



# RAND WATER

RAND WATER

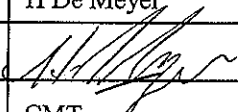
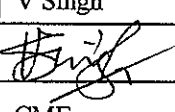
SPECIFICATION

FOR

SLUICE-, AIR-, REFLUX-, BUTTERFLY-, RESILIENT SEAL GATE- AND BALL  
VALVES AND POWERED ACTUATORS

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## Approval

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Date	May 2008	May 2008		

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Supplied separately:

Drawing	A11791 -	Standard flange dimensions
	B3157 -	Details of R W B operating spindle caps for valves outside diameter 100 and larger
	B2168 -	Details of conversion saddle for mounting of 25 mm air valves.

## **RAND WATER**

### **SLUICE-, AIR-, REFLUX-, BUTTERFLY-, RESILIENT SEAL GATE- AND BALL VALVES AND POWERED ACTUATORS**

#### **1 OBJECTIVE**

This Specification provides the minimum requirements for valves to be used by Rand Water and should be used when purchasing new valves.

#### **2 SCOPE**

This Specification is for the manufacture, supply, testing and delivery to Rand Water's Central Depot or construction site of valves for installation by Rand Water.

#### **3 REFERENCES**

Drawing A11791 - Standard Flange Dimensions

B3157 - Details of R W B operating spindle caps for valves diameter 100 and larger

B2168 - Details of conversions saddle for mounting of 25 mm air valves

#### **4 DEFINITIONS AND ABBREVIATIONS**

In these Conditions, or in the Agreement, Specification, schedules or drawings, the following expressions apply namely:

"contract price" shall mean the value of that portion accepted by Rand Water of the sum named in the form of tender, subject to such additions thereto or deductions there from as may be made from time to time under the provisions hereinafter contained.

"Contractor" shall mean the person or persons appointed to undertake the work specified herein and shall include the heirs, executors and administrators of the Contractor.

"Engineer" shall mean the Chief Engineer - Installations for Rand Water or other person duly authorized by him.

"Engineer's Representative" shall mean any person whom the Engineer may appoint as Inspector in terms of the Conditions of Contract, Agreement or Specification.

"Rand Water" shall mean the Rand Water Board, a body incorporated under the provisions of Section 84 of the Water Service Act 108 of 1997.

"Subcontractor" shall mean the firm, company, person, or persons to whom any portion of the work is sublet by Rand Water or by the Contractor with the approval of Rand Water.

"work" shall mean all the materials, articles, matters and things which are to be manufactured, supplied and delivered and which are described in the Specification and schedules or which may in the future be ordered as additions to the contract.

#### **5 GENERAL**

##### **5.1 WORKMANSHIP AND MATERIALS**

5.1.1 The workmanship shall be of the highest quality throughout and any inferior work will be a cause for rejection.

5.1.2 All valves supplied with non-metallic seals shall be suitable for operation at water velocities of at least 5.0 m/sec.

5.1.3 All materials shall be of that quality and possess those properties best suited to the purpose for which they are used. All materials and performances shall comply with the requirements of the most recent edition of the appropriate Standard Specification and test pieces forming part of the actual castings, or keel blocks cast simultaneously with the castings shall be subjected to the specified tests.

## 5.2 MATERIALS

5.2.1 The material of valve bodies, gates, doors and covers shall be in accordance with the following table:

Test pressure	Material	Specification
1500 kPa	Cast Iron	BS 1452 Gr 220 (min)
3500 kPa	Spheroidal Graphite Cast Iron	BS 2789 Gr 420/12 (min)
5000 kPa	Cast Steel	BS 3100 Gr A2 (min)
7000 kPa	Cast Steel	BS 3100 Gr A2 (min)
8500 kPa	Cast Steel	BS 3100 Gr A2 (min)

5.2.2 The design of all valves shall be such that safe stresses are not exceeded when the valves are subjected to the test pressures specified. The Tenderer shall insert the particulars of the materials to be used in the in the relevant schedule.

## 5.3 ITEMS NOT MENTIONED

5.3.1 This Specification does not necessarily mention every detail which has to be supplied and the type or design of any detail not specifically mentioned is left to the discretion of the Tenderer provided the complete equipment supplied complies with the Specification.

## 5.4 DEPARTURE FROM SPECIFICATION

5.4.1 Certain features and items which are considered essential are detailed in this Specification. Any departure by the Tenderer from these requirements shall be specially excluded or amended in writing by noting them in the contract at the time of tendering, otherwise the Engineer may require such features and items to be provided by the Contractor without any increase in the contract price.

## 5.5 DOCUMENTATION

Within three weeks after the date of receipt of Rand Water's letter of acceptance of the tender the Contractor shall submit a comprehensive proposal for a quality assurance plan. The Engineer will then issue his requirements for quality assurance which will be based on the Contractor's proposals provided these are adequate. The Contractor shall produce a quality assurance report on any component within seven (7) days of being so requested. Certain parts such as body, bonnet, gate, disc or blade-castings will be inspected after casting and the Contractor shall carry out metallurgical tests to establish material composition and mechanical properties as and when instructed by the Engineer. The method of obtaining the samples will be decided during manufacture. The Engineer shall, if necessary make further checks on the quality of the work and require the removal of the components for tests and measurements at a place to be selected by him.

## 5.6 DRAWINGS AND INFORMATION

5.6.1 Certain drawings and Specification sheets listed in Section A of Schedule 1 shall be supplied with the tender.

5.6.2 Within three weeks after the date of receipt by the Contractor of Rand Water's letter of acceptance of the tender, but before the manufacture commences the Contractor shall submit the drawings and information listed in Section B of Schedule 1 to the Engineer for approval.

5.6.3 Drawings for approval may be paper prints but, after approval, these drawings shall be supplied with the approved "CAD" drawings tabled and stored in a format that can be loaded, edited and printed from ACAD release 14 or later.

5.6.4 Before completion of the contract, the Contractor shall also supply any drawings that the Engineer may require additional to those listed.

5.6.5 All drawings shall bear Rand Water's contract number and reference number and the title shall state the type, size and test pressure of the valve.

- 5.6.6 Two sets of clearly marked 650 MB CDROM disks containing all drawings shall be supplied. Drawings shall be supplied with the approved "CAD" drawings tabled and stored in a format that can be loaded, edited and printed from ACAD release 14 or later.
- 5.6.7 The Certificate of Completion will not be issued until all the drawings and information listed in Sections A and B of Schedule 1 have been received and approved.
- 5.6.8 Should the makers consider any of the drawings or information to be confidential, the documents shall be marked "CONFIDENTIAL" and they will be treated as such by Rand Water.
- 5.6.9 Sufficient information shall be given on the drawings to enable replacement parts to be made locally, if necessary.
- 5.7 OPERATING, MAINTENANCE AND INSTALLATION MANUALS
- 5.7.1 The Contractor shall provide fully illustrated operating, maintenance and installation manuals for the valves and actuators written in English for approval within three weeks after placement of the order. One copy of the approved manuals and two sets of clearly marked 650 MB CDROM disks containing operating, maintenance and installation manuals shall be supplied to the Engineer with delivery of the valve.
- 5.7.2 Each document shall take the form of a fully indexed Workshop Manual containing, but not limited to the following data:
- General Arrangement drawing for each valve. (The GA must comply to the requirements laid down in Section A of Schedule 1).
  - Detailed operating instructions.
  - Proposed preventative maintenance schedules and procedures covering all wearing components.
  - Lubrication schedule together with recommended lubricant for each application and quantity used.
  - Detailed dismantling and reassembly instructions and procedures.
  - Full details of proprietary components used, i.e. descriptive literature bearing reference numbers, circlip and seal details, etc.
  - Spare parts lists with full re-order information.
  - Schedule of maintenance tools provided/required and the method of use.
  - Electrical schematic diagrams, instrumentation loop diagrams and cable schedules (if applicable).
  - Detailed installation requirements and procedures.
  - Detailed commissioning procedure.
- 5.7.3 Should the makers consider any of the drawings or information to be confidential the documents are to be marked 'CONFIDENTIAL' and they will be treated as such by Rand Water.
- 5.7.4 All data included in the manuals shall be produced on standard A4 size sheets. The materials used shall be resistant to oil and dirt.
- 5.8 VALIDITY OF INSPECTIONS AND TESTS
- 5.8.1 Any inspection, examination or test at the maker's works, either of material or performance, shall not exempt the Contractor from any obligation under this contract. The liability of the Contractor for defective material or workmanship that may be disclosed after the plant has been put into service shall be in accordance with the General Conditions of Contract notwithstanding that the defective item may have been passed previously during manufacture, or after installation.

## 5.9 INSPECTION AND TESTING AT WORKS

- 5.9.1 The whole of the work is to be inspected by the Engineer's Representative at the manufacturers', subcontractors' and/or other outside supplier's works during manufacture. Full information regarding the progress and the necessary facilities to enable the various components to be properly tested and/or inspected shall be given to the Engineer's Representative.
- 5.9.2 Each component shall be inspected, approved and stamped by the Engineer's Representative with his private mark before assembly commences. All castings shall be true and shall be thoroughly cleaned by shot or sand blasting before machining. Valve body surfaces shall be thoroughly cleaned of excess adhesive or other material used for securing sealing faces, guides and shoes.
- 5.9.3 Each hollow butterfly valve disc shall be tested in the presence of the Engineer's Representative for porosity by immersing it in a water bath and applying air at a pressure of 500 kPa to the internal void. Excessive porosity shall be cause for rejection of the disc. However, the Engineer may on the application in writing by the Contractor, grant permission for the porosity to be sealed by drilling, threading and plugging a blowhole or by the injection of an approved sealing compound.
- 5.9.4 All approved castings shall, before coating, be stamped by the Engineer's Representative on the edge of the flange with his private mark. A flat machined surface 15 mm by 25 mm in area shall be provided for this purpose.
- 5.9.5 After assembly and prior to hydrostatic testing the valves under each Item shall be numbered consecutively. This number shall be hard stamped on the valve flange and used as a reference during inspection and testing.
- 5.9.6 Rand Water reserves the right to reject any Item which has not been presented for such test and/or inspection.
- 5.9.7 Certificates of all tests on materials and components are to be forwarded to the Engineer immediately on completion of the tests.

