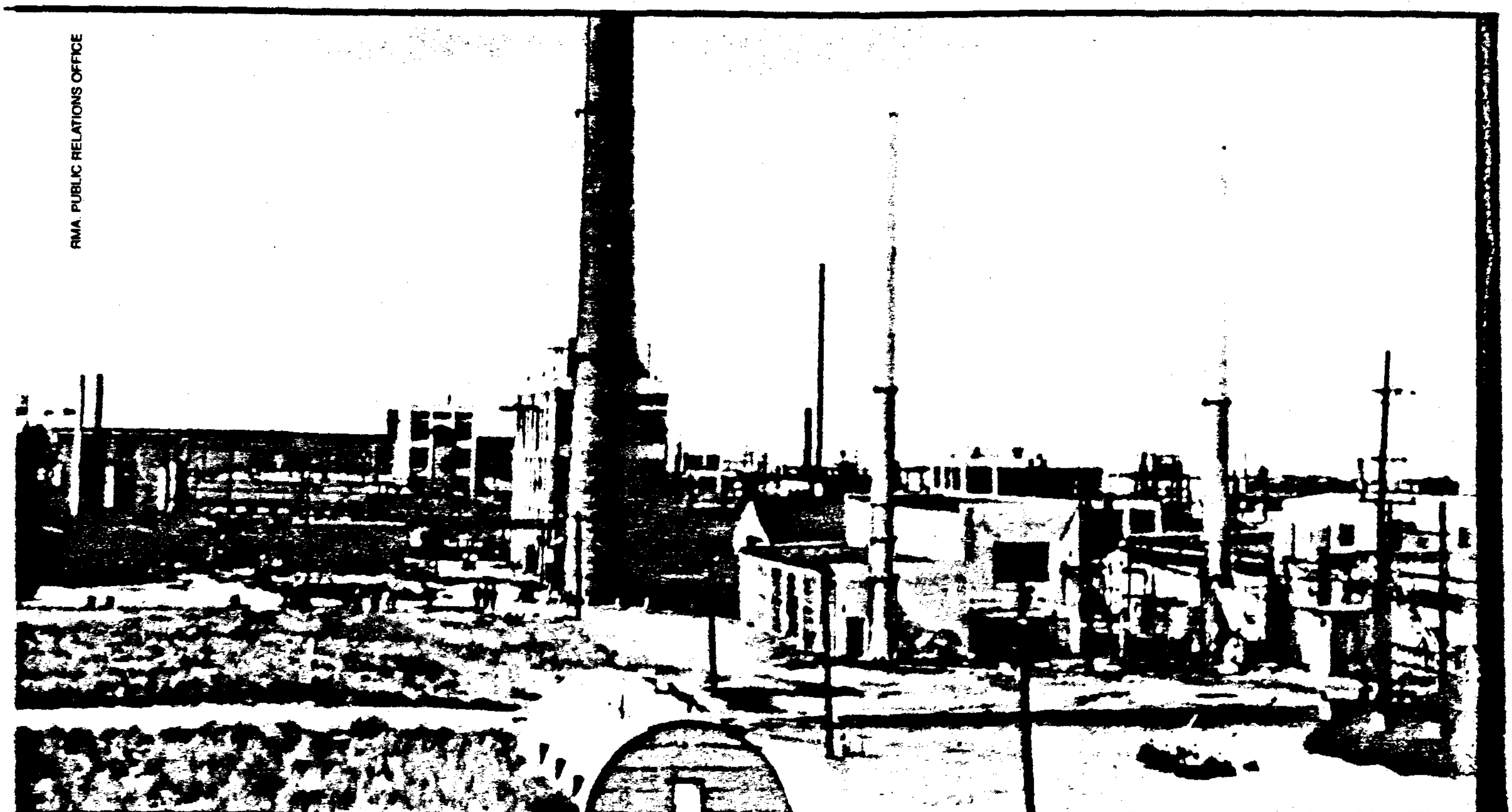

RMA PUBLIC RELATIONS OFFICE

FROM WEAPONS TO WILDLIFE

THE TRANSFORMATION OF THE ROCKY MOUNTAIN ARSENAL

by Karen B. Wiley and Steven L. Rhodes

In 1942, the U.S. Department of War built a chemical weapons plant northeast of Denver, Colorado. Following World War II and throughout the Korean and Vietnam conflicts and most of the Cold War, the Rocky Mountain Arsenal was used for the manufacture of nerve gas, conventional weapons, rocket fuel, and even commercial pesticide products. Decades of military and commercial production activities at the arsenal generated hazardous pollutants, some of which eventually migrated into the surrounding soil and groundwater, both on- and off-post. The federal government admits that the arsenal "is one of the Defense Department's most contaminated installations."[1]

By the 1980s, much of the arsenal's 27-square-mile expanse had been designated a Superfund site that by law required extensive, costly cleanup. The arsenal's steward, the U.S. Army, stubbornly resisted its sister federal agency, the Environmental Protection Agency (EPA), and EPA's insistence on comprehensive cleanup. Shell Chemical Company, which had manufactured pesticides in the former mustard gas facility at the arsenal, also strenuously opposed extensive cleanup of the site because it would have to pay a sizable portion of the remediation costs. Colorado's health department, governor, attorney general, and congressional delegation, as well as representatives of neighboring local governments, worried residents in the adjacent communities, environmental activists, civilian employees at the arsenal, and others joined the fray, with forces sharply divided over how extensive—and expensive—any cleanup of the Rocky Mountain Arsenal should be. A tangle of litigation, intergovernmental rancor, unrealistic and incomprehensible cleanup plans and cost estimates, and public concerns about human health and

safety made any movement toward actually solving the arsenal problem nearly impossible.

Then, in 1992, 50 years after the arsenal's creation, an almost surreal solution to the problem converted antagonists into collaborators. An idea born of controversy, conflict, and happenstance transformed a perceived wasteland into the future site of a wildlife refuge adjacent to a metropolitan area of more than a million people[2] (see Figure 1 on page 7). In short order, a bitter, lengthy, and costly dispute about the future of Rocky Mountain Arsenal virtually dissolved into a shared vision of a reformed, rededicated public amenity: a vast open space reserved for flora and fauna, nature education, and public tours, with select areas to be designated as permanently off-limits to public access.

How did this improbable solution to such a troublesome, complicated environmental problem arise? How was a litigious, politically sensitive stalemate over environmental cleanup suddenly transformed into a widely supported plan? What lessons can we learn from the Rocky Mountain Arsenal experience, particularly with respect to other contaminated sites dating from the Cold War and before?

The answers to these questions hinge on three interrelated factors: first, an extended dispute between the federal and state governments concerning jurisdiction over cleanup of arsenal contamination; second, a proposal to build a new commercial airport and a new regional beltway, both of which would dramatically change land-use patterns around the arsenal; and third, the totally coincidental—and surprising—appearance of a number of bald eagles within the arsenal boundaries. The convergence of these three factors framed and narrowed the range of options available to all parties interested in a long-term resolution of the arsenal problem.

The transformation of the Rocky Mountain Arsenal from military and commercial to aesthetic and recreational uses may not at first appear to offer useful lessons for other contaminated federal facilities. However, the arsenal is not the only instance of a military installation unintentionally providing protected habitat for an unusual array of wildlife.[3] Also, one should not overlook the insights from the arsenal case regarding the influence of local land-use planning and the importance of state jurisdiction over cleanup of contaminated government facilities. In addition, the arsenal offers a reminder of the importance of sheer luck in resolving controversial policy questions.

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The U.S. Army constructed a state-of-the-art chemical weapons facility in 1942 at the Rocky Mountain Arsenal to compete with Germany's much-feared chemical weapons program during World War II.

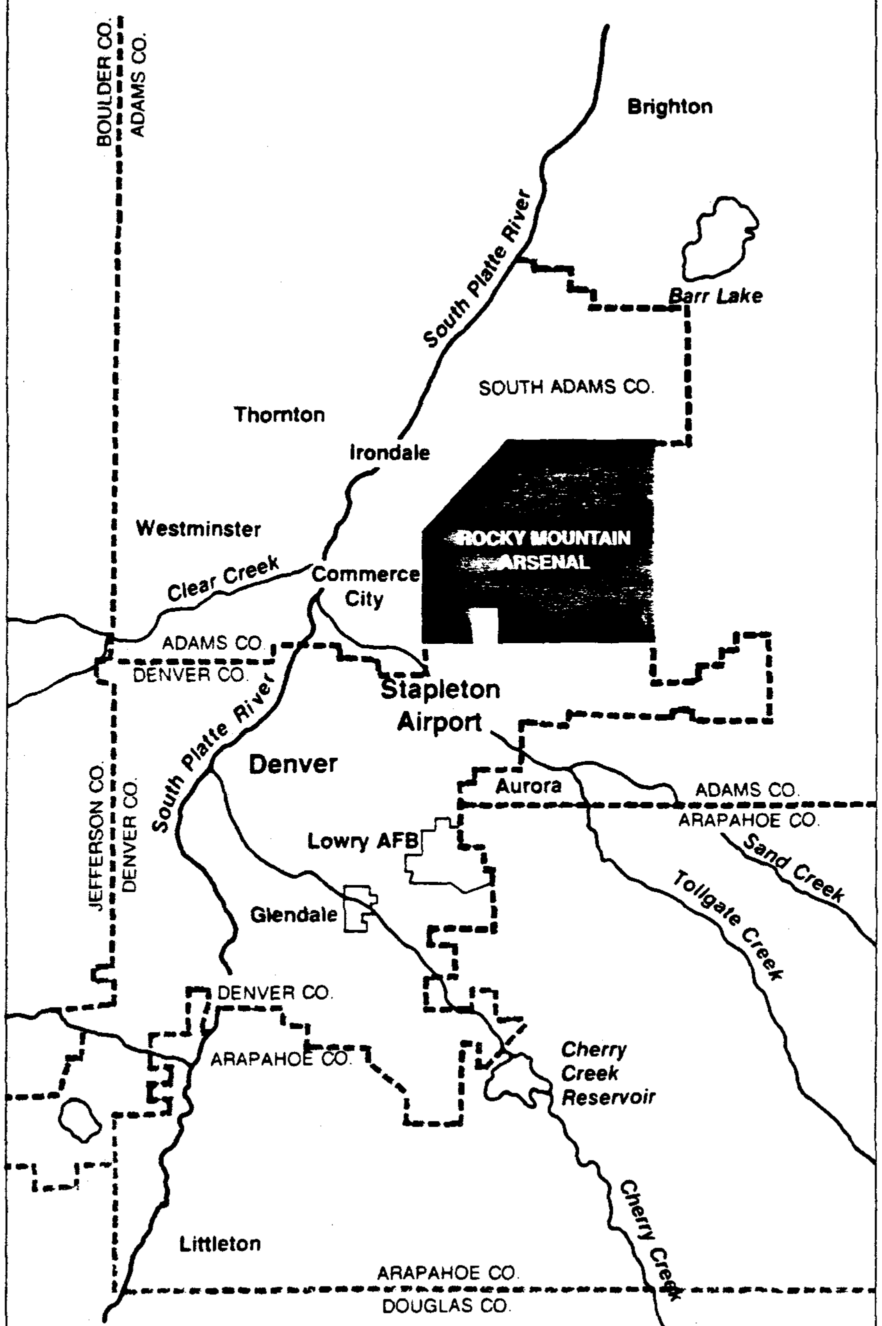
History of the Arsenal

Rocky Mountain Arsenal was built during World War II as a production facility for chemical and incendiary weapons, a function that it continued to serve until the early 1970s. In 1953, during the Korean War, the U.S. Army began the operation of a facility in the northeast quadrant of the arsenal for the manufacture of binary nerve gas weapons. The army ceased producing nerve gas weapons there in the early 1970s, but the facility remained on standby for another decade. During the 1970s and 1980s, the facility was used primarily for neutralizing and incinerating chemical warfare material and for storage of chemical weapons awaiting decommissioning.[4] (For an extended chronology of events, see the box on page 8.)

Beginning in 1946, the U.S. government leased portions of the arsenal to private companies for the production of commercial chemicals. Julius Hyman and Company produced pesticides at the arsenal from 1947 to 1952, at which time Shell Chemical Company acquired Hyman and then continued production until 1982. Colorado Fuel and Iron Company manufactured a variety of industrial chemicals such as chlorinated benzenes, chlorine, naphthalene, caustic, and DDT from 1946 to 1948. In addition, the U.S. Air Force utilized a portion of the arsenal for the manufacture of rocket fuel for civilian and military space programs.[5]

Both government and commercial occupants disposed of contaminants resulting from their manufacturing activities at numerous sites around the arsenal. Some of these pollutants eventually found their way off-post through groundwater transport (see Figure 2 on page 9). The first reported evidence of off-post contamination came in 1951, when farmers discovered damage to crops grown near the arsenal.[6] The army undertook several studies following these claims and reports of on-post fish kills, but the findings were not made public. The army also constructed a series of on-post surface impoundments—including an asphalt-lined pond known as Basin F—to consolidate liquid wastes from military and commercial activities at the facility. This, however, did not completely eliminate the contamination hazard. In 1957, residents living near the arsenal detected well-water contamination, which prompted the county health department to request information from the army about arsenal activities. The army's response was merely to assure residents that they had nothing to fear from arsenal operations. As a result, the county health department asked the U.S. Public Health Service (PHS) to investigate, and PHS concluded that the arsenal was, in fact, the source of the pollution. The army subsequently made public its own earlier studies of the origins of off-post water contamination.[7] Several residents filed damage claims against the army for pollution of their wells, and a local newspaper charged that the army had been "tardy and secretive" in its responses to public concerns.[8]

Figure 1. Map of Rocky Mountain Arsenal, Denver vicinity, 1986



SOURCE: Environmental Science and Engineering, Inc., *Report on Accelerated Cleanup Plan for the Contamination at RMA.* Draft Final Report (Commerce City, Colo.: Rocky Mountain Arsenal, Program Manager's Office, June 1986).

Recognizing that it had to address a potentially serious contamination problem, the army began construction of a deep injection well in 1961, intended for the permanent disposal of the arsenal's chemical wastes. More than 150 million gallons of liquid waste were injected to a depth of 12,045 feet, but this disposal method was suspended in 1966 because of "growing suspicion that the injection operations had caused an unusual series of earthquakes centered in the RMA area."[9] More than 20 years later, the well was permanently sealed.

After closure of the deep injection well, the army returned to the earlier disposal method of surface impoundment. This continued until the mid-1970s, when the army and the Colorado Department of Health detected several carcinogenic contaminants in ground- and surface water outside the arsenal's boundaries.[10] This prompted the state health department in 1975 to

ROCKY MOUNTAIN ARSENAL TIMELINE

1942: Rocky Mountain Arsenal established to produce chemical and incendiary weapons
1946: Pesticide and industrial chemicals production by private companies begins at arsenal
1950: Construction of nerve gas production facility (North Plants) begun
1951: Agricultural crop damage discovered on farms adjacent to arsenal
Army responds by constructing on-post impoundments, including Basin F
1953: Manufacturing of nerve gas GB (Sarin) begun at arsenal
1957: Contamination discovered in residential drinking water wells adjacent to arsenal, resulting in U.S. Public Health Service study
1970: Arsenal weapons production facility placed on standby status
1974: Carcinogens (DIMP and DCPD) discovered in off-post ground- and surface waters
1975: Colorado Department of Health issues three Administrative Orders
1981: New off-post groundwater contamination detected
1982: Army announces study of 14 alternative cleanup options
Memorandum of Agreement between Army, state of Colorado, Environmental Protection Agency, and Shell
1983: Army sues Shell for $1.8 billion in natural resource damages and cleanup costs
State of Colorado sues Army and Shell for natural resource damages under CERCLA
Shell sues its insurers
1984: Arsenal weapons disposal operations closed
Army announces selection of cleanup option
1985: District Court consolidates 1983 Army-Shell and Colorado-Army and rules that Army and Shell are liable
1986: Colorado sues Army under RCRA to gain control over Basin F cleanup
Eagles discovered at arsenal
1987: Army nominates Basin F as Superfund site; Department of Justice moves for dismissal of state RCRA case
1988: Shell loses suit against its insurers
Army and Shell file consent decree
Romer and Brown convene arsenal open space forum
1989: Army/Department of Justice motion to dismiss state's RCRA case denied
Army sues Colorado again, claiming state lacks authority over federal facilities
Army and Shell sign Settlement Agreement allocating costs
Federal Facilities Agreement signed by Army, Shell, EPA, Department of Interior, Department of Justice, and U.S. Agency for Toxic Substances and Disease Registry
National Wildlife Federation suggests Congress designate arsenal a National Wildlife Refuge
1991: Rep. Schroeder introduces bill (H.R. 1435) and holds hearings on refuge proposal
District Court rules against state of Colorado's authority over arsenal cleanup; Colorado appeals
1992: Rocky Mountain Arsenal National Wildlife Refuge Act passes
1993: Circuit court reverses district court, ruling in favor of state authority over arsenal cleanup; Army appeals
Modified 1988 Army-Shell consent decree entered by court
1994: Supreme Court upholds state of Colorado's cleanup oversight authority
Army and Colorado sign consent decree settling state's 1986 RCRA suit
Army sues Colorado over state's DIMP standard
1995: Army, EPA, and Colorado agree to "Conceptual Remedy" (Schoettler Agreement)
1996: Record of Decision published
FWS unveils wildlife refuge plan

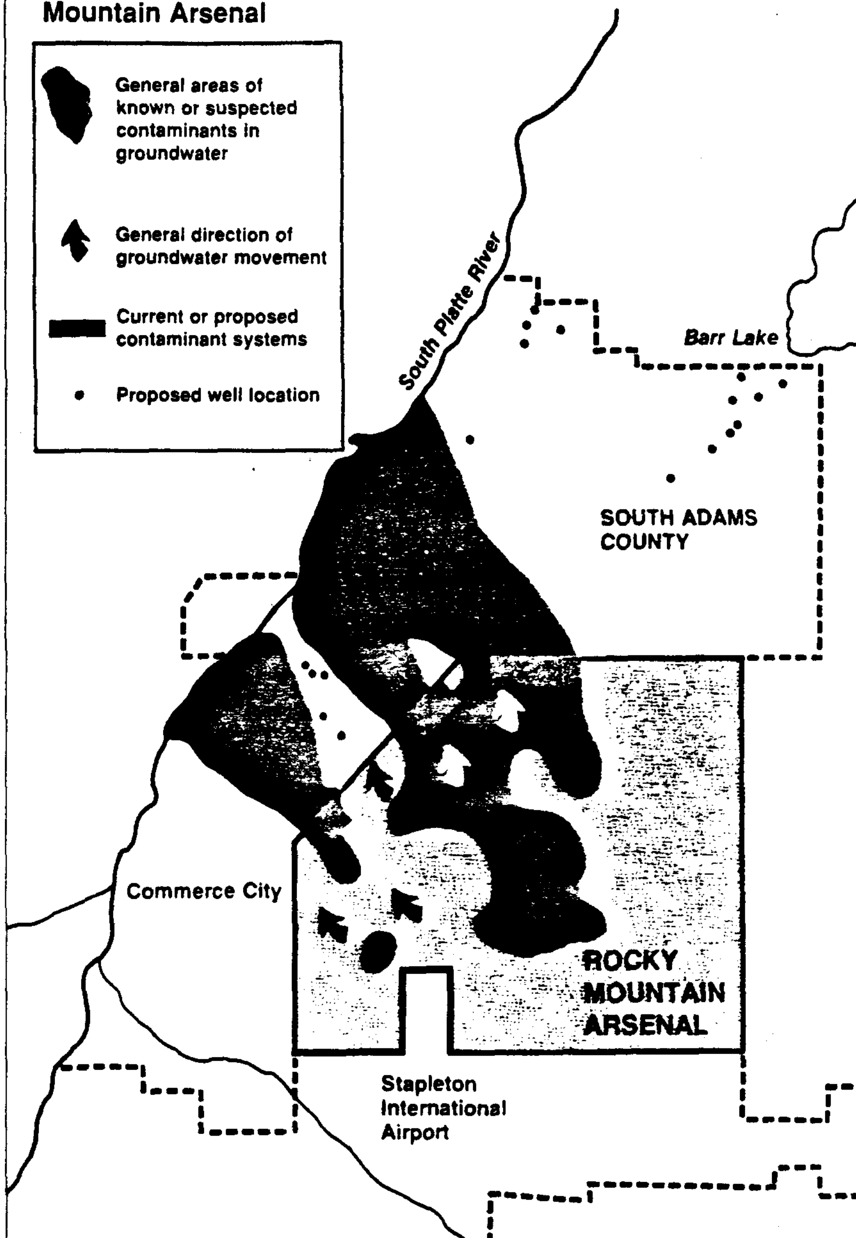
issue administrative orders for the army and Shell Chemical to stop discharging diisopropylmethylphosphonate (DIMP) and dicyclopentadiene (DCPD) into both groundwater and surface waters of the arsenal, clean up the pollution sources, and monitor water quality.[11] As a result of the state's administrative orders, army officials for the first time publicly discussed cleaning up the arsenal. The army's precise intent regarding cleanup was unclear, however. According to local newspaper reports at the time, two arsenal officials declared that the army would decontaminate the entire arsenal by 1991 at a cost of $300 million.[12] A different army official subsequently stated that there had been no intent to clean up the entire arsenal, despite the local news reports to the contrary.[13]

The army's actual response was to pursue a pollution containment strategy rather than a total or partial on-post cleanup program. Between 1975 and 1980, the army constructed and operated a groundwater purification system along the boundaries of the arsenal where the state health department had detected off-post contamination.[14] Unfortunately, in 1981 the army's pollution containment strategy proved to be insufficient; new groundwater contamination was detected west of the arsenal in heretofore uncontaminated water wells in Commerce City. Thus, confronted with evidence that its on-post containment strategy was inadequate, the army reported in July 1982—seven years after initiating its containment strategy—that it was examining a series of 14 alternative cleanup options. Meanwhile, the pollution containment strategy would continue and the arsenal boundary groundwater purification systems would continue to operate indefinitely.[15]

Six months later, the army announced cost estimates that ran as high as $6 billion, with implementation timeframes from 1995 to 2010. The public was stunned. Some observers speculated that the army was angling to abandon all cleanup efforts by projecting a price tag so high that Congress would refuse funding.[16] However, on the same day the army announced that arsenal cleanup could cost as much as $6 billion, it also signed a Memorandum of Agreement with the state health department, EPA, and Shell Chemical.[17] The agreement detailed cooperative procedures for monitoring and remedying the arsenal's pollution problems. It committed the army to continue its evaluation of various remediation strategies.

