

**BRISBANE CITY COUNCIL**

# **AIRVAC®**

**VACUUM SEWER SYSTEMS**

**The Viable Alternative®**

## **OPERATION & MAINTENANCE MANUAL**

**77 SUNSET ROAD, KENMORE  
VACUUM SEWERAGE SCHEME**



# **OPERATION & MAINTENANCE MANUAL**

## **77 SUNSET ROAD, KENMORE VACUUM SEWERAGE SCHEME**

**Brisbane City Council**

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# **OPERATION & MAINTENANCE MANUAL**

## **77 SUNSET ROAD, KENMORE VACUUM SEWERAGE SCHEME**

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## **SECTION 1**

### **77 SUNSET ROAD, KENMORE VACUUM SEWERAGE SCHEME**

<b>1.1</b>	<b>DESCRIPTION</b>
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**1. 77 SUNSET ROAD, KENMORE – STAGE 1 SEWAGE TRANSPORT SYSTEM****1.1 DESCRIPTION**

The pump station in Stage 1 will be a conventional pump station lifting sewage from an adjacent MH and discharging it to a rising main. In Stage 2 it will be modified to a vacuum collection system. The pumps and control panel will be retained in this revamped system.

**1.2 RETICULATION SYSTEM**

The Stage 1 drainage system consists of a network of gravity mains collecting into a manhole, located next to the pumping station. The future system will include vacuum pipe main east and west of this station. These pipes are sized in accordance with AIRVAC developed flow resistance data which allows us to calculate the optimum pipe sizes for a given flow. Future extensions and modifications to the system should be referred to AIRVAC-RSM Pty Limited.

**1.3 PUMPING STATION**

The Stage 1 Pump Station consists of:-

- Pump Prime Tank
- Sewage Discharge Pumps. Details of the sewage discharge pumps are contained in Section 5 – Hidrostral Sewage Pumps.
- Control Panel.
- Isolation Valve on discharge of sewage pumps.
- Check Valves
- Lifting Equipment

The 350 litre collection tank is primed with water initially. During normal pump operation it syphons waste water from the collecting manhole next to the station via the 100 NB PVC top entry pipe. It is imperative for the successful operation of this syphon type prime tank to avoid air breaking the syphon in this tank. The most likely cause of this would be unauthorised opening of the 18 mm fill line valve on the top of the tank. We strongly recommend removal of the handle on this valve after commissioning to avoid this potential problem.

**Section 1**

The Hidrostal sewage pumps toggle between duty/standby and are controlled by the level probe located in the collecting manhole MH/1/1, adjacent on the southern pumping station side.

#### **1.4      PRE-COMMISSIONING PROCEDURE**

##### **1.4.1      STAGE 1 SEWAGE PUMPS**

The objective of this test is to confirm that the pumps will suck from the manhole and have sufficient head to force waste into the nearby rising main.

The procedure is as follows:–

1. Shut the prime tank drain valve.
2. Shut isolation valves on the standby Pump No. 2 and the discharge valve to the rising main on the selected pump (No. 1).
3. Fill the prime tank via hose connection to the prime tank (Ø18 connection on the top of the tank).
4. Fix any leaks which may be apparent. This is important as a leak in the system will reduce the ability of the pumps to suck adequately. Ensure that the prime tank is full by checking overflow into MH 1/1. Disconnect hose and shut the Ø18 ball valves.
5. Fix the level probe in MH 1/1 so that it clears the base by approximately 100 mm.
6. At the control panel depress system start push button. Open the control panel door and check that lights have come up on PLC and that Multitrode level controller is functioning. (No level lights will be showing) green lights for pump availability should be on.
7. Check the direction of rotation on both pumps by momentarily running. Correct wiring as necessary.
8. Partly open the discharge valve on Pump No. 1.
9. Select and P.B. initiate manual mode switch and then pump 1 switch. Pump will run although the Multitrode is not controlling. Run briefly then follow same procedure for Pump No. 2. Check valves should open (hold shaft and feel movement).

#### **Section 1**

10. Refill prime tank as 3 above after checking/confirming absence of piping leaks. REMOVE HOSE AND CHECK ISOLATION VALVE ON THE TOP OF THE PRIME TANK IS CLOSED.
11. Fill the MH 1/1 using hose. The pump switches should be set up so that the level controller will initiate a pump running when level is 50m below the invert of the incoming sewers. Pump cut out should be 200mm above base level of M/H. Emergency cut out alarm initiation should be 100 mm above concrete base.

NOTE: Remove the hose and ensure isolation valve.

### 1.5 COMMISSIONING PROCEDURE

1. Brisbane City Council staff to open isolation valve on our line into the rising main.
2. Check this length of pipe for any leaks. Fix as required.
3. Place hose into MH 1/1 and fill at maximum rate.
4. Partly open the discharge isolation valve on Pump No. 1.
5. Select and P. B. initiate the manual mode switch and then Pump No. 1 switch. Run pump for one (1) minute and observe satisfactory operation of check valve. Repeat with Pump No. 2.

**NOTE:** Do not pump below selected LLS cut out as indicated by Multitrode M.T.I.C. inside panel door.

6. Allow hose to refill the M/H1/1 to appropriate level P. B. switch to auto mode and allow pumps to automatically switch and run as required.
7. Measure the level difference in the M/H1/1 between pump switch HLS and pump low level cut out switch LLS.

Approximately HLS  $\approx$  600 mm above base.

Approximately LLS  $\approx$  200 mm above base.

Different HT  $\approx$  400 mm approximately (but actual required)

Ø of MH is 1.2 m and volume pumped out is 114 L/100 mm of level change calculate volume –  $114 \text{ L} \times \frac{\text{HT difference}}{100 \text{ mm}}$  in mm.

8. Check the pump capacity rate by determining the time required to pump between the high and low level switches on auto mode.

## Section 1

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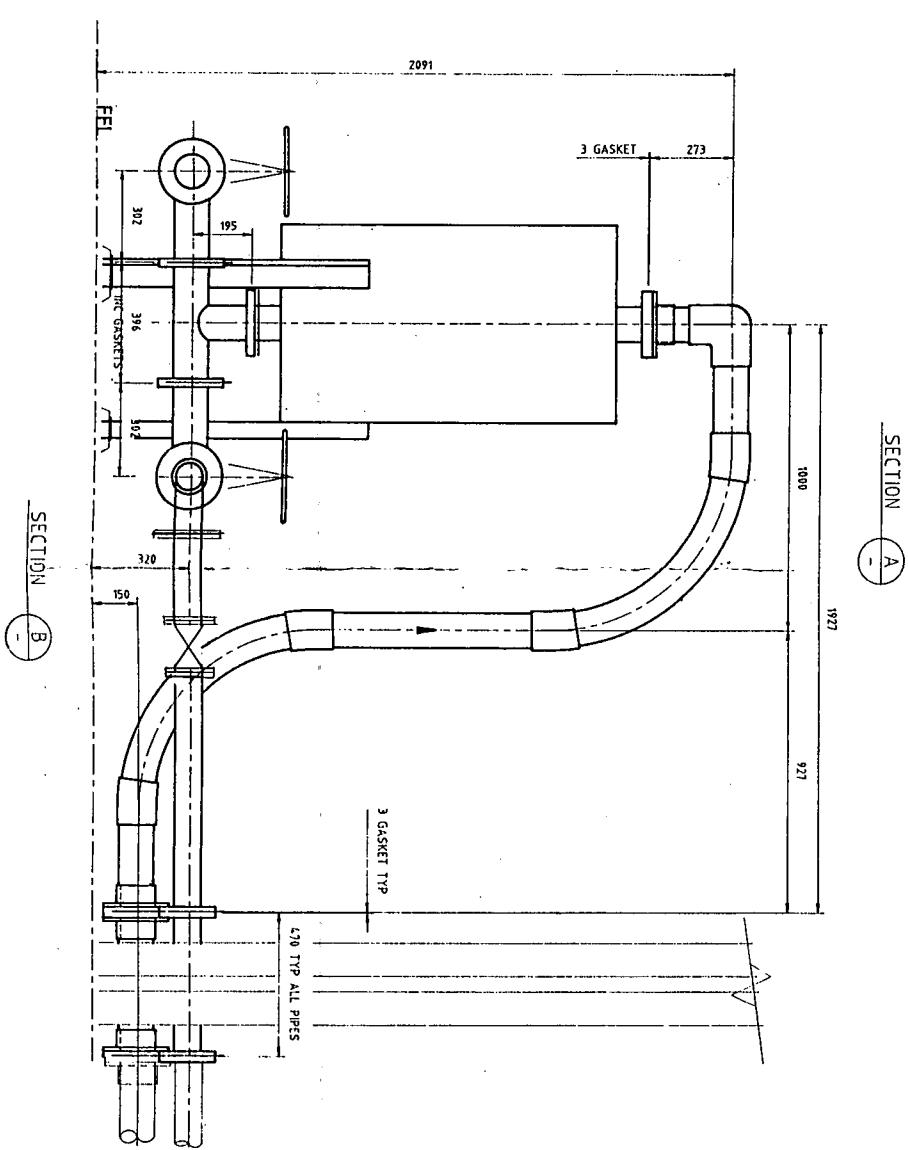
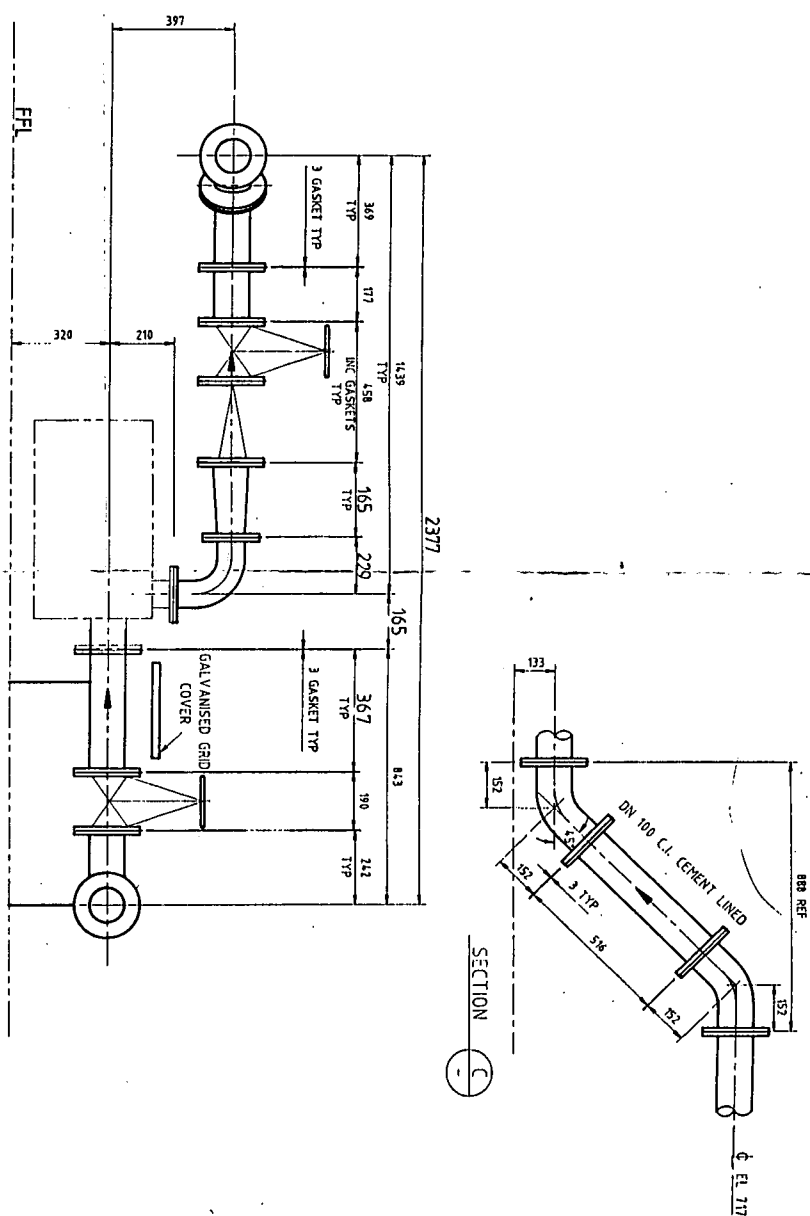
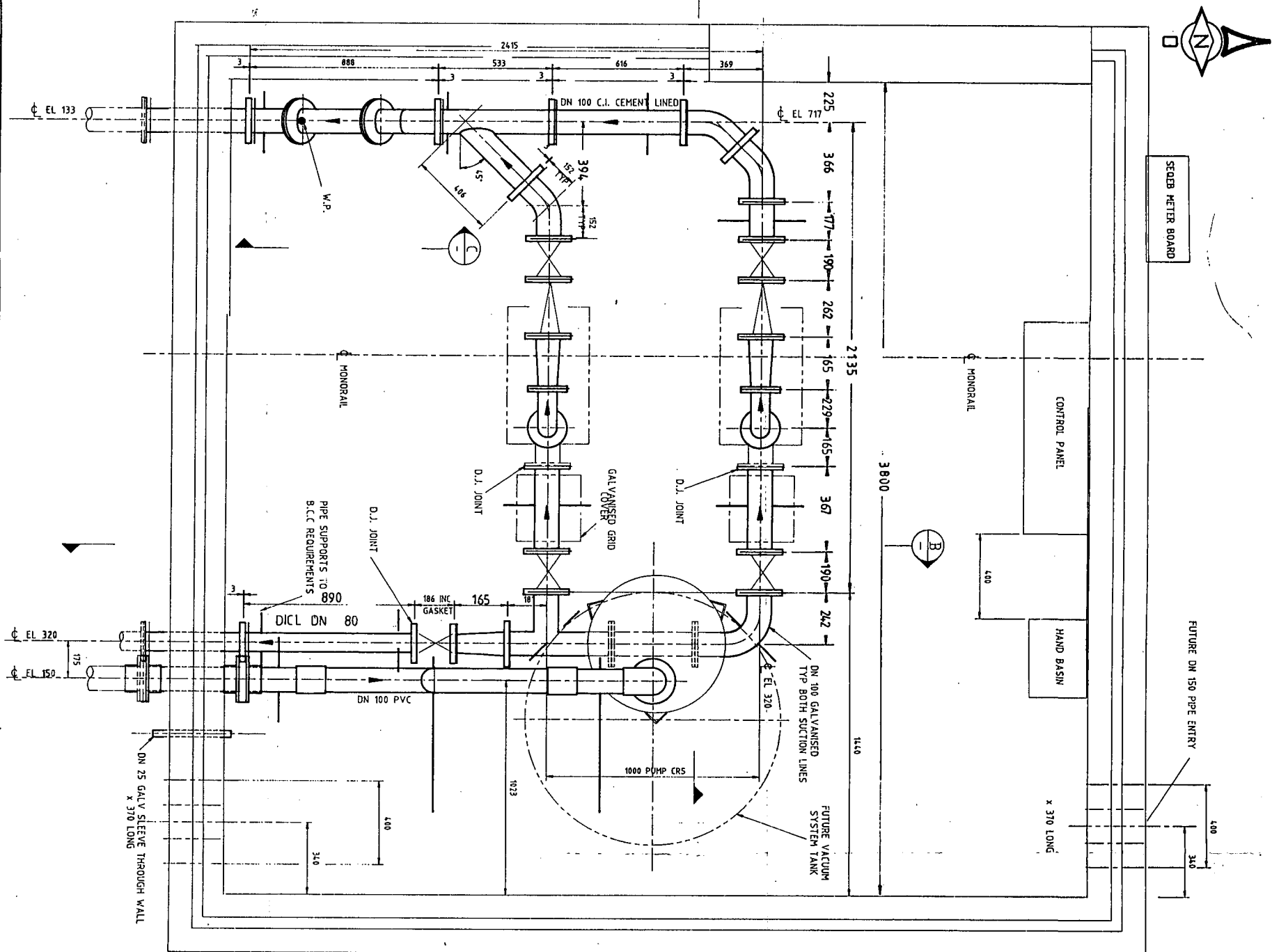
**77 SUNSET ROAD, KENMORE – STAGE 1 VACUUM SEWERAGE SYSTEM OPERATION & MAINTENANCE MANUAL**

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Calculate the rate ..... L/s.

9. Repeat using alternative pump.

**Section 1**



SCALE: 1:10 & NOTED						DATE	
						BRAVN	JBM
						CHECKED	DGS
							GR-5-14
							(1-9-94)
AIRVAC-RSM PTY LIMITED							
PUMP STATION LAYOUT							
76 SUNSET ROAD, KENMORE							
DETAILS AND SECTIONS - STAGE 1							
SITE 11 283 PENDING STREET MELBOURNE V.S.W. 2046							

## **SECTION 2**

### **CONTROL PANEL**

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## **2. CONTROL PANEL**

The control panel is a standard AIRVAC–RSM Pty Limited panel for small vacuum pump station.

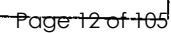
In the future development to a vacuum station it will be necessary to install vacuum pumps, vacuum tank and vacuum and level switches. These will be wired into the panel and will be accommodated without any changes to switches or the PLC. In Stage 1 AUTO mode the system running lights for the future stage vacuum pumps and low vacuum alarm lights will come on. A temporary sign on the panel should note that these lights are to be ignored in Stage 1.

### **2.1 STAGE 1 CONTROL PANEL**

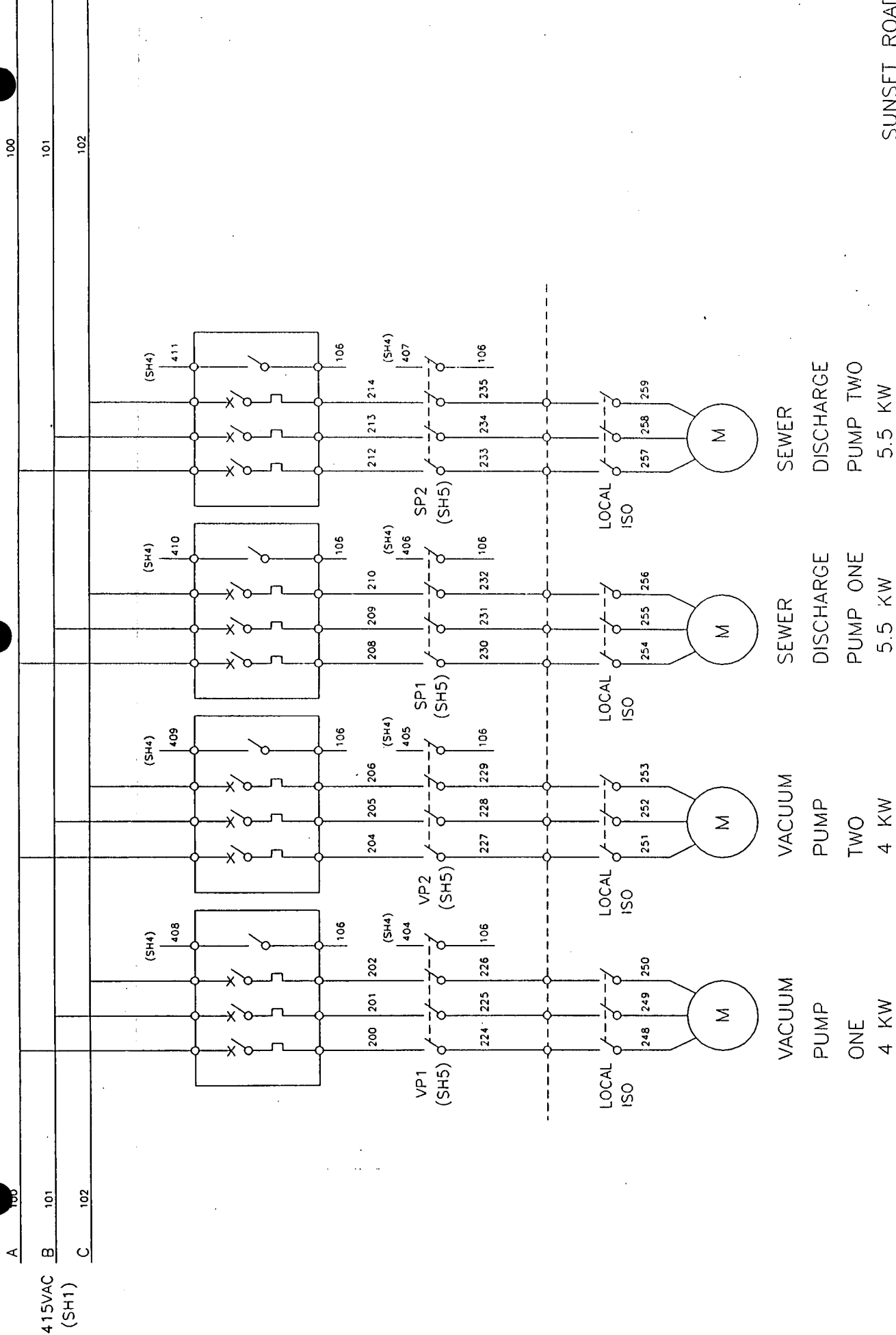
In Stage 1 the pump operation is as follows:–

1. P.B. select system start. Light should illuminate. PLC should have power lights illuminated.
2. P.B. select – auto start.
3. P.B. select duty pump.

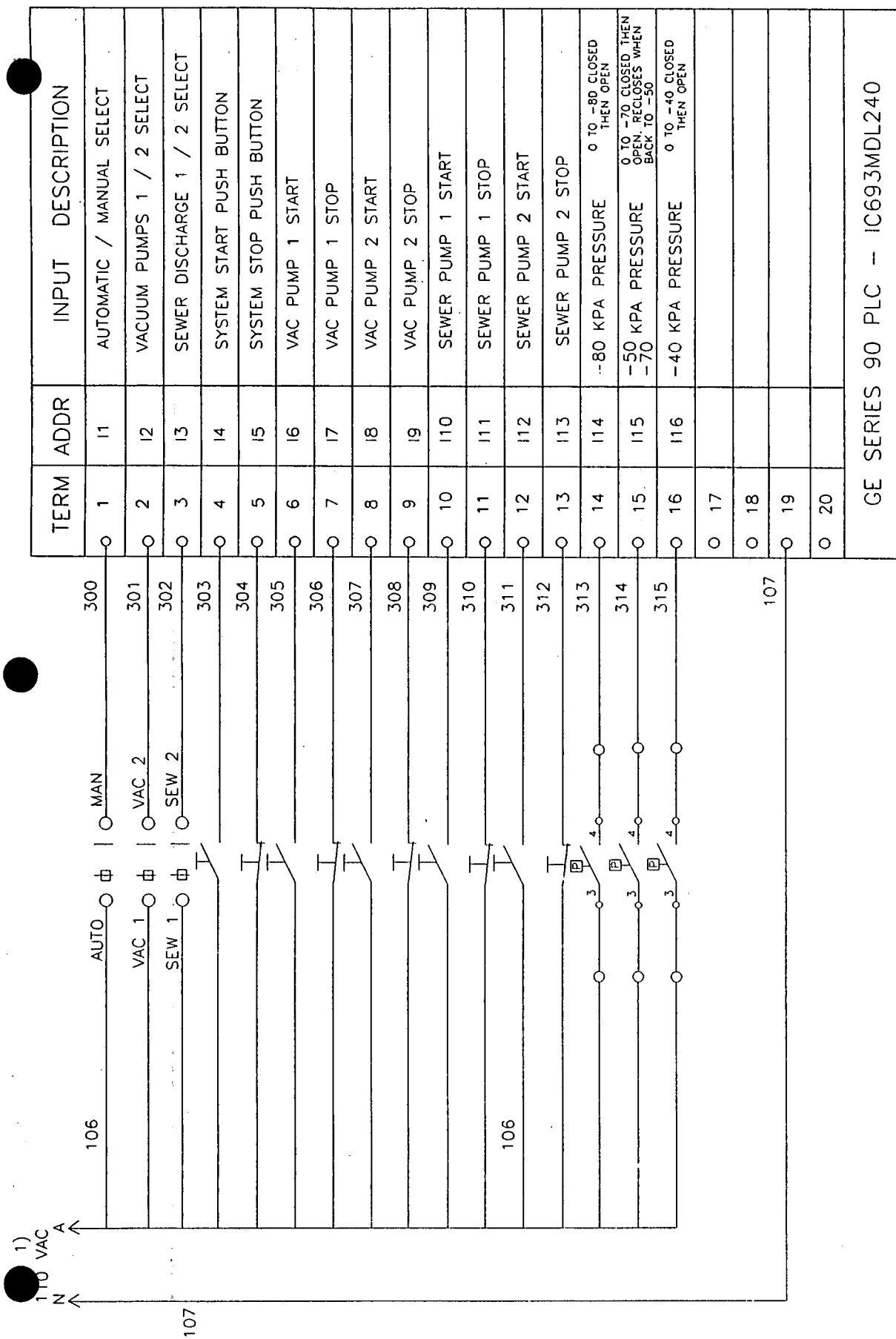
The duty pump will now run whenever the liquid level in the manhole 1/1 activates the multitrode pump switch. Pump will run until water level drops to pump cut out level. Levels are shown on the scale 1 to 10 inside panel.