## 5.10 HYDROSTATIC TESTING

- 5.10.1 Each pressure containing component and each assembled valve shall be subjected to the hydrostatic tests as described in Clauses 5.10.2 and 5.10.3, at the manufacturer's works, in the presence of and to the satisfaction of the Engineer's Representative. Each pressure containing component and assembled valve shall withstand the relevant hydrostatic test pressure specified without showing any sweating or defect of any kind. For the hydrostatic test blank flanges shall be bolted to each flange of the valve; through-bolts shall not be used. The pressure shall be applied steadily by approved means and maintained without variation for the duration as specified in Clause 5.10.4 for proof and inspection. Should water ooze or sweat from any part or any defect of any nature be discovered the casting shall be indelibly marked and rejected.
- 5.10.2 Each pressure containing component (such as bodies and bonnets of sluice gate valves and bodies of reflux-, butterfly-, resilient seal gate- and ball valves) shall be subjected to a pre-test at the specified test pressure prior to the application of any primer coating, at the manufacturer's works, in the presence of and to the satisfaction of the Engineer's Representative. Air Valves are excluded from this requirement
- 5.10.3 Each fully assembled valve shall be subjected to a second hydrostatic pressure test at the specified test pressure, at the manufacturer's works, in the presence of and to the satisfaction of the Engineer's Representative.
- 5.10.4 Each butterfly valve disc, reflux valve door, sluice valve gate, resilient seal valve gate, air valve float and ball valve ball shall be tested for mechanical strength to 75% of the test pressure stipulated and for leakage from 0 - 50% of the test pressure stipulated. The disc, door, gate, ball and sealing mechanism shall be tested assembled in the valve body by bolting a blank flange to one side of the body and applying the pressure steadily between the blank flange and the item under test. This test shall be carried out on both faces of a butterfly, sluice, resilient seal and ball valve for five equal increments in increase in pressure from 0 - 50% of the specified test pressure. Test duration and permissible leakage rates for all valves (excluding resilient seal gate valves) shall be limited to the following:

Size of valve	Max. leakage rate in ml/min	Test duration in minutes Body and seat test
50	1.5	1
80	2.5	1
100	3.0	1
150	4.5	1
200	6.0	2
250	7.5	2
300	9.0	3
400	12.0	3
450	13.5	3
500	15.0	5
600	18.0	5
700	21.0	5
800	24.0	5
900	27.0	5
1000	30.0	5
1200	36.0	5
1400	42.0	5
1500	45.0	5
1600	48.0	5
1800	54.0	5
2000	60.0	5
2200	66.0	6
2400	72.0	6
2500	75.0	6
3000	90.0	6

5.10.5 After the completion of the test specified in Clause 5.10.3 and with the pressure reduced to half the stipulated test pressure the butterfly valve disc, ball valve ball or sluice and resilient seal valve gate shall be moved with the operator or actuator that is to be supplied with the specific valve, until the pressure is broken. The butterfly valve seal, sluice valve sealing rings and resilient seal valve gate shall show no damage as a result of this test.

5.10.6 Each type of air valve shall be tested, fully assembled with all its respective components and hydraulically tested to the specified test pressure, in the presence of the Engineer's Representative and to his satisfaction. (see Clause 5.10.1 & 5.10.3).

5.10.7 Each valve shall be tested with its actuator fitted at the manufacturer's works in the presence of and to the satisfaction of the Engineer's Representative (see Clause 12.1.1). A detailed functional test on all circuits of each electric-motor-operated actuator shall be carried out in the presence of the Engineer's Representative.

5.10.8 The fact that any valve or fitting may have passed the hydrostatic test at the works shall not exempt the Contractor from his liability under the General Conditions of Contract.

5.10.9 The Contractor shall provide a suitable safety screen to enable the Engineer's Representative to witness all hydrostatic pressure testing of valves in complete safety. Detail drawings of the safety screen shall be supplied with the tender.

## 5.11 PATCH WELDING

5.11.1 The approval of the Engineer shall be obtained in every case before defects in castings are repaired by welding. In the case of castings subject to any stress, welding will be approved only when such repair is made for the purpose of producing sound surfaces for jointing etc and where no loss of strength is involved. A detailed weld repair procedure must in all cases be submitted and approved by the Engineer prior to any repair work.

5.11.2 Where approval is given for welding to be carried out, the part shall be radio graphically examined and subsequently heat treated to the Engineer's approval unless otherwise directed by the Engineer.

5.11.3 Any valve component which may be found by the Engineer to have been repaired by welding without his prior approval shall be rejected.

## 5.12 SIZE OF VALVE

5.12.1 The size of a valve shall be the diameter of the waterway through the valve and, in the case of sluice valves, there shall be no reduction in area through the valve.

5.12.2 Sizes of all the valves are indicated in millimeters.

## 5.13 OVERALL LENGTH OF VALVES

5.13.1 All valves of the same type, size and test pressure shall have the same overall length between flanges subject to the tolerance allowed in Clause 5.14.

5.13.2 The overall lengths of sluice, butterfly, reflux, resilient seal gate valves and ball valves shall be submitted with the tender.

## 5.14 TOLERANCE ALLOWED

5.14.1 The overall length between flanges shall not vary by more than 2,0 mm. Flange tolerances shall be in accordance with Drawing A11791.

## 5.15 FLANGES

5.15.1 Each valve body flange shall be fully machined on the face and spot-faced at each bolt hole on the back. All other drilled holes on cast surfaces shall be spot faced. Sufficient clearance shall be provided between the valve body flanges to enable flange bolts to be tightened (refer S A E wrench clearances). Bolt holes shall be drilled with the center of the bolt circle coincident with the center of the bore of the valve. Each flange shall be of the thickness shown, subject to the tolerance allowed and drilled in accordance with the table under Clause 5.14.

5.15.2 Each valve shall be supplied with two plain faced loose flanges in accordance with the details provided in Clause 5.15.4. Air valves are excluded from this requirement. Air valve isolators shall be supplied with one plain faced loose flange in accordance with the details provided in Clause 5.15.4

5.15.3 All flanges for valves having a test pressure of 5 000 kPa, 7 000 kPa and 8 500 kPa shall be of the raised face type in accordance with Drawing A11791.

5.15.4 The loose flanges shall be made of materials as listed in Drawing A11791, machined all over and each flange shall be indelibly marked with the reference number of the valve and in addition shall have lines marked across the valve body flanges and each of the loose flanges indicating the top dead center of the flanges for installation purpose.

5.15.5 The Tenderer shall state the analysis of the material proposed for loose flanges and in the event of cast steel flanges being accepted an analysis of the material used shall be submitted for each flange cast.

5.15.6 All bolts, nuts, washers, etc, necessary for jointing the loose flanges to the valve and those for any other joint in the valve shall be supplied. The loose flanges shall be attached to the respective valve with the complete set of bolts and washers under light tension. Gaskets for the joint between the loose flanges and the valve flanges shall not be supplied.

## 5.16 FLANGE DRILLING TABLE

5.16.1 All sizes in mm.

5.16.2 Each flange shall be drilled in accordance with the appropriate table indicated on Drawing A11791 for the specified test pressure of the particular valve.

5.16.3 NOTE: Bolt holes shall be drilled off center lines.

5.16.4 Valves of 600 mm diameter and larger having a test pressure of 5 000 kPa, 7 000 kPa and 8 500 kPa shall have their flanges grooved for "O" rings as indicated on Drawing A11791.

## 5.17 BOLTS

5.17.1 All bolts and nuts shall be threaded in accordance with BS 4190: 1967 or equivalent.



5.17.2 The length of the bolts shall be such that when the bolt is in position and fully tightened the bolt shall project beyond the nut; this projection shall be not more than two threads.

5.17.3 Two mild steel washers shall be provided with each bolt and nut.

5.17.4 Each stud bolt shall be screwed into the parent flange to a depth equal to the full thickness of such flange or a depth equivalent to 1.5 times the nominal bolt size.

5.17.5 All nuts and bolts will be gauged by the Engineer's Representative and nuts or bolts not complying with will be rejected.

## 5.18 LIFTING BOLTS

5.18.1 Each valve shall have at least two eye bolts of the requisite strength designed with a factor of safety of at least four securely attached so that the valve can be lowered into the pipeline in its correct position for installation. The depth of the tapped holes in the valve castings shall be at least 1,5 times the diameter of the eye bolt shank.

5.18.2 Additional eye bolts shall be supplied and located on the valves in positions that allow the valves of 450 mm diameter and larger to be lifted safely either in the vertical or horizontal position.

5.18.3 In close proximity of all the lifting bolts the words "LIFT HERE" to be stenciled on the valve body in red paint. The minimum letter size on valves smaller than 450 mm diameter to be 25 mm and on valves larger than 450 mm diameter to be 45 mm.

## 5.19 IDENTIFICATION PLATE AND NUMBER

5.19.1 A substantial brass or gun metal plate shall be securely attached near the top of each valve, on which the following information shall be recorded:

RAND WATER CONTRACT .....  
NAME OF MANUFACTURER  
YEAR OF MANUFACTURE  
SIZE OF VALVE ..... mm  
BODY TEST PRESSURE ..... kPa  
MASS ..... kg (including flanges, nuts, bolts and washers)  
REFERENCE No  
MAKER'S SERIAL No

5.19.2 In addition, each valve shall have the maker's serial number cast or stamped on all component parts of the valve and embossed figures showing the size and test pressure shall be cast on the body of the valve.