The following year the army released a new analysis comparing four arsenal decontamination scenarios.[18] The four options ranged in cost from $210 million to $1.86 billion, each with different assumptions about how much contaminated material was to be removed and whether permanent disposal of that material was to be on- or off-post.[19] In late 1984, the army announced its selection of a cleanup option costing $357 million with a target completion date of 2000.[20] This option entailed the consolidation of all contaminated materials in a permanent on-post disposal site.

Figure 2. On- and off-post contamination from the Rocky Mountain Arsenal



SOURCE: HRS Water Consultants. Inc., for South Adams County Water and Sanitation District. (February 1985).

Rising Conflict

Three important developments during the 1980s dramatically affected the arsenal's future and the respective influence of the many parties involved. First, there was an escalation in two legal conflicts, one between Shell Chemical and the army over who should pay for cleanup, and the other between the state of Colorado and the federal government over who should have the final say regarding the extent of cleanup. Second, two major construction projects were proposed by local authorities, one for a new commercial airport east of the arsenal and the other for a new tollroad around the eastern side of metropolitan Denver. The third significant development was the surprising appearance of dozens of bald eagles within the arsenal's boundary.

The Litigation Escalation

As the army continued to refine and evaluate remediation options while pursuing its pollution containment strategy, signatories to the Memorandum of Agreement were pursuing divergent goals. By 1983, it was becoming increasingly evident that the parties involved had conflicting interests. The army investigated decontamination options but continued to implement only its containment strategy. Shell Chemical was potentially responsible for at least some remediation costs but was naturally concerned about the impact of these costs on its bottom line and therefore sought to minimize them. The Colorado Department of Health, on the other hand, was demanding a comprehensive decontamination program for the arsenal, irrespective of cost. The arsenal's neighbors—both residents and local governments—shared the state's objections to mere containment as a long-term answer. EPA was responsible for enforcing federal antipollution laws but appeared reluctant to exercise its enforcement authority over the

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Upon completion of more than 31 environmental cleanup projects, the Rocky Mountain Arsenal will be transformed into the country's largest urban wildlife refuge.

army. The U.S. Department of Justice sought to protect the federal government's supremacy and its purse strings by controlling whether and to what extent federal laws applied to federal facilities such as the arsenal. Both EPA and the Justice Department ultimately aligned themselves with the army regarding jurisdiction. These conflicting interests resulted in several lawsuits regarding questions of authority and responsibility for decisions about cost and extent of cleanup: by the army against Shell Chemical, by Shell Chemical against its insurers, by Colorado against the army and Shell Chemical, and by the army against Colorado.[21]

The Army, Shell Chemical, and the Insurers. Considering that the estimated cleanup costs could potentially run into the billions, the army claimed that Shell Chemical should pay part of the tab, while Shell argued that the cleanup responsibility belonged solely to its landlord, the army. When the army sued Shell Chemical's parent company, Shell Oil, for $1.8 billion in 1983,[22] Shell attempted to shift financial liability to its insurers and filed suit against them. The resulting jury trial began in October 1987 and required moving the courtroom to a remodeled auditorium to accommodate representatives of all the parties to the lawsuit, including approximately 250 insurance companies. In late 1988, the jury decided against Shell, which announced shortly thereafter its intention to write off $120 million in after-tax income because of the verdict.[23] Shell's incentives to reach an accord with the army were altered by this outcome, but there was still no settlement in sight.

The State versus Shell Chemical and the Army. Both Shell and the army were on the defensive concerning the state's claims for compensation for damage to its natural resources. Colorado asserted that both the army and Shell Chemical should pay substantial monetary penalties for the contamination of groundwater flowing from under the arsenal. Further, Colorado claimed that the federal government and Shell should pay for the state's enforcement, administrative, and legal costs arising from pollution crossing the arsenal boundary. The first skirmish had occurred in 1975 when the Colorado Department of Health issued three administrative orders against the army and Shell for violations of the Colorado Water Quality Control Act after two hazardous chemicals had been detected in groundwater samples taken north of the arsenal.[24] After simmering for a decade, the dispute turned into open warfare in the mid-1980s. By late 1983, it appeared that any further pollution abatement beyond containment would have to await the outcome of lengthy litigation between the state of Colorado, the U.S. government, and Shell Chemical. Colorado filed suit in that year against the army and Shell for natural resource damage under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund).[25] Two years later, the state added a claim for reimbursement of CERCLA response expenditures.[26]

Colorado versus the United States. Colorado sought not only compensation for past damage done to the state's natural assets but also control over future cleanup standards and methods at the arsenal. To that end, the state initiated another major offensive in 1986 by suing the army under the state's Resource Conservation and Recovery Act (RCRA) delegated program, the Colorado Hazardous Waste Management Act (CHWMA). The state charged that the army had violated groundwater monitoring regulations at Basin F, the only major pollution site on the arsenal still not on Superfund's National Priorities List (NPL) by that time.[27] The army countered in late 1987 by nominating Basin F for addition to the NPL and the Department of Justice filed a motion to dismiss the state's case on the grounds that Superfund sites were not subject to state jurisdiction under RCRA. In early 1989 the court denied the motion to dismiss the state's complaint.[28]

As the end of the 1980s drew near, all major players were involved in legal actions against one another. The state of Colorado, Shell Chemical, and the federal government were locked in a knot of litigation that showed little prospect of loosening.

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Weapons—such as this napalm bomb assembled at Rocky Mountain Arsenal in August 1951—were produced during an effort to provide munitions for the Korean War.

Regional Development Proposals

Into this mix was added the complication of two local land-use proposals that could potentially affect arsenal cleanup decisions. One was a private sector proposal to construct a new highway around the east side of metropolitan Denver. Known as E-470, the proposed tollroad was intended to relieve traffic congestion on the interstate highways that intersect in the heart of metropolitan Denver and to help complete a regional beltway that had only been partly constructed in the 1970s. The second, more significant proposal was the city of Denver's plan to construct and operate a new international airport east of the arsenal.[29] Either of these proposed projects could be expected to spawn substantial new commercial, residential, and industrial development around the arsenal, thereby bringing new participants into an already crowded dispute about the facility's future.

The proposed new airport was especially relevant to the arsenal controversy because the city announced that its preferred site would actually incorporate a narrow strip of land along the arsenal's eastern edge. The sheer size of the proposed new airport and its projected aviation and commercial activity promised to dramatically change land-use patterns in the entire northeastern quadrant of metropolitan Denver, most notably in the area immediately adjacent to the arsenal.

At the time the new airport and E-470 beltway were first publicly proposed, development in the northeast-

(continued on page 28)

Weapons to Wildlife
(continued from page 11)

ern metropolitan area had largely been confined to the Interstate 70 highway corridor. Development in this region had been greatly restricted by the presence of the arsenal and Denver's Stapleton International Airport, whose combined 35-square-mile area had been a major obstacle to urban expansion in the northeastern metropolitan area. In fact, as of the mid-1980s nearly all of the land to the north and east of the arsenal was unirrigated farmland, with a mix of industrial and residential development abutting the western and southern borders.

While both the new airport and the new highway project would inevitably stimulate new development around the arsenal, it was the proposed new airport that most dramatically fired the imaginations of real estate investors, developers, and local government planners. It should be no surprise that the sponsors and supporters of each of these proposed projects were concerned about the plans and prospects for the arsenal's cleanup and future use. What before then had only been a topic of interest to state and federal government officials became a focus of attention for regional transportation planners, real estate developers, and local, state, and national politicians.

The two immediate concerns were whether the city of Denver would be able to utilize an eastern strip of the arsenal for the new airport and whether Commerce City would be able to obtain access across the arsenal to the proposed airport and the E-470 beltway. For years, Denver officials openly contemplated expansion of the city's Stapleton Airport onto arsenal property. However, on-post contamination in that area and concerns about possible legal and financial liability for cleanup finally convinced Denver officials that airport expansion onto most parts of the arsenal land should be avoided. Consequently, airport planners opted


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The Rocky Mountain Arsenal now provides habitat for more than 300 species of wildlife, including this mule deer fawn.

for a new airport site that would require only a small fraction of the arsenal's land area on the least polluted eastern boundary. Nevertheless, a new airport, no matter where located, would attract significant development in the vicinity of the arsenal.

Commerce City's growth and economic development had been limited for decades by the presence of the arsenal immediately east of the city. However, the prospect of both a new international airport and a regional beltway caused Commerce City officials and businesses to view the arsenal as a new frontier for economic development, both in terms of new employment and in terms of an expanded municipal tax base. Officials envisioned annexing all or parts of the arsenal to Commerce City for new airport-related industrial and commercial development. This was predicated, of course, on sufficient cleanup for such land uses. Commerce City officials envisioned the construction of (and development along) new surface transportation corridors across the arsenal to the proposed airport and regional beltway.[30]

These regional development proposals prompted new questions about off-post contamination and the army's cleanup plans in general. In the areas to the east or south of the arsenal where there had not yet been any evidence of surface or groundwater pollution, investors envisioned airport- and beltway-related development in the years ahead. Landowners with properties neighboring or near the arsenal also had begun to receive inquiries from real estate investors, causing the owners to ask whether the military and/or industrial activities on the arsenal might have depressed their property values. Thus, there were now several new parties interested in resolving the arsenal problem in addition to the state, federal agencies, and Shell Chemical.

Arrival of the Bald Eagles

The outcome of this case was overwhelmingly influenced by the intervention of sheer luck. In the proverbial words of Niccolo Machiavelli, "It is probably true that Fortune is the arbiter of half the things we do, leaving the other half or so to be controlled by ourselves."[31]

By 1986, the positions of the litigants and other players in the arsenal drama had hardened to the point that it seemed there might never be a resolution. This changed, however, with the introduction of a new, complicating factor in the early winter of 1986: Approximately two dozen bald eagles were observed in the southeast quadrant of the arsenal, appearing to have established a winter roost among a stand of tall cottonwood trees.[32] Any unexpected appearance of an endangered species might have unsettled some stakeholders' preconceived notions about the fate of the arsenal but the bald eagle is not just any endangered species. It is the national symbol and the longest-standing entry on the list of endangered species, protected under an Act of Congress first passed in 1940.[33]

As an endangered species, the eagles introduced yet another regulatory participant and a new layer of rules to the arsenal dispute. Under federal law, the U.S. Fish and Wildlife Service (FWS) had jurisdiction to take virtually any action it deemed necessary to protect the eagles. Consequently, FWS could conceivably prohibit any arsenal cleanup or require more extensive remediation; it could even prevent the construction of the new airport and/or the beltway anywhere near the eagles' winter roost. However, before making any such determinations, FWS required additional information about the eagles and their behavior on and around the arsenal. This meant that until FWS could sufficiently characterize the eagles' use of the arsenal and surrounding territory (e.g., as prey base and roost area), any activity that might disturb the raptors' activities was effectively prohibited.

Because of the eagles, the arsenal disputants were compelled to reevaluate their positions concerning future area land use, and this in turn forced reexamination of their preferences concerning both the extent and methods of cleanup. Prior to the eagles' arrival, land-use preferences differed among parties depending on what each had to gain or lose. The Colorado Department of Health had adopted the position that the arsenal should be clean enough to support relatively unlimited human use, perhaps even residential use. This dictated that the army and Shell Chemical should undertake—and pay for—a comprehensive cleanup of contamination both on- and off-post. In contrast, the army and Shell had come to support a selective remediation policy that included on-site pollution containment and treatment. This assumed continued restrictions on public access to and use of arsenal property. Neighboring local governments such as Commerce City and Adams County envisioned revenue-generating commercial, industrial, and residential land uses that would integrate most if not all of the arsenal into a regional development plan fueled by the new airport and beltway. Denver's posture was consistent with that of these other local jurisdictions. It based its plans on the assumption that any future arsenal land use would be compatible with the airport.[34]

The Refuge Proposal

The arrival of the eagles came as a shock to all of the parties in the arsenal conflict, whose unyielding positions heretofore had largely resulted in a policy stalemate concerning the facility's future. The eagles also galvanized the attention of previously uninvolved parties. The result of the shakeup was a novel proposal for future use of the arsenal. At least as early as 1988, FWS quietly raised the idea of dedicating the

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The chemical manufacturing disposal basin known as Basin F is shown full of hazardous liquid waste in 1984 (top photograph), during the interim soil cleanup stage in 1989 (middle), and during the final stage of draining the asphalt-lined pond in 1993 (bottom).

Annually, 30,000 people visit the wildlife refuge, which now provides hiking trails and bald eagle lookout stations.

arsenal land for use as a short-grass prairie wildlife preserve.[35] At first, the idea struck most as naive and fundamentally impractical: How could such a polluted expanse become a safe haven for deer, antelope, hawks, eagles, ducks, prairie dogs, and the like? In fact, however, the arsenal was already an unintended wildlife preserve, which supported an abundant wildlife population in large measure because of its decades of isolation.[36] Gradually the wildlife preserve idea began to attract serious consideration. Not only did it evolve into a real possibility in technical terms, it also offered an escape from the gridlock over both future land use and the level of environmental cleanup.

In early 1988, Colorado Governor Roy Romer and U.S. Senator Hank Brown publicly proposed that the arsenal be converted to an "open space park," and Romer convened a workshop of land-use experts to discuss options. By the end of 1988, the army and FWS had signed an agreement to protect the eagles' winter roost on the arsenal. In March 1989, the army agreed to grant FWS management responsibility for arsenal wildlife until 1993. Six months later, FWS opened a bald eagle viewing site on the east side of the arsenal.

In addition, environmental groups had launched an energetic public information campaign in support of converting the arsenal into an urban wildlife refuge. Newspaper stories on the natural attractions of the arsenal began appearing regularly. Glossy calendars and a book of photographs featuring arsenal wildlife were published.[37] In 1989, officials of the National Wildlife Federation (NWF), a private environmental group, urged Denver's congresswoman, Patricia Schroeder, to introduce an amendment to a Department of Defense spending bill to designate the arsenal a national wildlife refuge.[38] Although Schroeder's amendment would have mandated the use of the arsenal as wildlife habitat, it would also have required a speedier and less ambitious cleanup (only to the level required for open space uses). Largely due to the opposition of other Colorado leaders, including the governor and one of the state's senators, the amendment failed to pass the House that session; however, this prompted new negotiations among the arsenal stakeholders.[39]

Adams County and Commerce City objected to the refuge plan.[40] Commerce City officials had long envisioned using some portion of the arsenal for local economic development purposes, but the refuge proposal threatened that prospect. Consequently, they suggested that Commerce City obtain some portion of uncontaminated arsenal land for economic development in the future. In early 1992, the federal government agreed in principle to sell approximately 800 acres along the western boundary of the arsenal. (See Figure 3 on page 31.) The proceeds from the sale would be used by FWS to finance construction of a Refuge Visitor Center.[41] The Visitor Center was eventually constructed near the west entrance of the arsenal property.

Once Commerce City's concerns had been addressed, the way was cleared for congressional action in support of the refuge concept. In 1991, Rep. Schroeder joined forces with other members of the Colorado congressional delegation to advance her bill (H.R. 1435) to designate the arsenal a national wildlife refuge, transfer ownership and management to the U.S. Department of the Interior, and leave cleanup responsibility in the hands of the army. In October 1992, Congress enacted the law creating the Rocky Mountain Arsenal National Wildlife Refuge.[42]

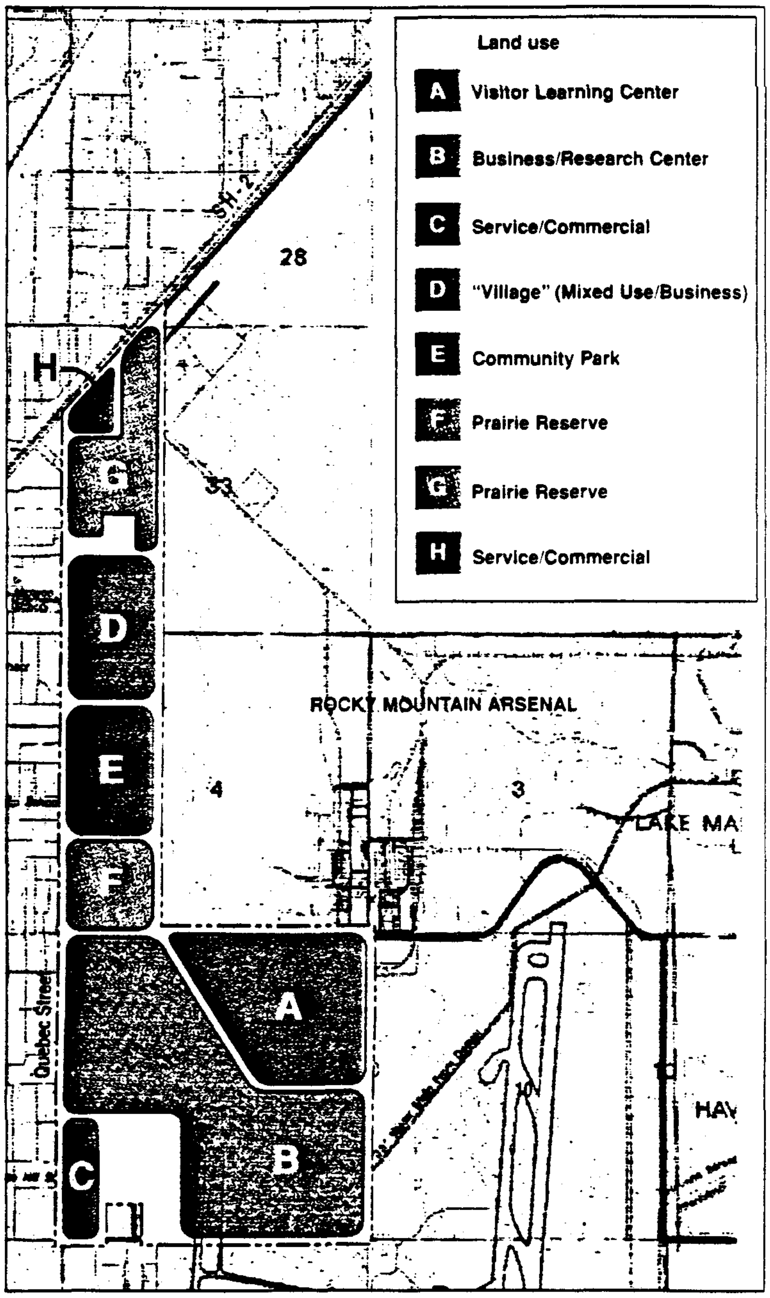
The "Conceptual Remedy"

The legislative foundation for the transformation of the arsenal into a national wildlife refuge was a notable achievement. The passage of the Rocky Mountain Arsenal National Wildlife Refuge Act, however, did not eliminate the dispute about whether the state of Colorado or the federal government would have jurisdiction over cleanup standards and methods.