BCC2A



SUNSET ROAD  
AIRVAC-RSM  
SHEET 2



AIRVAC-RSM  
SHEET 3

TERM	ADDR	INPUT	DESCRIPTION
O 1	I17	HIGH HIGH TANK LEVEL	CLOSED ABOVE LEVEL
O 2	I18	HIGH TANK LEVEL	CLOSED ABOVE LEVEL
O 3	I19	LOW TANK LEVEL	CLOSED ABOVE LEVEL
O 4	I20	LOW LOW TANK LEVEL	CLOSED ABOVE LEVEL
O 5	I21	VAC PUMP 1 RUNNING	
O 6	I22	VAC PUMP 2 RUNNING	
O 7	I23	SEWER PUMP 1 RUNNING	
O 8	I24	SEWER PUMP 2 RUNNING	
O 9	I25	VAC PUMP 1 OVERLOAD	
O 10	I26	VAC PUMP 2 OVERLOAD	
O 11	I27	SEWER PUMP 1 OVERLOAD	
O 12	I28	SEWER PUMP 2 OVERLOAD	
O 13	I29		
O 14	I30		
O 15	I31		
O 16	I32		
O 17			
O 18			
O 19			
O 20			
GE SERIES 90 PLC - IC693MDL240			

400

( SHEET 8 )

401

( SHEET 8 )

402

( SHEET 8 )

403

( SHEET 8 )

404

VAC PUMP 1 (SH2)

405

VAC PUMP 2 (SH2)

406

SEWER PUMP 1 (SH2)

407

SEWER PUMP 2 (SH2)

408

VAC PUMP 1 (SH2)

409

VAC PUMP 2 (SH2)

410

SEWER PUMP 1 (SH2)

411

SEWER PUMP 2 (SH2)

107

106

106

107

OUTPUT DESCRIPTION	ADDR	TERM
		1 O
VACUUM PUMP 1 CONTACTOR	Q1	2 O
VACUUM PUMP 2 CONTACTOR	Q2	3 O
SEWER PUMP 1 CONTACTOR	Q3	4 O
SEWER PUMP 2 CONTACTOR	Q4	5 O
		6 O
SEWERAGE HI HI LEVEL ALARM	Q5	7 O
VACUUM LOW PRESSURE ALARM	Q6	8 O
VACUUM PUMP 1 AVAILABLE	Q7	9 O
VACUUM PUMP 2 AVAILABLE	Q8	10 O
		11 O
SEWERAGE PUMP 1 AVAILABLE	Q9	12 O
SEWERAGE PUMP 2 AVAILABLE	Q10	13 O
VACUUM PUMP 1 RUNNING	Q11	14 O
VACUUM PUMP 2 RUNNING	Q12	15 O
		16 O
SEWERAGE PUMP 1 RUNNING	Q13	17 O
SEWERAGE PUMP 2 RUNNING	Q14	18 O
	Q15	19 O
	Q16	20 O
GE SERIES 90 PLC - IC693MDL940		

## TELEMETRY INDICATION

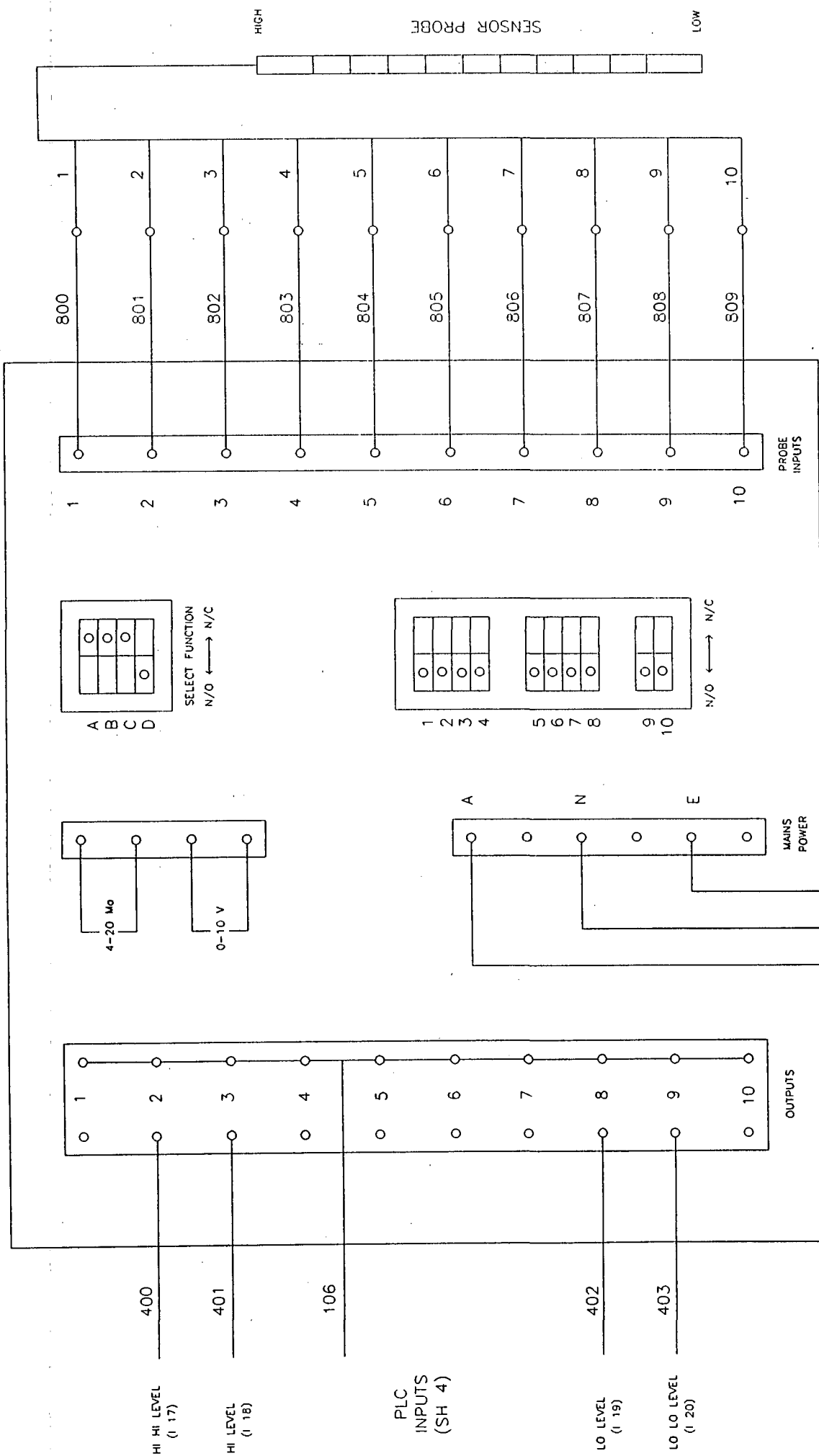
OUTPUT DESCRIPTION	ADDR	TERM
		1 O
SITE POWER FAIL	Q17	2 O
		3 O
AUTO/MANUAL SELECTION	Q18	4 O
		5 O
SEWERAGE HI HI LEVEL ALARM	Q19	6 O
		7 O
VACUUM LOW PRESURE ALARM	Q20	8 O
		9 O
		10 O
		11 O
VACUUM PUMP 1 AVAILABLE	Q21	12 O
		13 O
VACUUM PUMP 2 AVAILABLE	Q22	14 O
		15 O
SEWERAGE PUMP 1 AVAILABLE	Q23	16 O
		17 O
SEWERAGE PUMP 2 AVAILABLE	Q24	18 O
		19 O
		20 O
GE SERIES 90 PLC - IC693MDL930		

## TELEMETRY INDICATION

OUTPUT DESCRIPTION	ADDR	TERM	
		1 O	
VACUUM PUMP 1 STATUS	Q25	2 O	700
		3 O	701
VACUUM PUMP 2 STATUS	Q26	4 O	702
		5 O	703
SEWERAGE PUMP 1 STATUS	Q27	6 O	704
		7 O	705
SEWERAGE PUMP 2 STATUS	Q28	8 O	706
		9 O	707
		10 O	
		11 O	
	Q29	12 O	708
		13 O	709
	Q30	14 O	710
		15 O	711
	Q31	16 O	712
		17 O	713
	Q32	18 O	714
		19 O	715
		20 O	
GE SERIES 90 PLC - IC693MDL930			

BCC8

# MULTI TRODE MTIC 10/10



AIRVAC-RSM  
SHEET 3

## **SECTION 3**

### **HIDROSTAL SEWAGE PUMPS**

---

**3. HIDROSTAL SEWAGE PUMPS**

The Hidrostal sewage pumps and operation and maintenance are described in the manufacturers manual included in this section.

These pumps and downstream pipework will not require modifications for the future developments of Stage 2 and 3. However the Multitrode probe will require relocation to the collection tank.



# PUMPS

**AIRVAC - RSM PTY LTD**

**ORDER No: M038/92**

**ENVIROTECH JOB No: 946377**

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FACSIMILE (02) 950 5103**

## HIDROSTAL PUMPS

**D03K-M01+DDM1K-M112+D0**

SERIAL No.	TAG No.
H 2347	-----
H 2348	-----

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

Where adverse suction conditions exist and cause loss of prime, external priming devices should be used. Suction conditions such as liquid temperature, altitude above sea level and specific gravity must be compensated for by proper construction of the suction line.

When pumping liquids with gas separation, do not install the pipeline for negative suction.

Avoid gate valves for suction lift installations and for positive suction head installations, when the pump is operating ensure gate valves are completely open.

GOOD

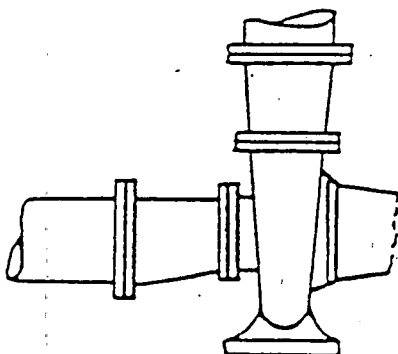


Figure 1.1

BAD

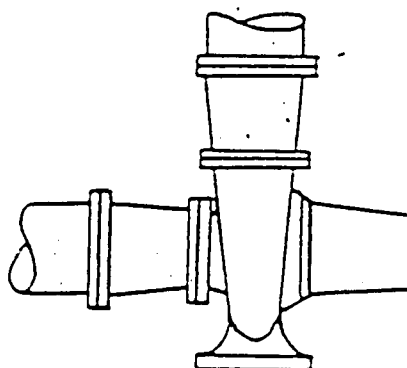


Figure 1.2

### ALIGNMENT

The pump driver, if supplied, is correctly aligned on the baseplate at the factory. However, a certain amount of deformation of the baseplate is possible during transit and it is therefore necessary to check the alignment between the pump and driver before start-up. The pump shaft should be checked for both angular and parallel alignment, a flexible coupling will not compensate for misalignment. Inaccurate alignment will result in vibration and excessive wear on the bearings, shaft sleeve and mechanical seal faces.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

The check for angular alignment (Figure 1.3) should be made by inserting an inside calliper or taper gauge at four points, 90° apart, between the coupling faces which must be within 0.3mm.

To check for parallel alignment place a straight edge across the coupling rims at the top, bottom and both sides. The unit will be in parallel alignment when the straight rests evenly on the coupling rim at all positions.

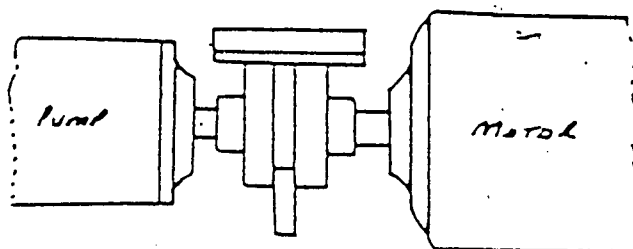
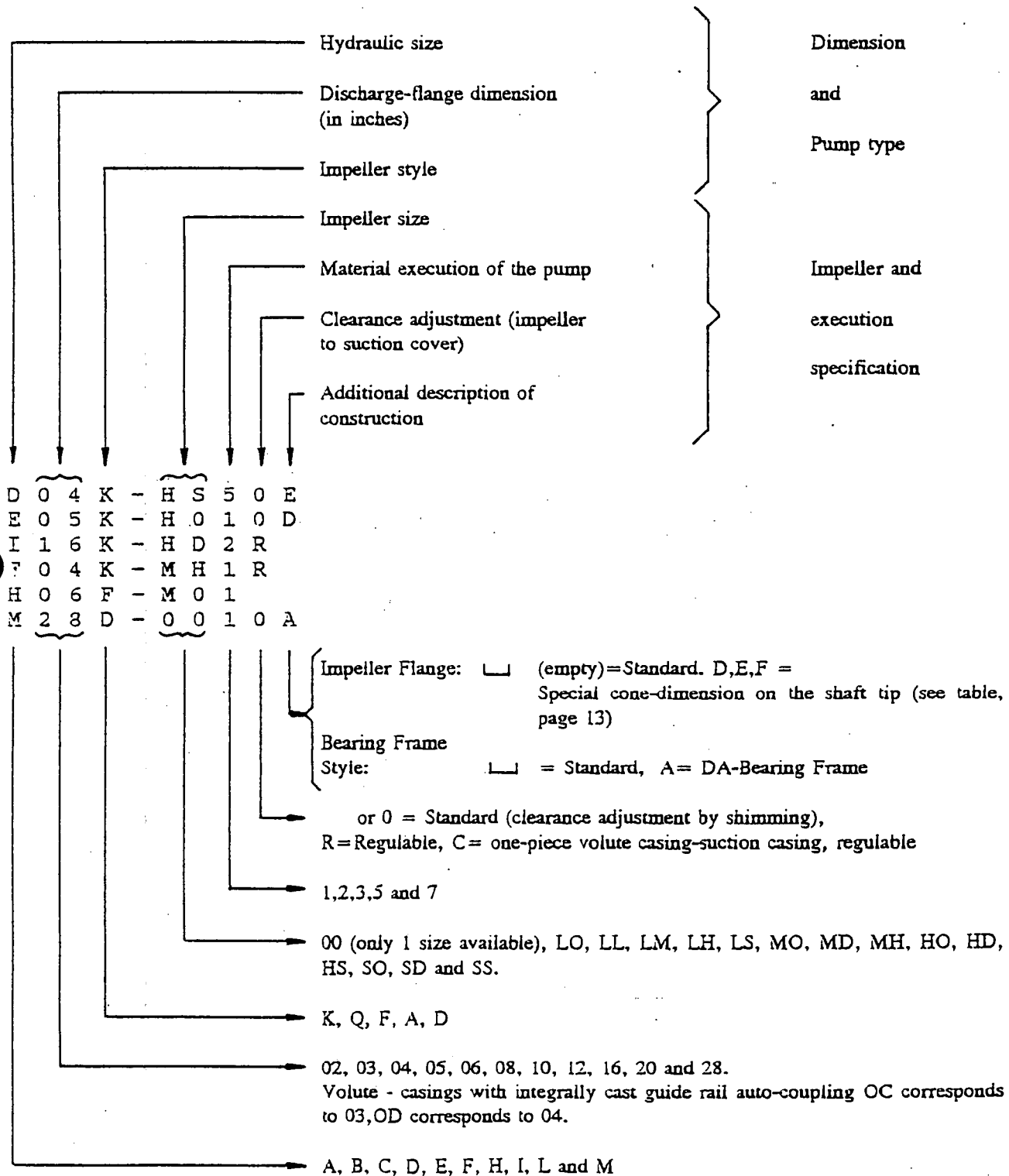


Figure 1.3

# SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

## TYPE CODE HYDRAULIC END



**NOTE:** On some sheets of the data book, where the discharge flange dimension of the hydraulic code is less than 10 inches, the zero has been left out.

**Example:** E05K ESK

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

### GENERAL

The original HIDROSTAL designs were of the D-Line construction: Most sizes utilised a parabolic suction piece as shown in Figure 1. The D-Line series is being replaced by the K-Line models, which utilise a straight conical suction for every pump size as shown in Figures 2 to 5. The advantage is in the ability to adjust uniformly for wear.

There are several different types of construction available for specific models. The design differences involve the volute/suction configuration and the availability of suction liners.

All models have been converted to the K-Line design. Refer to factory for possibility to retrofit D-Line pumps with K-Line impellers and suction pieces.

### COMMON CONSTRUCTION THROUGHOUT THE K-LINE MODELS

#### A. IMPELLERS

Impellers are of the screw-centrifugal design. Impellers are mounted on an impeller flange by means of a pinned and registered fit at the periphery (with the exception of the D3K and D4K-HS/S, which mount impeller directly onto shaft taper). The impeller is secured against the impeller flange by an allen-head impeller bolt. The impeller flange is secured to the shaft by a nut, utilising a woodruff key to transmit torque (except some D3K and D4K pumps). This construction protects the flange nut from the pumped material and provides for quick assembly and disassembly. Section drawings illustrate these features.

All impellers are statically and dynamically balanced for smooth mechanical performance.

Impellers are available in nodular iron (materials 1 & 2) and stainless steel (materials 3 & 5) for all sizes.

NOTE: The pump is available only in clockwise rotation.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

### B. VOLUTE CASING

Volute casing is separate from suction part in all pumps (except D3K and D4K, where suction casing is cast integrally with volute casing, and F4K and H5K, where both constructions - separate or integral - exist).

Hand hole cleanouts exist on all but D3K and D4K. All sizes have the back pullout feature. All sizes have rings of drilled and tapped holes for various mounting options.

All have a tapped hole for gauge near the discharge flange, and a tapped hole for drain at the lowest point of the casing. May be assembled with discharge in different positions.

Available in cast iron (material 1) or stainless steel (material 5) for all models, except D3K which is not available in material 5.

### C. SUCTION PART

Construction here varies according to pump size and material selected. The suction part construction may be in one of two categories:

#### 1. Suction cover

- Figure 2

This is a non regulable model, that means the clearance must be adjusted by shims. This type is available in cast iron (material 1) or stainless steel (material 5).

#### 2. Suction casing

There are three types of suction casing construction:

- Figure 3

One piece volute and suction casing with fixed (non regulable) liner. Clearance adjustment by shims.

- Figure 4

Regulable model. Clearance is adjusted by moving the liner within the suction casing by means of three external regulating screws.

- Figure 5 (obsolete model)

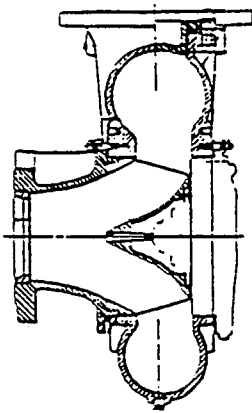
Same features as Figure 4 but with one-piece volute/suction casing.

**NOTE:** For availability of the different types of suction parts for the specific pump sizes and materials refer to the availability chart and the sectional drawings of this K-type section.

**SERVICE MANUAL FOR INSTALLATION AND  
OPERATION FOR K-LINE BEARING FRAME PUMPS.  
NON REGULABLE/MECHANICAL SEAL.**

**D-TYPE**

**Figure 1**

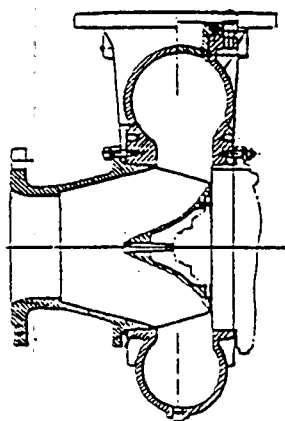


**Obsolete Model**

# **SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.**

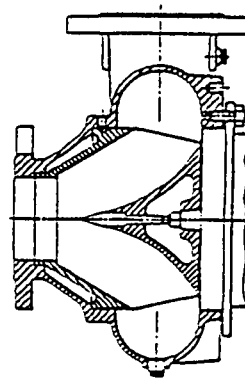
## **K-TYPE**

**Figure 2**



**Suction cover non regulable**

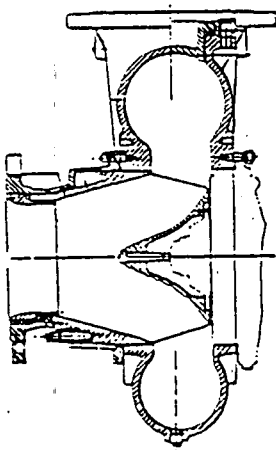
**Figure 3**



**One piece volute/suction casing with non  
regulable liner**

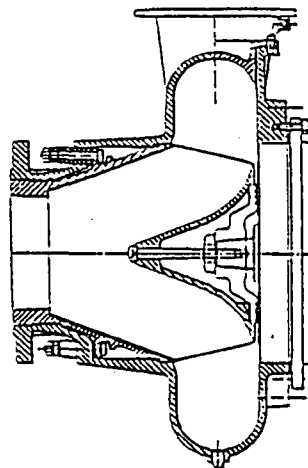
## **K-TYPE**

**Figure 4**



**Suction casing with regulable liner**

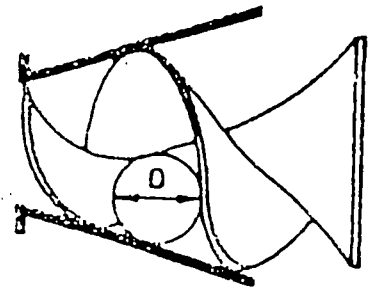
**Figure 5**



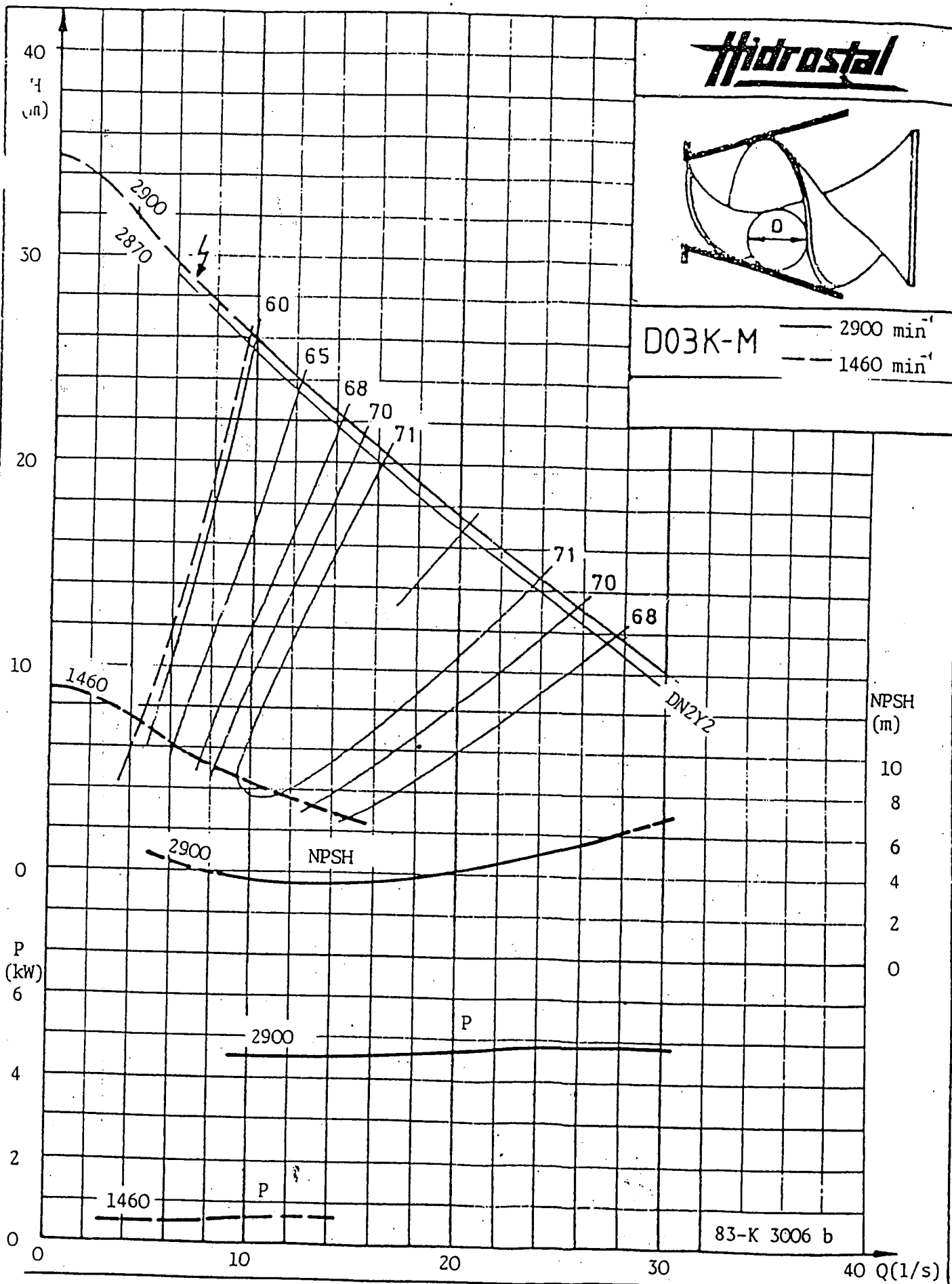
**One piece volute/suction regulable liner (obsolete model,  
use Figure 4 instead)**

**For further details see sectional drawings of this section.**

**Hidrostat**



**D03K-M** — 2900 min<sup>-1</sup>  
 - - 1460 min<sup>-1</sup>



83-K 3006 b


# SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

## GENERAL INSTRUCTIONS FOR FRAME MOUNTED SOLIDS HANDLING PUMPS

### INTRODUCTION

#### GENERAL INFORMATION

The HIDROSTAL distribution network provides service wherever our pumps are sold. Should you require sales or service information please contact your local HIDROSTAL representative.

 8213 NEUNKIRCH-CH	
TYP	<input type="text"/>
ORD	<input type="text"/> NR. <input type="text"/>
Q	<input type="text"/> f/s
H	<input type="text"/> m

#### NAMEPLATE DATA

Each pump has affixed to it a nameplate with the pertinent data as to rating and materials of construction. When enquiring about parts or service the above data should be supplied.

### INSTALLATION

#### PRELIMINARY

Prior to signing shipping documents, inspect the shipment for shortages or damages and promptly report any to the carrier. When a horizontal pump is unloaded, ensure it is lifted at four equal points on the baseplate. When a vertical pump is unloaded, use lifting eyes; couplings, extended shafts and other accessories are normally shipped in separate containers to avoid damage during shipment.

#### STORAGE INSTRUCTIONS

If the unit is not to be installed shortly after arrival, store it in a clean and dry place having moderately small changes in the ambient temperature. Rotate the shaft several times every two weeks by hand. This will ensure a positive coating on lubricated surfaces so retard rust and oxidation.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

### LOCATION OF PUMP

The pump should be placed as near the liquid source as possible, avoiding elbows where possible on the suction line.

### PIPING

The suction and discharge piping should be independently supported near the pump, expansion joints must be used where necessary to take care of temperature and pressure expansion, so that there will be no external loading of the casing.

### SUCTION PIPING

To obtain maximum available suction head, the suction line should be as direct and as short as possible, avoiding elbows. If elbows must be used, a long radius type is preferred. It is important in a suction line to avoid any sagging in which air may collect and thereby cause loss of prime. For this same reason it is imperative to have the suction line airtight when suction lift conditions exist. Unless a suction line runs entirely downward toward the pump all reducers must be eccentric (Figure 1.1) if installed in a horizontal position. A straight concentric taper reducer (Figure 1.1) should never be used in a horizontal position with the suction line rising toward a pump, as air pockets may collect in the top of the reducer and pipe.

### GROUTING

A space of approximately 25mm (1") should be left between the baseplate and top of the foundation to be filled with grout. After the grout has dried, the foundation bolts should be firmly re-tightened and alignment rechecked.

### SEAL CHAMBER CONNECTIONS

Water or grease connections to the sealing chamber must be provided according to applications, for details, see relevant section.

# SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

## OPERATION

### ELECTRIC MOTOR DRIVE

A starter with overload protection should be installed to prevent the motor from being damaged by overload. The overload reset should be set so that they trip if the current exceeds the nominal current of the motor. (See motor nameplate).

### BEFORE STARTING

The pump is ready to start when:

1. Pump baseplate is grouted and bolted to the foundation.
2. Pump and driver are correctly aligned.
3. Bearings are factory lubricated and ready for start-up. Refer to section entitled "Lubrication Instructions", after start-up to determine greasing procedure for each bearing frame type.
4. Seal water is supplied to the stuffing box, or oil level has been checked for units with mechanical seals as indicated in the relevant section "Seal chamber connections".
5. All rotating parts are found to be free when turned by hand.
6. Driver has been checked for correct rotation.
7. Pump is primed. Never run a pump dry. The liquid in the pump serves as a lubricant for close running surfaces within the pump and these may be damaged if operated dry for extended periods. If installed with suction lift, the pump may be primed by using an ejector or vacuum pump. Vertically installed solids handling pumps will prime automatically by having the impeller tongue submerged in liquid provided air evacuation through pump casing at ambient atmospheric pressure is allowed.
8. Inspect suction chamber to see that all debris from construction has been removed.
9. As momentum of inertia of the impeller is small, full load and full speed are reached within one second. Therefore, if reduced voltage starters are used (star delta) the time adjustment between star to delta should be no longer than two to three seconds.

## **SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.**

### **STARTING**

While the pump is running, an initial then periodic inspection should be made of:

1. Stuffing box or mechanical seal (refer to section entitled "Operating instructions for solids handling pumps with stuffing box" or "Operating instruction for solids handling pumps with mechanical seal").
2. Bearing temperature should not exceed 90°C.
3. Alignment: Successful operation of the pump depends on accurate alignment. It is recommended to recheck the alignment after initial run, then one week later.
4. Lubrication: According to section entitled "Lubrication Instructions".

### **SHUTDOWN**

To shut the pump down:

1. Disconnect power to the driver.
2. Close all valves.
3. Close seal water supply, if installed.
4. If the pump is to be out of service for a period longer than two weeks, the shaft must be rotated several times every two weeks to assure positive coating of lubricated surfaces.
5. If subject to freezing, the pump must be drained and blown down with compressed air. Also consult section entitled "Operating instructions for solids handling pumps with stuffing box" or "Operating instructions for solids handling pumps with mechanical seal".