## 5.20 PAINTING

5.20.1 Before assembly each valve shall be shot blasted or sandblasted to remove founding material, scale or rust to provide a degree of cleanliness equivalent to SA 2 1/2 of Swedish Standard SIS 05.5900/1967 and then given sufficient coats of Carboline 891 or approved equivalent to ensure a minimum dry film thickness of 250 micrometers to all internal body surfaces and non-machined parts. After each valve has passed the hydrostatic tests specified in Clause 5.10.1 all external surfaces shall be cleaned as above and coated with Carboline 134 or an approved equivalent to ensure a dry film thickness of 200 micrometers. The final colour to be medium sea grey code G24 as per SABS 1091. Gears, spindles, machined surfaces, including machined flanges, etc shall be adequately protected against corrosion.

5.20.2 In the case where a machining surface is to be painted, or where the cutting oil from the machining process has come into contact with a surface to be painted, that surface shall be cleaned with a suitable solvent-free de-greaser and then given a coat of etching zinc primer before the first coat of Carboline or approved equivalent is applied.

5.20.3 Details of the methods of protection to be provided shall be submitted for approval.

5.20.4 Fusion bonded epoxy coatings shall be acceptable but full details are to be provided for approval.

## 5.21 MARKING, SHIPPING

- 5.21.1 Each valve and fitting, etc shall have the mass and the reference number specified in the delivery schedule and the words "Rand Water" and the reference number painted in white on the outside. All cases or packages shall have the mass and contents and the words "RAND WATER" and the reference number painted clearly thereon.
- 5.21.2 Each valve shall be adequately protected against damage in transit.
- 5.21.3 Machined parts of valves shall be protected by means of plastic or similar protective coatings and other fragile components shall be packed in a separate crate.
- 5.21.4 Each Type 2 air valve shall be bolted to its isolating valve with a complete set of bolts, nuts, washers and rubber insertion gasket of three mm thickness and shall be delivered as an assembly, including drain and pressure gauge valves of the full bore type.
- 5.21.5 The actuator for the valve shall be packed in a packing crate separately from the valve and shall be delivered with the valve. The package shall be clearly marked with the relevant valve reference number and serial number (see Clauses 5.9.5 and 5.19) and the fact that the package contains electrical equipment requires that it should be stored in a dry place.

## 5.22 ACTUATORS

- 5.22.1 Refer to the Sub-clause 6.8.1 and relevant sections of the contract for type of operator to be fitted to the valves.

## 5.23 ELECTRICALLY OPERATED VALVES

- 5.23.1 For all valves requiring electrically operated actuators, refer to Clause 12 of this specification.

## RAND WATER

### 6 SLUICE VALVE SPECIFICATION

#### 6.1 CONDITIONS OF OPERATION

6.1.1 All sluice valves shall be capable of being opened or shut in an emergency under an unbalanced pressure equal to 50% of the specified test pressure (see Sub-clauses 5.10.4 and 5.10.5) and shall be designed to seal from 0 - 50% of the specified test pressure.

6.1.2 The number and size for the sluice valves to be supplied are listed in the contract.

#### 6.2 BODY

6.2.1 The body shall be flanged at both ends and sufficient clearance shall be allowed between the body and the flange to enable flange bolts to be tightened up (refer S A E wrench clearance). Where this is not practicable tapped holes shall be provided, but the number of tapped holes and studs shall not exceed eight per valve (four per side) (see Sub-clause 5.17.4).

6.2.2 Substantial ribs to minimize distortion under pressure shall be provided internally and externally.

6.2.3 Dovetailed recesses with an included angle of not more than 80 degrees and with a bottom stop-end shall be provided to contain the extruded brass channel guides (see Clause 6.7.1). Alternative designs will be considered, provided full details are submitted.

6.2.4 Each valve shall be provided with a 12,7 mm BSP screwed plug in the top of the bonnet for release of air. A substantial boss shall be cast into the body to house the plug.

#### 6.3 GATE

6.3.1 The design and construction of the gate shall be such that it will operate satisfactorily under the conditions specified in Clause 5.10.4.

6.3.2 A distinctive mark, corresponding to a similar mark on the body, shall be made on one face of the gate to ensure that if the gate is removed from the body it will be replaced in the correct position.

#### 6.4 MAIN SPINDLE

6.4.1 The valve spindle shall be forged from high tensile stainless steel in accordance with BS 970 Gr 431 S 29 and shall be of the non-rising type. The Tenderer shall state in the contract the diameter of the spindle proposed. The minimum diameters of main spindles and length of spindle nuts are given in Clause 6.4.8. The spindle shall be sufficiently long to ensure that when the gate is fully raised a clear passage is left through the valve. The thread load area of the spindle and nut assembly should be designed to prevent stripping of the assembly thread. All valves will be opened by clockwise turning of the input or reduction spindle (see Clause 6.8.6).

6.4.2 The valve spindles shall have machine cut stub acme threads in accordance with ASME/ANSI B1.5-1988. The threads shall be free of sharp edges, burrs, etc. Thread pitches are given in the table under Clause 6.4.8.

6.4.3 Each spindle shall be submitted to the Engineer's Representative for inspection before assembly.

6.4.4 Each gate nut shall be manufactured from nickel aluminium bronze which shall be completely free from casting or other defects. Each nut shall be submitted to the Engineer's Representative for inspection before assembly. The nickel aluminium bronze shall be in accordance with BS 1400: 1973 AB2.

6.4.5 The spindle thrust collar shall be fitted with a thrust assembly adequate to withstand the full thrust induced during operation at the shop test and provision shall be made for the radial thrust on the spindle. Bearings shall be accurately fitted into the thrust housing which shall be equipped with seals designed to contain the lubricant and exclude dust. Full details of the bearing and sealing systems shall be shown on the drawings submitted with the tender.

6.4.6 The stuffing box assembly shall incorporate a back seal between the spindle and bonnet to facilitate the repacking of the gland under pressure without shutting off the water. Gland bolts shall be made of stainless steel. The gland packing shall be pure PTFE fiber braided type.

- 6.4.7 The design of the stuffing box assembly shall be such that the packing can be adjusted or completely replaced without disturbing any part of the valve or operator assembly. Alternative designs may be offered but full particulars shall be stated in the tender.
- 6.4.8 Minimum outside diameters of main spindles, minimum lengths of spindle nuts and minimum widths of sealing ring faces:

Minimum outside diameter of main spindle							
Size of valve	Minimum length of spindle nuts	Test pressure 1 500 kPa	Test pressure 3 500 kPa	Test pressure 5 000 kPa	Test pressure 7 000 kPa and 8 500 kPa	Thread pitch	Minimum width of sealing ring faces
mm	mm	mm	mm	mm	mm	mm	mm
50	20	20	20	25	25	4	7
80	30	30	30	36	36	6	10
100	32	36	36	40	40	6	12
150	35	38	38	44	44	7	16
200	40	40	44	48	48	7	16
300	45	44	50	54	54	9	20
400	52	55	60	65	65	9	20
450	56	64	64	70	70	10	20
500	60	65	70	75	75	10	25
600	75	70	70	75	75	10	25
700	80	75	75	80	80	10	25
750	90	75	75	80	80	10	30
800	100	75	75	80	80	10	30
900	110	80	80	90	90	12	30
1 000	130	90	90	95	95	12	32
1 200	152	105	105	115	120	12*	36
1 400	160	105	110	130	150	12*	40
1 500	175	105	120	140	160	12*	45
1 600	225	160	160	180	190	14*	50
2 000	265	180	180	190	230	20*	60

\* Threads shall be two start. All other threads listed in the above table to be single start.

## 6.5 SEALING RINGS

- 6.5.1 The body and the gate of the valves shall be supplied with integral weld-deposited seats. A Welding procedure and details of the consumables used shall be provided if requested by the Engineer. Stainless steel sealing rings in accordance with BS 970 Gr 316 on the body and nickel aluminium bronze in accordance with BS 1400 Gr AB2 on the gate.
- 6.5.2 The leading edges of the face rings shall be slightly chamfered.
- 6.5.3 The internal diameter of the body sealing faces shall not be less than the bore and the face shall be co-axial with the center of the valve bore.
- 6.5.4 The valve seat shall be designed to seal when tested from 0 to 50% of the specified test pressure (see Clause 5.9.4).

## 6.6 GATE SHOES

- 6.6.1 Each valve shall have integral weld-deposited stainless steel gate shoes in accordance with BS 970 Gr 316 or nickel aluminium bronze in accordance with BS 1400 Gr AB2. Pinning is not acceptable.

## 6.7 CHANNEL GUIDES

- 6.7.1 Suitable channel guides in extruded brass in accordance with BS 1400 Gr PB2 and which shall be as long and deep as possible, shall be fitted to support the gate during its travel. Channel guides shall be of dovetail section to match the recess described in Sub-clause 6.2.3. The gate shoes shall be accurately machined and fitted in the guides to ensure that the sealing rings do not make contact before the gate is seated. When the valve is fully open at least half of the shoe shall be supported by the guides.
- 6.7.2 Guides shall be accurately fitted into the body recess and shall be secured with an approved metal adhesive. If an alternative method of securing channel guides is proposed, full details shall be submitted with the tender. Pinning of guides is not acceptable. The channel guide shall be fixed at each end so that there will be no sliding of the guide in the recess.
- 6.7.3 The all-round clearance between gate shoes and channel guides for valves of 600 mm diameter and larger shall be not less than 3 mm and shall not exceed the requirements specified in Sub-clause 6.7.1.