Irrespective of the refuge law, the army was proceeding with its own cleanup plans, most notably to incinerate liquid wastes then impounded in the arsenal's notorious Basin F and to use another surface impoundment—Basin A—as the site of a permanent on-site hazardous waste disposal facility.[43] The state of Colorado objected to both the Basin F and Basin A plans, but its objections went unheeded until the Tenth Federal Circuit Court of Appeals ruled in favor of state authority over arsenal cleanup. The army and the Department of Justice agreed to let the state monitor Basin F waste incineration—the first instance of cooperation with the state—but the army proceeded with plans to use Basin A as a disposal site. Consequently, the state objected to the Basin A plans and was joined this time by EPA, which ordered an overhaul of the Basin A plans as well. In the meantime, the army proceeded with an appeal to the U.S. Supreme Court, which in January 1994 upheld the Tenth Circuit's decision to grant cleanup oversight authority to the state. This prompted the army and the state to sign a consent decree in June 1994, which finally settled the state's 1986 Resource Conservation and Recovery Act suit.[44]

During the following year, under the watchful prodding of the Colorado governor's office, the army, EPA, and the state hammered out an agreement specifying that henceforth wastes would be placed in a landfill rather than incinerated. This agreement, signed in June 1995, was known as the "Conceptual Remedy."[45] A year later, representatives of all the stakeholder groups, including environmentalists and grassroots activists, had been persuaded to support the agreement.

Figure 3. Parcelization and land use of the western border of Rocky Mountain Arsenal (Commerce City)



SOURCE: Rocky Mountain Arsenal, *Surplus Property Master Plan* (Commerce City, Colo., 1995).

Although this did not entirely end the conflict between the state and the federal government, it did resolve most of the major intergovernmental disputes.[46]

The Conceptual Remedy evolved quickly into the final Record of Decision, the ultimate plan for all subsequent cleanup efforts. The Record of Decision detailed a $2.2 billion cleanup program, most of which was to be completed by the year 2012.[47] Among the tasks to be accomplished were continued containment, treatment, and monitoring of groundwater plumes; demolition of contaminated structures, monitoring and treatment of contaminated debris, and their disposal in an on-post, state-of-the-art hazardous waste landfill; excavation and treatment of contaminated soil and disposal in the on-post landfill; extension of municipal water lines to replace contaminated well water for affected Adams County residents; establishment of a medical monitoring program for evaluating and remedying off-post human health effects; creation of a trust fund to ensure long-term support of cleanup activities; and restrictions on land and water use (i.e., prohibitions on agriculture, the use of on-post groundwater for drinking, and consumption of fish and game taken from the arsenal) as well as limitations on public access to capped and covered areas.[48] Because much of the contaminated material will be stored on-post and must be monitored for an indefinite period of time, there is no true end-point for the cleanup. Rather, the Record of Decision stipulates reviews every five years to ensure the continued safety of the arsenal and its neighbors. Shortly after the official signing of the Conceptual Remedy and Record of Decision, FWS unveiled a comprehensive, $65 million wildlife refuge plan.[49]

Some critics complained that the state government had capitulated on some of its cleanup demands—most notably on the issue of on-post waste burial, which the state had previously protested vehemently.[50] There continued to be occasional complaints about the escalation of costs, lax army financial oversight, and inadequacies of cleanup procedures and standards, but the number and frequency of news stories regarding arsenal cleanup declined substantially after the announcement of the Conceptual Remedy. In 1996, there were only 10 arsenal stories in the two major Denver newspapers and in 1997 there were only 8, compared with more than 100 annually at the height of the controversy in 1988 and 1989. Most of the recent stories have been short announcements of remediation contract awards, payments of fines to the state, and upcoming wildlife viewing events.

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The bald eagle's status as an endangered species gave the U.S. Fish and Wildlife Service jurisdiction to take virtually any action it deemed necessary to protect the bird.

Lessons

More than a decade ago, the authors of this piece published an article in *Environment* speculating that the appearance of bald eagles and the empowerment of the state to compel the federal government to comply with federal environmental laws might substantially affect the pace and extent of cleanup of the Rocky Mountain Arsenal.[51] Recent history, in fact, has demonstrated that these were the two central determinants in delimiting both the final cleanup and the future use of the arsenal.

In retrospect, the arrival of the bald eagles proved to be critical to breaking the stalemate over the scale and scope of the arsenal cleanup. As explained above, the eagles' arrival dealt an entirely new and unexpected legal and institutional card into the controversy. The eagles brought the Endangered Species Act and the U.S. Fish and Wildlife Service into the jurisdictional dispute between the Colorado Department of Health, on the one hand, and the U.S. Army and EPA, on the other. The insertion of an endangered species into the federal-versus-state cleanup dispute tipped the balance of power in favor of the army because the Endangered Species Act prohibits any disturbance of an area used by listed wildlife. Purely by accident, this coincided with the army's express interest in limiting the geographic scope of the cleanup. The federal government thus gained a strategic advantage in the jurisdictional dispute with the state.

The question of ultimate jurisdiction over the *level* of cleanup, however, remained unsettled pending the outcome of Colorado's RCRA lawsuit against the army. In 1991, the state's strategic position relative to the army was further weakened as a result of the district court's decision in favor of the federal government. The state would not win its legal appeal concerning cleanup jurisdiction for another two years. In the interim, the refuge proposal began to look quite attractive to all the stakeholders and gained sufficient momentum to become law in 1992.

The federal circuit court, however, found in favor of the state's claim for jurisdiction under RCRA in 1993, and in 1994 the U.S. Supreme Court declined to alter that decision. This confirmed the state as an equal partner with the army and its sister agencies in designing and overseeing arsenal restoration. Thus, the combined impact of the bald eagles and the court decisions was to transform the relationship between the state and the federal government from that of deadlocked adversaries to coequal partners with respect to cleanup and any future use of the arsenal. Once the wildlife refuge framework had been established by Congress, these partners were able to refocus their energies on achieving a common goal that dictated limitations on future use of the entire arsenal and, consequently, the geographic scope as well as the level of cleanup.

The two critical variables that forced resolution were fortune and federalism. The fortuitous appearance of the eagles brought the Endangered Species Act's requirements into play. The court's decision in favor of the state rested on fundamental principles of federalism. These two elements combined—the eagles and the court decision—clarified the respective roles and powers of the partners. Finally, the refuge idea—another fortuitous consequence of the eagles' appearance—defined the goal for the partners in terms of future land use. Were it not for this congressionally mandated end-use of the arsenal, it is probable that the federal and state agencies would still be embroiled in litigation over the scope, level, and purpose of cleaning up this facility.

The history of the cleanup and ongoing transformation of the Rocky Mountain Arsenal offers three important lessons that may prove useful to public deliberations about the conversion of other government installations, including military facilities cited for future base closure or realignment as well as several Department of Energy compounds.[52]

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Two dozen bald eagles made the southeast quadrant of the Rocky Mountain Arsenal their winter roost site.

First, the arsenal is only one U.S. military installation that over time became an accidental shelter for wildlife near intensely developed areas. In fact, the Nature Conservancy reports that "many Defense installations are located along coastlines, in agricultural regions, or near urban areas. As a result, they often harbor the last or largest remnants of imperiled habitats."[53] Thus federal agencies in the future may confront the challenge of managing conflicting environmental objectives similar to those evident in the case of the Rocky Mountain Arsenal (i.e., the nature and extent of contamination cleanup, protection of habitat, and the expectations and desires of each facility's neighbors).

Second, the arsenal experience underlines the importance of collaborating with—as opposed to alienating—local land-use, planning, and state government agencies with respect to the development and implementation of federal facility cleanup, conversion, and reuse programs. Federal facilities, contaminated or not, are nestled among local and state government entities that are responsive to the concerns of private property owners, businesses, parents, and others. The army's arsenal cleanup and contamination efforts might have proceeded with less litigation and confrontation had the federal government been more responsive to local sensitivities following the discovery of on- and off-post contamination. This is not to suggest that the army and other federal agencies should have bowed to every state and local demand concerning the arsenal. However, the constitutional principle of federalism and existing case law generally empower state and municipal authorities to challenge in court any action of the national government that may adversely affect local interests—even if such challenges cause delays and rising costs to all taxpayers. Thus, the unwanted consequences of inadequate responsiveness to local concerns may include lengthy and costly litigation, the adoption of inflexible and uncompromising positions by all concerned, and extended delays in accomplishing anything beyond technical assessment, cost-benefit analyses, and feasibility studies.

Third, the arsenal experience demonstrates the influence of chance or accident on human affairs. In the case of the arsenal, the appearance of bald

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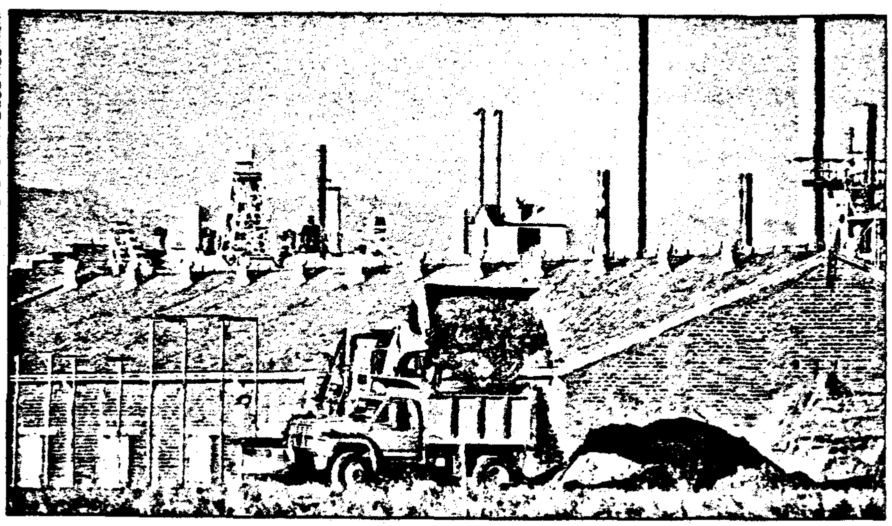

Rocky Mountain Arsenal's South Plant underwent extensive cleanup in 1994.

eagles abruptly and unalterably undermined the state government's entrenched position concerning cleanup. The superimposition of yet another layer of legal and regulatory constraints—embodied in the Endangered Species Act and the jurisdiction of the U.S. Fish and Wildlife Service—dramatically altered the character and direction of the dispute about the arsenal's future and challenged both federal and state authorities to revisit their intractable positions. The unexpected entry of an endangered species in the midst of the arsenal controversy helped break the stalemate over the scope, direction, and pace of the arsenal cleanup.

In summary, the cleanup and conversion of the Rocky Mountain Arsenal to nonmilitary, nonsecurity purposes has involved issues and concerns that are very likely to arise in relation to other government installations that have outlived their original missions. Efforts to remediate and transform these places inevitably will prompt jurisdictional and other disputes. The arsenal experience demonstrates that national defense installations that are or may be scheduled for closure or conversion may have unanticipated values that citizens wish to preserve; that national and local government authorities can facilitate the timely conversion of such installations by collaboration instead of confrontation; and that citizens and government officials should be receptive to any new opportunity to creatively integrate government facilities into the fabric of the surrounding land.

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30. H. Kite, testimony before Congress, *Rocky Mountain Arsenal National Wildlife Refuge Act of 1991*, Joint Hearing before the Fisheries and Wildlife Conservation and the Environment Subcommittee of the Committee on Merchant Marine and Fisheries and the Military Installations and Facilities Subcommittee of the Committee on Armed Services, U.S. House of Representatives, 102nd Congress, 1st session, 9 September 1991, 61–66.

31. N. Macchiavelli, *The Prince*, trans. by George Bull (Baltimore, Md.: Penguin Books, 1961), 130.

32. M. McGrath, "Wild Kingdom," *Westword*, 5–11 February 1992, 12.

33. *The Bald and Golden Eagle Protection Act*, *U.S. Code*, vol. 16, sec. 668a.

34. Relocation or expansion of Denver's commercial airport had been contemplated since the early 1970s. Regional aviation planners and Denver city officials often had suggested expansion onto Rocky Mountain Arsenal, which was located immediately north of Stapleton International Airport. In the mid-1980s, however, Denver officials abandoned the notion of expansion of the old Stapleton Airport onto the arsenal in favor of constructing an entirely new commercial airport. Rhodes, note 29 above.

35. McGrath, note 32 above.

36. Many other military installations around the country have found themselves in a similar position. This suggests that the arsenal experience may have lessons for these other unintended refuges. See, for instance, L. Friedman and K. Wiley, note 3 above.

37. See, for example, W. Shattil, B. Rozinski, and C. Madson, *When Nature Heals: The Greening of Rocky Mountain Arsenal* (Boulder, Colo.: Roberts Rinehart, Inc., 1990).

38. K. Cheroutes, former district office manager for Rep. Schroeder, personal communication with the authors, Denver, Colo., 4 September 1997; and McGrath, note 32 above, page 12.

39. J. Lowy, "Schroeder Plan for Arsenal Dumped," *Rocky Mountain News*, 2 November 1989, 10; R. Kowalski, "Schroeder's 'Fast' Arsenal Cleanup Loses: More Extensive Effort Urged by Wirth, Romer," *Denver Post*, 2 November 1989, 1B, 3B; T. Wirth, "Colorado Shouldn't Compromise on Arsenal Cleanup," *Rocky Mountain News*, 17 November 1989, 65; "Schroeder's Gambit Succeeds," *Denver Post*, 3 November 1989, 6B.

40. *Rocky Mountain Arsenal National Wildlife Refuge Act of 1991*, Joint Hearing before the Fisheries and Wildlife Conservation and the Environment Subcommittee of the Committee on Merchant Marine and Fisheries and the Military Installations and Facilities Subcommittee of the Committee on Armed Services, U.S. House of Representatives, 102nd Congress, 1st session (9 September 1991), 61–62.

41. A federal law authorizing the sale of 815 acres of arsenal land to Commerce City was finally signed by the president on 18 November 1997. The sale price had not yet been established, but Commerce City noted that the entire parcel would be annexed and some portion of it subsequently sold to private developers. M. Romano, "Commerce City to Get 815 Arsenal Acres," *Rocky Mountain News*, 19 November 1997, 32A–33A.

42. *Rocky Mountain Arsenal National Wildlife Refuge Act of 1992*, P.L. 102-4-2, 9 October 1992.

43. Amid all the public controversy and litigation, the army, Shell Chemical, and their contractors had managed to accomplish a substantial number of cleanup tasks by June 1996. The 1996 *Record of Decision* (Foster Wheeler) enumerated 14 Interim Response Actions that had been completed by the army and Shell, including six groundwater interception and treatment systems, cleanup of Basin F and nine other contamination sources, closure of abandoned wells and sewers, fugitive dust control, asbestos removal, and treatment of CERCLA hazardous wastes. By July 1995, the incineration of 10.9 million gallons of Basin F wastes had been completed and the incinerator deactivated. See M. Obmascik, "Toxic-Waste Incineration Completed Early at Arsenal," *Denver Post*, 7 July 1995, 4B. For years, Basin F had been used as a retention pond for contaminated liquid discharges from both military and commercial activities on the arsenal. Basin F was the primary source of off-post groundwater contamination that was discovered as early as the 1950s. Basin A, upgradient from Basin F, was also used as an open surface disposal impoundment for waste discharges from years of chemical warfare agent and pesticide production in the arsenal's South Plants complex. See Wiley and Rhodes, note 13 above.

44. 114 S. Ct. 922 (1994); Foster Wheeler Environmental Corporation, note 5 above, page 14.

45. F. Brown, "Big Step in Arsenal Wildlife Plan: Major Players Agree on 'Conceptual Remedy'," *Denver Post*, 14 June 1995, 1B, 3B; D. Luzadder, "Arsenal Cleanup Plan Unveiled," *Rocky Mountain News*, 14 June 1995, 4A; J. B. Verrengia and T. Fong, "Arsenal Cleanup Plan Calls for Burying Toxic Leftovers," *Rocky Mountain News*, 25 May 1995, 19A; Foster Wheeler Environmental Corporation, note 5 above, page 2-14; and "Agreement for a Conceptual Remedy for the Cleanup of the Rocky Mountain Arsenal," published on the internet at: <http://pmrma-www.army.mil/htdocs/backgrd/remdey.html>.

46. One of the still unresolved issues concerned DIMP (see note 24 above). In March 1994, the army had initiated a new suit against the state objecting to what it believed was an excessively high standard for DIMP. Obmascik and Chronis, note 24 above, page 1B.

47. Foster Wheeler Environmental Corporation, note 5 above, table 9.6-1; and B. Morson, "Romer Praises Environmental Laws," *Rocky Mountain News*, 12 June 1996, 36A.

48. Foster Wheeler Environmental Corporation, note 5 above, pages D-5 through D-9.

49. G. Gerhardt, "$65 Million Arsenal Refuge Plan Unveliled," *Rocky Mountain News*, 18 June 1996, 5A.

50. A. Knight, "Some of Our Big Problems Neither Die nor Fade Away," *Denver Post*, 18 June 1995, 1E.

51. Wiley and Rhodes, note 13 above, page 19, wrote that "a possible hitch in cleanup efforts [at the arsenal] developed in November 1986. Twenty bald eagles took up residence on arsenal grounds. As an endangered species, bald eagles are supposed to be protected from disturbance. If the eagles decide to make the arsenal their permanent roost, it may prove tricky for the arsenal cleanup project." Wiley and Rhodes also wrote, page 32: "The arsenal experience demonstrates the importance of the federal environmental legislation of the last decade—and particularly the value of empowering the states to act against the federal government itself to enforce these laws." See also K. B. Wiley and S. L. Rhodes, "State Environmental Regulation of Federal Facilities (SERFF): Colorado's Recent Experience," in F. A. Meyer Jr. and R. Baker, eds., *State Policy Problems* (Chicago: Nelson-Hall Publishers, 1993), 191–206.

52. See T. E. Ricks, "Cohen, in an Attempt to Close More Bases, Is Likely to Step Up Pressure on Congress," *Wall Street Journal*, 2 April 1998, B17; and General Accounting Office, *Military Bases: Lessons Learned from Prior Base Closure Rounds*, GAO/NSID–97–151 (Washington, D.C., 25 July 1997).

53. See Friedman and Wiley, note 3 above, page 6.

SPARLING INSTRUMENTS CO., INC.

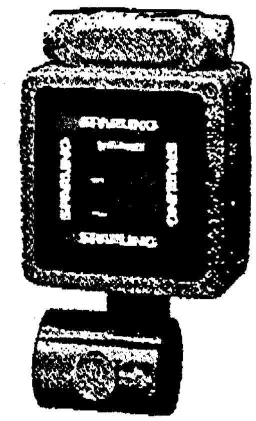
INSTRUCTION DATA SHEET

SERIES 600 METERS AND ACCESSORIES

FM621 WATERHAWK PULSED DC MAGNETIC FLOWMETER FLANGELESS AND FLANGED VERSIONS

IDS-621
Issue Date: August 1992
Supersedes: March 1992

TABLE OF CONTENTS **PAGE**



FIGURES **PAGE**

TABLES

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ISO 9001 Registered

MEMBER MCAA Measurement Control & Automation Association

SECTION 1 - GENERAL

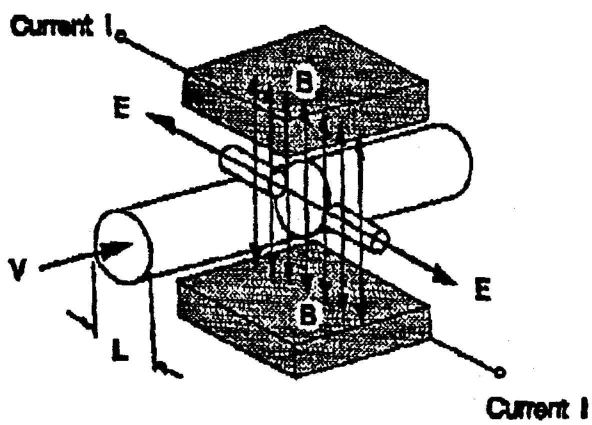
1.1 Measuring System

The Sparling WATERHAWK Model FM621 flowmeter is an obstructionless device for monitoring the volumetric flow of water-based and conductive liquids in full closed pipes. Temperature and pressure limitations are the meter's specification limits.

The FM621 consists of a cast ductile iron sensor lined with polyurethane. A measuring transmitter is integrally mounted to the sensor to form a compact unit. It may be remote mounted if vibration or temperature conditions dictate.

1.2 Operating Principle

Operation is based on Faraday's Law of Magnetic Induction. An electrically conductive liquid flowing through a magnetic field induces a voltage which is perpendicular to this field and to the direction of the flow. This voltage is proportional to the average flow velocity. See figure 1.1.



Measuring Principle
Figure 1.1

The mathematical formula describing Faraday's law reads:

$E = B \times L \times V$

- E = Induced voltage
- B = Magnetic field intensity (flux density)
- L = *Distance between the electrodes (pipe diameter)*
- V = Average flow velocity *of liquid*

1.3 Application to Magnetic Flow Measurement

In a magnetic flowmeter the liquid acts as a moving conductor as it flows through the pipe. The induced voltage in the liquid is measured by two sensing electrodes mounted opposite each other in the meter sensing head.

The length of the conductor is equal to the distance between sensing electrodes and also the internal diameter of the pipe. The flux density is proportional to the coil current, I times a constant, k. The above formula can be restated as follows:

$E = I \times k \times D \times V$

$V = \frac{\text{flow}}{\text{cross sectional area}} = \frac{Q}{A}$

This device can be used to meter clean or dirty water.