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

### OPERATING TROUBLES

The following table is provided as a guide to common operating troubles and their causes. Should the trouble continue, consult your HIDROSTAL representative.

PROBABLE CAUSES	NO LIQUID DELIVERED	NOT ENOUGH LIQUID DELIVERED	NOT ENOUGH PRESSURE	LOSS OF CAPACITY AFTER STARTING	VIBRATION	MOTOR RUNS HOT	CAVITATION (NOISE)	BEARING TEMPERATURE ABOVE 90°
1. Pump not primed	x							
2. Speed too low	x		x					
3. Speed too high						x	x	
4. Air leak on suction	x	x		x	x		x	
5. Air leak in mechanical seal or stuffing box		x		x				
6. Air or gas in liquid	x	x	x	x	x		x	
7. Discharge head too high (above rating)	x	x			x			
8. Suction lift too high				x	x		x	
9. Not enough suction pressure for hot liquid		x			x		x	
10. Inlet pipe not submerged enough	x	x	x	x	x		x	
11. Viscosity of liquid greater than rating		x	x			x		
12. Liquid heavier than rating						x		
13. Excessive suction head	x	x		x	x		x	
14. Impeller clogged	x	x			x			
15. Wrong direction of rotation	x	x	x					
16. Excessive running clearance		x	x					

# **SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.**

PROBABLE CAUSES	NO LIQUID DELIVERED	NOT ENOUGH LIQUID DELIVERED	NOT ENOUGH PRESSURE	LOSS OF CAPACITY AFTER STARTING	VIBRATION	MOTOR RUNS HOT	CAVITATION (NOISE)	BEARING TEMPERATURE ABOVE 90°
17. Damaged impeller		x	x		x			
18. Rotor binding						x		
19. Defects in motor							x	
20. Voltage lower than rating							x	
21. Incorrect lubrication								x
22. Foundation not rigid					x			
23. Misalignment of pump and driver					x	x		
24. Bearings worn					x			x
25. Impeller out of balance					x			
26. Shaft bent					x	x		
27. Impeller too small			x					
28. Suction line clogged	x	x	x					
29. Suction flange not sealed, hard gasket	x	x	x		x		x	
30. Impeller rubbing against suction belt					x	x		
31. Thick sludge and small impeller clearance						x		
32. Gas accumulation behind impeller on vertical inst.	x			x				
33. Pump does not prime - Vertical	x							

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

### MAINTENANCE OF HYDRAULIC PARTS

#### IMPELLER CLEARANCE ADJUSTMENT FOR WEAR

After some time of operation, the impeller and suction cover (or liner) may have worn, increasing the impeller gap. The impeller gap should be checked and re-adjusted whenever a significant decrease in pump performance is noticed, or at least once every year (until a history is developed at each different application to indicate how often adjustment will be required). Adjustment is most critical on high-pressure pumps (D3, E4, F4, H5, I6, L8), and least critical on low-pressure pumps.

Excessive clearance is not desirable especially in the smaller pump sizes, as a greater percentage of total flow can thus recirculate causing a drop in performance. Conversely, less clearance than the minimum listed can overload the motor and/or cause vibration due to too great a friction in between the impeller and the suction cover.

When pumping thick sludges or viscous material, larger clearances may be necessary to avoid friction, larger clearances may actually increase flow capability. Therefore, for thick sludges and high consistency materials, double the clearances in Figure 14 should be used.

Some pumps are easily adjusted by means of a movable liner (421); its position is regulated by three external regulator nuts (446) found on the suction casing (416) volute or casing (400). These pumps are designated "Regulable", and include the letter R or C in the pump code on the nameplate.

Other pumps have a one-piece suction cover (402) (or in pumps D3K and D4K, a fixed liner (421)); these pumps are adjusted by changing the thickness of the shims (411) between the motor and the volute casing (400).

Examine your pump for presence or absence of the regulator nuts, and proceed to the corresponding section of these adjustment instructions.

Loosen fasteners (419), and place shims of calculated thickness between motor and volute casing. (Shims may be washers of uniform thickness, or U-shaped shimstock - these must be placed under each fastener (419). Thin shims may be a single piece of steel wire - diameter equal to calculated thickness - wrapped all the way around motor, under the studs (419); ends can be bent outward around last studs (419), to avoid overlapping.

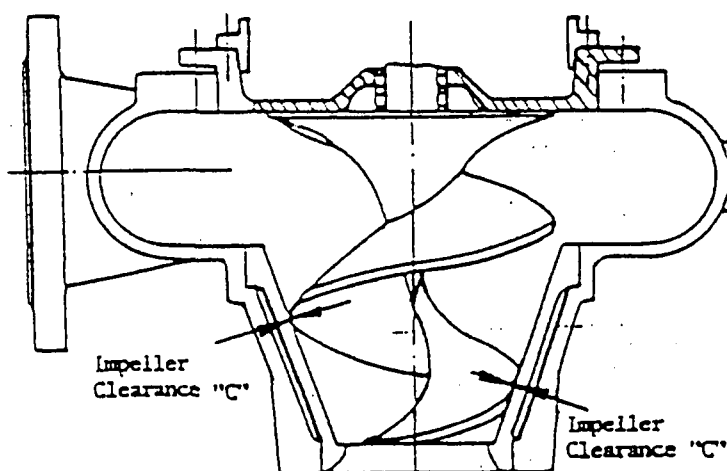
Tighten fasteners (419) again, and with a feeler gauge, check the actual clearance between impeller and liner (reaching in through the handhole cover (405) or through the suction of the pump). If the clearance is significantly different than "C" shown in column 2 of Figure 14, it is possible that the wear is excessive or not uniform: Disassembly and inspection is recommended.

If this adjustment procedure does not restore original pump performance, disassemble hydraulic end per following section to examine for uneven or excessive wear on impeller or suction cover/liner, and replace worn parts as necessary.

**SERVICE MANUAL FOR INSTALLATION AND  
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PUMP TYPE	CLEARANCE C(MM)	TRAVEL OF THE REGULATOR NUT B (mm)	APPROX. NO OF TURNS FOR REGULATOR NUT
D3K/D4K	0.35		
E 5 K	0.6	1.12	2/3
E8K-LS/LL			
E8K-HD/SS		1.55	1
F 6 K			1/2
F 6 K	0.5	1.40	1
F 10 K		1.93	1-1/3
H 5 K		0.85	1/2
H 8 K		1.67	1-1/6
H 12 K	0.6	2.32	1-1/2
I 6 K		1.02	2/3
I 10 K		2.09	1-1/3
I 16 K	0.75	2.90	2
L 8 K		1.28	5/6
L 12 K		2.51	1-2/3
L 20 K	0.9	3.48	2-1/3

Figure 14



**NOTE:** Clearance "C" should be checked along entire impeller edge, and again after rotating impeller 1/4, 1/2, and 3/4 turns.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

### DISASSEMBLY OF HYDRAULIC PARTS

#### DISASSEMBLY FOR INSPECTION

For the following steps the casing-suction cover assembly should be placed with the suction flange flat on the floor or workbench, and the motor-impeller assembly removed or lowered into place from above by a suitable hoist.

The rotating assembly including impeller and motor can be lifted from the pump casing after removing nuts (419) around the motor flange. Areas to be examined for wear will be the impeller surface (especially the edges) and the conical machined surface in the liner or suction cover. Uniform wear on any of these surfaces can, up to a point, be compensated for by re-shimming or adjusting according to Section 3.1 of this manual. However, excessive or uneven wear will require replacement of the worn parts.

#### REMOVAL OF IMPELLER

Hold the impeller (401) from turning by hand, or by a strap wrench, or by locking pliers clamped to the impeller. Inset a hexagonal key wrench (allen-head wrench) into the impeller bolt (415) and with a hammer, tap the wrench counterclockwise to loosen the bolt.

#### WRENCH SIZES

Pump size:	D	E	F	H	I	L
Wrench size:	8mm	10mm	14mm	19mm	27mm	27mm

After removal of bolt, the impeller can be tapped loose from its fit against the impeller flange (165) by a few taps with a rubber mallet.

**NOTE:** For pumps D3K, D4K-HS/S and E4T, the impeller is fitted directly onto the shaft taper (no impeller flange is used).

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

### IMPELLER CLEARANCE ADJUSTMENT FOR NON-"REGULABLE" PUMPS

Adjustment is accomplished by moving the motor inward toward the volute casing. For the following steps it has proven easiest that the casing-suction cover assembly be placed with the suction flange on the floor or work bench, and the motor-impeller assembly be removed or lowered into place from above by a suitable hoist.

Loosen all fasteners (419) between motor and volute casing. Remove shims or shim wire.

To estimate correct shim thickness, lower motor into casing just until impeller cannot be turned. Measure gap between motor and volute casing at several places around motor flange and take average. Now add the distance "B" shown in column 3 of Figure 14 to the average gap measured, this will be the approximate shim thickness required to obtain correct clearance "C" shown in column 2 of Figure 14.

NOTE: If impeller tip is binding on suction lip, see Section 3.3.6.

### REMOVAL OF LINER OR SUCTION COVER

#### (a) FOR D3K, D4K & E4T

These pumps have a non-adjustable liner (421) held in a fixed position inside a one-piece volute casing. After removal of the three allen-head setscrews (418), this liner can be pressed out of the casing. See Figure 15.

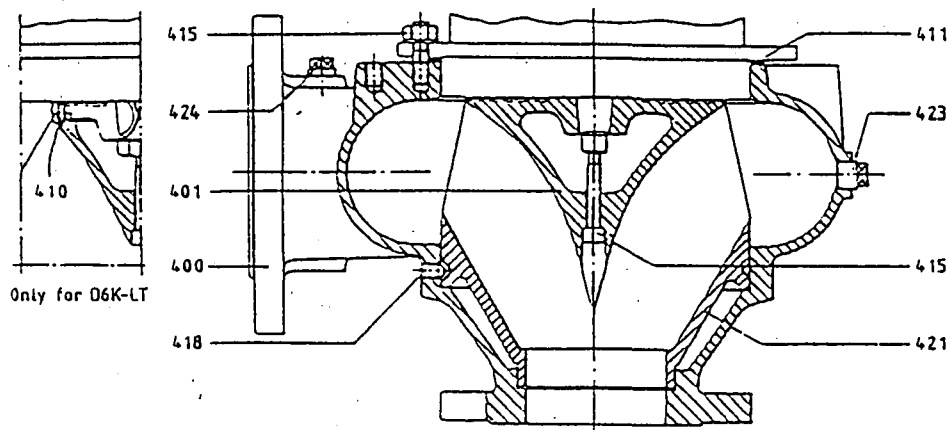


Figure 15 D3K, D4K, E4T

# SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

## (b) FOR ALL OTHER PUMPS WITHOUT "REGULABLE" FEATURE

These pumps have a one-piece suction cover (402) which is bolted to the volute casing (400) by studs and nuts (417). Adjustment of clearance is by shims (411) between the volute casing and the motor. Note that on certain models there may be a spacer ring (414) between mating surfaces of the suction cover and the volute casing. When there is excessive wear on the conical surface, the suction cover (402) should be replaced. See Figure 16.

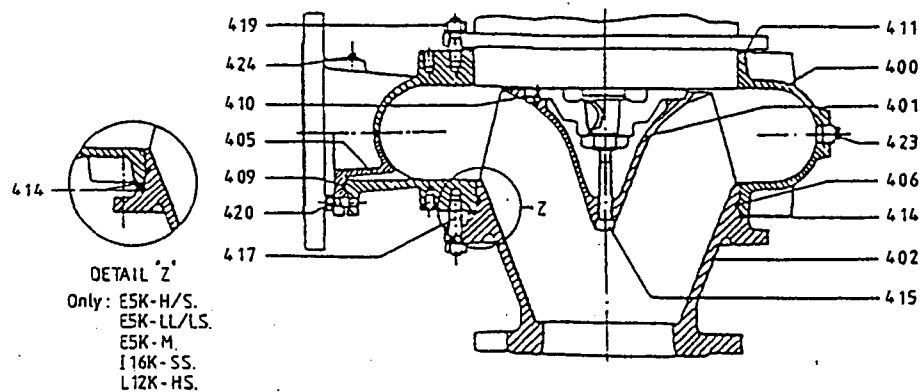


Figure 16: E5K, E8K, F6K, F10K, H8K, H12K, I10K, I16K, L12K, L20K: Non-Regulable.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

### ASSEMBLY OF IMPELLER

Place the impeller (401) onto impeller flange (165) of motor so that the pin (410) on back of impeller will fit into the corresponding hole on the flange. (Note: Replacement impellers are always supplied with pin (410) already installed).

Before fitting a new impeller (or a new impeller bolt), the length of the impeller bolt should be checked as follows:

1. Place impeller onto impeller flange (or onto shaft taper for pumps D3 or D4), and using a thin rod measure distance from end of shaft to the step in the impeller bolt-hole. Remove impeller.
2. Now measure impeller bolt length, from tip to underside of head, and subtract 1 1/4 times the bolt diameter. If remaining distance is shorter than (1) above, a longer impeller bolt is needed, to ensure adequate engagement of threads.
3. Now screw impeller bolt into shaft end as far as it will go without excessive force, and measure distance from shaft end to underside of bolt head. If this distance is longer than (1) above the bolt must be shortened, (to ensure that the bolt pulls the impeller tight against the impeller flange before the bolt "bottoms out" in the shaft threads). If the impeller bolt must be shortened a significant amount, check if the threads on the bolt also must be re-cut to permit the required assembled length.

**NOTE:** Impellers for pumps D3K, D4K-HS/S and E4T mount directly to the motor shaft (no impeller flange is used). Coat shaft taper with alight oil **ONLY** (do NOT use grease or anti-size compound here), then install impeller directly into shaft.

### TIGHTNESS TEST FOR LOWER MECHANICAL SEAL (All Types)

Remove oil plug "Oil" (536). This test assumes that oil has been previously drained from the motor. Connect dry compressed air source such as bicycle tyre pump to the opening. Use a pressure reducing valve and relief valve set to 7 psi (1/2 bar).

#### CAUTION:

**MAKE SURE THAT THE PRESSURE NEVER EXCEEDS 1 BAR. THIS COULD DISPLACE THE SEAL. DO NOT IMMERSE END OF CABLE.**

**IMMERSE THE MOTOR INTO A TEST TANK FULL OF WATER AND WATCH FOR CONTINUOUSLY ESCAPING BUBBLES. THIS WOULD INDICATE LEAKAGE PAST THE SEAL OR ASSOCIATED "O"-RING. CORRECT FAILURE IF LEAKAGE HAS BEEN FOUND. AFTER FINISHING TIGHTNESS TEST REMOVE PRESSURE CONNECTION HOSE AND FILL WITH OIL ACCORDING TO SECTION 2.2.3.1 OR 2.2.3.2.**

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

### ASSEMBLY OF IMPELLER FLANGE (Where Used)

Put in Woodruff key (112), coat the shaft taper with an anti-rust paste, put on the impeller flange (165), the locking washer (167) and the nut (166).

The impeller flange nut must be tightened to 12 mkp (90 ft-lbs) by using torque wrench. Bend over locking washer tab. Measure the clearance between the impeller flange (165) and the housing (507) with a feeler gauge. This clearance must be within the values given in the table below. If ever the clearance has to be adjusted, this can be done by inserting or revising shims between oil chamber casing (504) and seal chamber (507) close to fastening sets (534). See arrow, Figure 31.

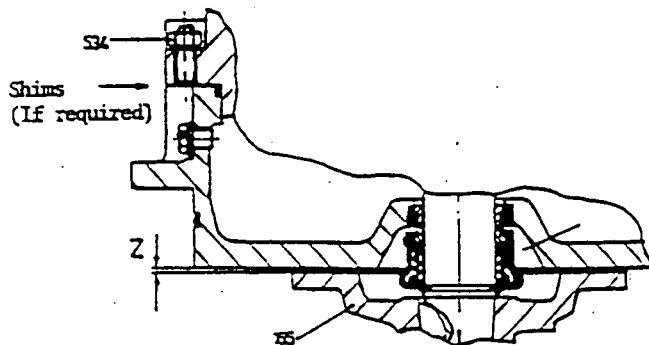


Figure 31

Coat the impeller bolt with grease or anti-seize compound. Install and tighten to following torque:

For Hi-chrome steel bolt (used with cast iron impeller) -

Pumpsize:	D	E	F	H
Torque(ft-lb):	32	56	140	510
(n-m):	44	77	190	700

for 316 stainless steel bolt (used with stainless steel impeller) -

Pumpsize:	D	E	F	H
Torque (ft-lb):	32	56	56	280
(n-m):	44	77	77	380

**NOTE:** If torque wrench not available, correct tightness can be approximated by hitting long end of standard L-shaped allen wrench with several sharp hammer blows.

**SERVICE MANUAL FOR INSTALLATION AND  
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NON REGULABLE/MECHANICAL SEAL.**

**REPLACEMENT OF LINER OR SUCTION COVER**

**(a) FOR D3K, D4K,E4T (See Figure 15)**

Carefully position liner (421) into one-piece casing (400); tap into place with lead hammer, or use hydraulic press (No "O"-rings are used between liner and casing). Fasten liner in place with three setscrews (418); use thread-sealant on these setscrews to avoid possible leakage.

**(b) FOR ALL OTHER PUMPS WITHOUT "REGULABLE" FEATURE:  
(See Figure 16)**

Place spacer ring (414) over spigot of suction cover (402), then grease and install "O"-ring (406) into groove on suction cover.

Install suction cover into casing opening, on the side of the casing where the cast-in arrow points counter-clockwise.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR K-LINE BEARING FRAME PUMPS. NON REGULABLE/MECHANICAL SEAL.

### CAUTION:

SINCE BOTH SIDES OF THE VOLUTE CASING ARE MACHINED IDENTICALLY IN SOME MODELS, IT IS POTENTIALLY POSSIBLE TO ASSEMBLE THE PUMP WITH THE VOLUTE CASING BACKWARDS. PAY PARTICULAR ATTENTION TO THE ARROW DIRECTION AS DESCRIBED ABOVE.

FASTEN SUCTION COVER TO CASING WITH FASTENING SET (417).

### FINAL ASSEMBLY

**NOTE:** (Whenever a new impeller is fitted, without also replacing the liner or suction cover at the same time, the following clearance check must be done: Install impeller-motor assembly into volute casing assembly. If the tip of the impeller touches the suction ring (408) or the lip in the liner (or suction cover) - or if there is less than 1mm clearance between the tip and the lip when the spiral edge of the impeller is firmly seated against the conical taper inside the liner (or suction cover), then the impeller tip must be ground off - parallel to the suction flange - until 1 to 2mm clearance is obtained. See Figure 32).

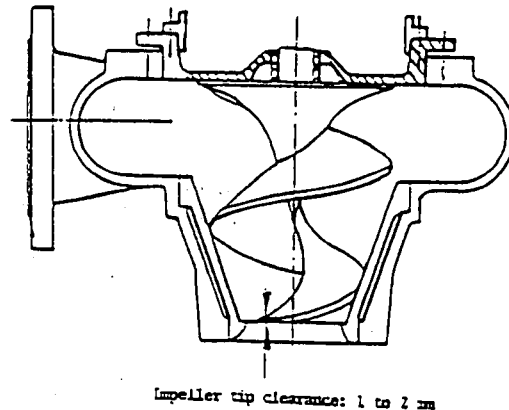


Figure 32

If (411) is a spacer ring in lieu of shims place this ring over the spigot of the motor.

Grease "O"-ring (209) and place into groove on spigot of motor.

Now install motor-impeller assembly into volute casing. Install and tighten nuts (416).

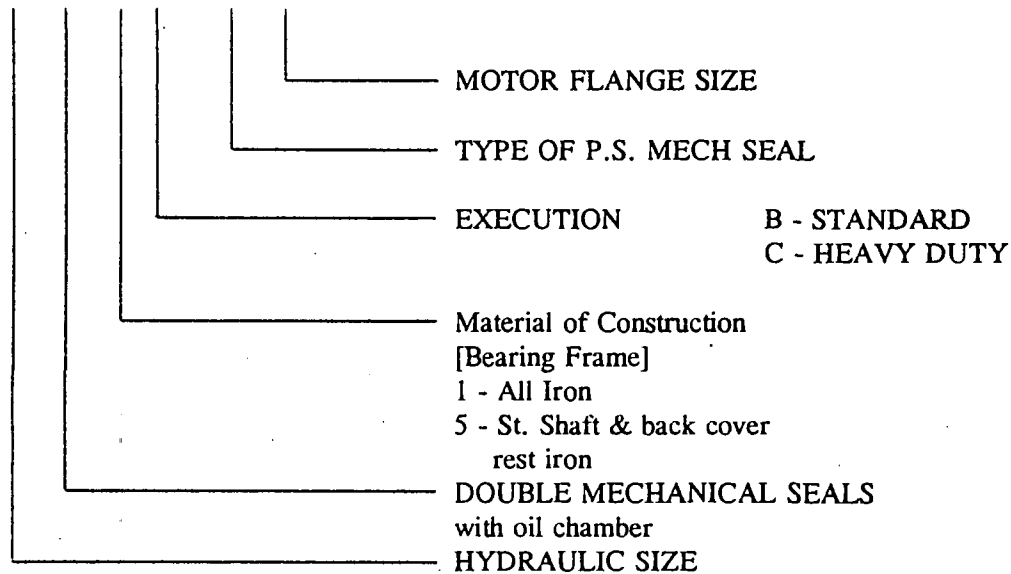
Proceed to Section 3.1 of these instructions for correct setting of regulator nuts - or for placement of shims (411) - for final adjustment of impeller clearance.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### PUMP CODE EXPLANATION

The HIDROSTAL pump code shown on the nameplate and referred to on our order confirmation uniquely defines all features of the pump. It is essential to give the complete data shown on the nameplate when enquiring about spares or services.

**B DM 1 B - M 112**

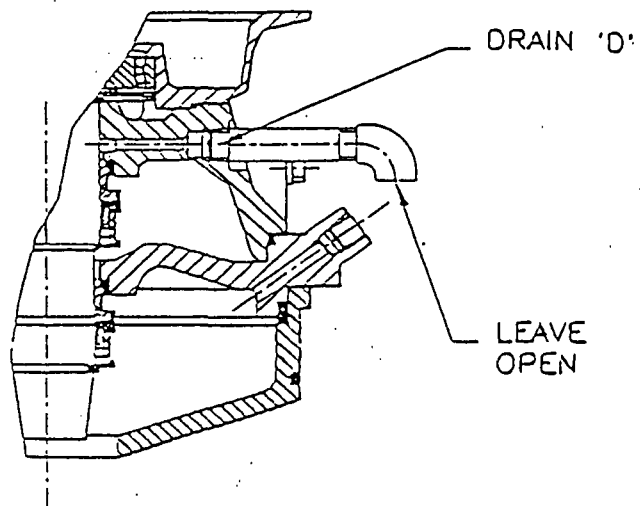


{2} For further detail see sectional drawing and parts list for Hydraulic end.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

On vertical units the drain can be in any position relative to the discharge nozzle.

When installed in dry environment, the drain can be left open. When installed out-doors, or in a situation where water could spray onto the bearing frame, i.e. when washing down, an elbow should be fitted to prevent ingress of casual water.



### Connection 163

On bearing frame

BDM.B - .112] For 112

DDM.B - .112] Frame flange

EDM.B - .122] Mounted motor

This is permanently plugged and is not required for these bearing frames. On larger, heavy duty versions, this connection provides a greasing point for the bearings. [Pos 131].

### Connection 131

Greasing point for bearings. SEE SECTION DEALING WITH "BEARING LUBRICATION" for full details.

This is applicable to bearing frames:-

BDM.B - .132 ]

DDM.B - .132 ] For 132 frame flange mounted motors

EDM.B - .132 ]

DDM.C - .160/180 ]

EDM.C - .160/180 ] For 160/180 frame flange mounted motors.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### 3.0 BEARING LUBRICATION

The following bearing frames are factory greased on assembly and require no further additions of grease between major overhauls. In this instance Connection 163 is permanently plugged.

<u>BEARING FRAME</u>	<u>SECTION DRAWING</u>
BDM.B - .112	90 - TU 4125
DDM.B - .112	90 - TU 4128
EDM.B - .112	90 - TU 4131

\_\_\_\_\_ digit indicates type of mech. seal [515]

\_\_\_\_\_ digit indicates materials of construction

We recommend all major overhauls are carried out in a Hidrostal authorised repair centre.

The following bearing frames require periodic greasing according to table below:

BEARING FRAME	SECTION DRAWING	RPM	LUBRICATION INTERVAL HOURS	AMOUNT OF GREASE [GRMS]
BDM.B - .132	90 TU 4126	3000	1000	3
DDM.B - .132	90 TU 4129	3000 1500	1000 1000	3 2
EDM.B - .132	90 TU 4153	1500	1000	2
DDM.C - .160/180	90 TU 4130	3000 1500	500 1000	3 3
EDM.C - .160/180	90 TU 4154	1500	1000	3

The factory grease the bearings with the following grease and we recommend that, where possible, the same grease is used for periodic greasing. STABURAGS NBU 8 EP by Kluber-Lubrication. Available in Great Britain from:-

Kluber Lubrication  
Hough Mills, Northowram, Halifax HX3 7BN  
Tel: 0422 205115  
Fax: 0422 206073

When it is not possible to use this grease, a grease of a similar specification should be used.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

STABURAGS NBU 8 EP by Kluber-Lubrication.

This grease is of a mineral oil base containing a barium complex as thickener.

Typical characteristics:

Colour	beige	
Apparent dynamic visco. [approx]	6000	mPas
Operating temp. range	-30..150	°C
Max. temp [short time]	170	°C
Consistency class [NLGI]	2	
Penetration DIN ISO 2137 [0.1 mm]	280	
Dropping point DIN ISO 2176	>220	°C
Corrosion protection DIN 51802	0	
RPM-parameter [n x d m]	5 x 10s	

STABURAGS NBU 8 EP is:-

### Rolling Bearing High Pressure Grease

suitable for long-life lubrication under high specific bearing loads and for the protection against unusual bearing wear. Proven for vehicle motors, axle bearings, electric motors, pumps and above all for taper roller bearings.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### 4.0 CHECKING OF SEAL OIL

The condition of the Seal Oil gives a direct indication as to the condition of the product side mechanical seal. {Pos 515}.

An oil condition check must be made after the first 1000 hours of operation and once a year thereafter. Or more frequently, if site experience indicates.

Immediately before checking the oil, either run the pump for a few minutes or if the pump has been removed from site shake the pump to distribute any impurities through the oil.

**NOTE:** Before proceeding to check the oil condition, carefully clean the area around the oil-sight-glass and the oil plugs 536a and 536b.

#### IMPORTANT

When a bearing frame is fitted with an oil-sight-glass it should only be used to obtain a quick visual indication as to the oil condition. It should not be regarded as an indication of the correct oil level.

The correct oil level is above the level of the sight-glass for both horizontally and vertically mounted pumps and, as long as oil level surface cannot be seen through the sight glass it can be regarded as having sufficient oil for satisfactory operation, even though it may be nominally below the original fill level.

If the oil appears through the sight-glass to be relatively clean a small sample of oil should be removed from the bearing frame through plug 536b into a suitable container and examined. If the oil is clear, there is no problem with the pump side seal [Pos 515] and the removed oil can be refilled into the chamber, [Pos 515] and plug 536a and the oil topped up, using the correct grade of oil to the required level.