## 6.8 GEARING

- 6.8.1 The following gearing is required:

Type A	-	<u>Multi-stage spur gearing with 6:1 minimum ratio, having operating spindles on the input spindle and at a stage where the valve can be stroked without exceeding the maximum input torque as tabulated in Clause 6.8.8 if no differential pressure is applied to the valve. (To be demonstrated to the Engineer if so requested.)</u>
Type B	-	<u>Single-stage spur gearing with 4:1 ratio having one spindle to operate with a 1:1 ratio and a second spindle to operate with a 4:1 ratio</u>
Type B 90°	-	<u>Single-stage 90° bevel gearing with 4:1 ratio having one spindle to operate with a 1:1 ratio and a second spindle to operate with a 4:1 ratio</u>
Type B 45°	-	<u>Single-stage 45° bevel gearing with 4:1 ratio having one spindle to operate with a 1:1 ratio and a second spindle to operate with a 4:1 ratio</u>
Type C	-	Direct operation on main spindle
Type C 90°	-	<u>Single-stage 90° bevel gearing with 1:1 ratio with one operating spindle only</u>
Type C 45°	-	<u>Single-stage 45° bevel gearing with 1:1 ratio with one operating spindle only</u>
Type E	-	Electrically operated actuators

- 6.8.2 The Type B 90° and Type C 90° gearing are required to allow valves installed with the direction of flow vertical to be operated from a vertical position above the valve, parallel to the direction of flow.
- 6.8.3 The gears shall be robust and machine cut and their mounting shall be of substantial design. Enclosed gearboxes are not acceptable for sluice valves.
- 6.8.4 The operating spindles shall be squared at the top to fit Rand Water's in accordance with Drawing B 3157.

- 6.8.5 Each pinion gear spindle shall be supported between two bearings or alternatively one bearing of sufficient depth to prevent misalignment of the pinion gear and spindle. The bearings shall be fitted with bronze bushes and shall be provided with grease nipple lubricating points and shall be lubricated prior to delivery (see Clause 6.8.11).
- 6.8.6 All valves shall open by clockwise rotation of the main spindle and gearboxes shall be fitted with an intermediate idler where necessary to enable the valve to open by clockwise rotation of either spindle.
- 6.8.7 The Contractor shall state in the contract the time required in seconds to fully open manually operated sluice valves under unbalanced conditions (i.e. 50% of the test pressure).
- 6.8.8 The table below specifies the maximum input torque on any input spindle to seal or stroke a valve.

Valve size	Torque in Nm
100 to 300	150
300 to 450	240
Over 450	275

- 6.8.9 In the case of type A and type B gearing a shear pin or other safety device shall be incorporated between the high and low gears to prevent damage to the valve if excessive force is applied. Two spare pins shall be attached to each valve.
- 6.8.10 Shear pins shall be easily replaced in the field. Hard- driven taper pins will not be accepted as shear pins. A drawing showing details of the shear pin type and location shall be submitted with the tender.
- 6.8.11 All points to be lubricated shall be fitted with 1/8 inch BSP straight nipples for grease-gun lubrication. Adequate lubrication shall be provided for all gear and indicator bushes.

## 6.9 LIMIT STOPS

- 6.9.1 Each valve, larger than 300mm, shall have two limit stops fitted in the body at approximately 15 degrees off the vertical line-line of the valve. The limit stops shall be located in substantial bosses cast into the body and shall be fitted with watertight seals and spacer clips. Limit stops shall not protrude below the level of valve supports.
- 6.9.2 The Contractor shall provide adequate means of securing the limit stops after they have been set to prevent abuse of the components.

## 6.10 INDICATORS

- 6.10.1 Each manually-operated valve shall be provided with a permanently secured cast gunmetal or cast brass direction-indicator dial of substantial design with an embossed arrow showing the direction for opening the valve.
- 6.10.2 All valves larger than 300 mm diameter shall be fitted with a substantial differential indicator to show the position of the gate. If gear driven indicator wheels are used these may be cut from mild steel plate but shall have firmly fixed to them embossed marking plates of cast gunmetal or cast brass. If a pointer is used it shall be of cast gunmetal or cast brass. The indicator shall show clearly:
- (1) When the valve is fully open.
  - (2) Each 100 mm of intermediate position.
  - (3) When the valve is fully closed.
- 6.10.3 All indicator dials or plates shall be of robust and rigid design, the embossed markings shall be large enough to be plainly visible from a distance of two meters. Sliding type indicators are not acceptable. A drawing showing details of the indicators offered shall be submitted with the tender.

## RAND WATER

### 7 AIR VALVE SPECIFICATION

#### 7.1 FUNCTION

The required valves shall provide any of the functions, or combination of functions, described below as specified in the schedule of quantities. All air valves shall be able to function in normal and in an emergency condition, under an unbalanced pressure equal to 50% of the specified test pressure (see Sub-clauses 5.10.4 and 5.9.5) and shall be designed to seal from 0 - 50% of the specified test pressure.

##### 7.1.1 Pipeline filling

Uninterrupted high volume air discharge through the large orifice.

##### 7.1.2 Pipeline draining or column separation

Uninterrupted high volume air intake through the large orifice.

##### 7.1.3 Pipeline full and operating

Discharge of disentrained pressurized air through the small orifice.

##### 7.1.4 Rapid filling/column separation

The valve must incorporate an integral surge alleviation mechanism which will automatically dampen surge pressures due to rapid air discharge or the subsequent rejoining of separated water columns.

#### 7.2 TYPE OF VALVE

7.2.1 The air valves shall be of two types. Both types shall have bodies designed for the test pressure stated and tested to meet the requirements of Clause 5.10.6.

7.2.2 TYPE I shall comprise a valve having one or more large orifices to allow air to escape or enter while the pipeline is being charged or emptied; the orifices shall be not less than 100% of the inlet branch diameter and the orifice diameter shall be stated in the contract. The inlet branch shall be flanged;

7.2.3 TYPE II shall comprise a valve having an orifice of not less than three mm diameter to allow the escape of air under a working pressure equal to 50% of the test pressure. The inlet branch shall be flanged. Valves with slotted air release apertures will be considered and the width of the slot shall not be less than two mm and an area of not less than 7.1 mm<sup>2</sup>. The orifice diameter shall be stated in the contract.

7.2.4 The number and the size of the air valves to be supplied are listed in the contract.

7.2.5 Type I valves shall incorporate a small orifice air valve or combination of Type I and Type II valves on one inlet branch.

7.2.6 The size of the valve shall be the diameter of the inlet branch.

7.2.7 Type I air valves shall be supplied complete with one set of nuts, bolts and washers.

7.2.8 The isolators for type I air valves shall be supplied complete with one loose flange and one set of nuts, bolts and washers.

7.2.9 Type II air valves shall be supplied with conversion saddles for mounting, together with two complete sets of bolts, nuts and washers and one loose flange as shown on Drawing B 2168.

7.2.10 Full particulars of the valves offered shall be submitted with the tender.

### 7.3 CLOSING MECHANISM, CONSTRUCTION AND DESIGN

- 7.3.1 The air release and vacuum break valve shall be of a compact single chamber design with High Density Polyethylene control floats. Floats of spherical design shall be acceptable, provided that substantiated proof is provided and verified by experimental tests to demonstrate that the Venturi phenomenon, which these designs are susceptible to, does not occur during air intake and discharge. Any hollow float design will be acceptable provided that the float can withstand the full test pressure specified without any signs of distortion or failure due to implosion and distortion making sealing difficult or impossible.
- 7.3.2 Floats shall be housed in a tubular stainless steel or corrosion protected body.
- 7.3.3 In Type II valves the small orifice shall be so designed that by the application of the specified working pressure the ball or float shall allow the release of air freely when air accumulates in the valve body.
- 7.3.4 The seats, spindles, guides, etc shall be of a suitable metal that resist corrosion or is adequately protected against corrosion, with sufficient clearance and shall be designed to prevent abrasion of the ball or float when subjected to frequent operation.
- 7.3.5 The seats of the orifices shall not have sharp edges and shall be designed so as not to damage the ball or float when subjected to the specified test pressure. Any form of Vulcanization of the sealing mechanism to the orifice seat shall under no circumstances take place during any stage of the complete life cycle of the air valve.
- 7.3.6 The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent rejoining of separated water columns.
- 7.3.7 The limitation of pressure rise must be achieved by deceleration of approaching water prior to valve closure.
- 7.3.8 Relief mechanisms that act subsequent to valve closure cannot react in the low millisecond time span required and are therefore unacceptable.
- 7.3.9 Devices dependant on any mechanical paraphernalia such as springs and the like are unacceptable.
- 7.3.10 The performance capability of an integral surge alleviation mechanism shall be substantiated through third party testing, conducted by a recognised authority.
- 7.3.11 Large orifice sealing shall be effected by the flat force of the control float seating against a seal circumferentially surrounding the large orifice.
- 7.3.12 Discharge of pressurised air shall be controlled by the seating and unseating of a small orifice on a natural rubber seal affixed to the control float.
- 7.3.13 The intake/discharge orifice area shall be equal to the nominal size of the valve i.e a 200 mm (8") valve shall have a 200 mm (8") intake/discharge orifice.
- 7.3.14 The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur by submission to the stipulated test pressure.

### 7.4 TESTING

- 7.4.1 A high pressure strength and leak test whereby the valve is filled with water and pressurised to the stipulated test pressure which shall be held for a period of 2 minutes. Any leaking, weeping and sweating shall be a reason for rejection. These tests must be on total, completed units including floats.