$= \frac{}{D2}$

Note that if I is held constant, E is proportional to Q. *The induced voltage is directly proportional to the average flow rate.*

1.4 Interference

1.4.1 Electrochemical Interference

The signal voltage is measured by two electrodes. Galvanic elements form on the surface areas between the ion-conducting liquid and the metal electrodes. The polarization voltages which result are dependent on temperature, pressure, and the chemical composition of the electrodes and liquid. They are direct voltages which cannot be predicted and which can be different at each electrode. The signal voltage must be separated from the interference direct voltage.

1.4.2 Induction Interference (Quadrature)

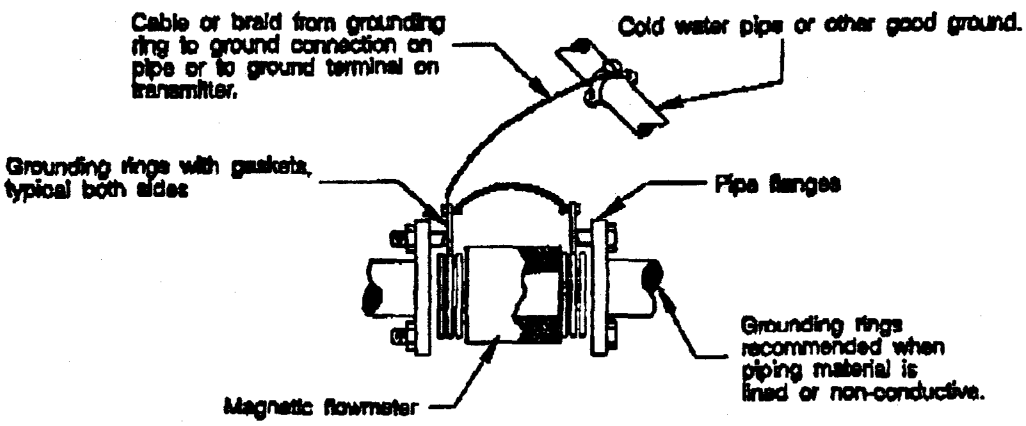
Electrode cables connect the electrodes with the meter electronics. Because these cables must run within the magnetic field, a voltage is induced which is proportional to the rate of change of the magnetic field strength. The meter design minimizes the length of conductor within the magnetic field in order to keep the value of this interference as low as possible.

1.4.3 Grounding

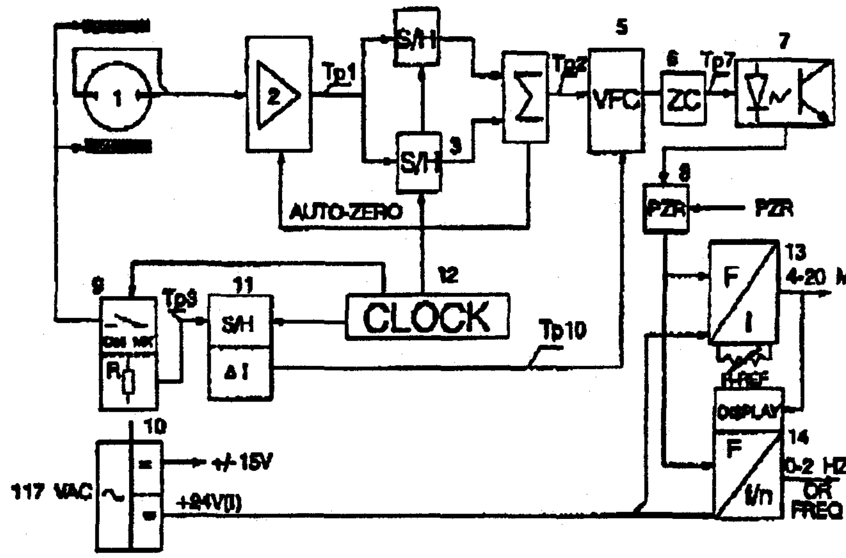
Magnetic flowmeters measure small voltages in order to calculate flow. These are generated by the conductive liquid flowing through the magnetic field within the flow tube. Therefore, grounding on both sides of the meter is essential to remove stray voltages or currents and ensure satisfactory operation. See Section 3.6 for more detail.

1.4.4 Other Interference Voltages

Pipes and the liquids within them are often used as conductors for electrical grounding. This creates a voltage potential between electrodes which can be high relative to the signal voltage. Proper grounding of the flowmeter to the liquid is necessary to achieve correct meter operation. In metallic pipes, all necessary grounding of the FM621 is accomplished by built-in grounding electrodes. In non-conductive piping, grounding rings may be required. See Figure 1.2.



Grounding Rings
Figure 1.2



1. Measuring Sensor
2. Input Amplifier
3. Sample-&-Hold
4. Summation Point
5. Voltage-to-Frequency Converter
6. Zero Cutoff
7. Input/Output Isolator (Optocoupler)
8. Positive Zero Return
9. Coil Current Multiplexer
10. Power Supply Section
11. Coil Correction Signal
12. System Clock Generator
13. Frequency/Current Converter
14. Pulse/Frequency/Display Output PCB (Option)

Block Diagram
Figure 1.3

1.5 Construction

1.5.1 Sensor

The FM621 WATERHAWK is manufactured in a wafer-style configuration. It is a flangeless cast ductile iron housing lined with polyurethane with an integral measuring transmitter.

Two stainless steel sensing electrodes are installed in the polyurethane liner. Two grounding electrodes are installed in each of the sizes 1" and 2" meters. One grounding electrode is installed in each of the sizes 3", 4", 6" and 8" meters.

All internal cavities in the sensor housing are filled with the same polyurethane that forms the sensor liner. This prevents collection of moisture.

When properly connected with customer-installed, liquid-tight conduit and an optional factory-installed junction box, the flow sensor will withstand accidental submergence. Standard configuration of the sensor is NEMA-4X.

1.5.2 Transmitter

The transmitter is housed in a die-cast aluminum, corrosion resistant, NEMA-4X instrument enclosure. The electrical connections are made in a conduit housing attached to and separate from the transmitter electronics.

1.6 Specifications

Power Requirements: - See nameplate for correct rating.

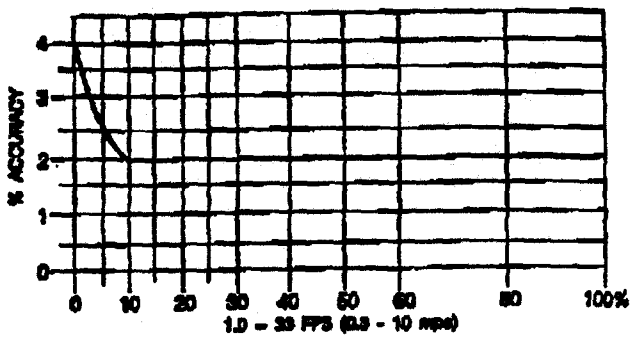
		Fuse
100 Vac ± 10%	50/60 Hz ±10%,	0.5 amp
117 Vac ± 10%	50/60 Hz ±10%,	0.5 amp
230 Vac ± 10%	50/60 Hz ±10%,	.25 amp
24 Vdc ± 10%		2.0 amp

Fuse:
5 x 20 BUSS

Wire Size:
Power: 16 AWG 14 AWG Max
Signal: 18 AWG

Ground Cable: Third wire ground of power cable.

Standard Accuracy:
± 2% of rate with flow velocity above 1 fps (0.3 mps)*
± .02 fps below 1 fps regardless of full scale.
*Accuracy statement based on digital outputs



Typical Accuracy Curve
Figure 1.4

Reference Conditions:
25° C, at 1,3 and 10 fps full scale.
Temperature effect, 0.025% Full Scale/°C
Voltage effect, 0.3% Rate/10% Fluctuation

Repeatability: within ± 0.2% FS

Power Consumption: Less than 25 VA (12W if 24 Vdc).

Output Signals: Simultaneous Isolated Analog and Digital
Analog: 4-20 mA dc into 800 ohms max.
Digital: Scaled pulse or Frequency

a. Scaled pulse. 24 Vdc square wave, 25 ms pulse width, 0-10 Hz max. into 150 ohm impedance minimum.
b. Unscaled frequency. 15 volts pulse train, approximately 50 ms on time. Frequency rate 0 to $\frac{KxQ}{60}$ Hz max into 1000 ohms (See section 5.2).

Input Signal: Positive zero return (PZR). Connect to remote contact to drive output to zero when an empty pipe condition can occur.

Minimum Conductivity: 20 micromho/cm

Full Scale Velocity Ranges: 0-3 to 0-33 fps (0 - 1 to 0 - 10 mps)

Ambient Temp. Limits: -20° to 120°F (-30° to 49°C). (Display may darken above 125°F (50°C))

Liquid Temperature Limits: 180°F (80°C)

Temperatures above 158°F (70°C) require mounting the electronics separately (max. distance 15 feet at liquid conductivity of 20 micromho and min. velocity of 1 fps).

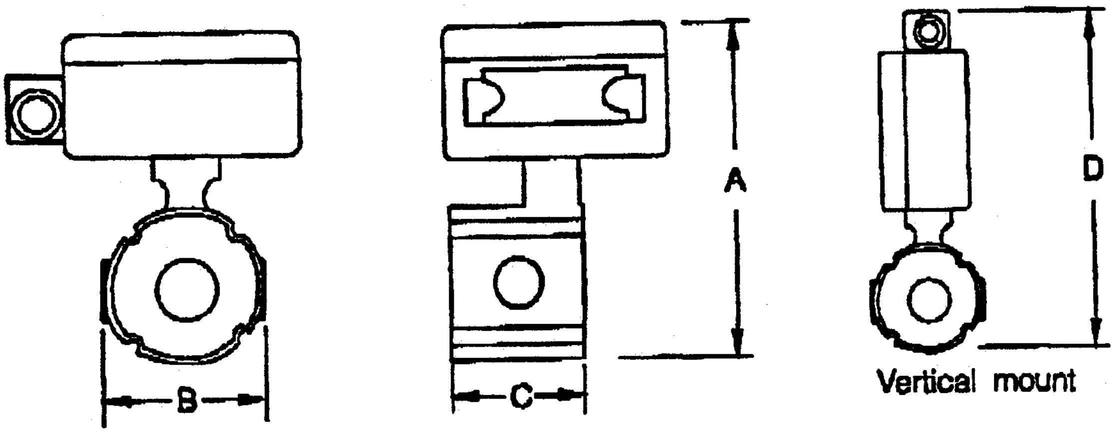
Storage Temperature Limits: -20° to 140°F (-30° to 60°C)

CONSTRUCTION

Metering Tube (Flangeless)	Cast ductile iron (1-8")
Lining	Polyurethane
Electrodes	316 SS, Others optional
Housing.	Die-Cast Aluminum Hi-build Epoxy Coated
Protection rating	NEMA-4X Hose-down proof
Electrical rating	General Purpose

1.7 Interchangeability

The FM621 transmitter is designed to be used with any FM621 sensor. Electronics are completely interchangeable and flow ranges adjustable with a potentiometer. A DVM is required to change span (see section 5.2). Contact the factory. Horizontally mounted transmitter housings are not interchangeable with vertical or remote mount units. Only like transmitter housings are interchangeable.



1" - 8" Flangeless

Meter Dimensions
Figure 1.5

FLOW AND DIMENSIONAL DATA

METER SIZE (in.)		GALLONS PER MINUTE*			DIMENSIONS IN INCHES/MM							
NOM	ACT	±2% above	Min. full scale	Max. full scale	A		B		C		D (Vertical Mount)	
		1 FPS	3 FPS	33 FPS	in	mm	in	mm	in	mm	in	mm
1	0.812	1.6	4.8	53	7.69	195	2.92	74	4.06	103	12.09	307
2	1.690	7	21	231	9.25	235	4.25	108	4.06	103	13.65	347
3	2.900	20	60	660	10.58	269	5.40	137	6.06	154	15.28	388
4	3.800	35	105	1155	12.22	310	6.60	168	6.06	154	16.62	422
6	6.000	88	264	2910	14.60	371	9.00	229	8.00	203	19.12	486
8	7.750	147	441	4850	16.65	423	10.70	272	8.00	203	21.37	543

Figure 1.6

*GPM calculated at actual I.D.

1.8 Application Considerations

The WATERHAWK can be used to accurately measure the volumetric flow rate of liquids having a minimum conductivity of 20 micromho/cm.

The presence of entrained air or gases in the process liquid will not prevent meter operation, but will produce a positive (+) error equal to the % by volume gas entrainment.

It is recommended that the WATERHAWK not be utilized for liquids containing more than trace amounts of acids or caustics or liquids containing high percentages of abrasive materials. If the liquid to be measured falls into the above categories, contact Sparling's application engineers for clarification. Use of this device outside its specification range could damage the meter and void the warranty.

Full scale flow rates should be selected above 3 feet per second (1 meter per second) for best accuracy. Full scale flow rates below 0-3 feet per second may degrade meter accuracy (consult factory). Verify proper velocities from the nomogram in figure 1.7.

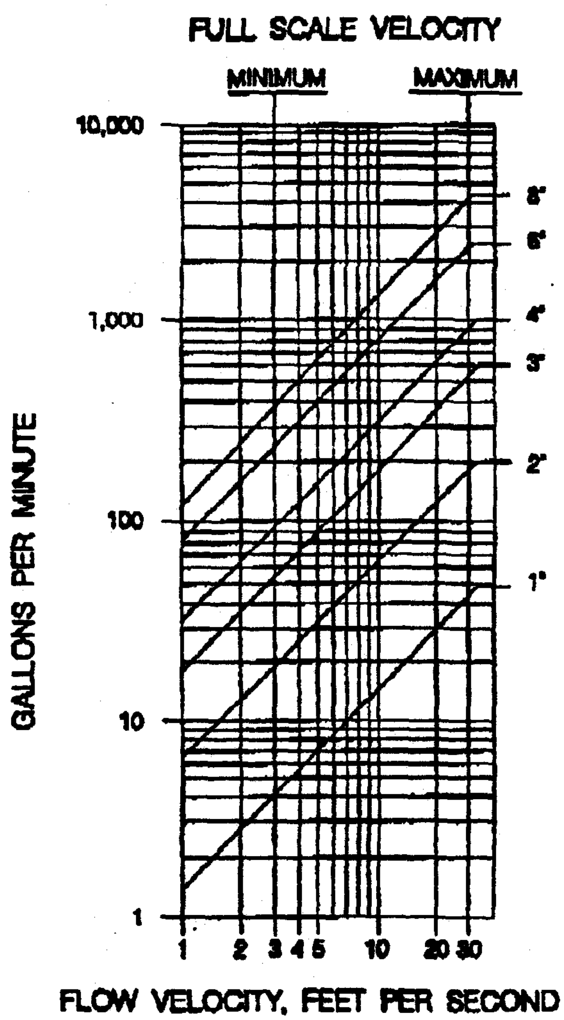


Figure 1.7

SECTION II - PRE-INSTALLATION

2.1 Receiving and Inspection

When the equipment is received, the outside of the package should be inspected for damage. If any damage or shortage is found, notation to that effect should be made on the carrier's delivery receipt.

Visually inspect the sensor and transmitter for damage from rough handling or faulty packaging. If concealed damage is discovered, notify the delivering carrier at once and request an inspection. Confirm telephone conversations in writing. If inspection is not made, prepare an affidavit stating that you notified the transportation company and that they failed to inspect. Save containers and packaging material.

It is essential that the carrier be notified within 15 days from the date of delivery in order to be in a position to present your claim. Make your claim promptly.

Unpacking and handling of FM621 magnetic flowmeters should be consistent with the procedures used to handle field instruments.

2.2 Storage

This equipment should be stored in a clean, dry environment. Do not store outside in an unprotected area. Observe the storage temperature requirements. Unpowered storage should not exceed 2 years.

2.3 Return of Equipment

Obtain an RGA (Returned Goods Authorization) number from the factory prior to returning any materials. The RGA number should be marked on the outside of the package. Failure to obtain authorization will unnecessarily delay any work to be performed at the factory.

SECTION III - INSTALLATION

3.1 Site Selection

Select a pipe location which will always be full of liquid. The equipment should be located where the sensor will be accessible for adjustment. Provide a minimum of 18" clearance to the electronics enclosure.

The meter may be located in any position from vertical to horizontal. Flow may be in either direction through the meter. Vertical installation with the liquid flowing upwards, minimizes the possibility of slurry separation and assures a full pipe condition (see Fig. 3.1a).

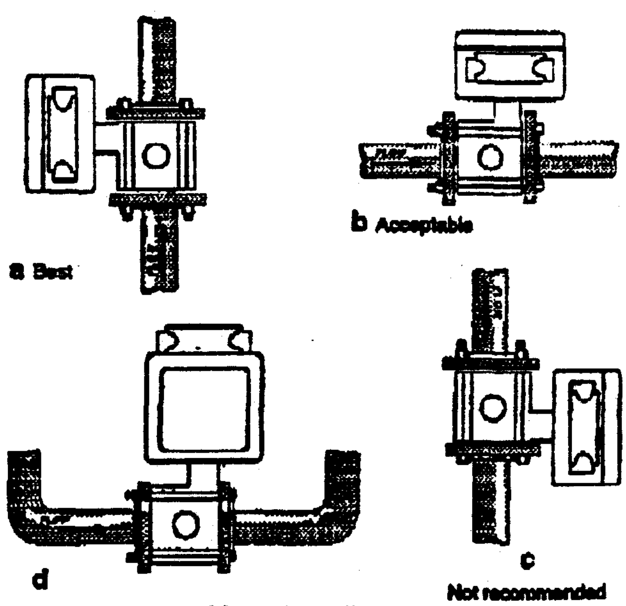
Horizontal installation requires that the sensing electrodes be positioned in the horizontal plane and grounding electrodes be positioned at the bottom of the meter (see Fig. 3.1b).

The 621 sensor housing should be installed with the arrow pointing to the right or upwards. This indicates direction of flow. It is considered poor practice to mount meter with flow in a downward direction, as this may impair meter accuracy (see Fig. 3.1c).

If the flow should be in the opposite direction from the arrow, reverse the coil plug. POWER TO THE UNIT MUST BE DISCONNECTED (see Fig. 5.1).

If your Waterhawk is equipped with flow rate indicator or totalizer, re-orient the display board to suit the desired viewing direction (See paragraph 3.3).

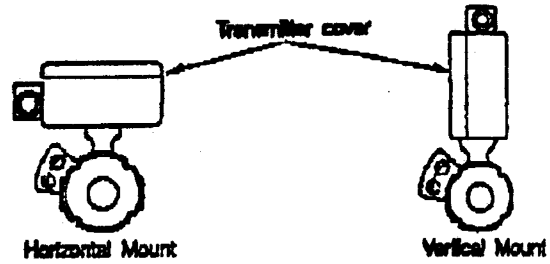
Provide at least three pipe diameters of straight piping approach between an upstream elbow and the midpoint of the meter. More straight approach should be provided after valves or multiple elbows. Provide at least 10 diameters after expanders or laterals which are smaller diameter than the line size (See Figure 3.1d).



Meter Installation
Figure 3.1

3.2 Transmitter Housing

The transmitter has been mounted either horizontally, with the cover facing up, or vertically with the cover facing outboard (optional). It is recommended that you do not attempt to remove or disturb the transmitter housing. It could invalidate the electrical rating of the enclosure and create a moisture problem and operational failure of the unit.



Transmitter Housing
Figure 3.2

3.3 Remounting the Transmitter Display

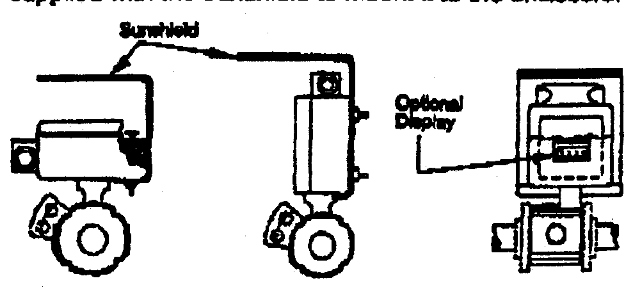
The optional transmitter display can be rotated inside the enclosure in any of four positions for optimum readability. POWER MUST BE OFF. To re-mount the display, remove the enclosure cover. Simply pull up gently on the corners of the display board to disengage from the plastic retainers. (Fig. 4.1a). Do not remove screws. Rotate the board 90°, 180°, or 270° to the desired position. (Be careful not to crimp or dislodge the wiring. Do not touch any components on the PCB.) Press down on the four corners to re-seat the PCB on the retainers and replace the enclosure cover. Be sure cover is seated to ensure proper seal.

3.4 Sunshield

The sunshield is an optional accessory designed to provide better readability of the optional flow rate/totalizer displays during periods of bright sunlight. It also protects the electronics from heat build-up due to direct exposure to sunlight.

3.4.1 Sunshield Installation

The sunshield is attached with four bolts and nuts for vertically mounted transmitters or with two bolts and nuts for horizontally mounted transmitters. Remove the cover of the electronics enclosure (4 screws) and expose the large mounting holes in the enclosure. Use the hardware supplied with the sunshield to mount it to the enclosure.