If the oil appears through the sight-glass to be somewhat milky, dirty, or the oil level is not apparent, a full oil check must be made by draining all of the oil through the plug 536b into a suitable container and examined.

If the oil is relatively clean and the water readily separates from the oil, the separated oil can be returned to the oil chamber and topped up with the same grade of oil to the required level. In this case it is advisable that the seal oil is then checked after a further 500 hours of operation.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

However, if too much water has entered the oil the viscosity will be much higher - as thick as motor oil or even thicker. In such cases it can be concluded that the pump side mechanical seal [Pos 515] must be repaired or replaced, which is best undertaken in an authorised workshop.

If there is a small quantity of water in the oil, but the oil is otherwise clean, it does not indicate a failure of the mechanical seal, as it is possible that a small quantity of water passed through the seal during the initial running-in period.

If the oil is dirty, or there has been a significant loss of oil, then it is recommended that the pump is removed to a workshop so that the mechanical seal assembly can be carefully examined.

If the oil level is at, or below, the sight-glass then there has been significant leakage of oil and the pump side mechanical seal 515 may require replacement, particularly if no oil leakage has been observed through drain connection "D". In this instance the pump should be scheduled for a workshop overhaul in the very near future.

**NOTE:** When re-installing plugs 536a and 536b always use a new copper sealing washer. The copper sealing washer must be softened as follows:-

Heat until red and quench immediately in cold water.

### SUMMARY

<u>OIL CONDITION</u>	<u>ACTION</u>	
Oil is clean	Top up to correct level*	PUMP INSITU
Oil is milky	Drain oil, separate water refill separated oil. Top up to correct level* with same grade of oil CHECK AGAIN AFTER 500 HOURS	PUMP INSITU
Oil looks dirty but of low viscosity and free of sludge [Small amount of dirty liquid dis- colours oil}	Completely drain old oil, flush out, refill* with new grade of oil CHECK AGAIN AFTER 500 HOURS	PUMP INSITU
Seal Oil Very Dirty	Remove pump to authorised workshop for inspection.	
Seal oil Below Sight-glass	Remove pump to authorised workshop for inspection	

\*SEE SECTION COVERING 'CHANGING SEAL OIL WITH PUMP INSITU' FOR  
METHOD OF DETERMINING CORRECT OIL LEVEL.

## **SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS**

### OIL QUANTITIES

To refill the seal oil chamber to the required level the following oil quantities can be used as a guide:-

### BEARING FRAME

BDM1B 0.9 - 1.0 litres

DDM1B 0.9 - 1.0 litres

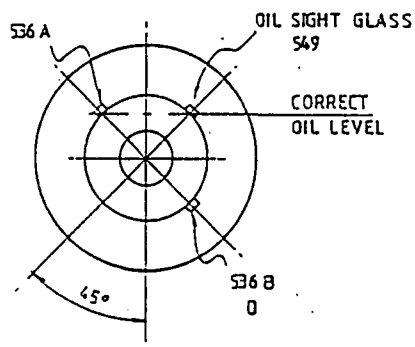
EDM1B 1.2 - 1.3 litres

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### CHANGING SEAL OIL ON INSITU HORIZONTAL PUMPS

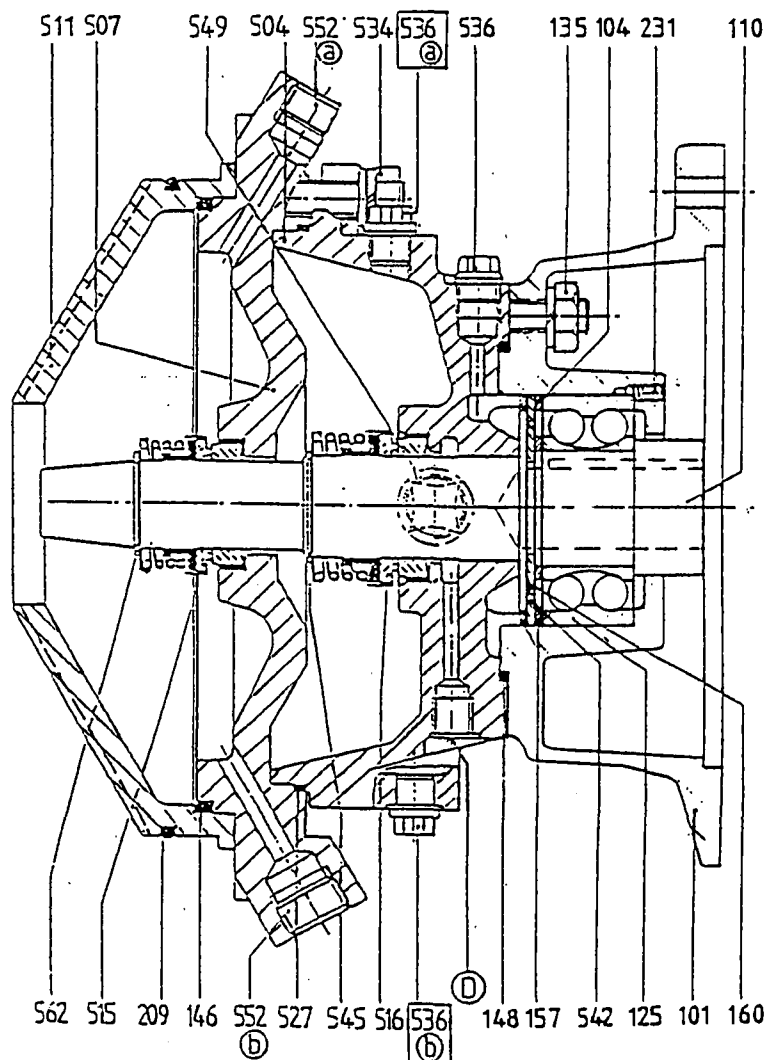
For horizontally installed pumps the oil can be drained via Plug 536b into a suitable container.

To refill the oil disconnect the bearing frame from the volute end, turn the bearing frame so that Plug 536a and the sight-glass [when fitted 549] are both lying at 45 degrees from the vertical [see sketch]. The oil should be refilled using Plug 536a and the correct level for the refilled oil is when the level is at the centre of the sight-glass, which is also the same level of the filling hole 536a.



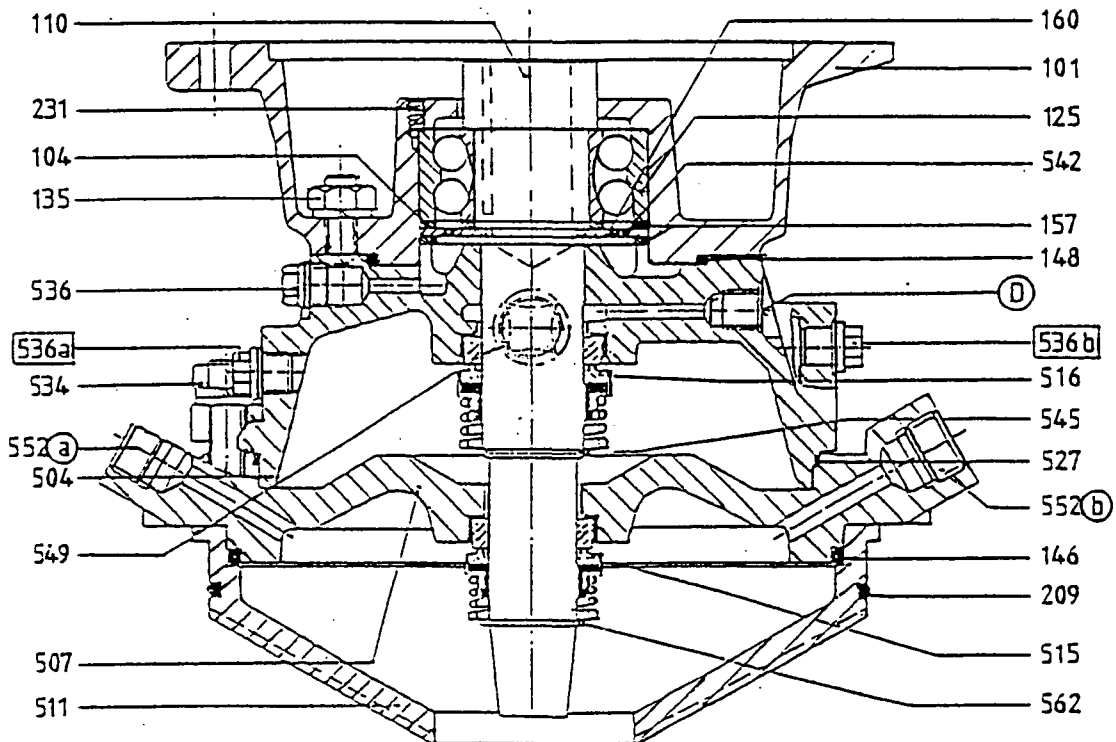
At this level the chamber is 90% full and leaves the required air space.

Re-install plugs 536 using a new softened copper seal [see note above] and re-install the bearing frame to the pump with Plug 536a on the top. Continue to monitor seal oil condition by visual inspection through the sight-glass.



### CHANGING SEAL OIL ON INSITU VERTICAL PUMPS

The oil must be removed by firstly draining down to the level of 536b and then using some means to remove the remaining oil below the level of Plug 536b. This could be done by either using a rubber tube as a syphon or by employing some form of suction device. This is best undertaken after removing plug 536a.



Having removed all the old oil, flush with a little clean oil and refill with clean oil up to the level of 536a.

#### **IMPORTANT**

It is important the correct sectional drawing is studied to determine Plug 536a. The level of this plug ensures the correct air space is left above the oil. If connection 536b is used this would not be the case.

Plugs 536a and 536b should be replaced using a soft copper washer.

Continue to monitor seal oil conditions by visual inspection through sight-glass.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### SEAL OIL SPECIFICATION

#### GENERAL

The factory fill the seal oil chamber on double-mechanically sealed close-coupled pumps with the same low viscosity oil used for cooling systems on immersible motors.

#### TYPICAL ANALYSIS

Specific gravity at 20°C	0.812 g/ml
Viscosity at 20°C	6.75 mm <sup>2</sup> /s [cst]
Viscosity at 40°C	3.52 mm <sup>2</sup> /s [cst]
Solidification point	-38.0°C
Flash point	132.0°C
Burning point	142.0°C
Evaporation energy	251.0 kj/kg
Solubility in water	none

For installations which are exposed to temperatures far below freezing point [e.g. outdoor installations], the solidification point is very important.

#### IMPORTANT FEATURES FOR APPLICATION IN PUMPS

Instead of this oil, another oil or even another liquid can be used. When selecting an alternative cooling medium the following features must be considered.

1. The viscosity may not be higher than indicated by ISO VG.
2. Emulsification with water is not acceptable, as water penetration could not be detected.
3. Corrosion resistance and non-aging quality are required.
4. Following temperatures must be considered:-
  - Solidification point and lowest possible surrounding temperature
  - Boiling point and highest possible temperature of pumped liquid.
5. In case of Bearing Frames equipped with electrical moisture probes, it is important that the liquid has good electric insulation qualities.

## **SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS**

### **LIST OF OIL SUPPLIERS**

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

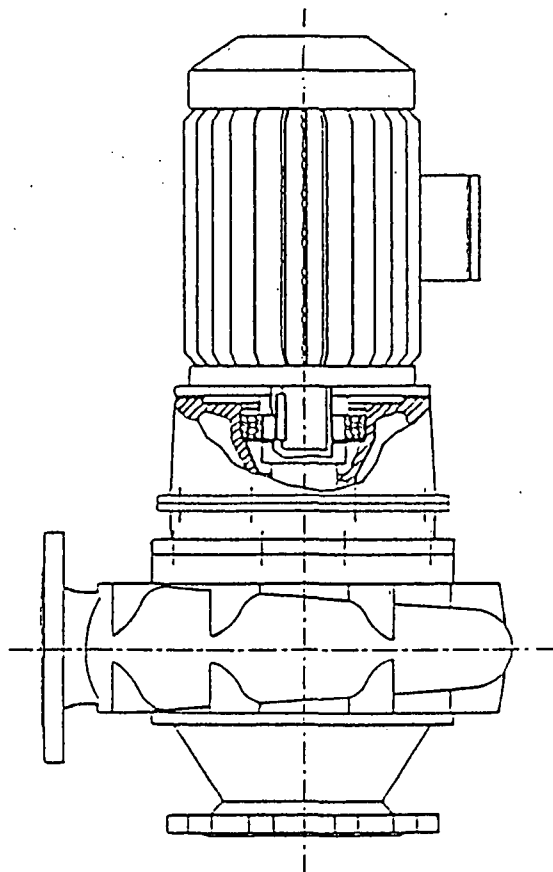
### 5.0

#### INSTRUCTIONS FOR FITTING MOTORS TO CLOSE-COUPLED PUMPS

Prior to commencing fitting of motor rotate impeller by hand to ascertain the degree of drag due to bearing and mechanical seals. This will assist in checking no increase in drag has occurred due to a badly fitted motor.

The motor should be assembled to the pump with the shaft vertical.

- a) Prior to commencing assembly carefully degrease and deburr motor shaft and key way.
- b) Deburr key way in hollow pump shaft, paying particular attention to run out at bottom of key way.
- c) The motor should be lowered slowly into the pump until the motor shaft engages into the hollow pump shaft, [Pos 110], ensure that the two shafts slide freely together with the key in position and that no undue force is necessary.
- d) Continue to lower the motor until the spigot on motor flange engages, then hold motor with a small axial clearance between motor flange and bearing casing [Pos 101].



Measure the axial clearance at the four motor fixing points using feeler gauges.

If there is a difference of more than 0.1mm [4/1000"] between the measurements, shims must be placed between the motor flange and bearing housing so that motor sits square onto the bearing housing. Failure to do this will preload the pump and motor bearings.

With shims in place tighten securing bolts.

If the motor should be removed at any time or replaced, repeat above instructions.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### FITTING MOTORS TO CLOSE-COUPLED PUMPS, CONTINUED

#### IMPORTANT

NEVER PUSH OR FORCE MOTOR SHAFT INTO HOLLOW PUMP SHAFT.

NEVER CLOSE UP A GAP BETWEEN PUMP AND MOTOR FLANGES BY TIGHTENING MOTOR FLANGE SECURING BOLTS. THIS WILL PRELOAD BEARINGS

BE CAREFUL KEY DOES NOT RIDE-UP ONTO RUN-OUT OF KEYWAY ON MOTOR.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### ADJUSTMENT OF BACK CLEARANCE "B"

Experience in the field has indicated that very little wear takes place between the back of the impeller and the back cone [Pos 511] and factory tests have shown that even with quite large back clearances "B" there is only a marginal effect on pump performance.

In most instances adjustment of this back clearance will be unnecessary between major overhauls. The factory build the pumps with "B" according to the dimensions shown in the table and in most instances it will be reasonable to allow this clearance to open up by 1-2mm. However, should it become necessary to reduce this clearance, shims should be placed between the back cone [511] and sealplate [507]. This might be particularly necessary if the pump is handling fibrous material which may become trapped between the impeller and the back cone.

The back cone is considered worn when; the spiral groove is heavily worn and is barely visible or has disappeared altogether. If the spiral groove is still clearly visible but the corners have become somewhat rounded, the pump will still operate at its design flow rate and head, but the cutting action of the impeller against the back cone will be somewhat reduced and if handling fibrous material it maybe worth considering replacing this back cone particularly if jamming of the material between the impeller and the cone has become a problem.

### REMOVAL OF IMPELLER

Hold the impeller [401] from turning by hand, or by a strap wrench, or by locking pliers clamped to the impeller. Insert a hexagonal key wrench [allen-head wrench] into the impeller bolt [415] and with a hammer, tap the wrench counterclockwise to loosen the bolt.

#### Wrench sizes

Pump Size:	B	DDM1B	DDM1C	E
Wrench Size:	10	10	14	14

After removal of bolt, the impeller can be tapped loose using a plastic hammer, rap the impeller face [NOT edge or tip!] to free it from the shaft taper. If it does not pop-off the taper after a few sharp raps, then heat the hub of the impeller [near the impeller bolt hole] with a soft-flame torch, then rap again.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

Before fitting a new impeller [or a new impeller bolt], the length of the impeller bolt should be checked, as follows:-

- 1) Place impeller into shaft and using a thin rod measure distance from end of shaft to the shoulder in the impeller bolt-hole. Remove impeller.
- 2) Now measure impeller bolt length, from tip to underside of head and, subtract  $1\frac{1}{4}$  times the bolt diameter. If remaining distance is shorter than [1] above, a longer impeller bolt is needed, to ensure adequate engagement of threads.
- 3) Now screw impeller bolt into shaft end as far as it will go without excessive force and, measure distance from shaft end to underside of bolt head. If this distance is longer than [1] above, the bolt must be shortened, [to ensure that the bolt pulls the impeller tight against shaft before the bolt "bottoms out" in the shaft threads]. If the impeller bolt must be shortened a significant amount, check if the threads on the bolt must be re-cut to permit the required assembled length.

NOTE: Coat shaft taper with a light oil ONLY [do not use grease or anti-seize compound here], then install impeller directly onto shaft.

Coat the impeller bolt with grease or anti-seize compound. Install and tighten to the torque listed below:

### FACTORY FITTED IMPELLER BOLTS

HYDRAULIC	SIZE	HEXAGON	TORQUE N-M
B050 D050] D080] DDM1B D100]	M12	10	60
D050] D080] DDM1C D100]	M16	14	147
E080] E125] DDM1C E200]	M16	14	147

NOTE: If torque wrench not available, correct tightness can be approximated by hitting long end of standard 'L'-shaped allen-wrench with several sharp hammer blows.

## **SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS**

### **REPLACEMENT OF BACK CONE [Pos 511].**

Firstly, remove impeller as previously described. The back cone [Pos 511] is an easy fit onto seal plate [Pos 507] and should remove easily, any resistance will be caused by the interference of 'O'-ring [Pos 146].

To replace back case, grease a new 'O'-ring [Pos 146] and fit onto spigot of seal plate [Pos 507]. Hand press a new back cone into place. On the larger sizes, a light tap with a plastic hammer maybe required to overcome the resistance of the 'O'-ring.

### **FINAL ASSEMBLY**

After fitting a new impeller and/or liner, the correct impeller clearance should be set by following the steps defined in "Adjustment of Impeller Clearance for Wear" taking particular care to check and, if necessary, adjust the impeller tip clearance.

### **IMPORTANT**

Should a complete strip-down of the pump be required and mechanical seals need replacing, we recommend this work is done in a HIDROSTAL authorised repair centre, who will have complete repair manuals and any special tools and facilities necessary to properly assembly and re-assembly the pumps.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### 7.0

#### DISASSEMBLY

- a) Remove hydraulic end as described in "Maintenance of Hydraulic Parts".
- b) Remove both 'mechanical seal' seals, as previously described in this section.

To remove shaft and bearing assembly from bearing housing [Pos 101] proceed as follows:-

- c) Remove oil chamber casing [504] if still fixed to [101], taking care not to damage the stationary mech seal face. Press shaft and bearing assembly from motor end out of bearing housing [101].
- d) If bearings are to be replaced remove from shaft using pullers or press - depending on facilities available in workshop.

#### AFTER DISASSEMBLING

Wash all lubricants from bearings and bearing housing with kerosene, and dry bearings by thoroughly spinning by hand or gently with clean and dry compressed air. Replace bearings if they do not rotate freely or its running surfaces show signs of deterioration. Coat bearings with a rust preventive oil and wrap in protective paper.

Mount shaft [110] between two centres and using a dial indicator, check shaft trueness at four positions by turning shaft by hand. These readings must not vary more than 0.002" [0.05mm]. If so, replace the shaft. Examine all parts to be refitted for wear and deterioration. Replace any which are beyond reconditioning.

Scour scale from all parts with kerosene and wire brush. Coat all parts with a rust inhibiting lubricant, with special care given to impeller bolt [415]. If unit is not to be installed immediately, store in a clean and dry place.

#### ASSEMBLING PREPARATION

- a) Insure all parts to be refitted are free from burrs, with screws and abutting faces clean and free from damage. Replace all 'O'-rings. All studs to be refitted must be coated with Loctite Adhesive 307. Wrap threads on all plugs with Teflon tape. 'O'-rings must be greased before assembling.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### ASSEMBLING PREPARATION/CONTINUED

b] Special recommendation:- To facilitate the mounting of the bearing on shaft, place bearing on an electric heating plate; do not exceed 80°C. Temperatures above 130°C may cause damage. After mounting of bearing on the shaft, hand-pack bearing full with grease.

c] Once lubricated, as explained, making sure that cavities between bearings are grease packed, there will be no need for further lubrication until next major strip-down is due.

d] When mounting bearing into the bearing housing, the bearing should be at ambient temperature. It is recommended to preheat the bearing housing to 80°C maximum.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### RE-ASSEMBLY

When new bearings are to be used in the re-assembly, it is very important that the bearings are of 'good quality' and of exactly the correct specification.

- 1] a) Pre-heat bearing [125] and press onto shaft [110] ensuring inner-race is hard-up against shoulder.
- b) Place spacer ring [104] on shaft and fit snap-ring [160] which locks the bearing onto the shaft.

### IMPORTANT

It is important that spacer ring is tight axially and if it can be rotated, shim rings must be fitted between [104] and the bearing. These shim rings are available in thicknesses of 1/10th and 2/10ths of a mm and it has been found that these two increments are sufficient for this shimming operation.

After bearing has cooled back with grease according to specification [See Section "Bearing Lubrication"].

- 2] Heat bearing frame [101] by gas torch to a temperature of approximately 60°C and install shaft bearing assembly by pressing on the outside race of the bearing using a long tube.

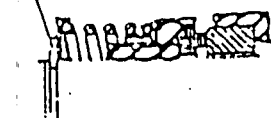
### DO NOT PRESS ON SHAFT OR INSIDE RING OF BEARING

### CAUTION

When pressing the bearing into the housing it is important that set-screw [231] is not fitted at this stage. This will ensure that the bearing goes hard against the shoulder and does not accidentally rest against the end of the set-screw.

- 3] Place spacer ring [157] on bearing followed by grease retaining disc [542] which should be followed by a second spacer ring [157].
- 4] Grease 'O'-ring [148] and place on [101].
- 5] Assemble oil-chamber casing [504] onto [101] and secure with fastening set [135].
- 6] Coat threads of set-screw [231] with Red Loctite Sealer and tighten uniformly so as to eliminate any axial clearance within the bearing assembly.
- 7] Check setting length of Mechanical Seal 516 (See Table).

546 \*



Bearing Frame	A*	H	I
516	38.1	28.59	12.7

\* ± 1mm

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

### 8.0 ASSEMBLY OF INNER MECHANICAL SEAL 516

Unless the bearing frame has been built for a special application this inner seal will always be Hidrostal type 'C' with open spring and a ceramic stationary face and carbon rotating face.

#### WARNING

While cleanliness is important during the entire bearing frame assembly, it is of utmost importance when re-assembling the mechanical seals.

Lubricate outside of the rubber seal which supports the ceramic part and carefully press ceramic face and rubber enclosure all the way into its seat in oil chamber housing [504]. The ring must fit tightly and square in its seat. **TAKE CARE TO PROTECT THE FACE DURING THIS OPERATION.** Examine gap between shaft and inner diameter of seal face; when face is correctly installed, gap will be uniform all round the shaft.

#### WARNING

The seal face is brittle and can easily chip if the inside edge catches a shoulder or groove when sliding along shaft. Take care to keep the seal square when sliding along shaft, also apply uniform gentle pressure when installing into seal.

#### IMPORTANT

Carefully clean faces of stationary and rotating parts using clean Tissue and lightly oil. **ABSOLUTE CLEANLINESS OF SEAL FACES IS ESSENTIAL IF SEAL IS TO BE TIGHT.**

Remove spring and spring-retaining ring from mechanical seal lightly lubricate the bore of the rubber part of the seal with oil, at the same time, lightly oil the shaft, as this will assist in sliding the mechanical seal into place.

Instal rotating part of the seal by carefully sliding along the shaft, taking care that the face does not 'catch' on any of the snap-ring grooves [545], when installed the carbon face should touch the stationary face. Be sure the rubber part sits uniformly on the shaft and that it has not rolled out from under the metal part of the seal face.

Instal seal-spring and spring-retaining ring.

Compress spring by pushing on the retaining ring and instal snap-ring [546] then turn shaft by hand, to check for free-running.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

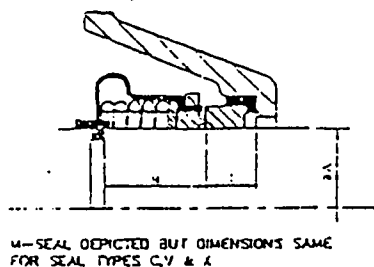
### 9.0

The next step is to prepare the Bearing Frame so that the tightness test of mechanical seal [516] can be checked. This should be done as follows:

- a] Fit a seal plate, complete with gasket over motor mounted flange to completely seal off this end of the bearing frame.
- b] Ensure plug [163] is fitted and connect a dry air supply to connection 'D' using a length of plastic/rubber hose.
- c] The interior of the bearing frame should now be pressurised using dry air to a pressure not exceeding 0.5 of a bar. We have found, from experience, a bicycle pump is obviously the most convenient method of carrying out this function. Immerse bearing frame in a tank of water and carefully check for bubbles leaking through the mechanical seal assembly. If a water tank is not available, stand bearing frame vertical and fill the open end of the oil chamber casing [504] with water and observe for air leaks around the mechanical seal.

10.0 Fit 'O'-ring [527] onto [504] and secure seal-plate [507] by gently tightening fastening set [534].

11.0 Check setting length of Mechanical Seal 515



BEARINGS FRAME	A*	H	I
BDM.B-112	28.58	27	11.1
DDM.B-112	28.58	27	11.1
EDM.D-112	38.1	28.59	12.7

\*  $\pm 1\text{mm}$

If this dimension is too long, shims should be placed between [504] and [507] by placing a shim either side of each stud. The maximum shim that should be used is 1.5 mm. If a thicker shim is required refer to your local Hidrosta Service Centre.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

12.0 Fit seal [515] according to instructions given previously in this manual.

13.0 The outer seal [515] has now to be air tested for tightness.

Ensure a length of open ended rubber pipe is connected to 'D' and the special tool enclosing drive shaft is still fitted.

Connect dry air supply to connection [536] and pressurise oil seal chamber to 0.5 bar. Immerse bearing frame into tank of water and check for leaks. Take care not to immerse free end of tube connected to 'D'. To check seal [516] is still tight when pressurised from opposite side carefully immerse free end of tube connection to 'D' from above into water, after a short while bubbles will appear if seal [516] is leaking.

If seals are tight fill seal chamber with oil according to instructions in section dealing with seal oil and assembly to hydraulic end, according to instructions given in "Maintenance of Hydraulic Parts".

### WARNING

Connection 'D' must be left unplugged, otherwise any leakage through seal [516] will penetrate bearing.

14.0 Place 'O'-ring [146] onto [507] and fit back-cone [511].

15.0 Fit impeller [401] onto shaft and tighten impeller bolt [415] and check clearance 'B' is within tolerances shown in table in "Maintenance of Hydraulic Parts".

If it is necessary to reduce the clearance shims should be placed between parts [511] and [507] and the shims should be placed in the exact location of fixing studs [419], which secure the bearing frame to the volute.