### 7.5 ISOLATING VALVES FOR AIR VALVES

- 7.5.1 Each air valve shall be provided with a valve to isolate the air valve from the main Pipeline.
- 7.5.2 Type I air valves shall have sluice valves in accordance with the SLUICE VALVE SPECIFICATION or butterfly valves in accordance with the BUTTERFLY VALVE SPECIFICATION, to isolate them from the main pipeline. Type II valves are to be isolated by a suitable flanged or screwed cast steel gate or ball valve rated for the stipulated test pressure.



- 7.5.3 The sluice and Type II cast steel gate or ball isolating valves shall be capable of operating in a horizontal position and shall be provided with a handwheel for operation and gearing is not required.
- 7.5.4 Each isolating valve shall be provided with a handwheel fitted to the spindle in an approved manner and shall have directional indication so cast into a recess on the upper surface of the rim that the top of the letter, arrows and rim are at the same level.
- 7.6 DRAIN AND PRESSURE FITTINGS
- 7.6.1 All air valves shall be provided with drain cocks so that the body of the valve can be drained when isolated from the pipeline. Cast steel gate or ball valves rated for the stipulated test pressure, shall be provided for this purpose.

## RAND WATER

### 8 REFLUX VALVE SPECIFICATION

#### 8.1 CONDITIONS OF OPERATION

8.1.1 Each reflux valve will be used to automatically prevent the reversal of flow in the event of pumps being tripped or in the case of pipelines which are cross connected and shall be designed to seal from 0 - 50% of the specified test pressure.

8.1.2 The number and size of the reflux valves to be supplied are listed in the contract

#### 8.2 BODY

8.2.1 The body shall be flanged at both ends and sufficient clearance shall be allowed between the body and the inside face of the flange to enable the flange bolts to be tightened up (refer S A E wrench clearances); where this is not practicable a maximum of eight tapped holes per valve (four per side) and studs shall be provided in the flange together with bolts of suitable length.

8.2.2 The body shall be of sound and robust design and shaped to give the minimum change in waterway.

#### 8.3 DOORS

8.3.1 Each valve shall be fitted with doors that meet the requirements of Clause 5.10.4 designed to operate freely with the minimum loss of head. Single door tilting disc type reflux valves with suitable dampers will be considered.

8.3.2 The Tenderer shall state the minimum area of the opening through the valve and the estimated loss of head through the valve when the velocity at the entrance is 1,2, 2,5 and 3,5 metres per second.

8.3.3 Each door shall be restricted in its travel so that its maximum lift is below the horizontal position and to ensure this feature permanent stops shall be provided for each door. These stops shall have substantial rubber facings to prevent wear due to metal contact. The rubber facings shall be returned over the sides of the stops and shall be vulcanized onto the metal and secured by means of countersunk screws into the sides of the stops. Details and drawings of the stops offered shall be submitted with the tender.

8.3.4 If the doors are provided with double hinges suitable provision shall be made to prevent the door fluttering; a metallic spring is not considered suitable or adequate for this purpose.

8.3.5 An inspection cover shall be provided to enable the doors to be examined.

8.3.6 Each door spindle shall be extended through a stuffing box on one side of the body only and a pointer shall be fitted to the extended spindle so that the open and closed positions of the valve door can be registered on a brass indicator plate. In order to reduce friction in the gland the neck bush shall be self lubricating, thermo-plastic or other material suitable for continuous operating conditions and designed to prevent the ingress of foreign matter. Such material shall be dimensionally stable in continuous contact under the foregoing conditions.

8.3.7 In addition to the position indicator detailed in Clause 8.3.6 the reflux valve shall be provided with a position transmitter for each valve door, or system of doors if so requested (see the contract document). The transmitters shall be of the two wire type, powered from an external 24 V DC power supply, by others and shall provide a 4 - 20 mA signal proportional to valve door position. The transmitters shall be capable of driving the 4 - 20 mA signal into an internal load of 750 ohms.

8.3.8 The transmitters shall be housed in a robust IP 68 or better housing.

8.3.9 As the position transmitters will be used to monitor door movement, flutter, etc, the transmitters shall have a positional accuracy of better than 0,5%, a hysteresis of better than 0,5% and a time constant of typically less than 0,1 second.

#### 8.4 SEALING FACES

- 8.4.1 The body and the gate of the valves shall be supplied with integral weld-deposited seats. Stainless steel seats in accordance with BS 970 Gr 316 on the body and nickel aluminium bronze seats in accordance with BS 1400 Gr AB2 on the door. A Welding procedure and details of the consumables used shall be provided if requested by the Engineer. Pinning will not be accepted.
- 8.4.2 The seats shall be accurately faced to enable the conditions specified in Clause 5.10.4 to be met.
- 8.4.3 Preference will be given to reflux valves that are fitted with an o-ring or dovetail-ring after the sealing rings have been accurately faced.

#### 8.5 BEARINGS

- 8.5.1 The Tenderer shall give full particulars of the type of bearings offered and the method of lubrication. The main bearings shall be external and accessible without emptying the valve body. Bronze or gunmetal bearings are preferred.

#### 8.6 COUNTERWEIGHTS

- 8.6.1 The reflux valves shall be supplied with suitably designed counterweights and lever arms on each door shaft. The position of the counterweights shall be adjustable to ensure effective closure of the valve and to reduce any unnecessary stresses in the valve body or doors.
- 8.6.2 The counterweight shafts shall be fitted with suitable bushes and glands and shall be so designed that the glands can be repacked during operational pressures of 50% of the test pressure.
- 8.6.3 The doors and lever arms shall be secured to the door shafts by suitable keys and keyways.
- 8.6.4 The counterweight arm, shaft and keys shall be designed to enable the door to be lifted by applying manual leverage to the arm under balanced pressure conditions.
- 8.6.5 Each counterweight arm shall be designed and supplied with an end fixture to prevent the counterweights from accidentally sliding off the arm during operation or adjustment of the counterweights.
- 8.6.6 Details of the counterweight leverage design shall be stated by the Tenderer in the contract.

## RAND WATER

### 9 BUTTERFLY VALVE SPECIFICATION

#### 9.1 CONDITIONS OF OPERATION

9.1.1 Each butterfly valve will be used to isolate a section of pipework or a pipeline and shall be capable of being opened or shut in an emergency under an unbalanced pressure equal to half the specified test pressure and shall be designed to seal from 0 - 50% of the specified test pressure (see Sub-clauses 5.10.4 and 5.10.5 and at flow rates as tabulated in the contract).

9.1.2 The number and size of the butterfly valves to be supplied are listed in the contract.

#### 9.2 BODY

9.2.1 The body shall be flanged at both ends and sufficient clearance shall be allowed between the body and the flange to enable flange bolts to be tightened up. (Refer S A E wrench clearances.) Where this is not practicable tapped holes shall be provided but the number of tapped holes and studs shall not exceed eight per valve (four per side) (see Clause 5.17.4.)

9.2.2 Hubs for shaft-bearing housings shall be integral with the valve body.

9.2.3 The valve shall be stable and capable of operating at any opening without variation of disc position and there shall be no flutter of the disc.

9.2.4 The disc shall close with a positive action and there shall be no possibility of it slamming shut. Where necessary suitable gearing shall be provided to prevent slamming.

9.2.5 An incorporated by-pass valve in the body of the valve is not required.

9.2.6 A flow directional arrow shall be cast on the body of the valve.

#### 9.3 DISC

9.3.1 The disc shall be of streamlined design to provide minimum resistance to water flow.

9.3.2 Substantial ribs to minimize distortion under pressure shall be provided if necessary.

9.3.3 The disc shall be of adequate section to sustain full working differential pressure across the closed valve disc without exceeding a stress of 20% of the tensile strength of the material used (see Clause 5.10.4).

9.3.4 The thickness through the centre hub section of the disc shall be 1,8 to 2 times the shaft diameter.

#### 9.4 VALVE SHAFT

9.4.1 The valve shaft may consist of a one-piece unit extending completely through the valve disc or may be of the "stub shaft" type.

9.4.2 The valve shaft shall be of stainless steel in accordance with BS 970 Gr 431 S 29 and shall extend through the valve bearings and into the valve disc.

9.4.3 Each stub shaft shall be inserted into the valve disc hub for a distance of at least 1,5 shaft diameters.

9.4.4 The valve shaft shall be attached to the valve disc by means of keys, dowel pins, taper pins or any combination of the three and the connection between the shaft and disc shall be designed to transmit shaft torque equivalent to at least 75% of the torsional strength of the shaft.

9.4.5 Dowel and taper pins shall be mechanically secured.

#### 9.5 VALVE SEATS AND SEALS

9.5.1 Valves with body spool seals are not acceptable. Valves with body seals which depend on a press fit for securement are not acceptable.