Sunshield Installation
Figure 3.3

3.5 Pipe Connections

The sensor is installed between two process pipe flanges. The sensor contains a polyurethane liner. The integrity of this liner must be maintained for the flowmeter to function. ***CARE SHOULD BE TAKEN DURING INSTALLATION TO INSURE THAT THIS LINER IS NOT DAMAGED.*** Depending upon meter size, a number of bolts will be required to mount the FM621 between existing flanges, (ANSI, AWWA, DIN, JIS, BS or AS).

Mounting hardware and gaskets are not supplied with the FM621 unless ordered as an option. It is, however, necessary that gaskets be used to mount this device regardless of flange type (raised or flat-face). Most commonly used gaskets materials are acceptable. See tables below for flange and bolt specifications.

Table 3.1 Flange and Bolt Specifications - ANSI and AWWA (Gaskets and bolts supplied by others)

Flange Size (inches)	Pressure Rating	O.D. Inch	Bolt Circle	Hole Dia	Bolt Size	Torque Limits (ft-lbs)
1	150	4-1/4	3-1/8	4 @ 5/8	7/16-14 x 6-3/4	17
1	300	4-7/8	3-1/2	4 @ 3/4	5/8-11 x 7-1/2	17
1	600	4-7/8	3-1/2	4 @ 3/4	5/8-11 x 7-1/2	17
2	150	6	4-3/4	4 @ 3/4	5/8-11 x 7-1/2	17
2	300	6-1/2	5	8 @ 3/4	5/8-11 x 7-1/2	17
2	600	6-1/2	5	8 @ 3/4	5/8-11 x 7-1/2	17
3	150	7-1/2	6	4 @ 3/4	5/8-11 x 9-1/2	24
3	300	8-1/4	6-5/8	8 @ 7/8	3/4-10 x 10-1/2	24
4	150	9	7-1/2	8 @ 3/4	5/8-11 x 9-1/2	30
4	300	10	7-7/8	8 @ 7/8	3/4-10 x 10-1/2	30
6	150	9-1/2	9-1/2	8 @ 7/8	5/8-11 x 9-1/2	30
6	300	10-5/8	10-5/8	12 @ 7/8	3/4-10 x 10-1/2	30
8	150	11-3/4	11-3/4	8 @ 7/8	3/4-10 x 10-1/2	30
8	300	13	13	12 @ 1	7/8-12 x 12	45

Table 3.2 DIN Flange and Bolt Specifications

Flange Size (mm)	Pressure Rating	O.D. mm	Bolt Circle	Number Of Holes	Hole Dia	Bolt Size	Torque Limits (kg-m)
25	10 Bar	115	85	4	14	M12	2.4
25	16 BAR	115	85	4	14	M12	2.4
50	10 BAR	165	125	4	18	M16	2.4
50	16 BAR	165	125	4	18	M16	2.4
80	10 BAR	200	160	8	18	M16	3.4
80	16 BAR	200	160	8	18	M16	3.4
100	10 BAR	220	180	8	18	M16	4.2
100	16 BAR	220	180	8	18	M16	4.2
150	10 BAR	285	240	8	22	M20	4.2
150	16 BAR	285	240	8	22	M20	4.2
200	10 BAR	340	295	8	22	M20	4.2
200	16 BAR	340	295	12	22	M20	6.3

3.6 Grounding

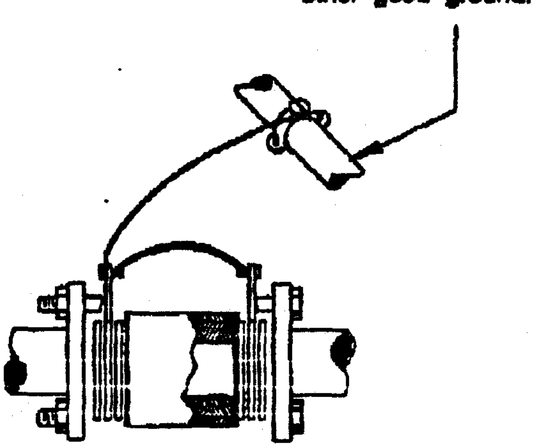
The WATERHAWK has built-in grounding electrodes. The grounding electrodes are in continuous contact with the process liquid providing a direct means for grounding electrical noise in the liquid and eliminating the need for grounding rings or straps in most cases. The grounding electrodes are connected to the meter housing and to the AC power electrical ground. The transmitter electronics operates on dc power and is isolated and floating electrically. The signal outputs therefore are isolated from process liquid and AC ground electrical noise.

Grounding electrodes ensure excellent performance of the meter in liquids such as water, water-based sludges and slurries, and other highly conductive liquids in conductive pipes such as carbon steel, stainless steel, ductile iron, etc. This makes it unnecessary to drill and tap the adjacent pipe flanges and connect them electrically to the meter ground.

In cases where a non-conductive pipe, or pipe lined with a non-conductive lining (such as bitumastic, glass, etc.) or a very low conductivity liquid is present, grounding rings should be used to supplement the existing grounding electrodes.

Grounding rings are shaped like orifice plates. Copper braid or cable can be connected to them and then to ground. They should be made from material that is compatible with the process liquid, and can be obtained from Sparling if required.

Grounding rings should be installed with four gaskets — one each between the grounding ring and the meter and between the grounding ring and the pipe flange. They should be concentric with both the pipe and the flowmeter and then connected with 12 AWG braid or wire to each other and to the ground terminal on the sensor or to a good external ground (see Fig. 3.4).



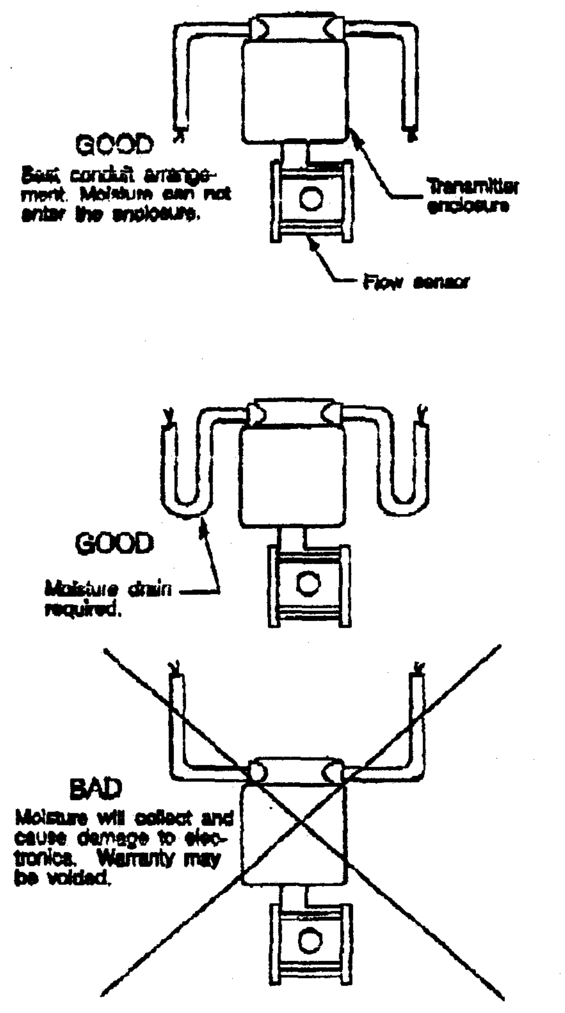
Grounding
Figure 3.4

Grounding rings are also considered essential when there is an electrical potential in the liquid — such as, but not limited to, cathodic protection.

The electrical noise potential in the process liquid is at a similar level to the electrical ground plane to which the AC supply ground is connected. This grounding method stabilizes the electrical field within the sensor measuring section permitting accurate flow detection. Contact our technical support group if process liquid is maintained at a potential to ground or if an unstable flow signal occurs.

3.7 Electrical Connections

Unscrew the small blind cover of the conduit enclosure to gain access to the I / O PCB. Separate conduit entrances are provided for power and signal wiring. Conduit entrances are 3/4" NPT. Conduit connections should follow good practice and should be routed from below the meter. If conduit cannot be routed from below, provide moisture traps to prevent moisture from entering the meter enclosure. See Figures 3.5, 3.6 and 3.8.



Conduit Connections
Figure 3.5

A connection diagram is located in the conduit connection section (figure 3.6a). Determine which of the outputs (4-20 mA, pulse or frequency) are to be used. Connect the required outputs to TB 201 as shown in figure 3.6b.

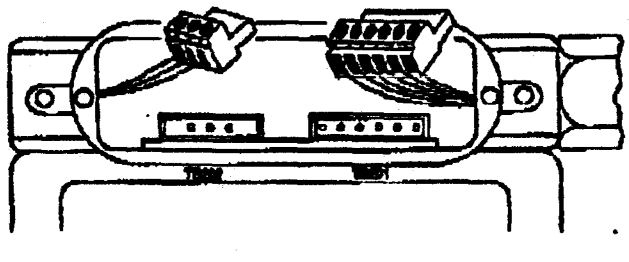
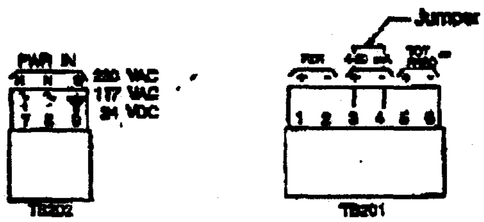


Figure 3.6



I/O Board Connections
Figure 3.6b

On TB 202 connect power wires to the power input (terminals 7 & 8). Be sure to connect the ground wire to terminal 9. If required, connect the Positive Zero Return (PZR) input. Note that meter output is forced to zero when terminals 1 and 2 are jumpered and connected to external contacts (PZR. When the meter is equipped with a flow rate indicator you will note a jumper across terminals 3 & 4. If the 4-20 mA output is to be connected to a load – remove this jumper. If the jumper remains in position, there will be no remote 4-20 mA output.

The external load on the outputs must be within the limits specified. Calculate the external load by summing the input resistance, including all interconnecting cable. Signal cable of 18-22 gauge is normally adequate.

External load limits:

Analog output:	800 ohms max impedance
Pulse output:	150 ohms min impedance
Frequency output:	1000 ohms min impedance

Both outputs are floating and use the same isolated ground. If both outputs are used simultaneously, only one of the common legs can be grounded. If both are grounded, a ground loop will occur causing erroneous signals.

> **CAUTION**
> ONLY ONE LOAD MAY HAVE A LEG STRAPPED TO GROUND UNLESS THE LOADS ARE ISOLATED FROM EACH OTHER.

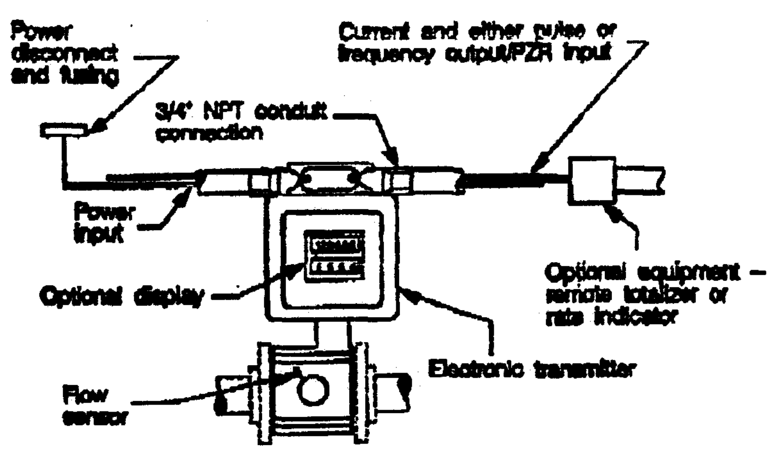
3.8 Remote Mounted Transmitter (vertical mount only)

Remote mounting of the electronics is required when process temperatures exceed 158°F (70°C), when pipe vibration is excessive when ease of readability is required or when flooding is possible. Remote mounting should be used when high process temperatures exist at high ambient temperatures.

A bracket for wall or pipe mounting is furnished as part of the optional remote mounting kit. Interconnecting cable is supplied between the sensor and transmitter enclosure. The cable is pre-wired to the transmitter. Also supplied is a sensor mounted NEMA-4X rated junction box in which coil and electrode connections are made.

The standard interconnecting cable length is 15 feet. Shorter or longer cables should be ordered from the factory. ***Do not attempt to change the cable length in the field.***

> **CAUTION**
> DO NOT MAKE CONNECTIONS WHILE POWER IS APPLIED. DISCONNECT POWER BEFORE PROCEEDING.



Integrally Mounted Transmitter
Figure 3.6c

Connect terminals 1 through 7 with the special cable provided. See figure 3.7. Installation in metal conduit is recommended for RFI protection as well as physical protection.

Prior to installing any wiring, install liquid-tight conduit and fittings between transmitter and the sensor. A drip leg in the conduit installation is recommended.

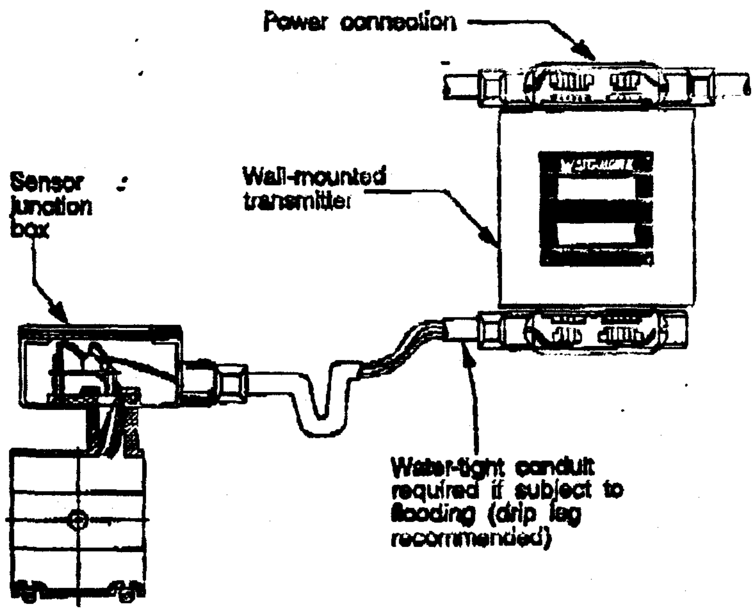
Mount the transmitter housing to a pipe by removing the transmitter cover and attaching the electronics housing to the flat sheet metal bracket and pipe brackets using the hardware supplied. You may mount the unit directly to a wall without using the flat sheet metal bracket. See Figure 3.8.

The transmitter may be fitted with rate indicator and/or totalizer. Use caution when removing the cover and working near the indicator displays.

When the housing is securely mounted, remove the covers from the two 3/4" NPT connection boxes. Note the gasket positions. Two fifteen foot cables are furnished with the remote kit. One of these cables has five wires and the other has three.

With the cable pulled through the conduit, dress the ends and connect the five-wire cable (electrode cable) to terminal board TB201 in the lower connection box. Also connect the three-wire cable (coil cable) to TB202. OBSERVE THE COLOR CODE. See Figure 3.8a.

Remove the cover from the sensor-mounted junction box. (Figure 3.8b). Insure that the gasket is replaced in the same position for positive seal. Connect the five-wire cable and the three-wire cable as shown in Figure 3.8c. OBSERVE THE COLOR CODE. (See Figure 3.8d). Be certain to connect the green ground wire to the ground location on the remote PCB.



Remote Mount Transmitter (option)
Figure 3.7

CAUTION:

The FM621 flow sensor, when fitted by the factory with a sensor junction box, is suitable for accidental submergence in 30 feet of water for 48 hours. The transmitter is not suitable for submergence.

If the sensor is subject to flooding, installation of water-tight conduit is required and is the responsibility of the user. Special gasketing is supplied when accidental submergence-proof is ordered as an option.

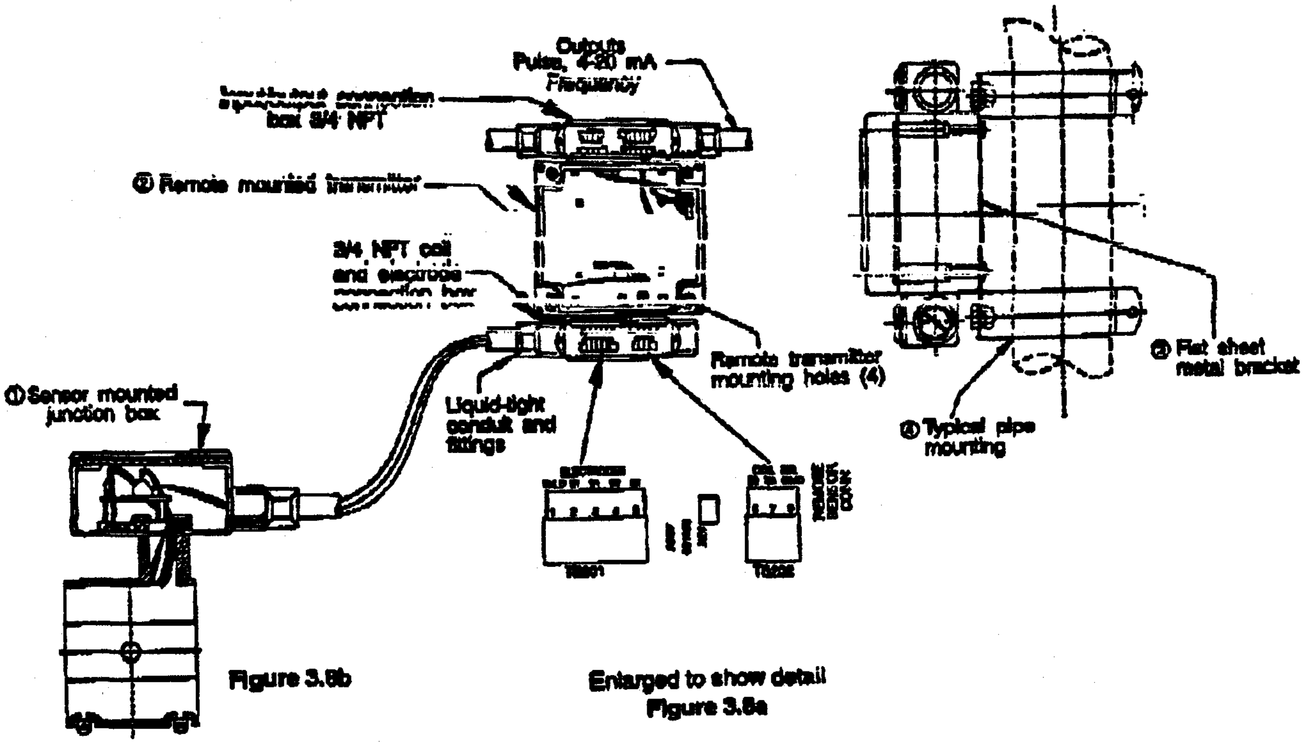
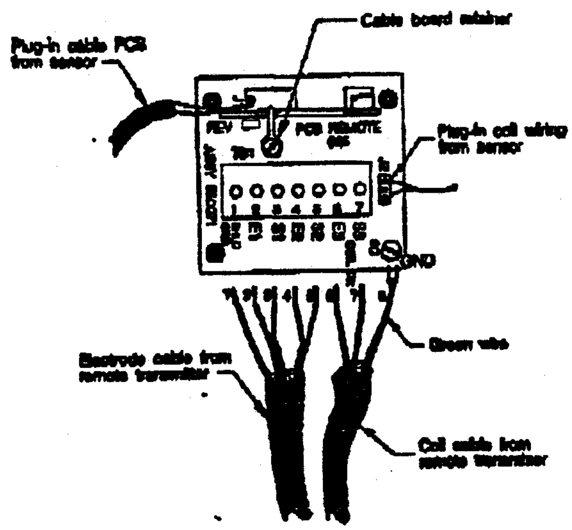


Figure 3.8b

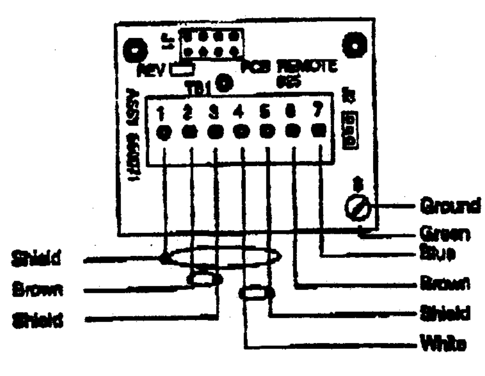
Enlarged to show detail
Figure 3.8a

Remote mount configuration includes:
① Sensor-mounted junction box with PCB
② Remote mount transmitter
③ Sheet metal bracket
④ Pipe brackets

Drip leg recommended in conduit installation.