## SERVICE MANUAL FOR INSTALLATION AND OPERATION FOR CLOSE COUPLED PUMPS

POS	DESCRIPTION	CODE	MATERIAL *	
	<b>General</b>			
101	Bearing support	1TL	A	
104	Spacer ring P.S.	1RD/8RS	K	
110	Shaft	1WO	H	
112	Woodruff key	2FK	L	
125	Double row angular contact ball bearing	8LW		
150	Snap ring for 102	8RF		
157	Spacer ring	1RD/8RS	K	
160	Snap ring for bearing	8RF	K	
163	Plug for 504	8FD		
103	Bearing cap	1DL	A	
121	Angular contact ball bearing	8LW	-	
131	Grease nipple	8NF	N	
135	Fastening set 101-504	8BB	M	
136	Fastening set 101-103	8BB	M	
146	O-ring	8DO	Q	
148	O-ring	8DO	Q	
231	Socket set screw	8FG	F	
542	Grease retaining disc P.S. + Monoblock M.S.	5SF		
	<b>Seal Parts</b>			
209	O-ring for 507	8DO	Q	
504	Oil chamber casing	5GD	A	A/F
507	Seal Plate/Back Cover	1PM/1GD	A	D/C
511	Back Cone	1K		
515	Mechanical seal P.S.	8DM		
516	Mechanical seal M.S.	8DM		
527	O-ring for 507=504	8DO	Q	
534	Fastening set 507-504	8BB	M	
536A	Plug with gasket [oil filling]	8FV	F&P	
536B	Plug with gasket [oil drain]	8FV	F&P	
545	Snap ring fo 516	8RF	O	
552A	Plug for flushing connection	8FO	N	
552B	Plug for flushing connection	8FO	N	
562	Snap ring for mechanical seal 515	8RF	O	C
D	Drain			

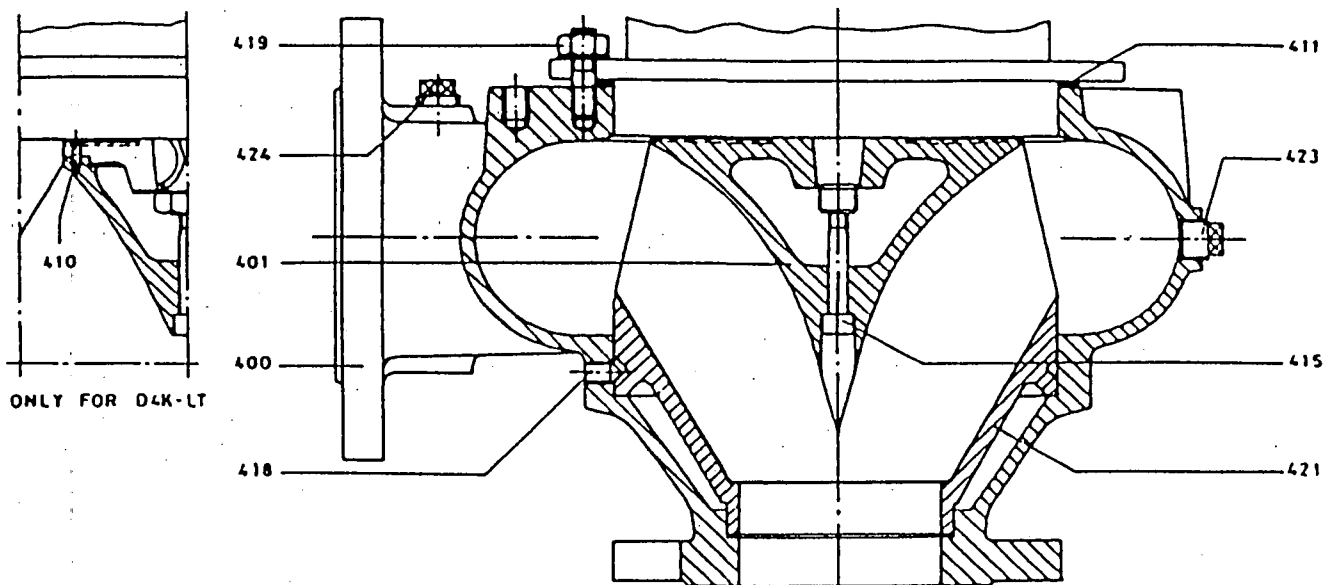
\*For material explanation, see material specification sheet of section "ENGINEERING DATA" in 'PRODUCT DATA BOOK'.

**Hidrostat**SECTIONAL DRAWINGS K-HYDRAULIC  
D03K/D04K/D0DK

Dat: 09.06.87

No: 83-TU 3174 C

File:



NOTE: D0DK WILL BE SUPPLIED: -WITH CLAW FOR LOWERING DEVICE  
-INSTEAD OF DISCHARGE FLANGE  
-WITHOUT SUCTION FLANGE

PART	DESCRIPTION	MATERIALS OF CONSTRUCTION			
		1	2	3	5
400	VOLUTE	GREY CAST IRON			STAINLESS STEEL A4
401	IMPELLER	NODULAR IRON(1)	NODULAR IRON FLAME HARDENED	STAINLESS STEEL A4	
410	DRIVING PIN (1)	STAINLESS STEEL A4			
411	SHIMS	CARBON STEEL			
415	IMPELLER BOLT	STAINLESS STEEL A4			
418	GRUB SCREW	STEEL			STAINLESS STEEL A4
419	FASTENING SET	RUSTLESS STEEL			STAINLESS STEEL A4
421	LINER	GREY CAST IRON	HIDRO HARD		STAINLESS STEEL A4
423	DRAIN PLUG	STEEL			STAINLESS STEEL A4
424	PLUG	STEEL			STAINLESS STEEL A4

(1) ONLY FOR D4K-LT

D03K NOT AVAILABLE IN CODE 5

D0DK IS NOT AVAILABLE IN BEARING FRAME OR BLOCK CONSTRUCTION

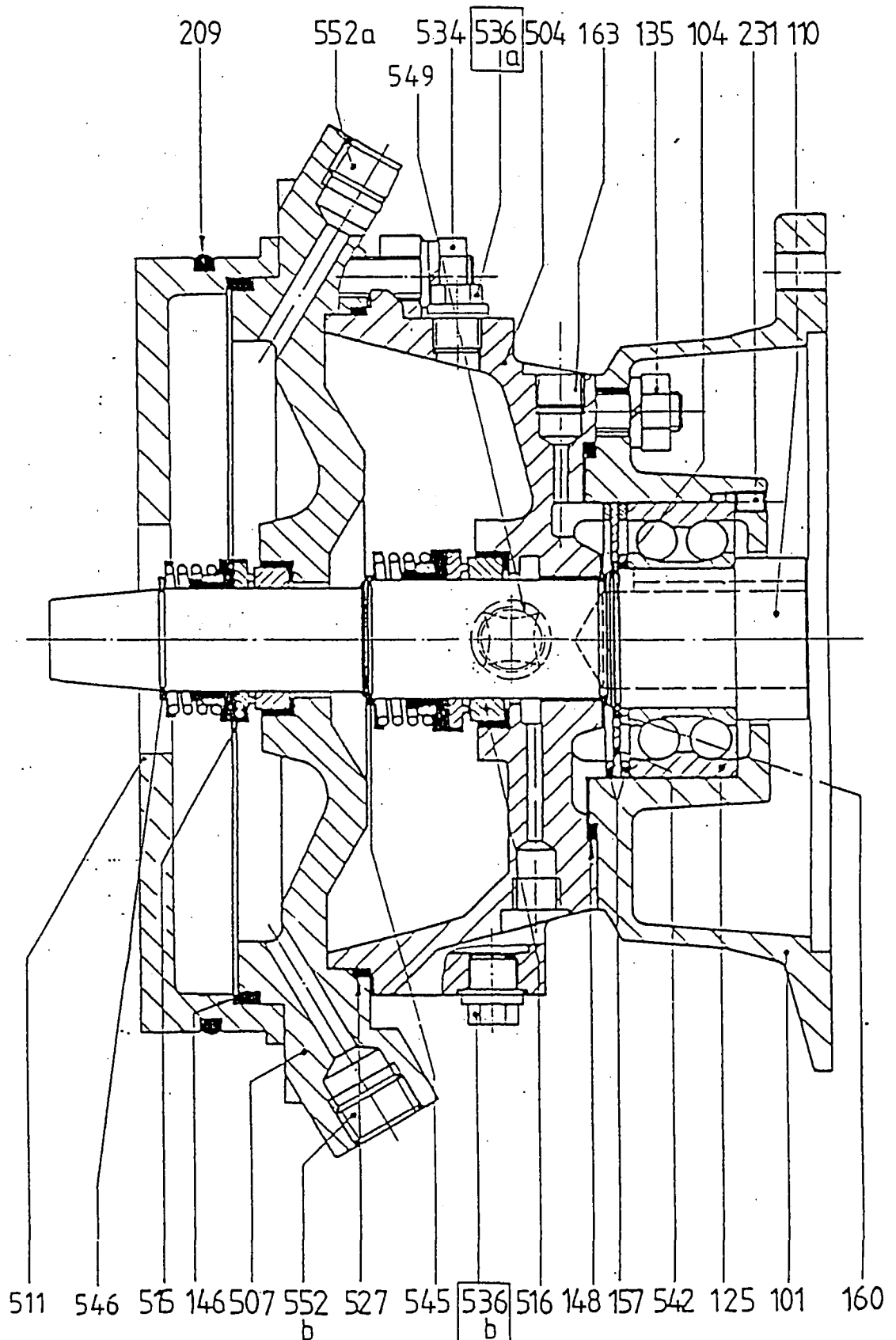
**hidrostat**

SECTIONAL DRAWINGS BLOCK-PUMPS  
SCHNITTZEICHNUNGEN BLOCK-PUMPEN  
DDM1K-112

Dat: 15.9.1992

No: 92-TU 4510

File:



## **SECTION 4**

### **INSTRUMENTS**

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**4.      INSTRUMENTS**

Multitrode and pump controller refer attached installation operation and maintenance instructions.

## MULTI TRODE MTIC 10/10 INSTALLATION SHEET

STEPPED ANALOGUE OUTPUT TERMINALS  
4-20mA TERMINALS 0V(-) & 4-20mA(+) 470ohms MAX  
4-20mA TERMINALS -12V(-) & 4-20mA(+) 940ohms MAX

NOTE:  
CONNECT BRIDGE BETWEEN  
4-20mA AND 0V WHEN  
4-20mA IS NOT USED

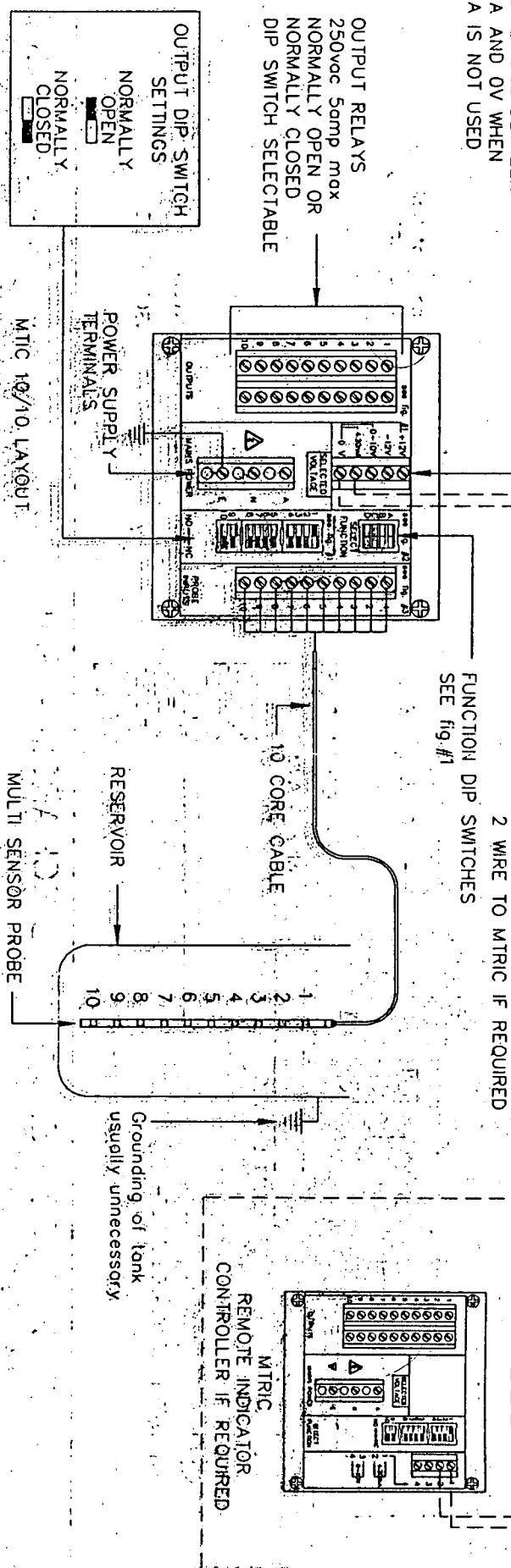
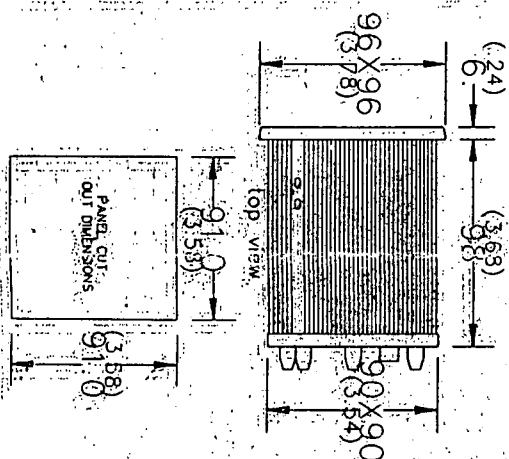


fig. #1  
DIP SWITCH SETTINGS SENSITIVITY AND TIME DELAY

SW. FUNCTION	POSITION	DESCRIPTIONS
A. TIMER	→	INSTANTANEOUS ACTUATION WHEN LEVEL REACHES SENSOR
B. TIMER	→	TIME DELAY ON ACTUATION APPROX. 5 SECONDS
C. TIMER	→	TIME DELAY ON ACTUATION APPROX. 10 SECONDS
D. TIMER	→	TIME DELAY ON ACTUATION APPROX. 15 SECONDS
E. EXTRA LOW SENSITIVITY	→	FOR CONCENTRATES SUCH AS ACIDS, MINERALS, ALKALINES, LEAVING RESIDUE
F. NORMAL LOW SENSITIVITY	→	ACIDS, ALKALINES, DILUTED BRINE, SEA WATER
G. NORMAL SENSITIVITY	→	SULLAGE, SEWAGE, EFFLUENT, TOWN WATER
H. HIGH SENSITIVITY	→	EFFLUENTS AND PROCESSES WITH OIL CONTAMINANTS, PURIFIED WATER

## MTIC DIMENSIONS



## SPECIFICATIONS

MTIC INDICATOR CONTROLLER  
10 points via MULTI TRODE PROBE  
12VAC nominal

Number of inputs  
Sensor voltage  
(per sensor)  
Number of outputs

Contact rating

Contact life  
Supply voltage AC (+/-10%)

Supply voltage DC  
Dimensions mm (inches)

Terminal size mm (inches)  
Display

Enclosure type  
Mounting arrangements

Sensitivity  
Standard sensitivities

Operating temperature  
C(F)

Auxiliary outputs

Other features

0.8mA (short circuit)  
10 sets of programmable N.O. or  
N.C. contacts

5-amp 250VAC resistive  
operations

240, 110vac 50/60Hz - 16 VA  
10 TO 30 VDC - 10 WATTS MAX

H96(3.78)xW96(3.78)xD128  
(5.03)

2.5mm<sup>2</sup> (0.64)  
High intensity LED per output on  
front panel arranged vertically to  
form bar graph

Extruded aluminium  
Panel mounted through cut-out  
brackets supplied

Selectable by switch at rear of unit  
1K, 4K, 20K or 80K ohms

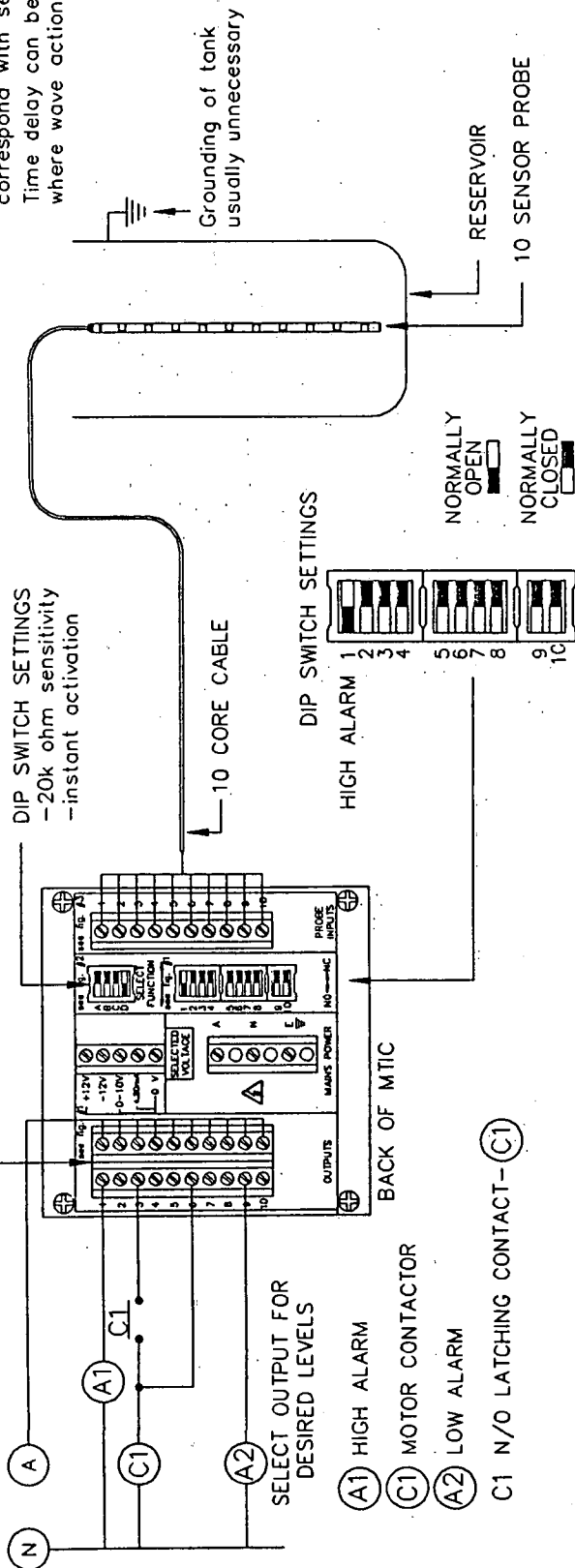
Minus 10C (+14F)  
Plus 60C (140F)

4-20mA 0.5-10 VDC  
Time delay of 5, 10, 15 sec.

selectable via switch at rear

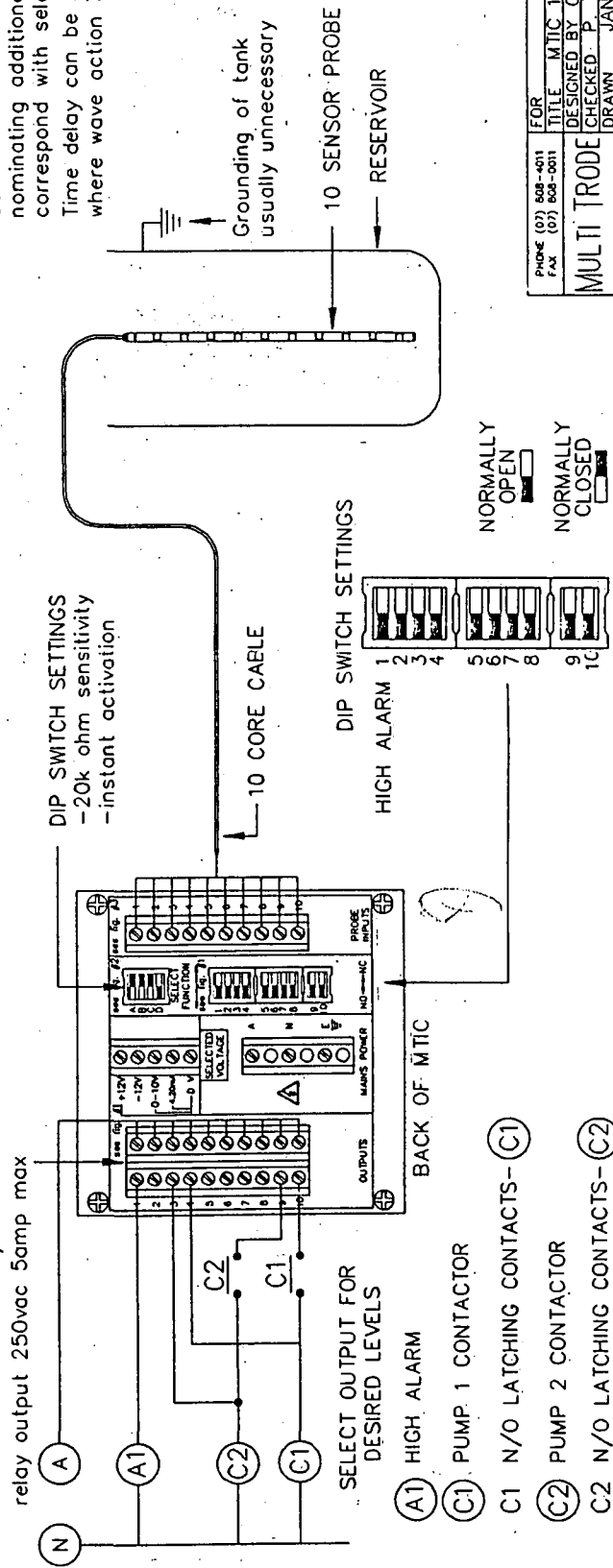
# MTIC 10/10 USED IN A CHARGING SITUATION

Several PUMPS & ALARMS can be used by nominating additional RELAY outputs to correspond with selected levels.  
Time delay can be selected for instance where wave action is present.



# MTIC 10/10 USED IN A DISCHARGING SITUATION

Several PUMPS & ALARMS can be used by nominating additional RELAY outputs to correspond with selected levels.  
Time delay can be selected for instance where wave action is present.

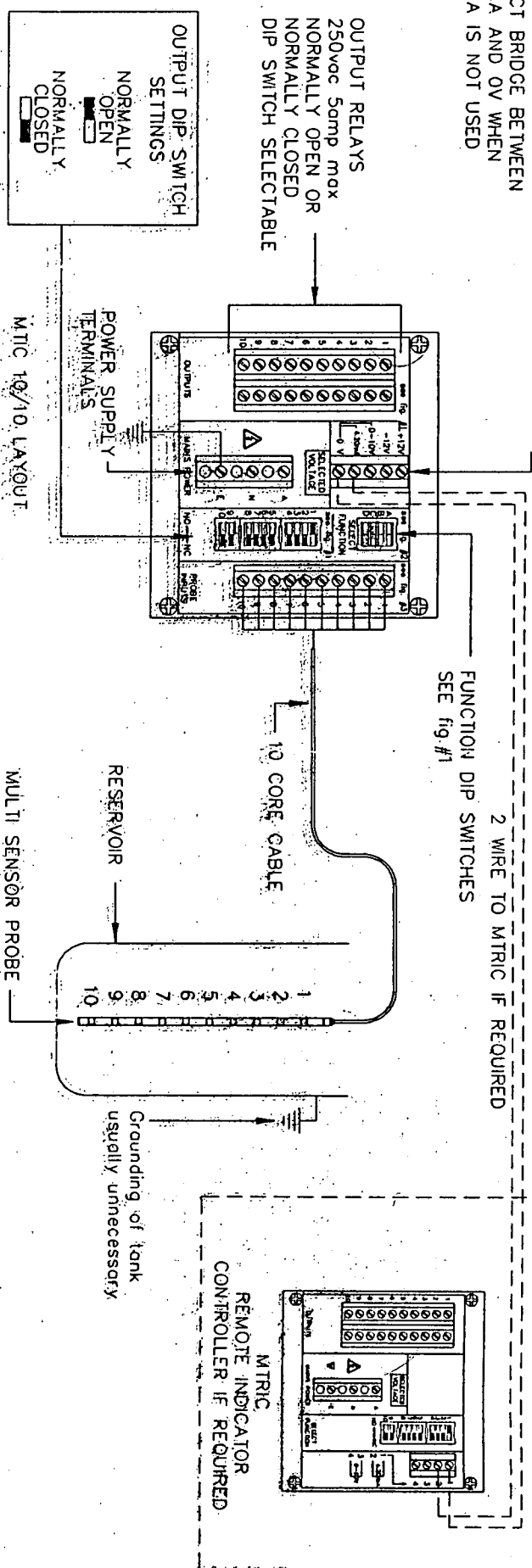


PHONE (07) 558-4011	FOR	TITLE	MTIC 10/10 INSTALLATION SHEET
FAX (07) 558-0011		DESIGNED BY	C. EATON
		REV.	1
		SCALE	NO
		CHECKED	P. TOWELL
		DATE	APRIL 93
		DRAWN	JAN PARKINSON
		DRAWING #	8852
		designed & manufactured by SARTEK Pty Ltd. BRISBANE, AUSTRALIA	

## MULTI TRODE MTIC 10/10 INSTALLATION SHEET

STEPPED ANALOGUE OUTPUT	TERMINALS	TERMINALS
4-20mA	0V(-)	470ohms MAX
4-20mA	12V(-)	940ohms MAX
4-20mA	0V(+)	470ohms MAX
4-20mA	12V(+)	940ohms MAX

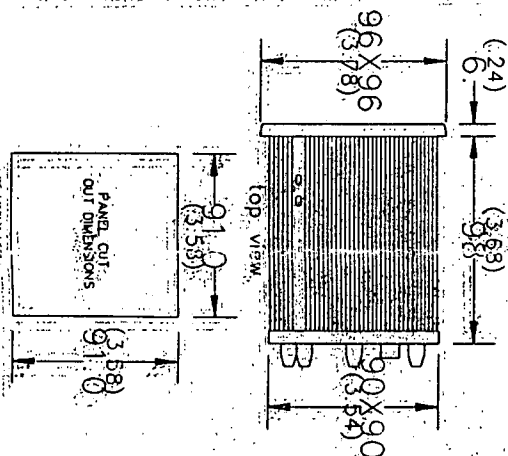
NOTE:  
CONNECT BRIDGE BETWEEN  
4-20mA AND 0V WHEN  
4-20mA IS NOT USED



DIP SWITCH SETTINGS SENSITIVITY AND TIME DELAY.  
fig. #1

SW	FUNCTION	POSITION	DESCRIPTIONS
A	TIMER	→	INSTANTANEOUS ACTIVATION WHEN LEVEL REACHES SENSOR
B	TIMER	→	TIME DELAY ON ACTIVATION: APPROX. 5 SECONDS
A	TIMER	→	TIME DELAY ON ACTIVATION: APPROX. 10 SECONDS
B	TIMER	→	TIME DELAY ON ACTIVATION: APPROX. 15 SECONDS
C	EXTRA LOW SENSITIVITY	→	FOR CONCENTRATES SUCH AS ACIDS, MINERALS, ALKALINES, LEAVING RESIDUE
D	1K OHM	→	
C	NORMAL LOW SENSITIVITY	→	ACIDS, ALKALINES-DILUTED BRINE, SEA WATER
D	4K OHM	→	
C	NORMAL SENSITIVITY	→	
D	20K OHM	→	SULLAGE, SEWAGE EFFLUENT, TOWN WATER
C	HIGH SENSITIVITY	→	EFFLUENTS AND PROCESSES WITH OIL CONTAMINANTS, PURIFIED WATER
D	80K OHM	→	

## MTIC DIMENSIONS



## SPECIFICATIONS

MTIC INDICATOR CONTROLLER

Number of inputs	10 points w/o MTL 7
Sensor voltage	TRODE PROBE
	12VAC nominal

Sensor current  
(per sensor)  
Number of outputs

**Contact rating.**

Supply voltage AC (+/-10%)  
Supply voltage DC  
Dimensions mm (inches),

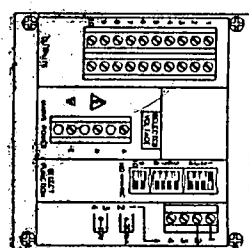
Terminal size (mm (inches))  
Display

Enclosure type:  
Mounting arrangements:

Sensitivity Standard sensitivities Operating temperature (°C/F)

Auxiliary outputs  
Other features

MTRIC.  
REMOTE INDICATOR  
CONTROLLER IF REQUIRED





**VACUUM SEWER SERVICES**

Vacuum Sewer Services (Aust.) Pty. Ltd. ACN 063 327 202  
P.O. Box 9, Lennox Head 2478, Australia  
Level 1, 64 Ballina Street, Lennox Head  
Telephone: (066) 877666  
Facsimile: (066) 877782  
Email: geolink @ peg.apc.org

15th July 1994

Brisbane City Council  
GPO Box 1434  
Brisbane QLD 4001

Attention: Mr. Paul Barber  
Manager Engineering Services

Dear Paul

I am pleased to announce that VACUUM SEWER SERVICES PTY. LTD. has been established to provide services to Local Government throughout Queensland in relation to Iseki vacuum sewerage installations.