- 9.5.2 The valve seat shall be designed to seal when tested from 0 - 50% of the specified test pressure (see Clause 5.10.4).
- 9.5.3 Each butterfly valve shall have a sealing seat and seal retaining rings which shall be chromed or stainless steel in accordance with BS 970 Gr 316L.
- 9.5.4 The seal shall be placed in the disc or body and shall be renewable without removing the valve from the pipeline. The seal shall be either a resilient elastomer material or shall comprise of a metal to metal seal (see the contract) which in both cases shall be suitable for potable and raw water. (Chemical properties available on request). The materials for the metal to metal seals shall be selected to ensure that galling or "pick up" does not occur.
- 9.5.5 Each valve body shall be provided with adjustable mechanical stops to prevent overtravel of the valve disc on the open or closed position. If the actuator is fitted with mechanical stops, stops in the valve body will not be required.
- 9.6 VALVE BEARINGS
- 9.6.1 Each valve shall be fitted with sleeve type bearings contained in the hubs of the valve body.
- 9.6.2 The valve shall be equipped with at least one thrust bearing set to hold the valve disc securely in the centre of the valve seat.
- 9.7 STUFFING BOX
- 9.7.1 The design of the stuffing box assembly shall be such that the packing can be adjusted or completely replaced under pressure without disturbing any part of the valve or operator assembly. Alternative designs may be offered but full particulars shall be stated in the tender.
- 9.8 MANUALLY-OPERATED ACTUATORS
- 9.8.1 Each manually-operated butterfly valve shall be fitted with an actuator that requires a maximum input force on the handwheel of not more than 250 Newton pull to seat and unseat the valve under 50% of the test pressure and to operate the valve while water is flowing through the valve at velocities up to 5,0 metres per second.
- 9.8.2 Actuator gears shall be machine-cut and of substantial design.
- 9.8.3 Each actuator shall be furnished with a device to hold the valve in a fixed position for an extended period of time.
- 9.8.4 All valves shall open by clockwise rotation of the actuator main spindle.
- 9.8.5 All valves shall have the gearbox or actuator installed on the right hand side of the valve (when looking with the preferred direction of sealing and flow) unless otherwise specified in the contract.
- 9.9 INDICATORS
- 9.9.1 A direction-of-rotation indicator shall be permanently attached to each handwheel and a pointer attached to the valve shaft shall indicate when the valve is full open or shut and each 10 degrees of intermediate travel.
- 9.9.2 The indicators shall be weatherproof and of robust and rigid design; the embossed markings shall be large enough to be plainly visible from a distance of two metres. A drawing showing details of the indicator offered shall be submitted with the tender.

## RAND WATER

### 10 RESILIENT SEAL GATE VALVE SPECIFICATION

#### 10.1 CONDITIONS OF OPERATION

- 10.1.1 All resilient seal gate valves shall be capable of being opened or shut in an emergency under an unbalanced pressure equal to 50% of the specified test pressure and shall be designed to seal drop tight from 0 - 50% of the designed test pressure.
- 10.1.2 The number and size of the resilient seal gate valves to be supplied are listed in the contract.

#### 10.2 BODY

- 10.2.1 The body shall be flanged at both ends and sufficient clearance shall be allowed between the body and the flange to enable the flange bolts to be tightened up (refer S A E wrench clearance). Where this is not practicable a tapped holes and studs shall not exceed eight (see Sub-clause 5.17.4). The valves shall be manufactured from the respective materials specified in Clause 5.2.1.
- 10.2.2 The valves shall be provided with a straight cylindrical unobstructed body passage without recesses to eliminate any possible deposits of foreign matter collecting in the body.

#### 10.3 GATE

- 10.3.1 The design and construction of the gate shall be such that it will operate satisfactorily under the conditions specified in Clause 5.10.4.
- 10.3.2 The gate shall be manufactured from materials specified in Clause 5.2.1 and shall be completely covered with nitrile rubber. The shore hardness of the rubber shall be suitable for the respective test pressures of the valves.
- 10.3.3 The rubber covering on the gate shall be of adequate thickness to ensure a drop-tight seal from 0 - 50% of the test pressure. The seal shall remain drop-tight in the possible event of particles up to a maximum diameter of 2 mm being trapped between the gate and body.

#### 10.4 MAIN SPINDLE

- 10.4.1 The valve spindle shall be forged from high tensile stainless steel in accordance with BS 970 Gr 431 S 29 and shall be of the non-rising type. The Tenderer shall state the diameter of the spindle proposed. The minimum diameter of main spindles is given in Clause 10.4.8. The spindle shall be sufficiently long to ensure that when the gate is fully raised a clear passage is left through the valve. All valves will be opened by clockwise turning of the input or reduction spindle (see Clause 6.8.6).
- 10.4.2 The valve spindles shall have machine cut single start stub acme threads. The threads shall be free of sharp edges, burrs, etc. Thread pitches are given in the table under Clause 10.4.8.
- 10.4.3 Each spindle shall be submitted to the Engineer's Representative for inspection before assembly.
- 10.4.4 Each gate nut shall be manufactured from nickel aluminium bronze which shall be completely free from casting or other defects. Each nut shall be submitted to the Engineer's Representative for inspection before assembly. The nickel aluminium bronze shall be in accordance with BS 1400 Gr AB2.
- 10.4.5 The spindle thrust collar shall be fitted with a thrust bearing and provision shall be made for the radial thrust on the spindle. Bearings shall be accurately fitted into the thrust housing which shall be equipped with seals designed to contain the lubricant and exclude dust. Full details of the bearing and sealing systems shall be shown on the drawings submitted with the tender.
- 10.4.6 Two or more nitrile or viton rubber O-ring seals shall be fitted to the stuffing box to prevent fluid leakage past the spindle. A wiper ring shall be fitted to the stuffing box to prevent ingress of dirt.
- 10.4.7 The design of the stuffing box assembly shall incorporate a back seal between the spindle and bonnet to facilitate the replacement of the O-ring seals under pressure without disturbing any part of the valve or operator assembly. Alternative designs may be offered but full particulars shall be stated in the contract.

10.4.8 Minimum outside diameters of main spindles.

Minimum outside diameter of main spindle			
Size of valve	Test pressure 1 500 kPa	Test pressure 3 500 kPa	Thread pitch
mm	mm	mm	mm
80	25	25	5
100	26	26	5
150	28	28	5
200	32	32	6
300	39	39	7
400	45	50	8

10.5 GATE GUIDES

10.5.1 Gate guides shall be incorporated in the bonnet and shall be of the tongue and groove type and shall support the gate until seating has commenced.

10.6 GENERAL

10.6.1 The gearing, direction of rotation of closure and indicators shall be in accordance with Clauses 6.8 and 6.10 and full details shall be stated in the tender.

## RAND WATER

### 11 BALL VALVE SPECIFICATION

#### 11.1 CONDITIONS OF OPERATION

- 11.1.1 Each ball valve will be used to isolate a section of pipework or a pipeline and shall be capable of being opened or shut in an emergency under an unbalanced pressure equal to half the specified test pressure and shall be designed to seal from 0 - 50% of the specified test pressure (see Sub-clause 5.10.4 and 5.10.5).
- 11.1.2 The number and size for the ball valves to be supplied are listed in the contract.

- 11.1.3 The Tenderer may offer ball valves as an alternative to sluice valves. The maximum velocity through the valve will not exceed 5 m/s.

#### 11.2 BODY

- 11.2.1 The body shall be flanged at both ends and sufficient clearance shall be allowed between the body and the flange to enable flange bolts to be tightened up. (Refer S A E wrench clearances.) Where this is not practical tapped holes shall be provided but the number of tapped holes and studs shall not exceed eight per valve (four per side) (see Clause 5.17.4).
- 11.2.2 Hubs for shaft-bearing housings shall be integral with the valve body.
- 11.2.3 The valve shall be stable and capable of operating at any opening without variation of ball position and there shall be no flutter or vibration of the ball.
- 11.2.4 The ball shall close with a positive action and there shall be no possibility of it slamming shut. Where necessary suitable gearing shall be provided to prevent slamming.
- 11.2.5 A flow directional arrow shall be cast on the body of the valve.
- 11.2.6 The body shall incorporate an adequate number of feet (minimum of four) to ensure the valve is balanced and stable when free standing. Feet that are bolted onto the valve flange are not acceptable.

#### 11.3 BALL

- 11.3.1 The ball shall provide minimum resistance to flow and shall be of the full bore pattern type.
- 11.3.2 For valves less than 300 mm the ball shall be of the floating ball type, the seats shall support the ball in its correct position. Valves 300 mm and larger shall be of the trunnion mounted type, the ball shall be supported by two stub shafts (see Clause 11.4).
- 11.3.3 The ball shall be of cast steel to BS 3100 Gr A2 or stainless steel to BS 3100 Gr 316C16 and shall be of adequate section to sustain full working differential pressure across the closed valve ball without exceeding a stress of 20% of the tensile strength of the material used (see Clause 5.10.4).

#### 11.4 VALVE SHAFT

- 11.4.1 The valve shafts shall be of the "stub shaft" type and shall be of the blow-out proof design.
- 11.4.2 The valve shaft shall be of BS 970 431 S 29 stainless steel and shall extend through the valve bearings and into the valve ball, or shall be flanged and bolted onto the ball.
- 11.4.3 Each stub shaft shall be inserted into the valve ball hub for a distance of at least 1,5 shaft diameters, or the centre thickness of the ball for floating ball type valves.
- 11.4.4 The valve shaft shall be attached to the valve ball by means of two machined flats on the shaft into a corresponding slot in the ball, for larger diameter valves the shaft shall be flanged and bolted onto the ball. The connection between the shaft and ball shall be designed to transmit shaft torque equivalent to at least 75% of the torsional strength of the shaft.
- 11.4.5 Dowel and taper pins shall be mechanically secured.



## 11.5 VALVE SEATS AND SEALS

- 11.5.1 Valves with body spool seals are not acceptable. Valves with body seals which depend on a press fit for securement are not acceptable.
- 11.5.2 The valve seat shall be designed to seal when tested from 0-50% of the specified test pressure (see Clause 5.10.4).
- 11.5.3 Each ball valve shall have two sealing seats in the valve body, which shall be virgin PTFE or 15% glass filled PTFE, alternative sealing materials will be considered, details to be submitted in the contract.
- 11.5.4 Ball valves that incorporate a retractable seal will be considered, however the main seal shall incorporate at least five mechanical locking devices, a drawing showing the device shall be submitted with the Tender.
- 11.5.5 Tenderers that offer valves with metal to metal seals shall incorporate a resilient elastomer secondary seal which shall be secured to prevent extraction from the seat at the maximum velocity across the seat when the valve is partially open.
- 11.5.6 Each valve body shall be provided with mechanical stops to prevent overtravel of the valve ball on the open position. If the actuator is fitted with mechanical stops, stops in the valve body will not be required.