Remote PCB
Enlarged to show detail
Figure 3.8c



Color Codes for Remote PCB
Figure 3.8d

Remote Mount Connections
Figure 3.8

SECTION IV – START-UP

4.1 Start-Up Checks

Prior to applying power, the following checks should be made:

a) Check the flowmeter nameplate to insure that the power supply voltage is correct.
b) Verify that all electrical connections are correct. See figures 3.6 and 3.7.
c) Check the polarity of external loads connected to the outputs.
d) Check the flow direction. If the arrow on the flow sensor is not pointing in the direction of flow - the meter will not function. See paragraph 4.2 to change flow direction.

4.2 Changing the flow direction

The flow direction can be changed by reversing the position of the coil plug J3 on the amplifier PCB with the power off. See figure 5.1, page 15.

4.3 Resetting the optional LCD totalizer

To clear the totalizer display to zero, briefly short out the two pins marked "RESET" on the rate/totalizer board (see Figure 4.1, page 14).

SECTION V – CALIBRATION

5.1 Calibration

All flowmeters are calibrated before leaving the factory. No field recalibration is required.

WARNING
When the cover is removed and line voltage is applied to the meter, several points have sufficient voltage to be hazardous. NEVER UNPLUG THE CONNECTOR PCB WITH THE POWER ON.

5.2 Changing Meter Range (4-20 mA output)
(Refer to figure 5.1, page 15)

Necessary Tools:
Digital Ohmmeter
(Soldering iron and new metal film resistor. 50 PPM or better may be required for some range changes.)

Value to be taken from the nameplate on the transmitter housing:

Meter constant K

Calculate a new value for the reference resistor as follows:

$$R(\text{ohms}) = \frac{K \times Q}{7.5}$$

where Q is the desired measuring range in GPM.

Example:

Meter constant
(from the nameplate): K = 1605.85

Needed: New value for Rx

Solution:

$$Rx = \frac{1605.85 \times 100}{7.5}$$

$$Rx = 21410$$

TURN OFF POWER BEFORE PROCEEDING

Lift the reference PCB off the amplifier PCB and connect the digital ohmmeter across the resistor and potentiometer, (figure 5.1). Adjust the new value of Rx with the potentiometer replacing the fixed resistor if necessary to obtain the correct value of Rx. You will find easier access to the reference PCB, if you first remove rate/total PCB, if fitted.

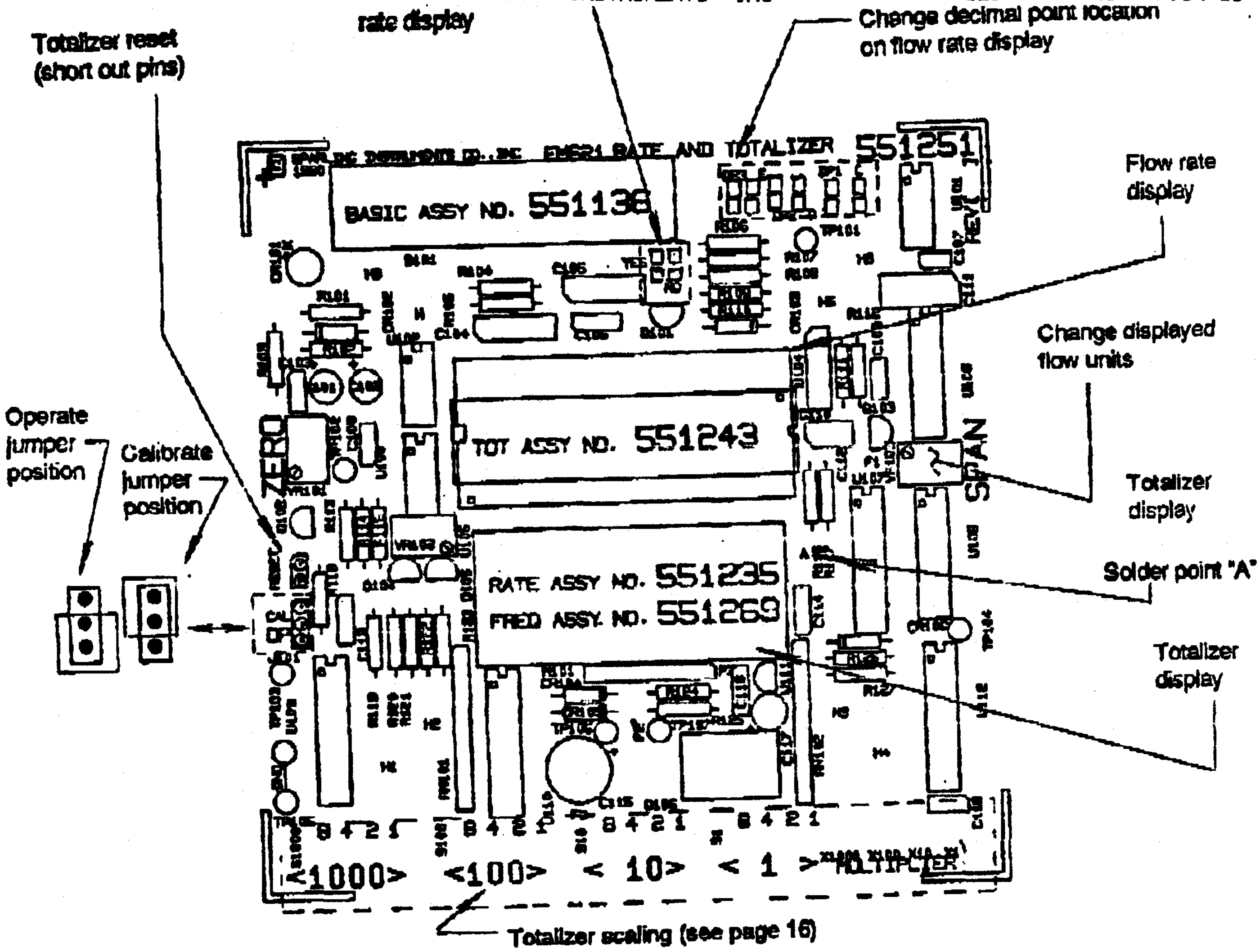
In our example, adjust the pot to get a reading of 21.41 K ohms. Disconnect the ohmmeter and plug the reference PCB into the main amplifier board. Re-apply power and install the enclosure cover. MAKE CERTAIN TO OBTAIN A GOOD SEAL AROUND THE COVER GASKET.

5.3 Rescaling optional digital rate display

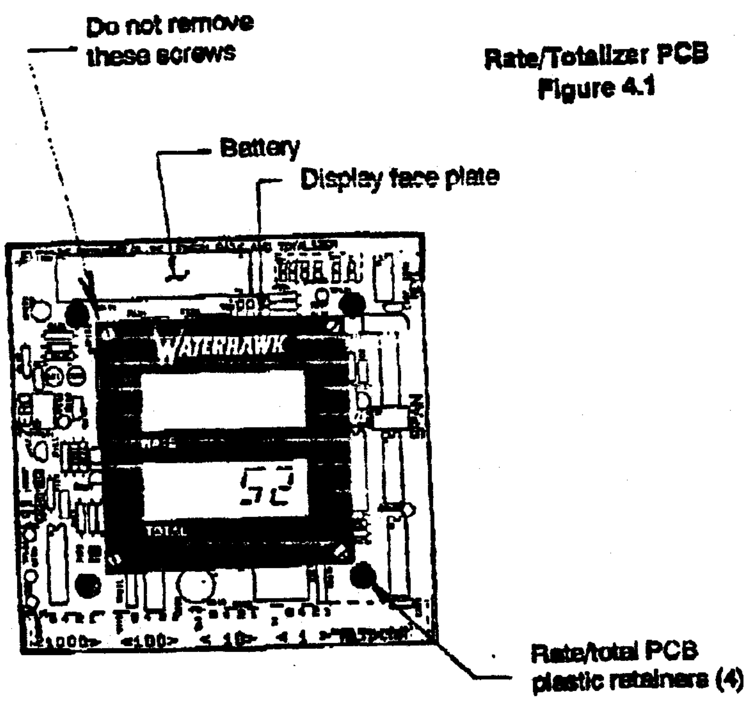
This procedure is necessary whenever you change meter range for current output (see section 5.2). Also, to select new flow units to display, you should carry out step 5.2 first. Once the 4-20 mA output tracks the flow in desired units, proceed as follows. On the rate/totalizer board (see figure 4.1), move the jumper to "CAL" position and adjust "SPAN" pot, until you see the full scale flow in selected units on the display. Then move the jumper back to "OP" position. You may have to change the location of the decimal point by resoldering selection points. TURN THE POWER OFF.

For:	*Solder:*	*Leave Open:*
x.xxx	"DP3", "D", "C"	"E", "DP2", "DP1"
xx.xx	"E", "DP2", "C"	"DP3", "D", "DP1"
xxx.x	"E", "D", "DP1"	"DP3", "DP2", "C"

Also if the full scale is a number below "400" (disregarding the decimal point), bridge solder point "A" (otherwise leave it open). If you want to activate a dummy zero in the last position of the display (for full scales greater than "2000"), solder "YES" and open "NO" (otherwise "YES" is left open and "NO" is bridged.)



Rate/Totalizer PCB
Figure 4.1



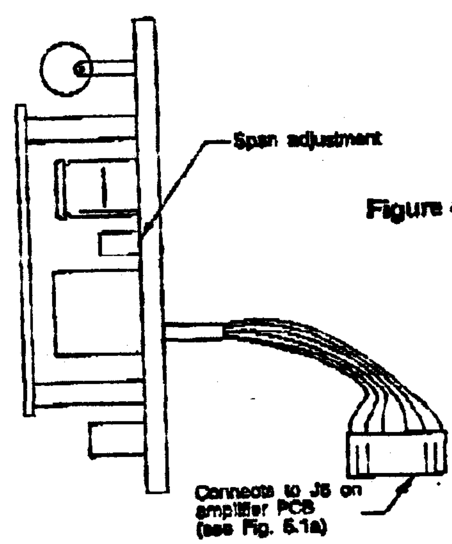
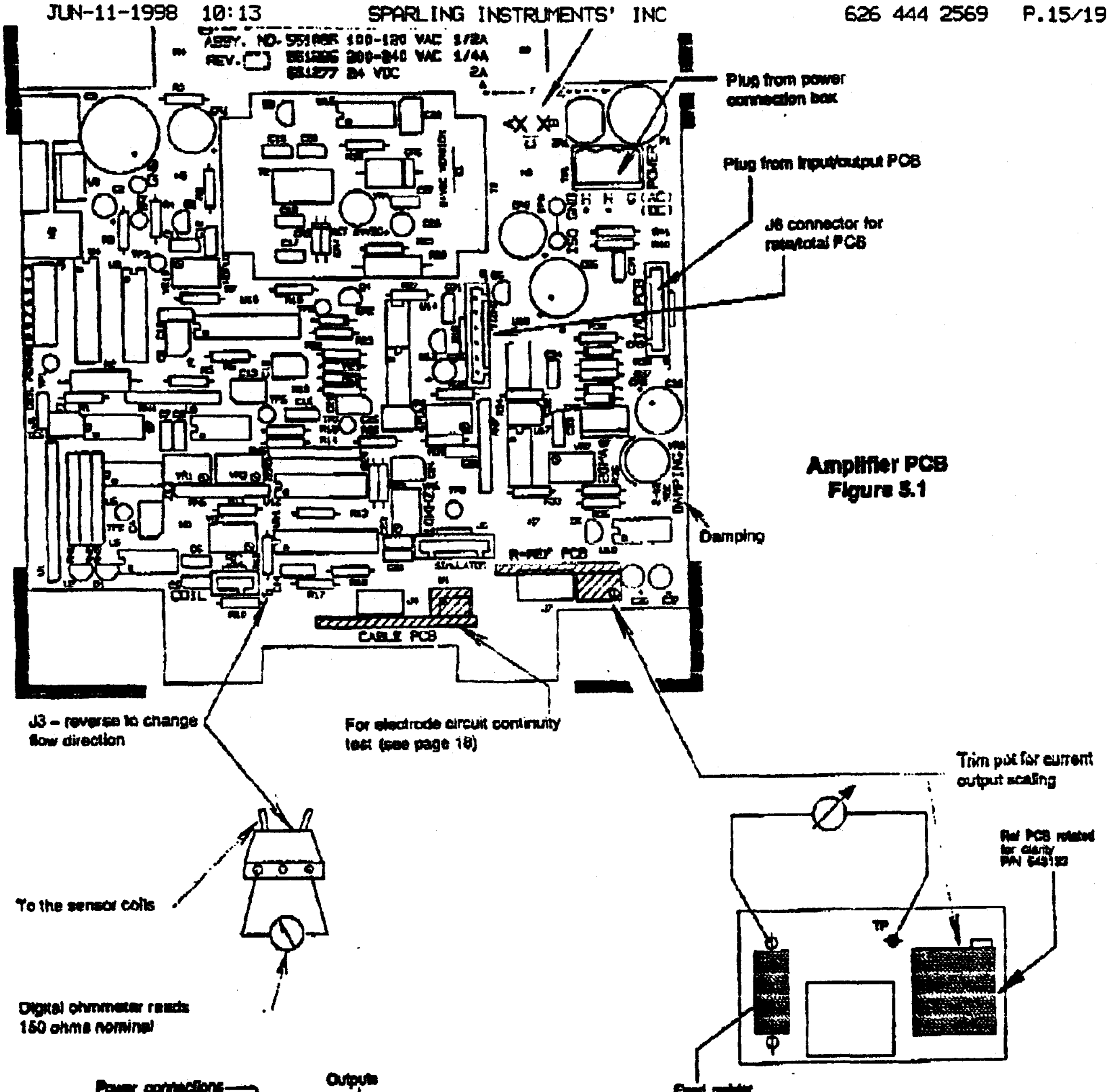


Figure 4.1a



Amplifier PCB
Figure 5.1

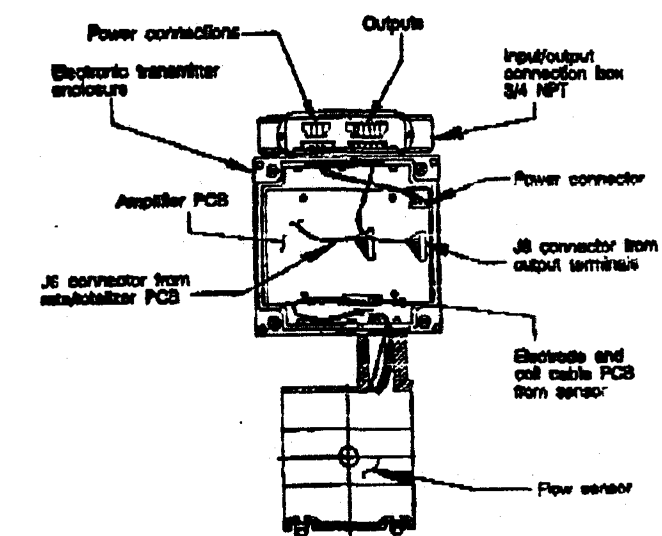
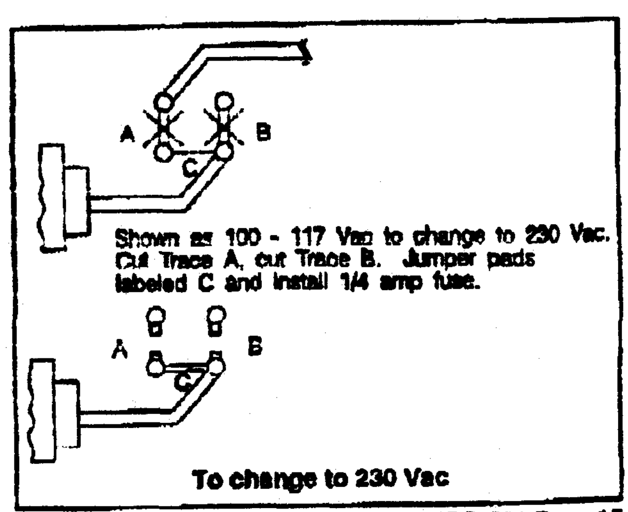


Figure 5.1a



To change to 230 Vac

5.4 Rescaling the Pulse Rate Output Option

Series FM621 flowmeters may be ordered with an additional printed circuit board that provides a 24 Vdc pulse rate output proportional to flow. This circuit board is equipped with pulse rate scaling circuitry to divide the frequency so that each pulse represents a known volume of process liquid in pre-defined engineering units. Meters are factory set per the original order. The following procedure allows divider resetting in the field if necessary.

Example:

Meter constant K (see nameplate): 2769.23
Required output registration, R: 100 Gal/Pulse

Needed:

Divided factor, N
N = K x R

Where:

R = Registration in gallons/pulse
K = Meter constant in pulses/gallon
N = 2769.23 x 100 = 276,923.0

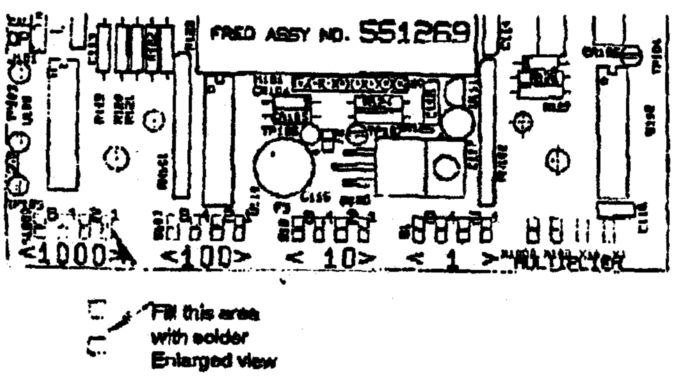
N should be a number less than 9,999,000. The result may be rounded off to four significant digits. N = 276,900.

Restate the N value as the product of a coefficient between 100 and 9999 and a multiplier of 1, 10, 100 or 1000. Where more than one combination is possible, make the coefficient as large as possible and the multiplier small. N = 2769 x 100.

The coefficient is set by bridging solder points on the rate and totalizer board. Bridge only one multiplier, i.e. 1, 10, 100, or 1000. See figure 5.2.

In the example 2769 x 100 above:

At the <1000> location, solder bridge 2.
At the <100> location, solder 4, 2 and 1. This totals 7.
At the <10> location, solder 4 and 2. This totals 6.
Then solder 8 and 1 to give you the last digit, 9. Now select "x 100" just to the right.



Rescaling Pulse Rate
Figure 5.2

SECTION VI - MAINTENANCE

No routine maintenance is required.

The flow sensor is of cast ductile iron construction and has no replaceable parts. In the event of a failure, the flow sensor must be replaced. The transmitter is removable.

Sparling's repair/exchange program allows you to expedite replacement of a defective flow sensor or transmitter. If the equipment is within the warranty period (two years), a fixed price will be charged to the buyer for replacement of the defective equipment. The appropriate credit will be issued upon return of the goods to the factory in good condition.

The transmitter electronics utilize IC and LSI components. Troubleshooting integrated circuit devices can be difficult. It is recommended that PCB level maintenance not be attempted.

Caution must be exercised when connecting test probes -- even a momentary accidental short circuit may damage an IC device. Only qualified technicians should attempt to service this equipment.

In the event of a malfunction in the transmitter, a replacement PCB assembly can be quickly substituted for the defective assembly, minimizing system down time. Servicing by substitution of spare assemblies is more economical than stocking a large variety of IC chips, transistors, diodes, etc. Also, test equipment requirements and the level of technical expertise necessary are minimized. It is suggested that the user contact the Sparling service facility for technical assistance at 800/800-FLOW.

SECTION VII - TROUBLESHOOTING

7.1 General

Each flowmeter is rigorously tested during production. The final test stage is a wet flow calibration in Sparling's precision primary flow laboratory traceable to the National Institute of Standards and Technology (formerly NBS).

Before troubleshooting, carefully verify the operating conditions of the meter:

1. Verify the interconnecting wiring by using a local milliammeter connected to the current output with no other load connected.
2. Verify that the sensor is completely filled with liquid. An empty or partially full sensor will continue to send a flow signal even with no flow.
3. Verify that the flow test comparison is valid to be sure that the meter is in error.
4. If in doubt, verify the conductivity of the liquid to see that it exceeds 20 micromhos/cm.
5. Verify that there is suitable grounding of the meter and interconnecting piping. See figure 3.4.

7.2 Troubleshooting Chart

The following trouble shooting chart should assist in correcting meter malfunction. For additional information, contact Technical Assistance at 800/800-FLOW.

SYMPTOM	POSSIBLE CAUSE AND CURE
1. Display is blank.	1. Check the power and the fuse. Check all PCB and field connections. See that Terminals 3 & 4 on TB 201 are jumpered.
2. Display is turning black around the edges.	2. Temperature is too high inside the enclosure. Relocate the meter or shield against the heat source. Continuing to power the meter in this condition will permanently damage the display.
3. Display is difficult to read.	3. Improve the lighting conditions if ambient light is dim.
4. Displayed flow rate changes rapidly (jitters).	4. Unsteady flow. Increase damping. Figure 5.1.
5. Recorder trace is too wide (paints).	5. Increase damping. Figure 5.1.
6. Rate display and/or current output does not correctly track the flow.	6. Incorrect selection of R–ref resistance which defines the flow rate for 20 mA. Change the meter range. See section 5.2. Rescale the digital rate display. See section 5.3.
7. Display is correct, but totalizer does not correctly track the flow.	7. Incorrect pulse scaling. See section 5.4.
8. Display and outputs are at zero.	8. Dry Sensor Full pipe no flow condition. PZR contact closed. Reverse flow conditions (change flow direction).
9. Display and outputs are not zero at zero flow.	9. Leaky valves Some liquid movement.
10. Display and outputs are erratic or wander.	10. Pipe partially full. Large air bubbles are present in the process liquid. Increase the head in the line by restricting downstream flow. Pipe freshly drained. If part of process cycle, utilize PZR to inhibit outputs.