Vacuum sewerage can provide very significant benefits over conventional sewerage systems in terms of both capital and operating costs and as you may be aware is rapidly gaining acceptance throughout the world as an alternative to conventional sewerage.

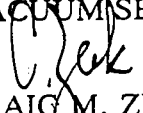
We believe that there are many locations, particularly in the coastal and inland plain regions of Queensland where vacuum sewerage, utilising the Iseki vacuum interface valve, is the most economical sewerage reticulation/ transportation option.

The many advantages and applications for vacuum sewerage systems are listed in the brochure which I have enclosed for your reference. The brochure also outlines the general operating principles of this highly effective method of sewage collection.

Should you be contemplating a new sewerage reticulation system or a significant amplification or reconstruction of an existing system, we would be pleased to prepare a budget estimate and preliminary layout for your consideration.

I look forward to the opportunity to discuss with you any possible application of the Iseki vacuum sewerage technology. Please do not hesitate to contact the undersigned if you require any further information.

Yours faithfully,  
VACUUM SEWER SERVICES

  
CRAIG M. ZERK  
Director

---

Vacuum Sewer Services operates by arrangement with Iseki Utility Products, U.K.



# VACUUM SEWER SERVICES (AUST) PTY LTD

## The Company

*Vacuum Sewer Services (Aust) Pty. Ltd.* (ACN 063 327 202) is an Australian owned company specialising in the investigation, design and construction of Vacuum Sewage Collection Systems based on the utilisation of the *Iseki* vacuum interface valve.

The objectives of Vacuum Sewer Services are to:

- Promote a cost effective alternative sewerage system that is robust, easily maintained and environmentally sound.
- Provide to government and private sectors a professional and reliable service in the investigation, design, construction and maintenance support of vacuum sewerage systems.

Vacuum Sewer Services offer a comprehensive range of professional services including:

- Investigation and feasibility analysis
- Design and documentation
- Supply of hardware
- Construction
- Installation and commissioning
- Construction supervision
- Supply of spare componentry
- Technical support
- Staff training
- Maintenance contracts

Vacuum Sewer Services operates under an arrangement with the U.K. based company *Iseki Utility Products* to provide services associated with the *Iseki* vacuum system.

## Technical Support

Vacuum Sewer Services provides a comprehensive and professional service covering the investigation, design, documentation, construction, operation and maintenance aspects of wastewater collection using the vacuum transportation technology.

Vacuum Sewer Services comprises a staff of highly qualified engineers with extensive practical experience in wastewater engineering.



# VACUUM COLLECTION STATION

The vacuum station is the heart of the system where the vacuum is generated and supplied through the vacuum mains to the interface valves. Vacuum stations can range in size from a skid mounted unit to an individually constructed station within a purposely designed building. Vacuum stations comprise the vacuum/collection vessel, vacuum pumps, discharge pumps and associated switchgear and control gear.

Vacuum stations can be sized to suit most flows, usually from 18 cubic metres/hr (5 litres/sec) upwards. Station capacity is not the controlling factor in the design of a vacuum sewerage system. The total static head loss in any single sewer controls the limits of a service area.

Due to the static head limitations of the sewer, more than one vacuum station may be required to serve the catchment. Where multiple stations are required, the size of collection vessels and machinery will be standard as far as practicable.

Vacuum stations should, where possible, be located to:

- Give equal flows in the branching vacuum mains
- Equalise lift losses in each vacuum main
- Keep vacuum main lengths to a minimum

The main components of the station are listed below.

## Vacuum Sewage Collection Vessel

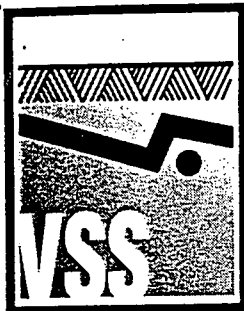
The vacuum vessel is usually made of steel, suitably protected on the inside or of glass reinforced plastic (GRP). Connections are provided on the vessel for sewage discharge pumps, vacuum supply, vacuum switches, level probes, pump prime lines, manhole and the incoming vacuum sewers, the latter having a ninety degree bend inside the tank which we recommend is turned through a 45 degree angle to the horizontal and pointed away from the sewage pump suction connections.

## Vacuum Reservoir Vessel

This vessel is used as an additional vacuum reservoir and as a moisture removal vessel. The use of this vessel is not essential. However, we do recommend it be used when mechanical sliding vane vacuum pumps are installed.

## Vacuum Pumps

These are of the liquid ring or mechanical sliding vane type.



# THE SYSTEM

## Principles

Since the time of the Romans, sewage has been collected by gravity, indeed some of their sewers such as the Cloaca Maxima in Rome are still in use today. Gravity sewers require pipes to be laid to a constant fall with the sewage generally discharging into a pump station. The excavation associated with gravity sewers is often wide, deep and costly. Such excavations can have significant environmental impact. Further, inspection manholes can be a major cause of surface water infiltration.

A typical vacuum system for sewage collection essentially comprises:-

- **Gravity Collection System** - a gravity sewer main serving each property designed and operated as a conventional gravity sewer;
- **Vacuum Interface Valve Chambers** - chambers into which the gravity sewer lines flow. Each chamber houses a vacuum interface valve and typically serves up to 4 properties. Chambers are similar to conventional sewer manholes and are generally about 2m deep;
- **Vacuum Main** - which operates under a vacuum of about 65 kPa and connects the interface chamber to the vacuum/pumping station. The vacuum main is usually class 6 uPVC solvent weld jointed pipe laid at a depth of about 1.0m to 1.2m in a sawtooth profile; and
- **Vacuum Collection Station** - comprising a collection/vacuum vessel, vacuum pumps, discharge pumps and associated control gear.

In brief, vacuum sewerage systems operate as follows.

- Wastewater from each property flows by gravity into the interface chamber.
- When the small sump in the interface chamber is full, the vacuum interface valve in the chamber automatically opens and the liquid, followed by a quantity of air, is rapidly drawn into the vacuum main.
- Each slug of fluid is moved incrementally along the vacuum main under the momentum imparted by air and liquid admitted as the valves within interface chambers open as required throughout the system.
- When the momentum of each inrush is consumed, the sewage temporarily collects in the sags of the sawtooth profile of the vacuum main until another upstream valve fires and repeats the movement sequence.
- When the slug of liquid arrives at the vacuum/pump station, it enters the sealed collection chamber where it is pumped to the sewage treatment plant.



# VACUUM INTERFACE VALVE

Vacuum Interface valves interface between the vacuum within the vacuum mains and the atmospheric pressure within the vacuum interface chamber. When sewage is entering the system from a source and the sewage level in the chamber rises, it pressurises air in the 63mm sensor line. This air pressure is transmitted by a hose to the controller/sensor unit which opens the valve and the wastewater is rapidly drawn into the vacuum main. The suction of the sewer creates a vortex in the sump and air is drawn into the sewer with the sewage.

As the valve opens, a pneumatic timer in the controller/sensor unit starts a pre-set time cycle. The timer holds the valve open for sufficient time to draw all the sewage out of the sump and allows a designated amount of air to enter the system. The Iseki interface valve is capable of serving at least four equivalent tenements and multiple valve chambers may be installed to serve higher flow rates.

No electricity is required at the valve chamber. The vacuum valve is automatically operated by the pressure generated with the rising sewage level and the pneumatic timer, and actuated by the vacuum in the sewer.

## Features

The unique features of the Iseki valve system (illustrated overleaf) can be summarised as follows.

- Glass filled polypropylene construction
- Superior corrosion resistance
- Band clamps for demounting controller and valve operator
- Robust controller mounting ring
- No internal controller tubing
- Manual controller operation actuated by pushbutton
- Built in surge suppressor
- Built in 6 digit cycle counter
- Waterproof
- Lightweight
- Option extra - valve telemetry equipment



# APPLICATIONS

## Versatility

- Vacuum collection and transportation systems can provide significant capital and ongoing operating cost advantages over conventional gravity systems particularly in flat terrain, high water table or hard rock areas. Vacuum sewer systems are installed at shallow depths significantly reducing excavation, shoring and restoration requirements, and minimising the disruption to the community.
- The alignment of vacuum mains is extremely flexible, without the need for manholes at changes in grade or direction. Vacuum sewer mains can skip over and around other services or obstacles and can be used to achieve uphill flow.
- Turbulent velocities of 5 to 6m/sec are developed as the sewage and air passes through the interface valve. This disintegrates solids and reduces the risks of sewer blockages which are unknown in a correctly designed and constructed vacuum system.
- No electricity is required at the interface valve, enabling the system to be installed in virtually any location.
- Fractures in gravity systems may go undetected for a long time. A leak in a vacuum main will raise an alarm within minutes of the break. The mains have to be repaired for sewage transport to continue, ensuring up to date maintenance and eliminating deterioration and infiltration.
- Due to the shallow depth of the installation, additional connections can be quickly and simply made by a small construction crew, thus reducing the disruption and restoration work normally required for conventional gravity sewers.
- The Iseki valve has been developed to withstand highly aggressive conditions and all materials in the Iseki valve resist salt water corrosion and deterioration by a wide range of corrosive and toxic materials.
- Vacuum collection and transport systems have many applications in industry for collecting all forms of liquid waste including toxic and radioactive fluids. Collection pipes may be installed above ground, overhead or in utility ducts.



# COMPARISONS

## Costs

### Vaccum System

Narrow, shallow installation trench of minimal depth required, minimising excavation, backfill and reinstatement costs.

Small bore uPVC pipe that is watertight and flexible, does not crack and eliminates exfiltration and infiltration of ground water.

High velocities of sewage flow (6m per second) generated eliminates blockages and ensures self cleansing of pipes and generally low maintenance.

No manholes are required.

Vacuum mains are capable of servicing additional capacity to the original design. In extreme situations, the vacuum pumps can be easily replaced with larger units.

Only small trenching machines and back-hoes are required in main and interface chamber construction.

Installation of a vacuum sewer system into an existing residential or commercial development presents minimal disruption, and is relatively time and cost efficient.

The vacuum sewer system is self cleaning and requires minimal housekeeping.

### Gravity System

Depth of trench dictated by the lowest point in the system. Deep trenches can result in expensive excavation and backfill costs, especially in waterlogged or rocky terrain.

Conventional rigid pipes are susceptible to cracking, leaking joints, exfiltration of sewage and infiltration of water.

On a minimum slope, the slower velocity generated encourages solids settlement and odour problems.

Manholes are required at changes in direction, slope, and at line intersection, to relieve blockages and effect general maintenance.

Sewage lines may need to be replaced at great expense to accommodate capacities greater than those allowed for in the original design.

Heavier earth moving equipment is generally required for sewer main and manhole construction.

The installation or extension of a conventional gravity system in a built up area can be extremely disruptive over a prolonged period.

Conventional sewer pump stations require regular flushing out and cleaning for purposes of safety, odour control and treatment efficacy.



## Vacuum System

There is no need to enter deep, confined and explosive/noxious environments for maintenance purposes.

Shallow trenches present no risk of unstable excavations.

Equipment at the vacuum station constantly monitors the system resulting in prompt action to any fault.

Flexible layout patterns. Vacuum mains can be laid uphill, downhill, around or over obstacles, on the surface or above ground.

Vacuum main pipes can be laid over a distance of up to 3km from the collection station.

Vacuum mains require a minimum slope of only 0.2% regardless of the diameter of the pipe.

Valve chambers with traffic bearing covers can be installed in the street.

Air present in the system results in some pre-aeration of sewage making the treatment plant more efficient.

Pipe movement due to soft foundations is not critical to the performance of the system.

## Gravity System

Occupational health and safety standards require strict controls over entry to gravity sewer systems.

Deep trenches require shoring or very wide excavations.

Problems can go undetected for a period of time.

Laying of sewers is restricted to straight lines and constant slopes. A positive downhill slope is required. Lift stations are needed for uphill transport.

Gravity main lengths are dictated by topography and the resulting trench depths.

In a gravity sewer system, the minimum slope is proportional to the diameter of the pipe and the hydraulic load.

Lower velocities can result in septic sewage arriving at the plant, making treatment more difficult.

Uneven settlement due to deep mains in poor foundation conditions can result in blockages and high repair costs.

## Profile

SECTION 200ADVANTAGES AND APPLICATIONS OF VACUUM TRANSPORTA. SEWERS

Since the time of the Romans sewage has been collected by gravity, indeed some of their sewers such as the Cloaca Maxima are still in use today.

Gravity sewers require pipes laid to a constant fall with the sewage discharging into either a watercourse or into a pump station which lifts the sewage to a higher level. The excavation associated with gravity sewers is often wide, deep and costly. Usually such excavations have a major environmental impact. Manholes are normally placed at a maximum of 100 metre intervals and can be a major cause of surface water infiltration.

Vacuum sewers are constructed using welded polyethylene pipe which is laid in a Liernur style invert lift profile at shallow depth.

Compared with gravity systems vacuum collection has, but is not limited to, the following advantages:

CONSTRUCTION

Uses small diameter pipes. No cranes or machinery required to lift heavy clay or concrete pipe.

Shallow excavation. This reduces costs in land having unstable soil, a high water table or where rock excavation is necessary. It also makes the system cost effective in rural areas with low building density.

Manholes or cleanouts are not required. This reduces the risk of surface water infiltration.

Field changes can be easily made to route vacuum sewers around, up and over obstructions discovered during excavation.

The elimination of exfiltration allows vacuum sewers to be installed in the same trench as water mains.

Reducing infiltration allows the construction of a smaller size treatment plant.

Less environmental impact caused by the narrow, shallow trench.

OPERATION

Turbulent velocities of 5 to 6 m/sec are developed as the sewage passes through the interface valve. This disintegrates solids and reduces the risks of sewer blockages which are unknown in a correctly designed and constructed vacuum system.

The health risks to manhole maintenance crews are completely eliminated.

Comminutors are not required at the treatment plant.

No electricity or telemetry is required at the interface valve.

Fractures in gravity systems may go undetected for a long time. A leak in a vacuum sewer will raise an alarm within minutes of the break. This is an important feature of the system in that the sewers have to be repaired for sewage transport to continue. This ensures the sewers are maintained in an 'as built' condition and not allowed to deteriorate as so often happens with conventional systems.

With the shallow depth of the fusion welded sewers, additional connections can be quickly and simply made by a small construction crew using electrofusion welding couplings. This reduces traffic disruption when compared to gravity sewers.

## B. DOCKS AND MARINAS

Overboard discharge of sewage from all forms of marine transport has been, or is in the process of being regulated in most countries.

The majority of small craft are fitted with some form of sewage holding tank which must be emptied at the dockside. This task is simple to perform when using the Iseki vacuum system.

Advantages of using vacuum systems in docks and marinas include:

**Flexibility.** Most marina piers have services either suspended beneath, or laid in a duct below the dock surface. With the vacuum system flexibility, it is usually possible to install sewers in the duct or suspended under the pier.

The Iseki vacuum interface valve maybe installed to operate automatically in conjunction with a small sump or manually through a hose connection to the vessels sewage holding tank.

All materials of the Iseki valve are designed to resist salt water corrosion.

Vacuum collection and transport systems have many applications in industry for collecting all forms of liquid waste including toxic and radioactive effluent. Collection pipes maybe installed above ground, overhead or in utility ducts.

If collector pipes are installed above ground in arctic conditions the use of double wall insulated pipe is recommended.

Vacuum collection and transport systems are being used for wider and more varied applications than those envisaged just a few years ago.

## SECTION 300

### MAIN COMPONENTS OF THE ISEKI SYSTEM

There are three main components of the vacuum transport and collection system. These are:

Vacuum Station This is the heart of the system. Here vacuum is generated and supplied through the sewers to the interface valves. Sewage is collected and discharged from the station.

Vacuum Sewers These interconnect the vacuum station and the Iseki interface valves.

Vacuum Interface Valves These valves interface between the vacuum of the sewers and the atmospheric pressure of the sewage sump at the valve chamber.

### VACUUM STATION

The vacuum sewage collection station is very similar to a large lift station of a conventional sewerage system. In a conventional station the wet well is a large sump at atmospheric pressure. In the vacuum alternative the wet well is a closed vessel maintained at around one half atmospheric negative pressure.

Gravity sewers in the conventional system connect to the wet well. Vacuum sewers connect to the vacuum vessel (vacuum wet well).

Sewage pumps, duty and standby connect to the wet well in both systems. Likewise level probes in the atmospheric wet well and vacuum vessel control the sewage pumps.

The only features found in a vacuum station not found in its conventional counterpart are: vacuum pumps, vacuum chart recorder and a low vacuum alarm system.

Vacuum stations can range in size from a 2000 litre vessel with all pumps, controls, etc. factory mounted on it to large installations where the machinery is shipped to site in a kit form for assembly in a two storey building.

Even with a large vacuum station serving 500 to 600 houses floor area required in the building will only be around 7 m x 7 m.

Vacuum stations can be sized to suit most flows. Stations can be built to serve 2000 or more homes. The main limitation of the system is not the size of the vacuum station but the total head loss in the sewers. This is discussed in Section 500 - Vacuum Sewer Design.

### VACUUM SEWERS

Iseki vacuum sewers are laid in the same invert lift profile first used by Mr. Liernur over 100 years ago. This profile is designed so that any liquid, of sufficient quantity, lying in the sewer at low or zero flow periods will completely

seal the pipe bore at the lowest point.

Mr. Liernur's sewer profile is shown in figure 300.1 with Iseki profiles shown in figure 300.2.

The importance of correct pipeline materials cannot be too highly stressed. We recommend the use of polyethylene (PE) 6 bar rated pipe with electrofusion welded joints and fittings. Using this material will ensure the integrity of the vacuum pipelines and eliminate the risk of leaks in future years.

The pipes are laid and bedded using water main practice, normally they are located under the pavements, footpaths or in the verges of the roadside.

Ring main systems are not used with vacuum collectors. All sewers start at one end of the service area and terminate at the vacuum vessel.

Division or shut-off valves are installed every 400m and at every branch sewer serving several Iseki interface valves.

Depth of vacuum sewers varies with climate, local codes and any traffic loads that maybe imposed upon the sewers. Usual depth of cover required by most regulatory authorities is 900 mm at the top of the invert lift when the sewer is laid in verges and across fields.

#### VACUUM INTERFACE VALVE

The 90 mm Iseki vacuum interface valve has been designed for use with 90 mm outside diameter (3.5" o.d) pipe.

Figure 300.3 shows a diagrammatic arrangement of the valve installed in its combined sump/chamber. The principle of operation is: sewage flows by gravity from a number of homes into the lower sump. As the sewage level rises it pressurises air in the 63 mm sensor line. This air pressure is transmitted by hose to the controller/sensor unit mounted on top of the valve where it causes the controller/sensor unit to switch and apply vacuum from the sewer, to the main valve operator. As the main valve opens a pneumatic timer in the controller/sensor unit starts a pre-set time cycle. At the same time vacuum is applied through the 90 mm suction pipe to the sewage in the sump. The suction of the sewer creates a vortex in the sump and air is drawn into the sewer with the sewage. The timer holds the valve open for sufficient time to draw all sewage out of the sump and allow the main valve to close as air is passing through it.

No electricity is required at the valve chamber. The vacuum valve is automatically operated by the pressure generated with rising sewage level, the vacuum in the sewer and the pneumatic timer.

Iseki Vacuum Interface Valves are of robust construction and are designed to work under water. Figure 300.4 shows the Iseki Valve.

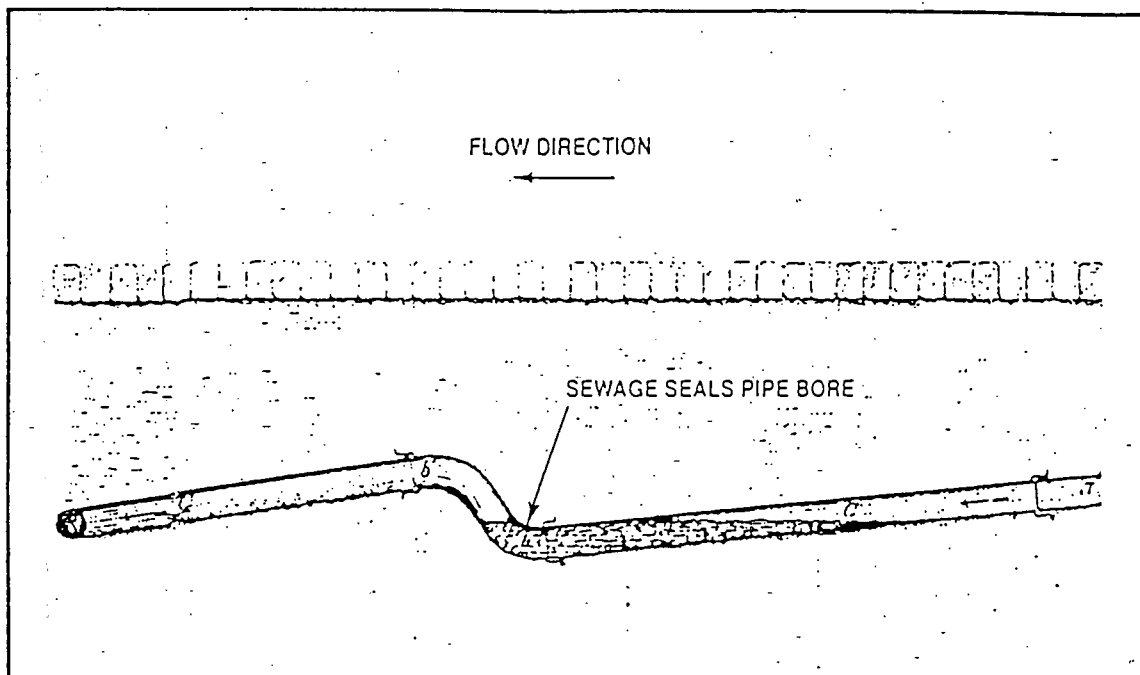
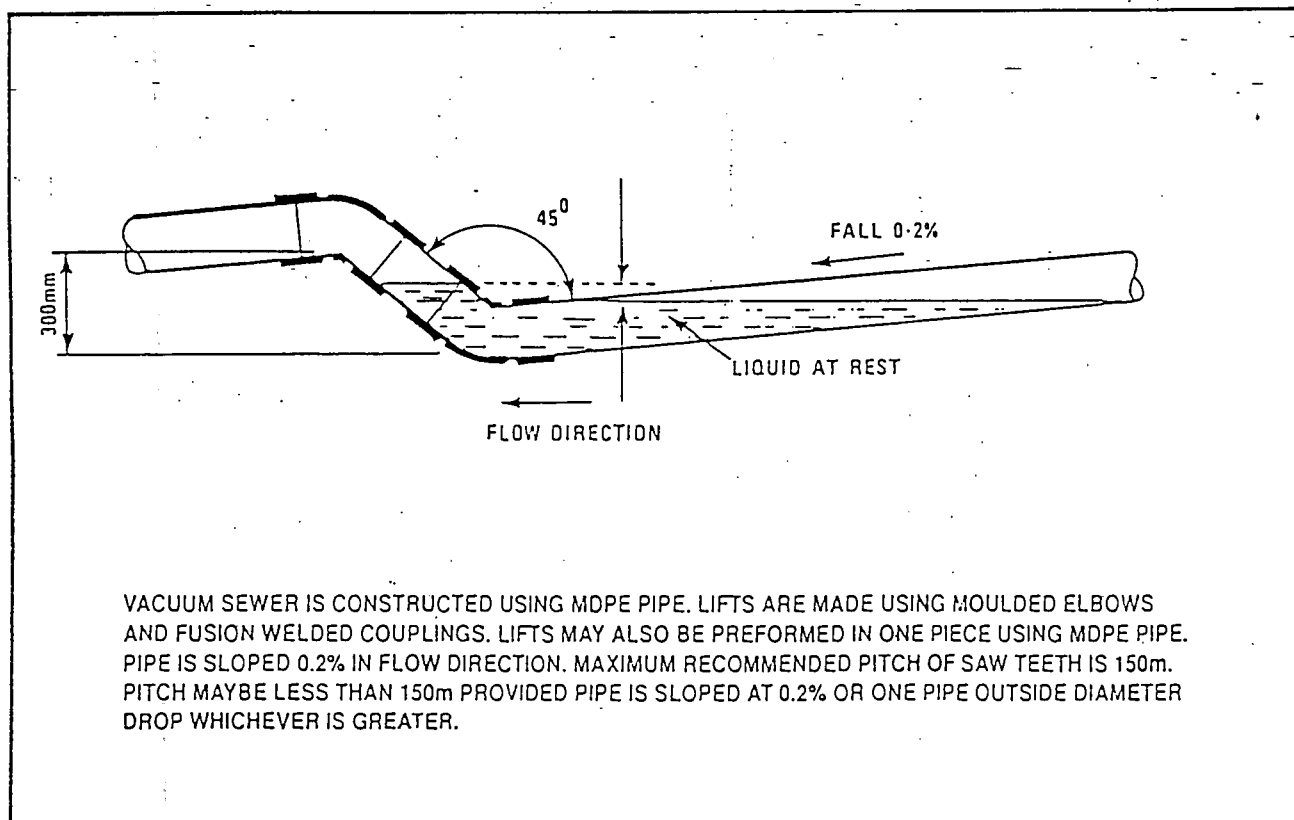


FIGURE 300.1 LIERNUR SAW TOOTH PROFILE



VACUUM SEWER IS CONSTRUCTED USING MDPE PIPE. LIFTS ARE MADE USING MOULDED ELBOWS AND FUSION WELDED COUPLINGS. LIFTS MAY ALSO BE PREFORMED IN ONE PIECE USING MDPE PIPE. PIPE IS SLOPED 0.2% IN FLOW DIRECTION. MAXIMUM RECOMMENDED PITCH OF SAW TEETH IS 150m. PITCH MAYBE LESS THAN 150m PROVIDED PIPE IS SLOPED AT 0.2% OR ONE PIPE OUTSIDE DIAMETER DROP WHICHEVER IS GREATER.