## 11.6 STUFFING BOX

- 11.6.1 The design of the stuffing box assembly shall be such that the stem seals or glacier thrust bearings can be adjusted or completely replaced under pressure without disturbing any part of the valve or operator assembly. Alternative designs may be offered but full particulars shall be stated in the tender.

## 11.7 ACTUATORS

- 11.7.1 Manually-operated actuators
- 11.7.2 Each manually-operated ball valve shall be fitted with an actuator that requires a maximum input force on the handwheel or lever of not more than 250 Newton pull to seat and unseat the valve under 50 per cent of the test pressure and to operate the valve while water is flowing through the valve at velocities up to 5,0 metres per second.
- 11.7.3 The ball valve actuator shall be either a gearbox or a hydraulic oil operating system. If retractable seals are offered the hydraulic operating system shall automatically sequence the seals to ensure the valve cannot open or close with seals pressurised and that the seals are pressurised when the valve is closed.
- 11.7.4 Actuator gears for gearboxes shall be machine-cut and of substantial design.
- 11.7.5 Each actuator shall be furnished with a device to hold the valve in a fixed position for an extended period of time, provision shall be made for the valve to be locked in either the fully open or closed position.
- 11.7.6 All valves shall open by clockwise rotation of the actuator main spindle.

## 11.8 POWERED ACTUATORS

- 11.8.1 Electrically-operated and electro-hydraulic actuators shall be in accordance with Section 12. Electro-hydraulic power pack systems shall comply with Sub-clauses 12.1.2 to 12.1.4 and 12.2.

## 11.9 INDICATORS

- 11.9.1 A direction-of-rotation indicator shall be permanently attached to each handwheel and a pointer attached to the shaft shall indicate when the valve is full open or shut.
- 11.9.2 The indicators shall be weatherproof and of robust and rigid design; the embossed markings shall be large enough to be plainly visible from a distance of two metres. A drawing showing details of the indicator offered shall be submitted with the tender.

## RAND WATER

### 12 POWERED ACTUATORS - ELECTRICAL REQUIREMENTS

#### 12.1 ELECTRIC-MOTOR-OPERATED ACTUATORS

12.1.1 Each electric-motor-operated valve shall be fitted with suitable reduction gearing designed to unseat the valve under 75% of the test pressure and to operate the valve while water is flowing through the valve at velocities up to 5,0 metres per second. Each operation from the full-open to the full-closed position or vice versa shall be completed within the time stated in the relevant schedules and shall be witnessed by the Engineer's Representative at the suppliers works.

12.1.2 The actuator housing shall be a double sealed, water tight enclosure and shall afford protection to IP 68.

12.1.3 All gearing, shaft bearings, torque limiting clutch mechanism, limit switch assemblies etc shall be totally enclosed and adequately lubricated.

12.1.4 The motor shall be totally sealed squirrel-cage induction type and shall conform to BS 4999 and BS 5000 requirements. The power supply will be 400/231 V, 10%, 3-phase, 4-wire, 50 Hz. Actuators to be used for valves for modulating service shall be continuously rated. All other actuators may be 15 minutes duty rated. All motors shall be fitted with an information plate bearing the following information:

Maker's name, type, serial number and valve reference number (see Clauses 5.9.5 and 5.19)

Wiring diagram number

Continuous rated output in kW and starting and full-load torques

Speed in r p m and frequency in Hz

Stator voltage and number of phases

Full-load current in amps

Auxiliary switch rating

Class of insulation

Temperature rise in °C

Type of enclosure

12.1.5 Each electric-motor-driven actuator shall be supplied with an integral control system and features as specified below:

- (a) Integral reversing contactor starter mechanically and electrically interlocked.
- (b) The actuator motor shall have integral winding thermostat protection which shall have facility for being overridden for emergency shutting of the valve.
- (c) Local indication of valve position by means of a back lit liquid crystal display or mechanical indicator giving position indication. Additional LED's shall be provided to indicate fully open, fully closed and valve running.
- (d) Externally mounted open/stop/close pushbuttons with a padlockable local/off/remote selection. The controls shall form an integral part of the actuator and shall be non intrusive.
- (e) Phase rotation discrimination and single phasing protection.
- (f) A 4-20 mA analogue signal derived from an internal power supply proportional to valve position, selectable for minimum signal corresponding to fully closed position and maximum signal for fully open position with automatic zero and span setting.
- (g) One normally-closed contact for wiring in each of the "closing" and "opening" control circuits and operated by a torque-limiting clutch in the drive from the valve operating motor; this contact shall be arranged to open-circuit the coil of the "close" or "open" contactor if the torque developed rises above a pre-set adjustable value during the closing or opening cycle and in the fully closed valve position.
- (h) Two normally-closed and two normally-open electrically separate contacts to operate only when a valve is in the fully open position.

- (i) Two normally-closed and two normally-open electrically separate contacts to operate only when a valve is in the fully closed position.
  - (j) The actuator shall be provided with stall protection that shall de-energise the motor if no movement is detected after receipt of a signal to open or close.
  - (k) All contactors controlling the actuator motor shall be AC 3 duty rated with proper overload protection. The controls will be 24 VDC.
  - (l) The actuator shall have power and control terminals segregated from each other.
  - (m) Anti condensation heater rated for the specified supply voltage.
  - (n) Actuators supplied with internal batteries for memory back-up purposes shall not be allowed.
  - (o) Two additional potential free contacts programmable by the user to indicate functions such as high torque, thermostat tripped and remote selected.
  - (p) The actuator shall also have the facility for positioning the valve in proportion to a 4-20mA analogue current derived from an external source.
  - (q) The valve will be controlled with a 24 VDC supply via PLC output relays from Rand Water panels.
- 12.1.6 The setting of parameters such as torque, turns settings and configuration of contacts shall preferably be carried out manually. Alternative systems will be accepted provided full details are submitted with the tender.
- 12.1.7 All electrical equipment in the actuator shall be prewired and all external connections, including the relevant limit switches and any switches which may be in excess of those specified shall be wired to an easily accessible and clearly marked terminal block. The markings on the terminal blocks and wiring shall correspond to those used on the wiring diagrams. Paper identification markings are not acceptable and non-fading plastic markers shall be provided. The terminal blocks shall be complete with all screws, nuts, washers and springwashers for connecting power and control cables to each terminal supplied.
- 12.1.8 Wiring and schematic diagrams of the control circuit of each valve shall be provided. An installation and maintenance booklet shall be supplied with each valve actuator.
- 12.1.9 At least one 20 mm diameter and one 32 mm diameter screwed conduit entries shall be provided for cable entries. The 32 mm diameter entry shall be fitted with a 32 mm/25 mm and a 25 mm/20 mm reducers to allow flexibility in the use of cable glands. All conduit entries shall have standard metric screw threads.
- 12.1.10 The compartment into which the cables are terminated shall be sealed from the balance of the actuator so that in the event of leakage through the cable glands no damage will occur to the actuator.
- 12.1.11 Cable entries shall be sealed against the ingress of water by means of tapped steel plugs. The use of plastic plugs for this purpose is not acceptable.
- 12.1.12 Each electric-motor-operated valve shall be fitted with manual operating gear in the form of a handwheel or detachable crank handle.
- 12.1.13 If a handwheel is offered this shall incorporate an isolating mechanism to prevent it turning when the valve is being power-operated. A direction-of-rotation indicator shall be permanently attached to each handwheel and a pointer attached to the shaft shall indicate when the valve is full open or shut and each ten degrees of intermediate travel. The indicators shall be weatherproof and of robust and rigid design; the embossed markings shall be large enough to be plainly visible from a distance of two metres. A drawing showing details of the indicator offered shall be submitted with the offer (see Schedule I). If a detachable crank handle is offered, the insertion of this handle shall operate a safety switch to cut off the electric power supply to the motor.
- 12.1.14 In the case of electric actuators that operate through an intermediate gearbox between the valve and actuator a shear pin or other safety device shall be incorporated on one of the gears to prevent damage to the valve spindle and nut if excessive force is applied. Two spare pins shall be attached to each valve. The shear pin shall be designed to withstand the torque required to unseat the valve at 75% of the test pressure.

- 12.1.15 Alternative methods for protection of the valve spindle and nut under overload conditions, in addition to the torque limit switches, will be considered by Rand Water.

## 12.2 ELECTRO-HYDRAULIC ACTUATORS

- 12.2.1 Where electro-hydraulic actuators are offered the electric motors shall be TEFC, IP55 electric motors complying with SABS-IEC 34. Motors shall be preferably four or greater pole motors.
- 12.2.2 Rand Water will provide the necessary starter and control panels and the Contractor shall provide a detailed functional Specification on the control philosophy to enable Rand Water to design the respective control panels.
- 12.2.3 The Contractor shall include all the necessary solenoid valves and shall provide a limit switch (change over contact) for both the fully open and fully closed positions and an adjustable lever switch adjustable between 0% and 10% open and 90% and 100% open.
- 12.2.4 All electrical equipment in the actuator shall be prewired and all external connections, including the relevant limit switches and any switches which may be in excess of those specified shall be wired to an easily accessible and clearly marked terminal block. The markings on the terminal blocks and wiring shall correspond to those used on the wiring diagrams. Paper identification markings are not acceptable and non-fading plastic markers shall be provided. The terminal blocks shall be complete with all screws, nuts, washers and springwashers for connecting power and control cables to each terminal supplied.
- 12.2.5 All electrical control devices shall be suitable to operate from a 231 Vac supply.
- 12.2.6 Wiring and schematic diagrams of the control circuit of each valve shall be provided. An installation and maintenance booklet shall be supplied with each valve actuator.