If the above steps fail to correct the problem, try different flow rates and disconnecting loads temporarily and see if the problem persists.

Please have the following information available when you call:

Meter serial number (see meter nameplate on transmitter housing).

Description of the problem. (Display, current output, totalizer/frequency, all of the above.)

Is the pipe full of liquid?

When does the symptom occur or repeat?

What are the flow rates, the orientation of the meter in the pipeline, environmental conditions and the output loads on the meter?

How did you verify the discrepancy?

Are the gaskets installed and concentric with the bore of the meter?

If the piping material is non-conductive, is the meter properly grounded?

Contact Technical Assistance 800/800-FLOW for additional help.

7.3 Circuit Board Replacement

No adjustments are required if a circuit board is replaced. The PCB has been calibrated at the factory. Make sure that the reference and connection boards remain together with the original flow sensor.

7.4 Electronics PCB Replacement

Meter electronics are mounted on an easily removable PCB. *This PCB contains no user serviceable parts.*

7.5 Sensor Testing

The sensor consists of a measuring section with electrodes and coils enclosed in a cast ductile iron housing. Defective sensors should be returned to the factory for repair. OBTAIN A RETURNED GOODS AUTHORIZATION PRIOR TO RETURNING MATERIALS TO PREVENT DELAYS.

7.6 Coil Continuity Testing

CAUTION
DO NOT MAKE OR BREAK COIL CONNECTION WHILE POWER IS APPLIED. DISCONNECT POWER BEFORE PROCEEDING.

Unplug coil plug J3 (see Fig. 5.1). Using a short test lead, connect ohmmeter between coil wires and measure resistance of 150 ohms nominal (±5% if unpowered at 68°F). Refer to figure 5.1.

The nominal coil resistance for all sizes is 150 ohms. If the coil resistance is too high or low (including open and short circuits) the sensor must be returned to the factory for inspection and/or repair.

The sensor can fail for the following reasons:

1. Defective coil windings
2. Moisture penetrating the coil housings due to leaking electrodes.
3. Moisture penetrating the sensor junction box due to loose conduit connections or junction box cover.

7.7 Coil Insulation Test

Required test equipment: Insulation tester 1010 ohm

Disconnect power and signal cables.

Disconnect coil plug J3.

Connect insulation tester between coil wire and housing ground. Test the insulation at 500 Vdc. A reading below 10,000 meg ohms indicates moisture in the sensor. The sensor must be returned to the factory for inspection and/or repair.

7.8 Electrode Circuit Continuity Test

Remove sensor from the pipeline. Drain sensor and dry interior thoroughly.

Unplug electrode cable PCB (figure 5.1).

Connect ohmmeter to E1 on cable PCB (center conductor of one electrode cable) and to the electrodes which are accessible through the open sensor. (Use the sensing electrodes which are located opposite each other midway through the sensor. Do not use the grounding electrodes which are located at the ends of the pipe).

Measure 0 ohms for one electrode and ∞ ohms for the other.

Connect ohmmeter to E2 and repeat the above procedure.

7.9 Electrode Circuit Insulation Test

Unplug electrode cable PCB.

Connect insulation tester three ways:

1. Between E1 and housing ground
2. Between E2 and housing ground
3. Between E1 and E2

A reading below 1400 meg ohms at 500 Vdc indicates moisture in the sensor. Return the sensor to the factory for inspection and repair.

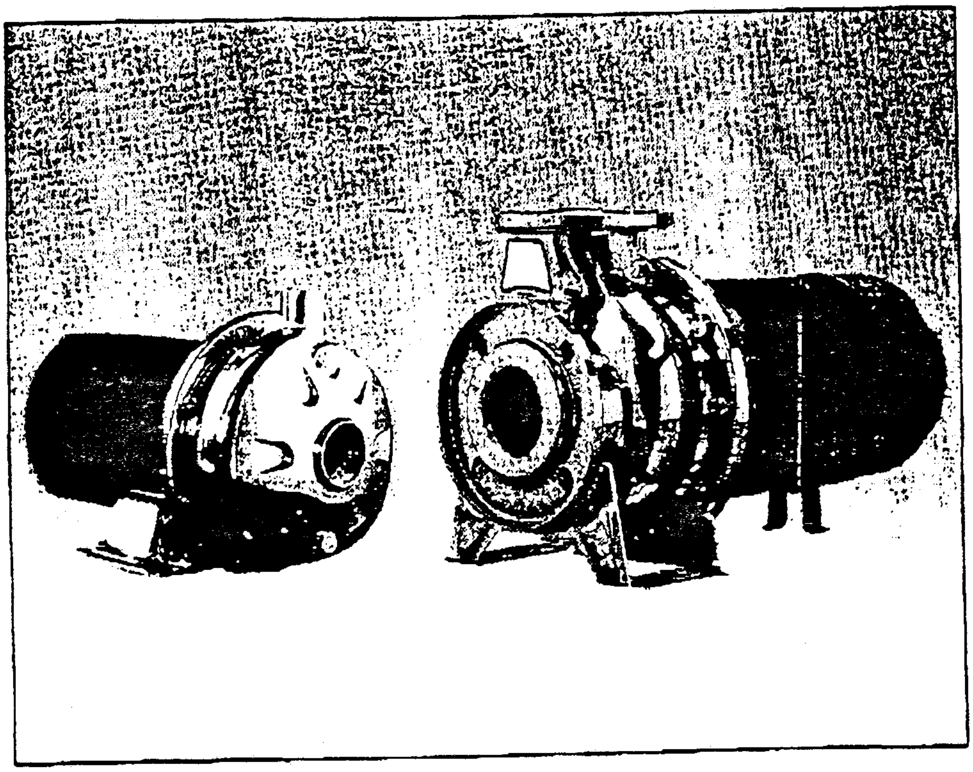
SECTION VIII REPLACEMENT PARTS LIST

		Part Number
1. Main Amplifier PCB (4-20 mA standard)		
100 - 117 Vac		551095
230 Vac		551285
24 Vdc		551277
2. Rate/Totalizer PCB (optional)		
4-20 mA only		551269
No display and frequency.		
Flow-rate display only		551235
Totalizer display only		551243
Flow and totalizer displays combined		551251
No displays, external totalizer output only		551136
3. Fuse, 5x20 BUSS		
100-117 Vac	0.5 amp	136532
230 Vac	.25 amp	138231
24 Vdc	2.0 amp	136558
4. Transmitter, remote mount assembly includes:		551722
a) Remote electronics enclosure		
b) Sensor junction box		
c) 15 ft. cable assembly		
d) Cable grip		
e) Mounting brackets and hardware		
5. Replacement remote mount cable, ft		
3-conductor		142860
2-conductor/double shield with overall shield		139924
6. Remote mount PCB		550071
7. Sunshield kit		552069

Instruction Manual

Ampco "S" Series

MODEL CDU & 3U



Contents

* WARNING *

IMPORTANT SAFETY INSTRUCTIONS

RULES FOR SAFE INSTALLATION AND OPERATION

1. Read these rules and instructions carefully. Failure to follow them could cause serious bodily injury and/or property damage.
2. Check your local codes before installing. You must comply with their rules.
3. For maximum safety, this product should be connected to a grounded circuit equipped with a ground fault interruptor device.
4. Before installing this product, have the electrical circuit checked by an electrician to make sure it is properly grounded.
5. Before installing or servicing your pump, BE CERTAIN pump power source is disconnected.
6. Make sure the line voltage and frequency of the electrical current supply agrees with the motor wiring. If motor is dual voltage type, BE SURE it is wired correctly for your power supply.
7. Complete pump and piping system MUST be protected against below freezing temperature. Failure to do so could cause severe damage and voids the Warranty.
8. Avoid system pressures that may exceed one and a half times the operating point selected from the pump performance curve.
9. Do not run your pump dry. If it is, there will be damage to the pump seal.

INSTALLATION

PACKAGE CONTENTS – 1. Each pump is carefully tested and packaged at the factory.
2. The catalog lists all parts included with package. A packing list packed with pump, also lists contents.
3. Be sure all parts have been furnished and that nothing has been damaged in shipment.
4. OPEN PACKAGES AND MAKE THIS CHECK BEFORE GOING ON JOB.

PIPING – Pipes must line up and not be forced into position by unions. Piping should be independently supported near the pump so that no strain will be placed on the pump casing. Where any noise is objectionable, pump should be insulated from the piping with rubber connections. Always keep pipe size as large as possible and use a minimum of fittings to reduce friction losses.

SUCTION PIPING – Suction pipe should be direct and as short as possible. It should be at least one size larger than suction inlet tapping and should have a minimum of elbows and fittings. The piping should be laid out so that it slopes upward to pump without dips or high points so that air pockets are eliminated. The highest point in the suction piping should be the pump inlet except where liquid flows to the pump inlet under pressure.

The suction pipe must be tight and free of air leaks or pump will not operate properly.

DISCHARGE PIPING – Discharge piping should never be smaller than pump tapping and should preferably be one size larger. A gate valve should always be installed in discharge line for throttling if capacity is not correct. To protect the pump from water hammer and to prevent backflow, a check valve should be installed in the discharge line between the pump and gate valve.

ELECTRICAL CONNECTIONS – Be sure motor wiring is connected for voltage being used. Unit should be connected to a separate circuit. A fused disconnect switch or circuit breaker must be used in this circuit. Wire of sufficient size should be used to keep voltage drop to a maximum of 5%. Single phase motors have built-in overload protection. Flexible metallic conduit should be used to protect the motor leads.

PRIMING – The pump must be primed before starting. The pump casing and suction piping must be filled with water before starting motor. In the CDU models, remove vent plug in top of casing while pouring in priming water. A hand pump or ejector can be used for priming when desired. When water is poured into pump to prime, remove all air before starting motor.

STARTING – When the pump is up to operating speed, open the discharge valve to obtain desired capacity or pressure. Do not allow the pump to run for long periods with the discharge valve tightly closed. If the pump runs for an extended period of time without liquid being discharged, the liquid in the pump case can get extremely hot.

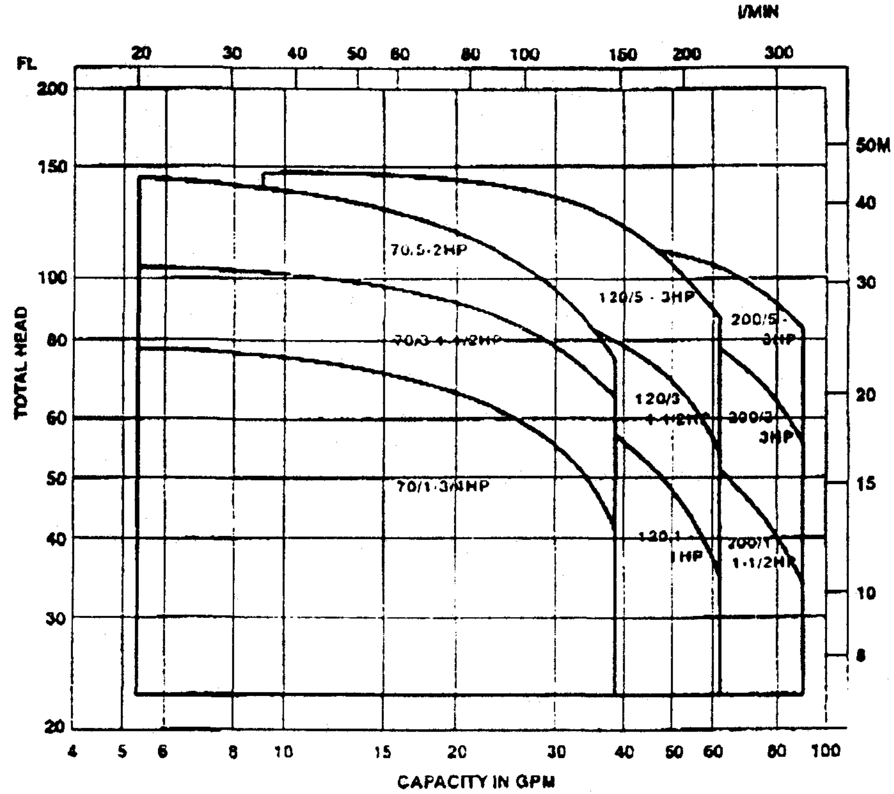
ROTATION – All single phase motors are single rotation and leave factory with proper rotation.

FREEZING – Care should be taken to prevent the pump from freezing during cold weather. It may be necessary, when there is any possibility of this, to drain the pump casing when not in operation. Drain by removing the pipe plug in the bottom of the casing.

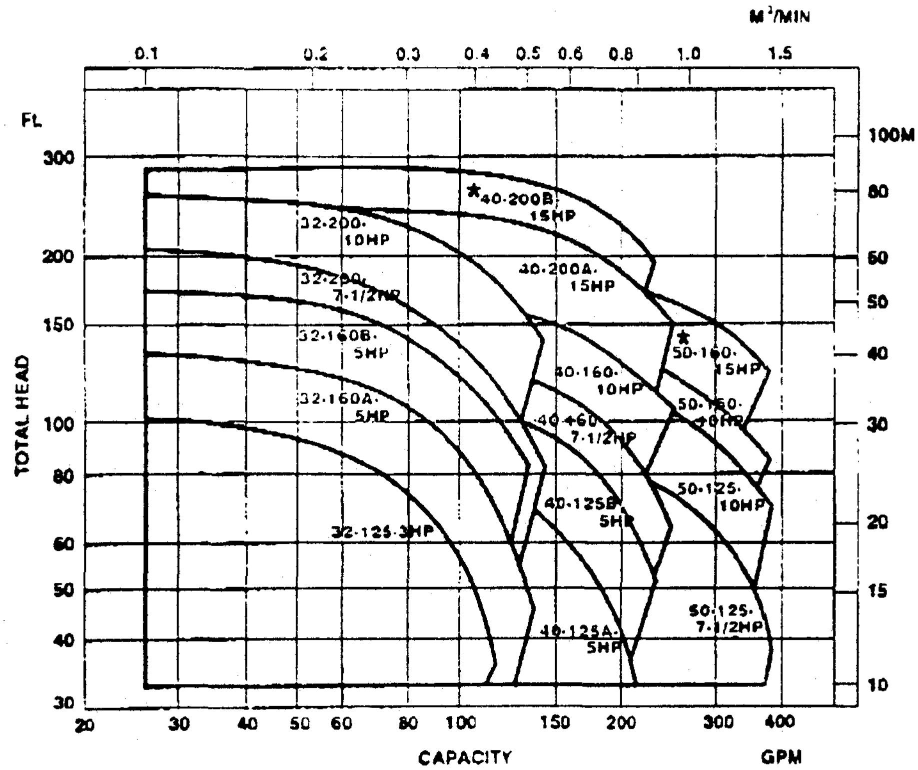
ROTARY SEAL – "S" Series pumps are fitted only with rotary seal. This seal is recommended for LIQUIDS free from abrasives.

LOCATION OF UNIT – The pump should be installed as near to the liquid source as is practical so that the static suction lift (vertical distance from the center line of the pump to water level) is minimum, and so that a short, direct suction pipe may be used. The capacity of a centrifugal pump is reduced when the unit is operated under a high suction lift. The piping should be as free from turns and bends as possible, as elbows and fittings greatly increase friction loss. Place the unit so that it is readily accessible for service and maintenance and on a solid foundation, which provides a rigid and vibration-free support. Protect the pump against flooding and excess moisture.

MODEL: CDU SELECTION CHART



MODEL: 3U SELECTION CHART



★ Three phase motor only.

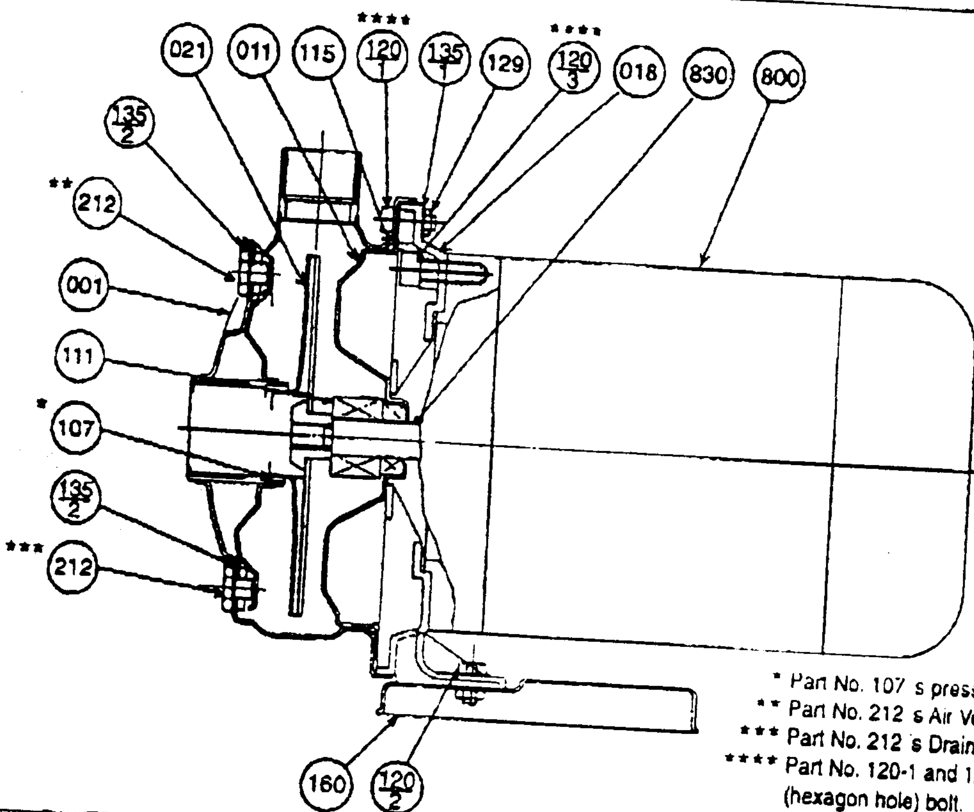
SPECIFICATIONS EPS

	STANDARD	OPTIONAL
Size		
Suction	CDU70 : 1¼" NPT thread CDU120 : 1¼" NPT thread CDU200 : 1½" NPT thread	
Discharge	1" NPT thread	
Range of H.P.	3/4 H.P. to 3 H.P.	
Range of Performance		
Capacity	5.5 to 90 GPM at 3450 R.P.M.	
Head	23 to 144 feet at 3450 R.P.M.	
Liquid Handled		
Type of Liquid	Clean Water	
Temperature	CDU70 : Max. 140°F (60°C) CDU120 : Max. 194°F (90°C) CDU200 : Max. 194°F (90°C)	CDU120 & 200: Max. 250°F (121°C) with optional seal
Working Pressure	Max. 115P.S.I. (8 Bar)	
Materials		
Casing	304 Stainless Steel	
Impeller (Closed Type)	304 Stainless Steel	
Shaft	Stainless Steel	
Bracket	Aluminum	
Shaft Seal	Mechanical Seal John Crane Type 21	High Temp. Version Mild Chemical Version
Bearing	Ball Bearing	
Direction of Rotation	Clockwise when viewed from motor end	
Motor		
Type	NEMA 56J Frame	
Speed	60 Hz 3450 RPM (2 poles)	
Single Phase	TEFC: 3/4 H.P. to 3 H.P. ODP : 3/4 H.P. to 3 H.P. 115/230 V*	
Three Phase	TEFC: 3/4 H.P. to 3 H.P. ODP : 3/4 H.P. to 3 H.P. 208-230/460 V	Explosion proof
Motor Protection	Single Phase: Built-in overload protection	