FIGURE 300.2 ISEKI INVERT LIFT PROFILE

300.3

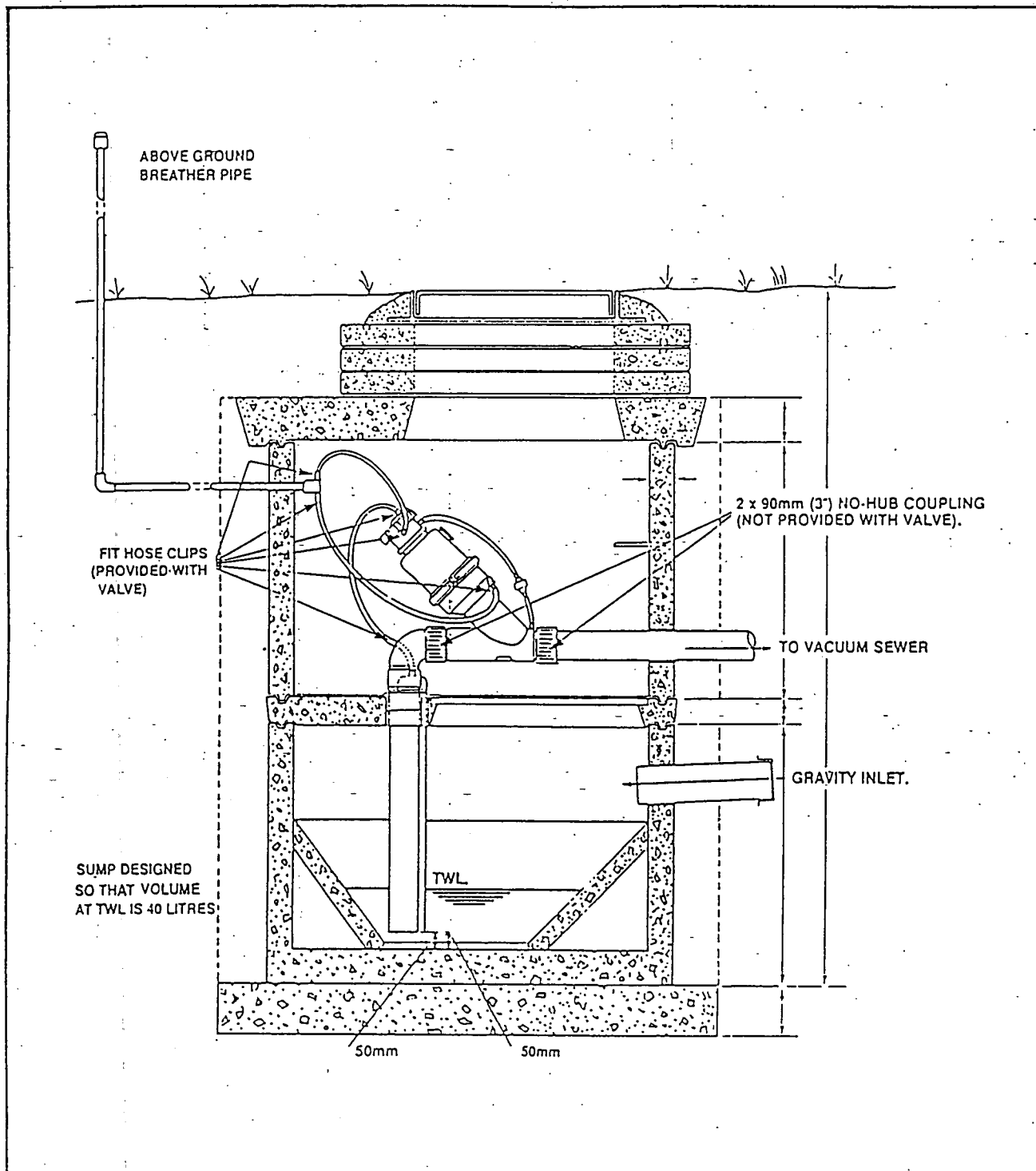


FIGURE 300.3 VALVE INSTALLED IN SUMP

300.4

VACUUM GAUGE

SEWAGE PUMP  
PRIME LINES 25

PROVIDED CLEAR PVC  
OR SIMILAR IS USED  
FOR THESE LINES THE  
SIGHT GLASS MAYBE OMITTED

DUPLICATE HORIZONTAL  
SEWAGE PUMPS

HAND RAILS

SECTION A - A

RECOMMENDATIONS

DIVISION SHOULD BE MADE FOR VACUUM STATION  
ATING AND VENTILATION  
E VACUUM RECORDER SHOULD BE A 7 DAY  
CULAR CHART 300 0 TYPE  
NON RETURN VALVE TONGUES SHOULD BE  
CUSTOMER FACED  
UUM GAUGE LINES AND COCKS SHOULD BE  
YPROPYLENE, PVC OR STAINLESS STEEL  
VALVES SHALL HAVE SHAFT SEALS SUITABLE  
VACUUM SERVICE  
UUM SWITCH AND GAUGE DIAPHRAGMS SHALL  
SUITABLE FOR USE WITH SEWAGE  
UUM VESSELS MAYBE STEEL INTERNALLY EPOXY  
ATED OR GLASS REINFORCED PLASTIC  
FTING BEAM SHOULD BE PROVIDED TO ASSIST  
H REPLACEMENT OF THE SEWAGE PUMPS

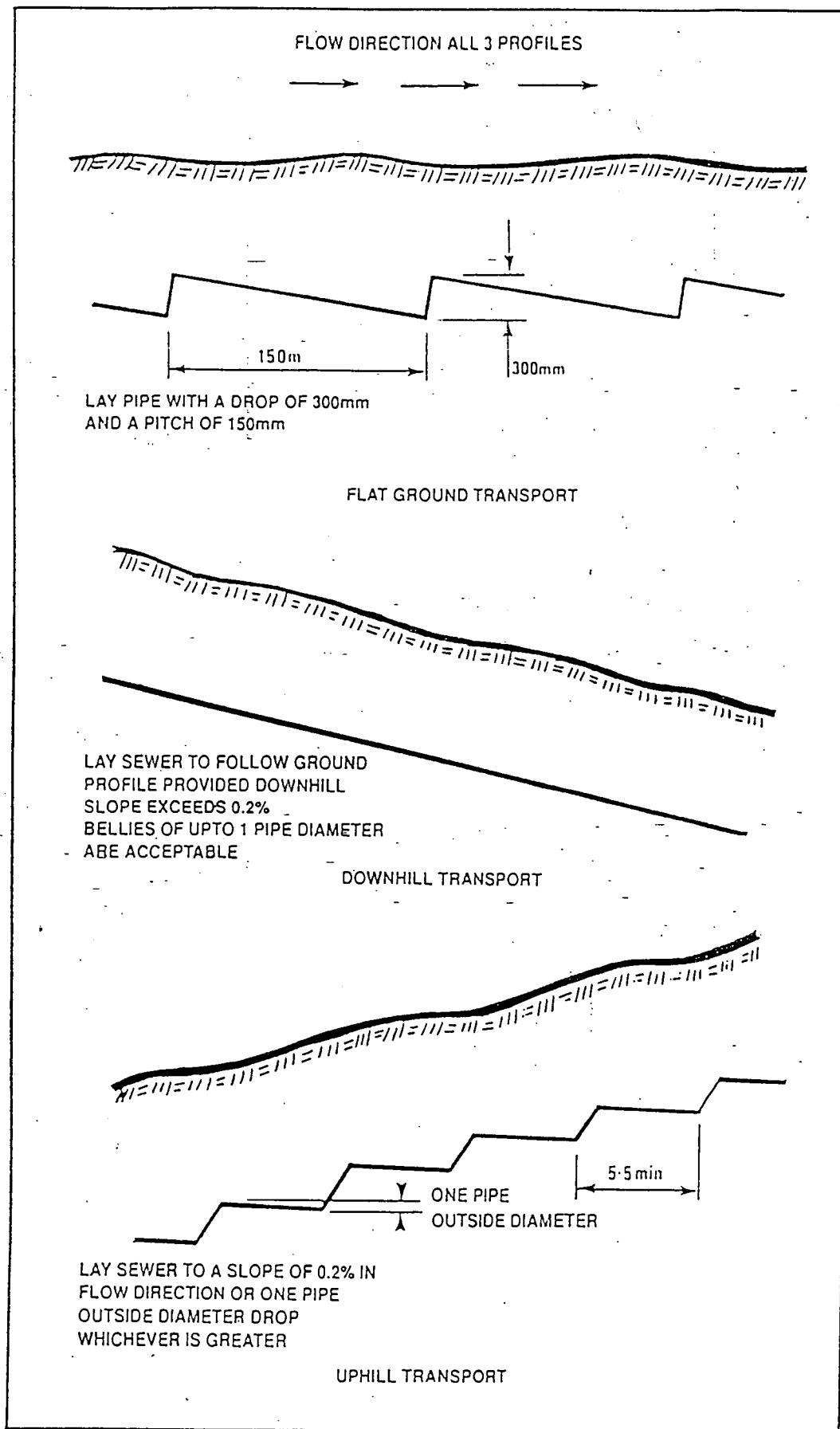


FIGURE 500.7 ISEKI INVERT LIFT  
PROFILE DETAILS

500.10

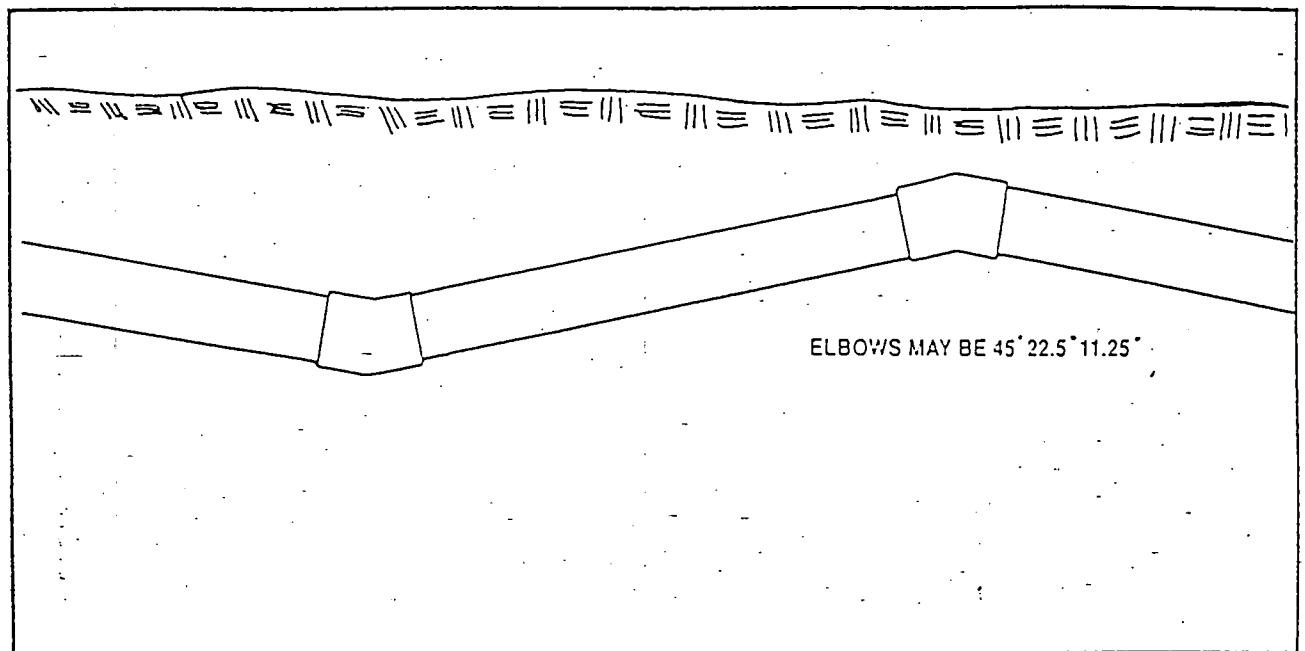


FIGURE 500.8 ALTERNATIVE CONSTRUCTION METHODS FOR ISEKI INVERT LIFT

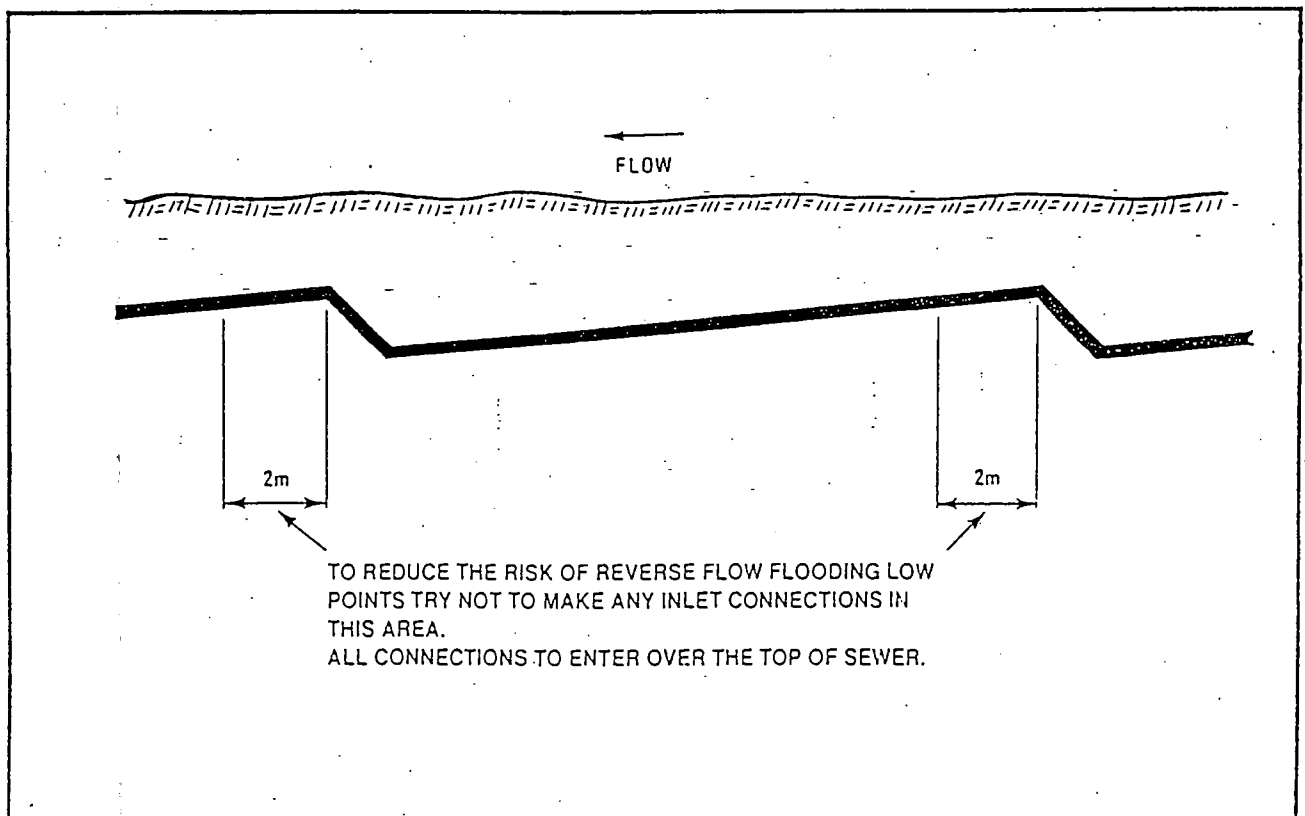


FIGURE 500.9 CONNECTION POSITIONS TO INVERT LIFT PROFILE

SECTION 600VACUUM INTERFACE VALVE AND SUMP

The Iseki 90mm vacuum interface valve is shown in figure 600.1.

Hubless stainless steel and rubber couplings are used to clamp the valve in position as shown in figure 300.3. These allow fast valve removal for maintenance purposes.

Malfunctions of Iseki valves are rare, but the majority of these that occur are found to be either in the controller/sensor unit or stones under the valve seat, (this has happened on system start up only). The valve has been designed with the control system and the complete valve operator to be held in place with separate band clamps. These clamps allow fast removal of the controller or the complete upper section of the valve to gain access to its seat.

Principles of operation of the Iseki valve are given in Section 300.

Valve open time is the only adjustment that can be made to the unit. The factory set open time of five seconds will give, for most installations, the correct air to liquid ratio. This timing may be adjusted in the range of 3 to 10 seconds by turning the small adjusting screw on the side of the controller. Clockwise to increase and anticlockwise to reduce open time.

The valve, its controller/sensor and its sewage sumps are designed to generate two phase flow as the sewage passes through the valve. Controller timing is set so the valve closes after all liquid has passed through it. This avoids the risk of water hammer and possible valve damage.

Sump design plays an important part in the generation of the two phase flow. Volume of accumulated sewage, at the controller trigger point, should be 40 litres at a depth of 260 to 300 mm. With the shallow liquid depth a vortex is drawn in the sump as the 90 mm suction pipe has vacuum applied to it, which draws air into the valve with the sewage and generates two phase flow.

The lower edge of the 90 mm suction pipe and 63 mm sensor pipe should be 50 mm above the sump floor. This will allow solids to pass through the valve and any grease build up inside the sensor pipe to be drawn out when the Iseki valve is on its suction cycle.

Capacity of the Iseki valve is 2.0 litres per second when connected to a 160 mm o.d. sewer.

Figures 600.2 and 600.3 shows the controller sensor unit. Rising pressure from the 63mm sensor pipe is applied to the sensor port through a tube and passes through a small hole in the suppressor diaphragm to the sensor diaphragm chamber. Vacuum from the sewer is applied to the underside of the small 3-way valve which is shown in the closed position, (main valve is also closed). The same vacuum source is applied to the closed side of a pilot valve. When sufficient pressure has been applied to the sensor diaphragm, it applies pressure, through the plunger to the pilot

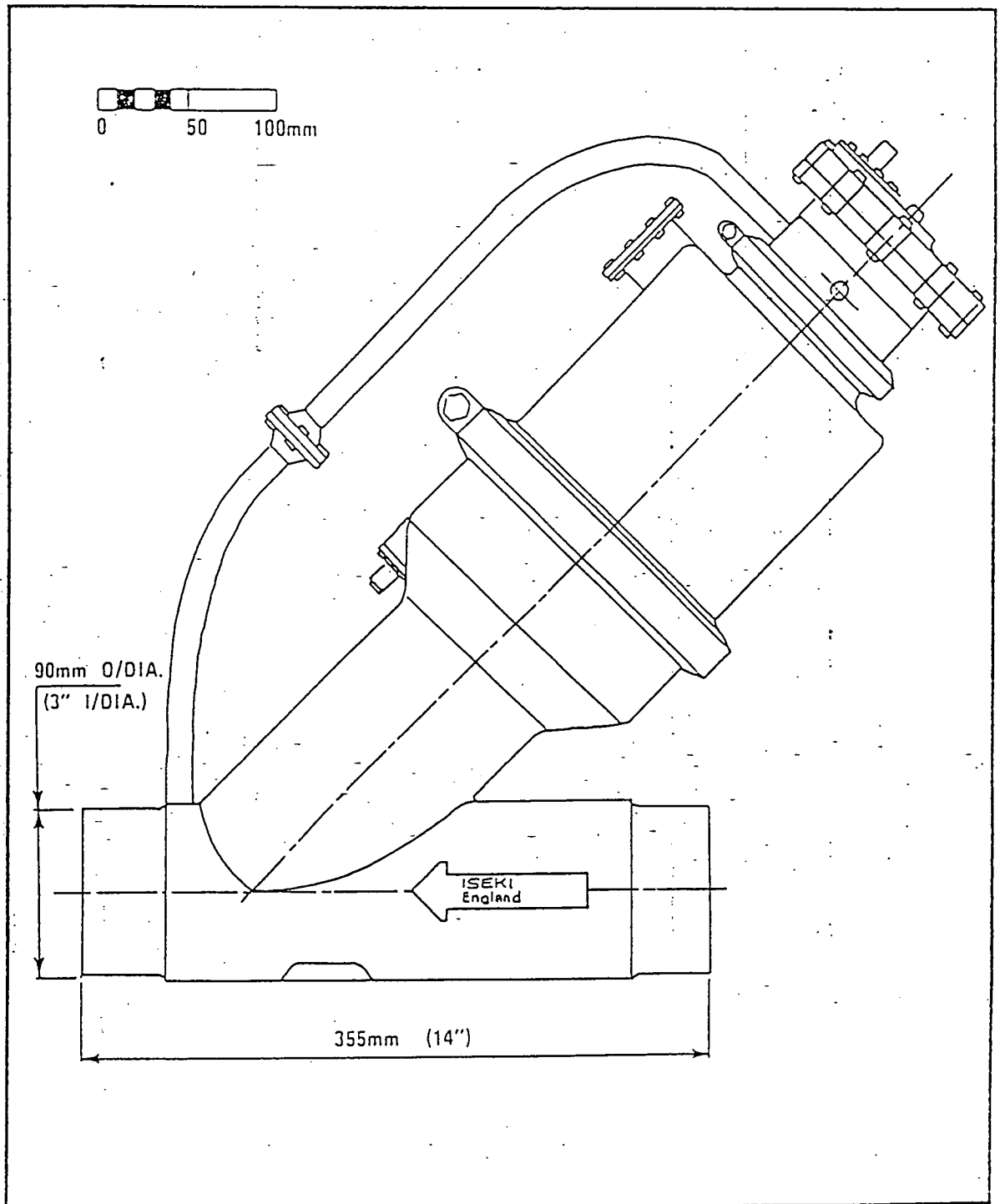


FIGURE 600.1 ISEKI INTERFACE VALVE

600.2

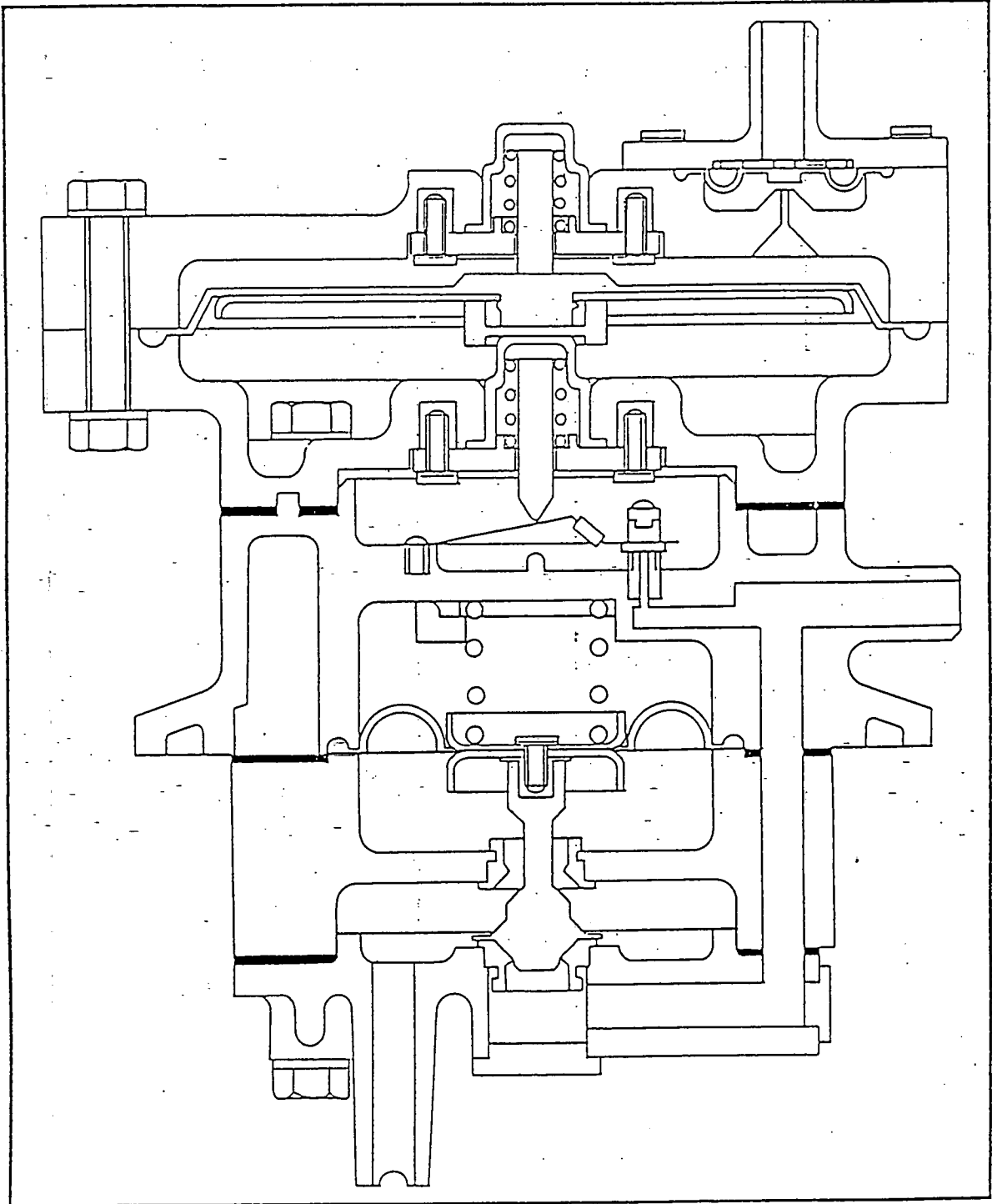


FIGURE 600.2 ISEKJ CONTROLLER IN STANDBY POSITION

600.3

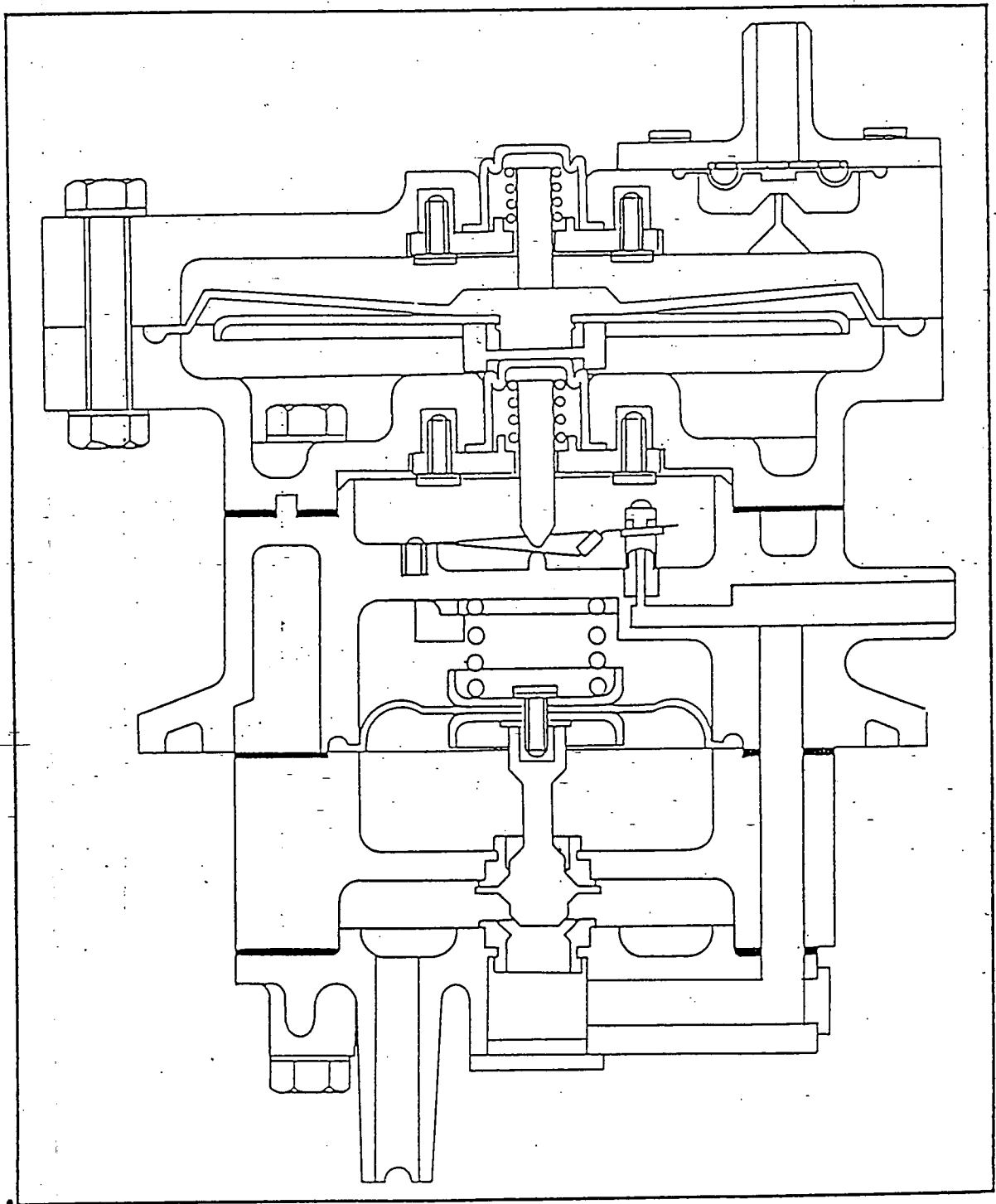


FIGURE 600.3 ISEKI CONTROLLER IN SWITCHED POSITION

600.4

valve which opens. Vacuum flows through the pilot valve into the operator of the 3-way valve which opens and applies vacuum to the main valve operator.