## 12.3 TEST OF ACTUATOR PERFORMANCE

Actuators shall be tested in accordance with Clauses 5.10.7 and 12.1.1 of this Specification.

## RAND WATER

### SCHEDULE I - DRAWINGS AND INFORMATION

- A. The following drawings and information shall be submitted with tenders:
1. General arrangement drawings clearly indicating the contract and reference number, main dimensions with an itemised parts list and material specifications. The GA drawing will also show the operator requirements such as input torque, maximum output torque, gear ratio, type, speed and torque of actuator.
  2. Fully completed Schedules with all technical information as requested in the tender document.
- B. The Contractor shall also supply, within three weeks of receipt of the letter of acceptance of the tender but before manufacture commences any copies of the drawings listed above that the Engineer may require as final drawings, together with drawings of the following:
1. Detail drawings of all main components of sluice valves such as body, bonnet, gate, spindle, nut, sealing faces, channel guides, gate shoes and limit stops. The method of securing channel guides, gate shoes and sealing rings must be clearly shown.
  2. Detail drawings of the air valve body, cover, float, sealing faces, type and sizes of orifices.
  3. Detail drawings of the resilient seal valve spindle sealing arrangement.
  4. Detail drawings of butterfly valve body, disc, shafts, seals, seats and retaining rings.
  5. Detail drawings of reflux valve body, door, spindle and seats.
  6. Detail drawings of ball valve body, ball or rotor, shafts, thrust bearings, seals, seats, retaining rings, mechanical stops and locking devices of seals.
  7. Detail drawings of the valve position indicators offered.
  8. Detail drawings of the electric-motor-operated valve actuators wiring diagrams.
  9. Detailed manufacturing programme with milestones for activities such as drawings, approval of drawings, pattern manufacturing, casting, pre-machining, hydro testing, final machining, testing, painting and shipping.
  10. Quality assurance plan.
  11. Operating, maintenance and installation manual as specified in Clause 5.7.2.

#### NOTES:

1. The Engineer may require the Contractor to submit, for approval, drawings and or documents additional to those listed above.
2. The Contractor shall supply a complete set of final drawings covering all the items supplied and shall submit a list of the final drawings and information that it is proposed to supply; this list shall include all the drawings listed above and be approved by the Engineer. For definition of final drawings see Clause 5.6 with particular attention to Clause 5.6.3.
3. The Certificate of Completion will not be issued nor payment made until the Documentation specified in Clause 5.5 and 5.6 have been received and approved by the Engineer.

## NOTES

- i) RING GROOVES ARE REQUIRED ONLY ON INTEGRAL FLANGES WITH NOMINAL DIA. OF 600 AND OVER FOR TEST PRESSURES 5000kg/cm<sup>2</sup> AND ABOVE.
- ii) SPOKE FACTS ARE REQUIRED ON ALL FLANGES RATED FOR TEST PRESSURES 5000 TO 8000kg/cm<sup>2</sup>.
- iii) SPOT FACING IS NOT REQUIRED IF THE FLANGE THICKNESS IS LESS THAN THE SPECIFIED THICKNESS.
- iv) PROFILES SHALL NOT REDUCE THE FLANGE THICKNESS TO LESS THAN THE SPECIFIED THICKNESS.
- v) MATERIALS, THERMAL TYPE FLANGES:
  - a) - CAST IRON BS 1452 GR 210 (MHT)
  - b) - DUCTILE IRON BS 3789 GR 420/12 (MHT)
  - c) - CAST STEEL BS 3100 GR A2 (MHT)
  - d) - CARBON STEEL BS 4360 GR 43A(MHT)
- vi) ALL DIMENSIONS ARE IN mm.

THIS DRAWING  
SUPERSEDES  
DRAWING A8312

[illegible]

BOX 1127  
JOHANNESBURG  
2000  
TEL: 687-0911

JOB No	_____	CHECKED	HOW
CONTRACT No	_____	SECTION HEAD	VS
SCHEME	_____	APPROVED	C. Eng
DRAWN BY	_____	CAPACITY	_____
DATE	30/3/1997	DATE	_____

STANDARD  
FLANGE

## STANDARD FLANGE DIMENSIONS

SCALE		DOC. TYPE S	
STATION	WKS	D	M
R/W	C	C	Z
DRG No A11791		REVISION	
		A1	

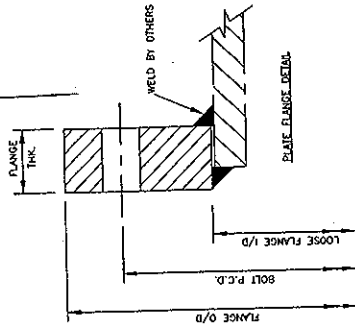


TABLE FOR TOLERANCES ON FLANGE

FLANGE THICKNESS	TOLERANCE
$\leq 10$	$\pm 3$ $-0$
$> 10 \leq 20$	$\pm 3.5$ $-0$
$> 20 \leq 30$	$\pm 4.5$ $-0$
$> 30 \leq 50$	$\pm 6.5$ $-0$
$> 50 \leq 70$	$\pm 8.5$ $-0$
$> 70$	$\pm 10.5$ $-0$

TABLE FOR SURFACE FINISH OF FLANGE FACES

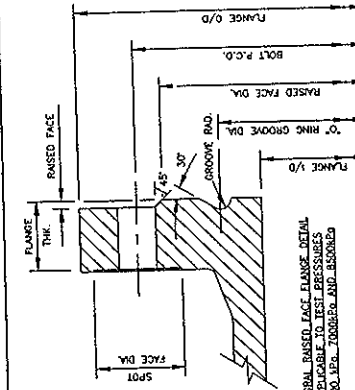
MANUFACTURING PROCESS	R <sub>0</sub> <sup>a</sup>
TURNING	μm 3.2 TO 12.5
OTHER MACHINING PROCESSES	3.2 TO 6.3
CAST SURFACE	3.2 TO 25

AD-PC DECEASED IN 1951/54

TABLE CONVERTER TO FRANCES

OVER	RANGE		FLANGE O/D		NON-BORE FLANGE BORE	P.O.D. OF BANK BORE DIA	ECCENTRICITY
	INCL		MACHINED	NOT MACHINED			
0	300	+1	+2	+2	+2	+1	1
300	1200	+3	+3	+3	+3	+1.5	2
		+3	+3	+3	+3	+2	4

1200	-3	-4	BCD
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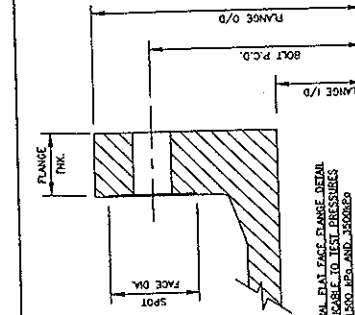


INTEGRAL RAISED FACE FLANGE DETAIL  
APPLICABLE TO TEST PRESSURES  
5000 kPa, 7000 kPa AND 8500 kPa

TEST PRESSURE - 1500 MPa

[illegible]

2000	2425	95	98	48	70	2300	64	128	2040
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INTEGRAL FLAT FACE FLANGE DETAIL  
APPLICABLE TO TEST PRESSURES  
1500 KPa AND 3500KPa

0.001 0051 = 38155360 1304

TEST NUMBER	FLG INCHES	FLG THK C/L	FLG THK C.S.	FLG C.S.	NO. OFF HOLES	HOLE PCD	BOLT DIA.	BOLT DIA.	BORE OF DRILL	
2000	115	16	16	16	4	14	85	12	34	35
2001	115	16	16	16	4	18	125	16	32	62
2002	165	20	15	18	4	18	125	16	32	92
2003	80	200	22	20	8	18	180	16	32	92
2004	100	220	24	20	20	14	180	16	32	117
2005	260	26	22	22	6	22	240	20	46	171
2006	150	265	26	22	8	22	295	20	40	222
2007	340	26	24	24	8	22	350	20	40	275
2008	250	335	28	26	12	22	400	20	40	327
2009	445	28	26	26	12	22	400	20	40	327
2010	455	32	26	26	16	26	515	24	48	409
2011	565	32	28	28	20	28	565	24	48	469
2012	615	32	28	28	20	26	620	24	48	512
2013	670	34	28	28	20	26	620	24	48	512
2014	760	38	30	28	20	33	725	30	60	615
2015	855	40	33	30	24	33	840	30	60	718
2016	855	42	34	32	24	33	900	30	60	770
2017	855	42	34	32	24	33	900	30	60	770
2018	1015	44	35	32	24	33	950	30	60	820
2019	1115	46	38	34	28	33	1050	30	60	922
2020	1230	50	40	34	28	38	1160	36	72	1024
2021	1455	58	45	38	32	38	1360	38	72	1226
2022	1675	62	46	42	36	45	1590	42	84	1432
2023	1785	65	48	45	40	45	1700	42	84	1534
2024	1915	68	49	46	40	52	1830	48	96	1635
2025	2010	71	50	48	40	52	2000	48	96	1840
2026	2115	70	52	50	44	52	2230	48	96	2040
2027	2325	74	55	54	46	52	2240	48	96	2040
2028	2500	80	60	58	52	62	2440	56	112	2240
2029	2560	82	70	62	56	62	2650	56	112	2440
2030	2760	82	70	62	56	62	2750	56	112	2540
2031	2860	85	72	64	60	62	2750	56	112	2540
2032	3405	100	85	75	68	62	3200	56	112	3040

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466
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061 0009 - 2011222222

[illegible]

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**—0.07 0.0000000E+00 — 7000 INH 8500 kPa**

TEST PRESSURE = 7000 AND 10000	DATE	TIME	NO. OF RINGS	NO. OF RINGS
			0 RING	

[illegible][illegible]