SPECIFICATIONS EPSC

	STANDARD	OPTIONAL
Size		
Suction (150 lb. ANSI R.F. Equivalent)	3U32 : 2" ANSI Equivalent 3U40 : 2½" ANSI Equivalent 3U50 : 2½" ANSI Equivalent	
Discharge (150 lb. ANSI R.F Equivalent)	3U32 : 1¼" ANSI Equivalent 3U40 : 1½" ANSI Equivalent 3U50 : 2" ANSI Equivalent	
Range of H.P.	3 H.P. to 15 H.P.	
Range of Performance		
Capacity	13 to 380 GPM at 3450 R.P.M.	
Head	33 to 285 feet at 3450 R.P.M.	
Liquid Handled		
Type of Liquid	Clean Water	
Temperature	Max 194°F (90°C)	Max. 250°F (121°C) with optional seal
Working Pressure	Max. 145 P.S.I. (10 Bar)	
Materials		
Casing	304 Stainless Steel	
Impeller (Closed Type)	304 Stainless Steel	
Shaft	Stainless Steel	
Bracket	Cast Iron	
Shaft Seal	Mechanical Seal John Crane Type 21	High Temp. Version Mild Chemical Version
Bearing	Ball Bearing	
Direction of Rotation	Clockwise when viewed from motor end	
Motor		
Type	NEMA JM Frame	
Speed	60 Hz 3450 RPM (2 poles)	
Single Phase	TEFC: 3 H.P. to 10 H.P. ODP : 3 H.P. to 10 H.P.	
Three Phase	TEFC: 3 H.P. to 15 H.P ODP : 3 H.P. to 15 H.P. 208-230/460V	Explosion proof: 3 H.P. to 10 H.P.
Motor Protection	Overload protection must be provided	
Standard Accessories	Suction and Discharge Flange Gasket Motor Support	

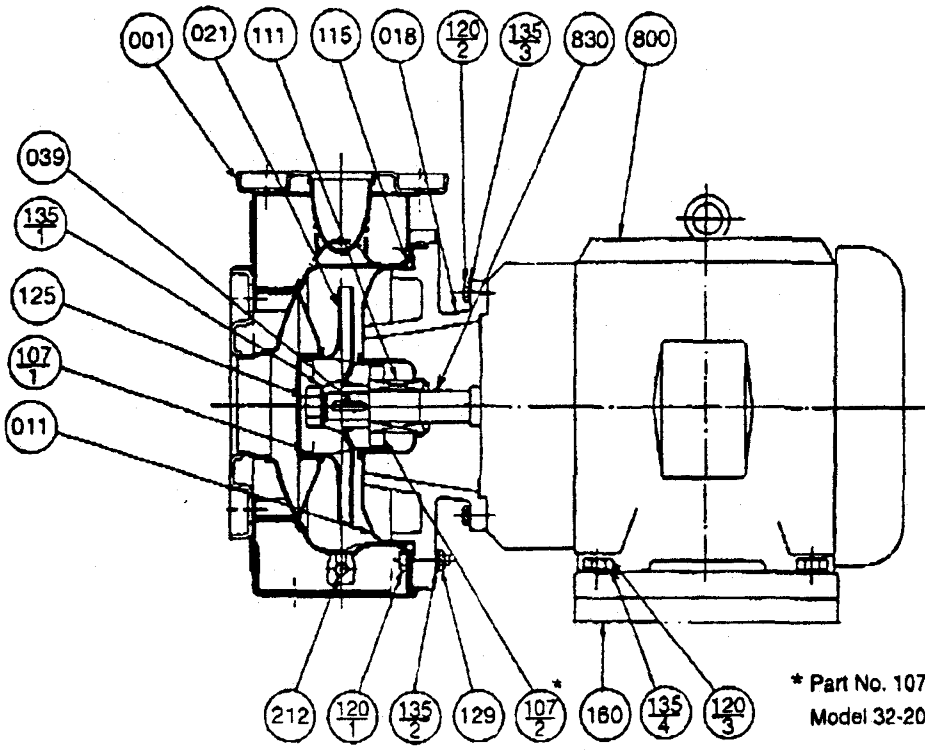
SECTIONAL VIEW EPS



* Part No. 107 is pressed into Part No. 001.
** Part No. 212 is Air Vent Plug.
*** Part No. 212 is Drain Plug.
**** Part No. 120-1 and 120-3 are round head (hexagon hole) bolt.

PART NO	PART NAME	MATERIAL	ASTM, ANSI CODE	NO. FOR 1 UNIT
001	CASING	304 STAINLESS	AISI 304	1
011	CASING COVER	304 STAINLESS	AISI 304	1
018	BRACKET	ALUMINUM		1
021	IMPELLER	304 STAINLESS	AISI 304	1
107	CASING RING	RUBBER		1
111	MECHANICAL SEAL	———		1
115	"O" RING	RUBBER		1
120-1	BOLT	304 STAINLESS	AISI 304	8
120-2	BOLT	STEEL	A283 Grade D	2
120-3	BOLT	STEEL	A283 Grade D	4
129	NUT	304 STAINLESS	AISI 304	8
135-1	WASHER	304 STAINLESS		8
135-2	WASHER	ALUMINUM	AISI 304	2
160	BASE	STEEL	A283 Grade D	1
212	PLUG	304 STAINLESS	AISI 304	2
800	MOTOR	———	NEMA 56J Frame	1
830	SHAFT	STAINLESS	NEMA 56J Frame	1

SECTIONAL VIEW EPSC



* Part No. 107-2 is only for Model 32-200, 40-200, 50-160.

	PART NAME	MATERIAL	ASTM, ANSI CODE	NO. FOR UNIT
001	CASING	304 STAINLESS	AISI 304	1
011	CASING COVER	304 STAINLESS	AISI 304	1
018	BRACKET	CAST IRON	A48 Class 30	1
021	IMPELLER	304 STAINLESS	AISI 304	1
039	KEY	304 STAINLESS	AISI 304	1
107-1	CASING RING	304 STAINLESS	AISI 304	1
107-2	CASING RING	304 STAINLESS	AISI 304	1
111	MECHANICAL SEAL	——		1
115	"O" RING	RUBBER		1
120-1	BOLT	304 STAINLESS	AISI 304	8/10/12
120-2	BOLT	STEEL	A283 Grade D	4
120-3	BOLT	STEEL	A283 Grade D	4
125	BOLT	304 STAINLESS	AISI 304	1
129	NUT	304 STAINLESS	AISI 304	8/10/12
135-1	WASHER	304 STAINLESS	AISI 304	1
135-2	WASHER	304 STAINLESS	AISI 304	8/10/12
135-3	WASHER	STEEL	A283 Grade D	4
135-4	WASHER	STEEL	A283 Grade D	4
160	MOTOR SUPPORT	STEEL	A283 Grade D	2
212	PLUG	304 STAINLESS	AISI 304	1
800	MOTOR	——	NEMA JM Frame	1
830	SHAFT	——	NEMA JM Frame	1
	SUCTION FLANGE GASKET			1
	DISCHARGE FLANGE GASKET			1

MAINTENANCE

Service

Keep ventilation openings clear of extraneous objects which may hinder free flow of air thru motor. Motor bearings are lubricated during manufacture. Additional lubrication is not required during their normal lifetime.

Draining

The pump and piping should always be protected against freezing temperatures. If there is any danger of freezing, the unit should be drained. To drain the pump, remove the drain plug at the bottom of the volute, and remove the priming plug to vent the pump. Drain all Piping.

REMOVING MOTOR FOR SERVICE AND REPLACING SHAFT SEAL (Fig. 1)

Shaft Seal Replacement

Turn disconnect switch to "OFF" position.

1. Remove the four cap screws holding pump volute to motor.
2. Separate volute from motor.
3. Remove shaft closure on end of motor opposite shaft
4. With a large screwdriver, hold shaft and remove impeller. NOTE: shaft to impeller has right hand thread. Shaft seal is now accessible.
5. Pry rotating shaft seal member from impeller (Fig. 1A).
6. Pry ceramic seat free and remove from motor (Fig. 1B).
7. Remove loose particles from seat cavity in motor bracket and wipe clean.

Installing New Shaft Seal

Before handling shaft seal parts, wipe hands clean.

1. Wet the inside surfaces of the seal cavity in bracket with a few drops of lubricating oil.
2. Coat rubber cup enclosing the ceramic seal with oil.
3. Place rotating seal member in position on impeller and press or lightly tap into place. Take care not to press against the polished seal surface (Fig. 1C).
4. Place ceramic seal over shaft and push into cavity securely using cardboard washer and 3/4" pipe to push in place (Fig 1D).
5. Position impeller on shaft and tighten securely (Fig. 1E).
6. Shaft must rotate freely without binding.
7. Place volute gasket in position.
8. Assemble volute to motor.
9. Replace volute to motor cap screws and tighten securely.
10. Pumping unit repair now complete.

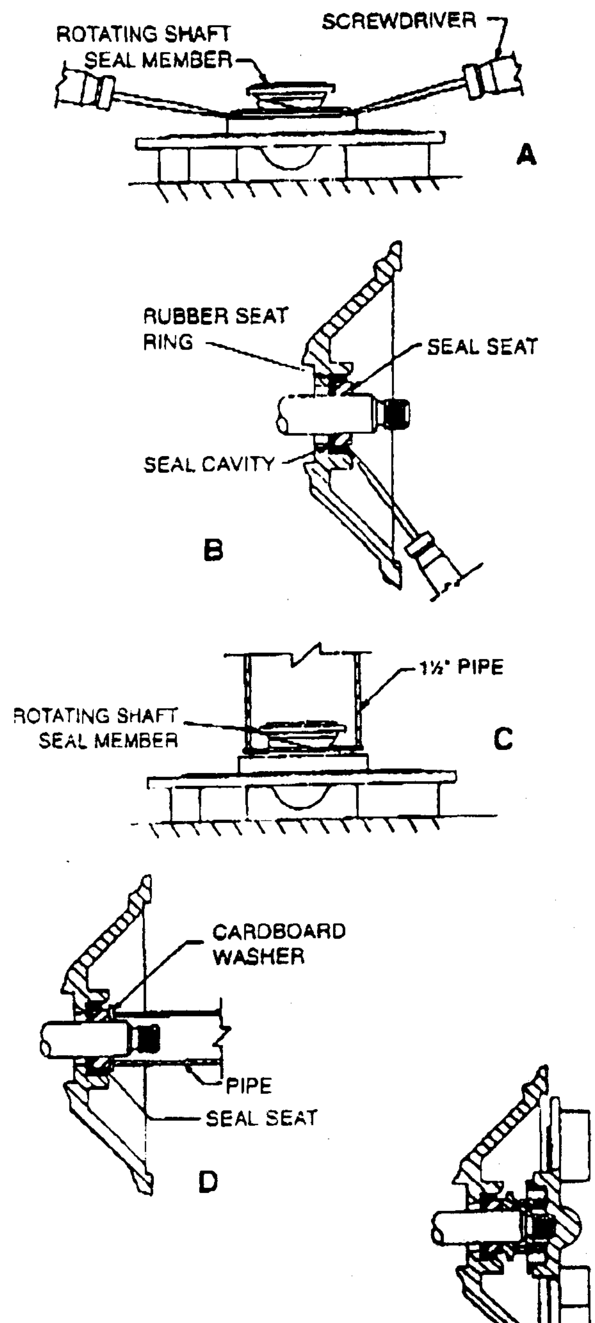


FIG. 1

DISASSEMBLY INSTRUCTIONS

All pumping parts can be removed from case without disturbing the piping.

POWER SUPPLY – Open the power supply switch contacts and remove fuses. Disconnect the electrical wiring from the motor.

VOLUTE CASE

(a) Drain pump case by removing drain plugs.
(b) Remove the bolts securing volute case to pump bracket.
(c) Pry volute case from seal plate with a screwdriver.

IMPELLER

(a) Hold the motor shaft with a screwdriver in the shaft end slot. Grasp and turn the impeller counterclockwise (as viewed from pump end).

SEAL

(a) Remove the rotating part of the seal by pulling it off the shaft.
(b) The stationary seat can be pressed from the seal plate.

CHECK LIST FOR EXAMINATION OF PUMP PARTS

IMPELLER

Replace the impeller if any vane is broken, excessive erosion shows, or if labyrinth surfaces are worn. Impeller capscrew, washer and lockwasher should be replaced if damaged.

MECHANICAL SEAL

Seal face, "O" ring and sealing members should be free of burrs and dirt. Complete seal assembly should be replaced if not in perfect condition.

SHAFT

Check for straightness.

SHAFT SLEEVES

Shaft sleeve surface under seal or packing must be clean, smooth and without any grooves. It should be replaced if necessary.

VOLUTE AND SEAL/PACKING PLATE LABYRINTH SURFACES (Wear Rings)

If worn, replace the necessary part. If furnished with pressed in wear rings, only the rings need be replaced.

GASKETS

Volute, suction pipe and discharge pipe gaskets should be checked for damage. Replace if necessary.

NOTE

If replacement parts are ordered, please furnish the following information to your Ampco distributor:

1. Reference Numbers
2. Description of Pump Part
3. Ampco Model Number and Serial Number on the Nameplate.

ASSEMBLY INSTRUCTIONS

All pump parts should be cleaned thoroughly before being reassembled.

MOTOR

(a) Assure that the rubber slinger is in place on the motor shaft.

SEAL

(a) A new pump seal should always be used when rebuilding a pump.
(b) Apply some light oil to the rubber which surrounds the ceramic stationary seat. Insert the seal seat into the seal plate using finger pressure to press firmly and squarely until it bottoms. Care must be taken to keep grease and dirt off face areas of the seal. Be sure the seal faces are not damaged during assembly (cracked, scratched, or chipped) or the seal will leak.
(c) Position the seal plate into the motor flange. Use care not to chip the stationary seal seat by hitting the motor shaft.
(d) By hand, carefully press the rotating seal assembly onto the motor shaft. The smooth face of the carbon ring must contact the ceramic seat. The rubber ring must seal against the shaft.

IMPELLER

(a) Hold the motor shaft with a screwdriver.
(b) Turn the impeller clockwise onto the shaft. Check that the rubber ring of the seal is positioned on the shaft.

VOLUTE

(a) Assure that a new or good condition gasket is in place on the seal plate.
(b) Carefully position the volute in alignment over the impeller and seal plate.
(c) Assemble the components with cap screws.

RESTARTING OPERATION

(a) Prime the pump by adding liquid to the volute case through the top plug.
(b) Reconnect electric power.
(c) After a few minutes of operation, check that there is no leakage from the pump or piping.

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Trouble	Possible Cause	Troubleshooting
Pump does not run.	• Faulty connection of power supply circuit. • Wrong wiring of control circuit. • Bound shaft • Mechanical seal faces stuck together • Faulty motor • Damage to bearing	• Check power supply circuit. • Correct control circuit. • Remove cause of obstruction. • Release seal by turning shaft. • Repair or replace motor. • Repair or replace any damaged bearing.
Pump does not pump water. Inadequate quantity.	• Considerable voltage drop. • Rotation direction reversed. • Lack of priming. • High discharge head. • Large piping loss. • Clogged foot valve. • Leakage from suction piping. • Too high suction lift. • Low water level.	• Correct rotation direction. • Reprime the pump. • Re-examine the plan. • Re-examine the plan. • Clear foot valve suction. • Check and repair suction piping. • Re-install as per our instructions. • Foot valve in ample immersion.
Overcurrent	• Considerable fluctuation of power supply voltage. • Considerable voltage drop. • Low head and overflow rate. • Damaged bearing.	• Throttle flow rate at outlet. • Replace any damaged bearing.
Pump vibrates, excessive operating noise	• Beyond rated capacity. • Cavitation. • Improper piping. • Damaged bearing. • Foreign matter clogging cooling fan.	• Reduce flow rate. • Consult distributor • Secure piping again. • Replace any damaged bearing. • Remove foreign matter.
Pressurizing application. Pump starts and soon stops	• Too limited pressure switch setting. • Leakage in system.	• Replace pressure switch to wider range. • Check and repair leaks.
Pump does not stop	• Too high pressure setting.	• Reduce max pressure setting to the lower in pressure switch.

MAINTENANCE:

The pump does not require special maintenance.

The following rules must be observed for safe operation:

If the pump is not going to be used for a long period, the pump should be drained of water and flushed with clean water. Where the pump is exposed to freezing temperatures, it should always be left drained when not in use.

* All specifications subject to change without notice.

TECHNICAL DATA

304 Stainless Steel Products Materials Suitability For Pumpage

APPLICATIONS

Item No.	Pumpage Type	Formula	Conc. %	Temp. °C	*Code Level
1	Acetic acid	CH_3COOH	10	20	2
2	Ammonium bicarbonate	NH_4CO_3	10	20	2
3	Ammonium carbonate	$(NH_4)_2CO_3$		60	3
4	Ammonium chloride	NH_4Cl	10	20	3
5	Ammonium hydroxide	NH_4OH	10	<80	3
6	Ammonium nitrate	NH_4NO_3	5		3
7	Beer				1
8	Benzoic acid	C_6H_5COOH	10	20	2
9	Benzoic acid	C_6H_5COOH		20	2
10	Boric acid	H_3BO_3	5	20	1
11	Boric acid	H_3BO_3	5	80	2
12	Brine				2
13	Butyric acid	C_3H_7COOH	Wat. Sol.		2
14	Calcium chloride	$CaCl_2$		20	3
15	Calcium nitrate	$Ca(NO_3)_2$	10		2
16	Calcium phosphate	$Ca_3(PO_4)_2$	10	≤100	2
17	Citric acid	$C_6H_8O_7$	5	20	2
18	Coffee				1
19	Copper sulfate	$CuSO_4$	5	20	2
20	Ethylene glycol	$CH_2OH\ CH_2OH$			1
21	Fluosilicic acid	H_2SiF_6	20	20	4
22	Fruit juices				1
23	Hydrocyanic acid	HCN		20	2
24	Hydrogen peroxide			20	2
25	Lactic acid	$C_3H_6O_3$	5	≤65	3
26	Lactic acid	$C_3H_6O_3$	10	20	2
27	Magnesium chloride	$MgCl_2$			3
28	Magnesium sulfate	$MgSO_4$		20	2
29	Maleic acid	$(CHCO_2H)_2$	10	20	3
30	Milk				1
31	Nitric acid	HNO_3	20	20	4
32	Nitric acid	HNO_3	20	70	4
33	Oleic acid	$C_{18}H_{34}O_2$	20	20	3
34	Oxalic acid	$(COOH)_2$	≤10	≤20	2
35	Oxalic acid	$(COOH)_2$	10	70	4
36	Phosphoric acid	H_3PO_4		≤80	3
37	Phthalic acid	$C_6H_4(COOH)_2$	Wat. Sol.	20	2
38	Potassium bicarbonate	$KHCO_3$	30	20	1
39	Potassium carbonate	K_2CO_3	40	20	1
40	Potassium chloride	KCl	10	20	2
41	Potassium hydroxide	KOH	10	<80	2
42	Potassium permanganate	$KMnO_4$		20	2
43	Potassium phosphate	KH_2PO_4	10	80	3
44	Potassium sulfate	K_2SO_4			2
45	Propionic acid	$CH_3CH_2CO_2H$	20	20	2
46	Propylene glycol	$CH_3CHOHCH_2OH$	60	20	3
47	Salicylic acid	$C_6H_4OHCOOH$		20	2
48	Sodium bicarbonate	$NaHCO_3$	10	20	1
49	Sodium carbonate	Na_2CO_3		<60	1
50	Sodium chloride	$NaCl$			3
51	Sodium hydroxide	$NaOH$	<10	<60	2
52	Sodium nitrate	$NaNO_3$	10		2
53	Sodium phosphate	Na_3PO_4		≤100	1
54	Sodium sulfate	Na_2SO_4	5	<60	2
55	Sulfuric acid	H_2SO_4	10	20	4
56	Sulfurous acid	H_2SO_3	Sat	20	3
57	Sulfurous acid	H_2SO_3	10	20	2
58	Tannic acid	$C_{76}H_{52}O_{46}$	10	20	1
59	Tartaric acid	$C_4H_6O_6$	10	20	2
60	Tea				1
61	Vinegar			≤60	1
62	Water			≤110	1
63	Water, condensation				1
64	Water, de-cationized				3
65	Water, demineralized				1
66	Water, distilled				1
67	Water, mine				1
68	Water, sea				3
69	Water, thermal				1
70	Wine-Whiskey				1

Where hot and aggressive liquids are to be pumped, in addition to checking the chemical compatibility, bear in mind that any deviations in temperature, density and viscosity from the reference data would bring about variations in terms of power input, hydraulic performance and suction capacity. Make sure, in all cases, that the power input is not higher than the rated power and the suction lift does not exceed the permissible values.

Code Key: 1 = Good 2 = Fair 3 = Poor 4 = Not Recommended
Important—Pumpages coded 3 "poor" may result in reduced or unsatisfactory service life.

LIMITED WARRANTY

Ampco Pumps warrants its centrifugal pumps against defects in material and workmanship under recommended use and service for a period of one year from the date of shipment. Responsibility under this warranty is limited to furnishing or repairing or replacing, at Ampco Pumps' option, without charge, f.o.b. its plant, any part which within one year from date of shipment is proved to have been defective at the time it was shipped. In no event shall Ampco Pumps be held liable for damages or delays caused by defective material and no allowance will be made for returned parts, repairs or alterations unless written consent or approval is given by Ampco Pumps.

This warranty is void and does not apply if damage is caused by improper installation, improper maintenance, accident, alteration, abuse or misuse.

Warranty service and information will be provided by Ampco Pumps upon receipt of written notice describing the defect or problem to: Ampco Pumps Company, 4000 W. Burnham Street, Milwaukee, WI 53215.

All motor warranties are to be handled through the particular motor manufacturer's authorized local service center.