As the main valve draws sewage out of the sump the pressure on the sensor diaphragm is removed and the pilot valve closes. Vacuum remains in the controller/sensor vacuum chamber keeping the 3-way and main valves open. Air pressure is slowly leaked to the vacuum chamber through the adjustable needle valve. When the chamber vacuum has dropped sufficiently for its suction to be overcome by the spring, the 3-way valve switches. Vacuum supply to the main valve is replaced by atmospheric air pressure and the Iseki valve closes.

The rate of the vacuum chamber spring has been selected to ensure the main valve will not open unless a suitable vacuum is available in the sewer.

A large diameter dip tube is fitted in the controller vacuum chamber. This is to remove any water that may collect, through condensation or otherwise.

Water from the chamber is removed through the pilot valve into the vacuum sewer. Removal is greatly assisted by the air flowing into the chamber through the needle valve.

The Iseki vacuum interface valve closes very quickly. When it is connected to a sealed sump atmospheric air enters the sump and valve at high velocity through the gravity connections. Rapid valve closure may cause the fast moving air to raise the pressure in the sump, for a split second, sufficient to activate the sensor diaphragm. The purpose of the suppressor diaphragm is to close the pressure port on a sudden pressure surge and eliminate a second cycle of the Iseki valve.

During routine vacuum valve maintenance manual operation of the controller/sensor unit is often required. A button has been provided on the controller which when pushed will activate the controller/sensor unit.

Each Iseki valve is fitted with a 6 digit magnetically operated cycle counter, no batteries, power supply or vacuum connections are needed to operate this unit. The counter is a small cartridge which is easy to replace in the event of a failure.

A typical vacuum interface valve chamber installation is shown in figure 300.3.

UNIQUE FEATURES OF THE ISEKI VALVE SYSTEM

BAND CLAMPS FOR DEMOUNTING CONTROLLER  
AND VALVE OPERATOR.

AIR ASSISTED DIP TUBE FOR EVACUATING LIQUID FROM  
CONTROLLER VACUUM CHAMBER.

MANUAL CONTROLLER OPERATION ACTUATED BY PUSHBUTTON.

BUILT IN SURGE SUPPRESSOR.

BUILT IN 6 DIGIT CYCLE COUNTER

BUILT IN MINIMUM VACUUM SWITCH.

NO INTERNAL CONTROLLER TUBING.

ROBUST CONTROLLER MOUNTING RING.

COLOUR CODED VALVE.

SUPERIOR CORROSION RESISTANCE.

EASY "ABOVE VALVE" MAINTENANCE

## SPECIFICATION

The vacuum interface valve is vacuum operated on opening and spring assisted on closing. The valve is designed so that the vacuum in the sewer ensures positive contact of the flexible elastomer seat.

It is a Y configuration, 90 mm outside diameter valve made in glass filled polypropylene and is capable of passing solids up to 65 mm diameter, with a visual flow through area of at least 60%. The valve has a vacuum operator of the rolling diaphragm type which overcomes all sealing forces to fully open the valve using sewer vacuum from the downstream side. The conical plunger is fitted to a stainless steel shaft whose bearing is fitted with an elastomer wiper/lip seal. A silicone rubber umbrella check valve is connected to the lower valve housing to automatically remove condensation each time the valve operates.

An umbrella type check valve is fitted in the vacuum supply tube to the controller/sensor unit.

Stainless steel vee band clamps are used to secure the controller/sensor unit to the bonnet and the bonnet/lower housing to the Y body. Removal of the bonnet/lower housing clamp allows speedy removal of the shaft/plunger/seat assembly.

The valve is fitted with a magnetically operated 6 digit cycle counter which is fitted in a sealed chamber forming part of the valve bonnet. This unit operates without the use of batteries or mains power supply.

Integral with the valve is a controller/sensor unit which has a surge suppressor valve built into the sensor port.

The silicone rubber sensor diaphragm initiates the controller sequence when air pressure in the range of 100 to 150 mm water pressure is applied to it.

A stainless steel needle valve moulded into the controller body is capable of controlling the Iseki valve open time in the range of 3 to 10 seconds. Small tubes are not used to connect the needle valve to the controller body parts.

The controller/sensor is fitted with a pushbutton capable of manually initiating its operation. This button is marked "Push to Test".

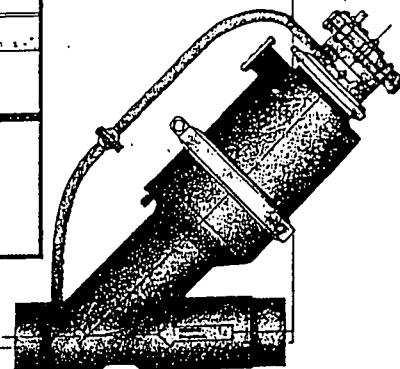
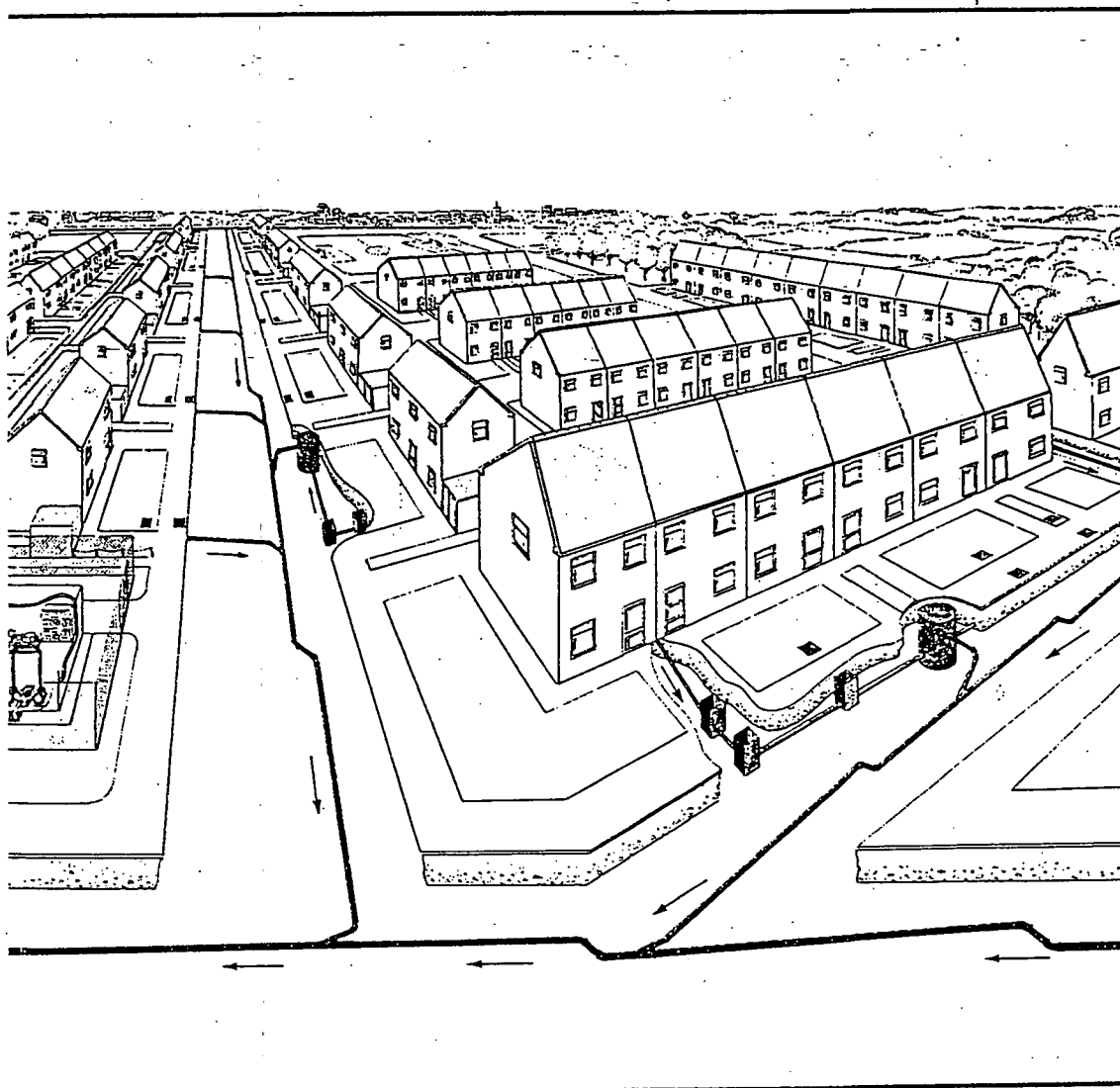
Automatic sequence of controller operation is initiated by air pressure applied to the sensor diaphragm activating a snap action pilot valve to admit vacuum to the controller timing/operating volume. This action switches the controller 3 way valve which supplies vacuum to the Iseki valve operator, which then opens. When the sensor pressure is relieved, atmospheric air enters the timing volume through the needle valve until the controller spring reverses the 3 way valve. Atmospheric air pressure then enters the Iseki valve operator which closes.



# VACUUM SEWERAGE SYSTEMS

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# Iseki

## INTRODUCTION

Vacuum Sewerage systems were first used in the 1860's. Little was heard of the systems until the late 1970's when engineers started to take a fresh look at the many advantages of vacuum collection of sewage and other liquids.

The Iseki systems use proven technology and the 90mm. Vacuum Interface Valve which was developed in England and has been in operation since 1989.

Vacuum sewerage systems have many applications from "hard to sewer" marginal land to marinas, conference centres, airports etc. Iseki systems also have many other applications in general industry, building services, etc., for the collection of any liquid including toxic and radio active effluents.

Iseki systems are flexible in design and installation - we offer a range of services including, design evaluation, detail design, installation, commissioning, factory-reconditioned units and replacement parts.

## PROVEN TECHNOLOGY

Vacuum Sewerage systems were invented in the 1860's by the pioneers Mr. Charles T. Liernur and Mr. Adrian le Marquand.

Over the past 120 years the principle of using vacuum to collect effluents and waste of all forms has become proven and accepted technology in many advanced countries.

The development of electro-fusion welded polyethylene (PE) pipe with its freedom from leaks has given engineers even greater confidence in the system.

Today engineers specify vacuum because of its high integrity collection system combined with its low maintenance and construction costs.

## THE VACUUM WAY™

Vacuum sewers are laid at approximately 1 metre depth in an invert lift profile using electro-fusion welded PE pipes.

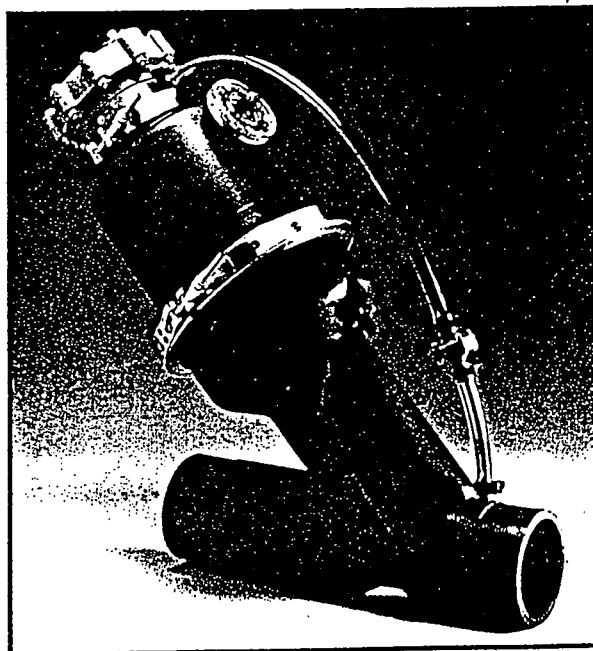
Within design parameters the sewers can flow uphill, around sharp corners, over buried obstructions, over or under streams and can flow downhill without the use of drop manholes.

No special plumbing fittings are required in the home. To the homeowner there is no difference in service between a gravity and an Iseki Vacuum System.

Connected between the vacuum sewers and the gravity lateral from the house is the Iseki Vacuum Interface Valve. This valve is sited within a chamber which has a sump into which the sewage flows from the house lateral. Rising liquid level in the sump generates sufficient pressure to automatically open the Iseki Valve, without the use of mains power, batteries or telemetry. When the sewage has passed through the vacuum valve into the sewers, the valve automatically closes.

Several homes are normally connected to each sump. The energy contained in the air which enters with the sewage provides the motive power to move the liquid along the invert lift sewer profile to the vacuum vessel from where it is pumped to the treatment plant.

Max. distance  
from vacuum  
station  
3.4 km.  
Max "Lift"  
4 1/2 m.



The Iseki Vacuum Interface Valve

## SYSTEM ADVANTAGES

Compared to gravity the vacuum system has the following cost effective advantages :

- Small bore, high integrity, lightweight pipelines
- Shallow excavation depth
- Land with high water table or unstable soil conditions
- Minimum environmental impact caused by construction
- No infiltration or exfiltration
- Blockages are eliminated
- No manholes
- Reduced health risks to maintenance crews
- Reduced maintenance costs
- Water and sewer mains may be laid in the same trench

## COMPONENTS OF THE VACUUM SYSTEM

There are three main components of the vacuum system. These are :

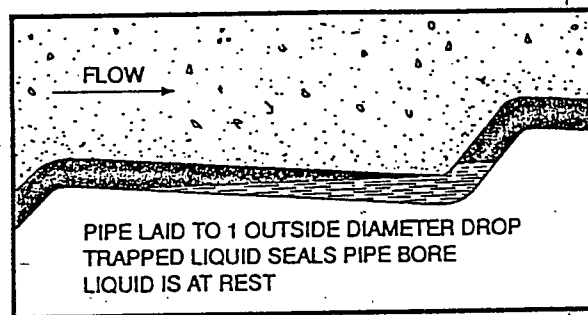
- VACUUM COLLECTION STATION
- VACUUM SEWERS
- THE VACUUM INTERFACE VALVE

## THE VACUUM STATION

This is the heart of the system. It contains the vacuum vessel, which is equivalent to the wet well of a conventional sewage pumping station, the sewage and vacuum pumps together with their controls and alarms.

The vacuum sewers connect to the vacuum vessel into which the sewage is collected and then pumped to the treatment plant.

Vacuum stations may be above or below ground level to suit the project design.



Figures 1, 2 and 3 show the process of two phase flow regeneration

Figure 1

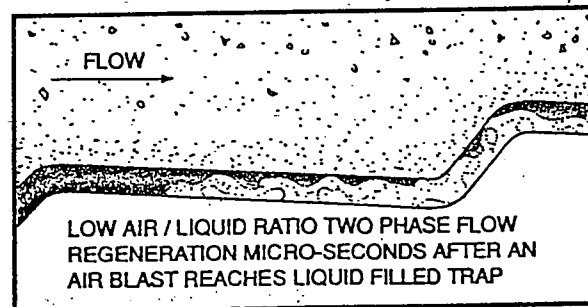


Figure 2

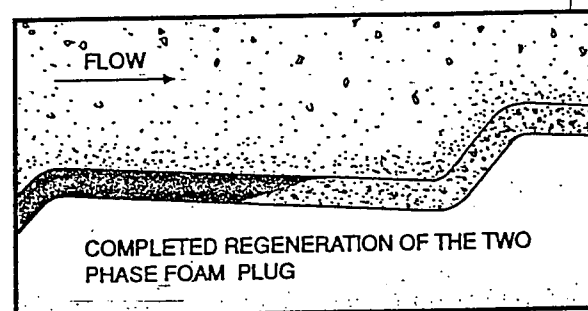


Figure 3

## VACUUM SEWERS

For level and upgrade transport the sewers are laid in an invert lift profile system. This profile is specifically designed, so that liquid lying in the low spots will completely seal the pipe bore. At Iseki we term these low spots "Two phase flow regenerators".

When air passes down the sewer, after being admitted by an upstream Iseki Valve, it passes through the sewer at high velocity. This air flow passing through the liquid filled low spots, regenerates two phase flow or foam, which flows through the sewer towards the vacuum station in the form of a foam plug at velocities of up to 6 metres per second.

The energy contained in the high velocity air is rapidly used up in friction losses causing the foam to slow, reform into liquid, and then flow by gravity to the profile low spot.

Figures 4, 5 and 6 illustrate the various profiles used in the Iseki system. For level grade transport the invert lift pitch may vary depending upon the pipe diameter (outside diameter) used. Figure 4 shows a typical flat ground transport profile.

With downgrade transport the sewers follow the gradient provided the downhill slope exceeds 0.2%. Accuracy of pipe laying in downhill transport is relatively unimportant as any dips or "bellies" in the pipe of up to a pipe diameter will assist with two phase flow regeneration.

Uphill transport is achieved by 'steps' climbing the incline as illustrated in figure 6. Note it is important, for two phase flow regeneration, that each step has a minimum drop of one outside pipe diameter.

The golden rule for sewer profile design is - "lay sewer with 0.2% slope or one pipe outside diameter drop in the direction of flow prior to lifting to the next higher elevation". Lifts in sewers should not normally exceed 300mm. Greater lifts may be used although these usually result in shorter overall sewer lengths.

Trench depth for vacuum sewers need only provide sufficient cover for protection of the pipe from wheel loads and freezing. The pipeline must be properly bedded and backfilled in accordance with the best pipelaying practice for thermo plastic material.

Several sewer lines may be connected to the vacuum vessel and a total lift of 4.5 metres from the vacuum interface valve to the vacuum vessel inlet may be accommodated on each sewer with the recommended air to liquid ratios being used.

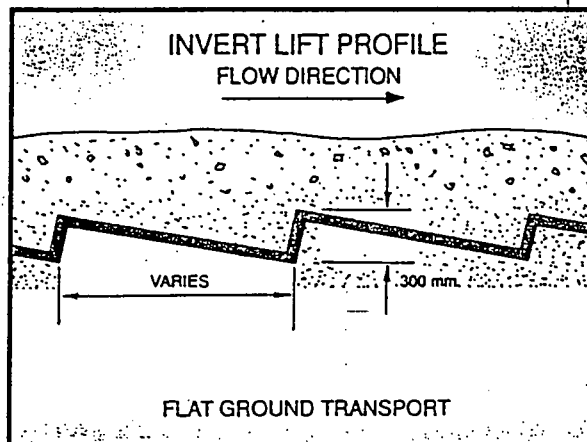
Electro-fusion welded polyethylene pipe is recommended for vacuum sewers although both ABS and PVC have been previously used.

## VACUUM INTERFACE VALVE

Interface valves separate the vacuum within the sewers from the atmospheric pressure of the sumps into which the house laterals drain.

The Iseki Vacuum Interface Valve is operated by pressure generated by the rising sewage level in the sump and vacuum supplied from the sewer.

When there is sufficient sewage in the sump, the valve opens and the sewage is admitted to the sewers with around 6 times its volume of air. The air transforms the sewage into foam which moves through the valve and sewers at a velocity of around 6 metres per second.



Figures 4, 5, and 6 illustrate the various profiles used in the Iseki system.

Figure 4

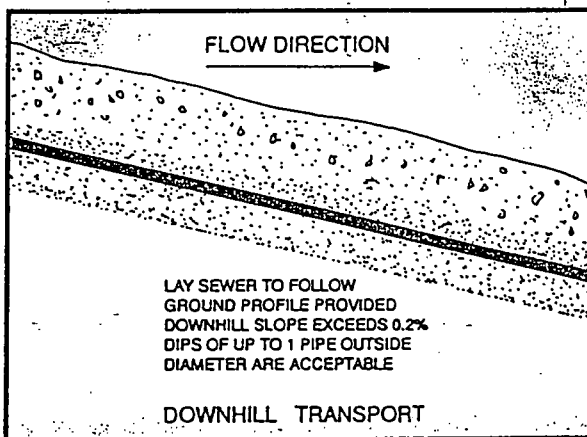


Figure 5

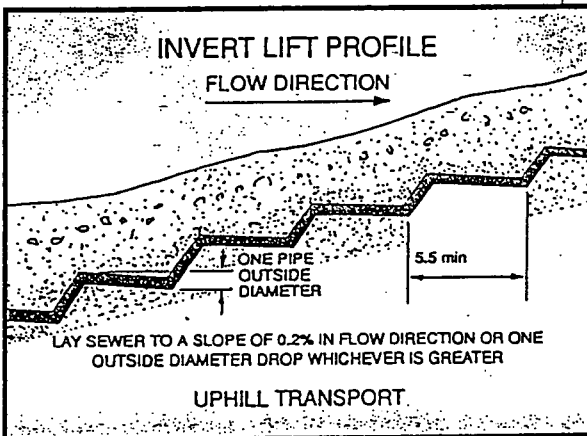


Figure 6

The valve is held open by its built in, field adjustable pneumatic timer which closes the valve after the appropriate volume of air has been admitted to the sewers.

Iseki Vacuum Interface Valves are manufactured from glass filled polypropylene and include features such as a built in cycle counter, surge suppressor, manual override and quick connect couplings for the controller and valve body.

The power to operate the valve is provided by the sump liquid level and the sewer vacuum.

## JOURNEY BY VACUUM

If we were to follow the progress of sewage from a typical house through an Iseki vacuum system, it would travel as follows:-

Leaving the sanitary appliance in the house it would run by gravity through a sealed pipe into the sump of the vacuum valve chamber, as shown in figure 7, which is normally located outside the property line.

When the level of the sewage in the sump reaches the designed top water level it generates pressure in the level sensor pipe, which is transmitted by tube to the interface valve controller.

The controller then opens the valve by taking vacuum from the sewer and applying it to the valve operator. A pneumatic timer in the controller holds the valve open for a pre-set time period to allow the accumulated volume of sewage and some air to enter the system. When the pre-set time has elapsed the valve closes.

On entry to the sewer, the sewage is transformed into two phase foam which moves through the sewer at a velocity of around 6 metres per second. This momentum carries the sewage up and over the invert lifts towards the vacuum vessel located in the collection station.

The vacuum vessel acts as the wet well of the system. Once the sewage level rises in the vessel, level probes start one of the duty sewage pumps which discharge the sewage to the treatment plant.

As the Iseki Valve cycles, the vacuum in the vessel at the collection station drops. Switches then operate the duty vacuum pump to maintain system vacuum in the range of 0.5 to 0.6 bar.

## SYSTEM ADVANTAGES

### ■ Reduced Costs

The small diameter electro-fusion welded PE pipes laid in narrow trenches at minimum depth allow the use of smaller lighter weight construction equipment, which reduces construction costs and the environmental impact caused by the sewer construction.

### ■ Infiltration

Infiltration is eliminated in a vacuum collection system which allows engineers to design smaller and less costly treatment plants. Manholes and lift stations are eliminated with their inherent risks to sewer maintenance crews.

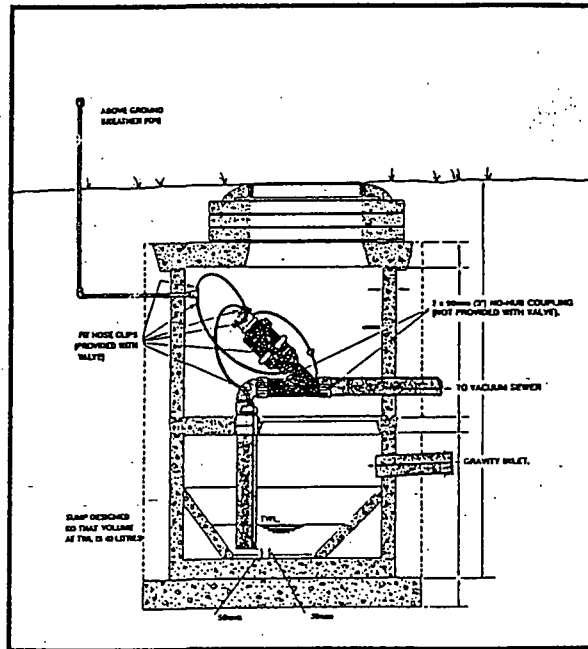


Figure 7 shows a typical valve chamber and sump.

### ■ Additional Advantages

The Iseki System offers additional construction and cost savings in flat terrain or when high water table, unstable soil and rock conditions are prevalent. These advantages allow sewer systems to be built in communities where the high construction costs of gravity systems have previously prevented any collection systems from being provided.

### ■ Flexible System

The vacuum system can be applied to serve the problem areas in large communities which are at present unsewered because of one or more of the site conditions previously listed. The system is extremely flexible and can be integrated with traditional designs where elevation variations may prohibit conventional systems from serving the entire community. It may also be used to separate sanitary and storm sewers.

### ■ Industrial Applications

Vacuum systems with their elimination of exfiltration (any leaks would be inwards), are particularly suited for the collection of toxic and radio-active effluents, also for the separation of chemical drains and discharges. With the lift capabilities of the system it is possible to run the collection pipework overhead in factories and above ground around the factory complex. The small bore above ground collection system can be simply re-designed should a change in factory layout be made.

### ■ When to consider Vacuum Systems

When designing collection systems, the Engineer should ask himself, "Will the excavation or installation costs for conventional systems be higher than normal?" If the answer is YES, THE VACUUM WAY™ could prove to be the best ENGINEERED and COST EFFECTIVE SOLUTION.

# THE VACUUM WAY™

Using

# Iseki

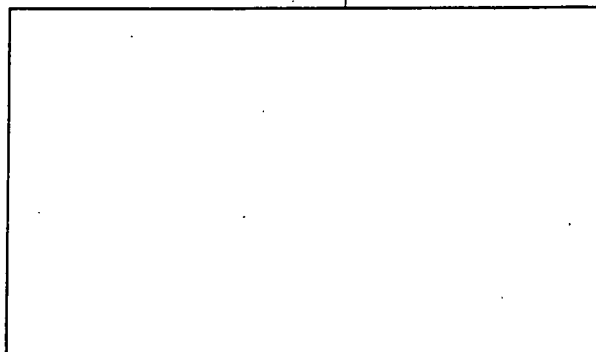
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