Symptom	*Possible causes*	*Recommendations/remarks*
	Seal running too hot.	(1) Check all cooling lines are connected and operational. (2) Check that flow is not obstructed in cooling lines or jackets (e.g., from scale formation). (3) Increase the capacity of cooling lines. (4) A recirculation or bypass flush line may be necessary. (5) Check for possible rubbing of some seal component on the shaft (see also 'misalignment' above). Some good points to check are: neck bush clearance; clearance between the rotating seal unit and the seal chamber bore; the bore of the seat, and the seal plate clearance from the sleeve.
	Inadequate seal type or seal material for duty.	If there is a concern, advice is readily available from seal manufacturers. Seal materials deficiencies may well result in deterioration from corrosion or excessive heat.

10.3 CHECKS BEFORE DISMANTLING

In addition to noting any seal failure symptoms, other checks prior to disassembly can be valuable, either directly or to facilitate later diagnosis. Most of these checks are straightforward and are carried out as routine by most engineers. Thus they are presented as a check-list to act as an 'aide-memoire'.

Topic	*Checklist*
Toxic/hazardous product	In such cases, all necessary precautions to be observed prior to and during assembly.
Service life of seal	Hours of operation. Duty cycle, stop/starts, etc.
Process change	Identify any change – often the key to a solution. Seal may have been selected on *theory* of process, not practice. Changes in fluid pressure, temperature, or composition. Process variation or fluctuation.
Background information required	Fluid sealed (including contaminants). Fluid pressure on seal and in system. Fluid temperature at seal and in system. Fluid flow rate within the seal chamber. Sealed fluid vapour pressure/temperature data. Operating shaft speed(s). Special operating conditions. Machine assembly drawing. Seal assembly drawing. Seal design data.
Machine vibration	Useful even when not immediately apparent as a symptom. Axial and radial bearing housing or shaft vibration. Frequency analysis to confirm out-of-balance, misalignment, etc., until machine can be stopped for physical checks.

Topic	*Checklist*
Seal leakage pattern	*Safety Note:* all necessary precautions must be observed during any leakage checks, especially if the fluid is toxic or hazardous. Amount and nature of abnormal leakage? Leakage constant or variable? Leaks when shaft is stationary? Leaks when shaft is rotating? Related to changes of speed, pressure or temperature of operation?
Possible leakage path(s)	An assembly drawing is of great assistance. If possible, identify source of abnormal leakage while equipment is still operating. Inspect exposed machine surfaces for indications of leakage path(s), for example, along shaft, under sleeve, from seal plate gasket, etc. This inspection to continue through subsequent equipment and seal dismantling until the leakage path(s) are all found. Typical leakage paths: face leakage; secondary seal on sealing ring; secondary seal on seat; seal/gasket on seal plate(s); seal/gasket under shaft sleeve; cracked or damaged housing component.
Hydrostatic testing	If possible, for example with double seals, bench testing of equipment can be a useful method of identifying the leak path. With other seal layouts, a suitable test fixture for subassembly pressure testing may be justifiable if large numbers of seals are being examined.

Symptom	*Possible causes*	*Recommendations/remarks*
		(8) Ensure pipe strain or machine misalignment is not causing distortion of seal faces (especially end suction overhung type pumps). (9) Improve cooling flush lines.
	Secondary seal concerns:	Typical actions for such concerns are as follows.
	Secondary seals nicked or scratched during installation	(1) Renew secondary seals. (2) Check for proper lead in chamfers, burr removal, etc.
	Leakage of liquid under pump shaft sleeve.	(3) Check for correct seals with manufacturer. (4) Check for correct seal materials with manufacturer.
	Overaged 'O' ring.	
	Compression set of secondary seals (hard and brittle).	
	Chemical attack of secondary seals (soft and sticky).	
	Seal hardware concerns:	Typical actions for such concerns are as follows.
	Spring failure.	(1) Renew parts. (2) Check for improved material availability.
	Erosion damage of hardware.	(3) Modify recirculation flow arrangement to reduce high velocity jets on hardware. Install cyclone separator to remove solids from recirculation flow.
	Corrosion of drive mechanisms.	
Pump/shaft vibration	Misalignment	This will reduce seal life even though leakage may not be immediately apparent. See Chapter 9, sections 9.2, 9.3, and 9.6 for details.
	Impeller/shaft system imbalance.	
	Cavitation.	
	Bearing problem.	
Short seal life	Equipment mechanically out of line (e.g., from undue pipe strain).	See above. In the extreme this can cause rubbing of the seal on the shaft.
	Abrasive product (causing excessive seal face wear).	Typical actions are aimed at determining the source of abrasives and preventing them accumulating at the seal faces. (1) If abrasives are in suspension, bypass flushing over the seal faces will improve the situation by keeping the abrasive particles moving and so reducing their tendency to settle out or accumulate in the seal area. A cyclone separator is often added to this bypass line (filters give longer term problems unless regularly cleaned). (2) When abrasives are forming locally in the seal area, a bypass flush will help introduce the maximum product to the seal cavity at the correct temperature. Abrasives form in the seal area because of the process liquid cooling down and crystallising or partly solidifying, or because of local product evaporation.

10.4 CHECKS DURING DISMANTLING

A checklist of points worth noting, divided into three categories; general, premature failure, and mid-life failu checks.

10.4.1 General checks

Topic	*Checklist*
Seal surfaces	Avoid disturbing the seal surfaces. Avoid wiping or cleaning the faces more than is necessary for safe disassembly. Visual examination of seal faces is included in section 10.5.
Dimensional checks	The necessary marks and measurements to determine seal working length; squareness of seal faces to shaft axis; concentricity of seal faces to shaft axis; shaft end play; shaft radial run out, whip and deflection.
Possible leakage path(s)	Examination of surfaces as they become exposed for all possible causes of abnormal leakage.
Deposits and debris	Examination prior to cleaning for: foreign contaminants; wear debris; small fragments or chips from broken components; corrosion products; miscellaneous debris/deposits.
Seal hang-up	Check for hang-up by flexing the seal slightly above and below its installed working length.
Seal sub-assembly cleaning	Avoid removing or obscuring any vital evidence on the seal failure mechanism (especially on the seal faces). Avoid using wire brushes, sharp tools, abrasive cleaners or powerful solvent cleaning agents (which can attack the elastomeric components).
Packaging	For seal manufacturer examination/repair. Many seal makers will personally collect unusual/critical seals for failure diagnosis. Packaging needs to be of high standard (as for new seals). Avoid wire mounted identification tags, etc., which can damage parts in transit.

10.4.2 Premature failure checks

Topic	*Checklist*
Seal faces	Examination for nicks, scratches and fractures: low power magnification can assist; see also sections 10.5 and 10.6. Examination of non-uniform contact pattern: dirt trapped between the faces; distortion of one or both faces; improperly finished faces; see also Section 10.6 re optical flat checking. Examination for thermal distress: from running dry; heat checks/thermal cracking; pitting, grooving, galling, spalling, blistering, etc.
Secondary seals	Examination for: omitted seals; mismatched seals; nicks, scratches, cuts, and tears; twisted, extruded, or distorted static seals; score marks from relative rotational movement between secondary seals and mating surfaces; excessive volume change or compression set; fretting of sealing surfaces at secondary seal positions.
Drive mechanism	Examination for: misassembly; misindexing; omission. Check for loss of secondary seal interference when used for drive purposes, e.g., static seals and bellows.
Face loading hardware	Examination for: incorrect type; misassembly; misindexing; omission.

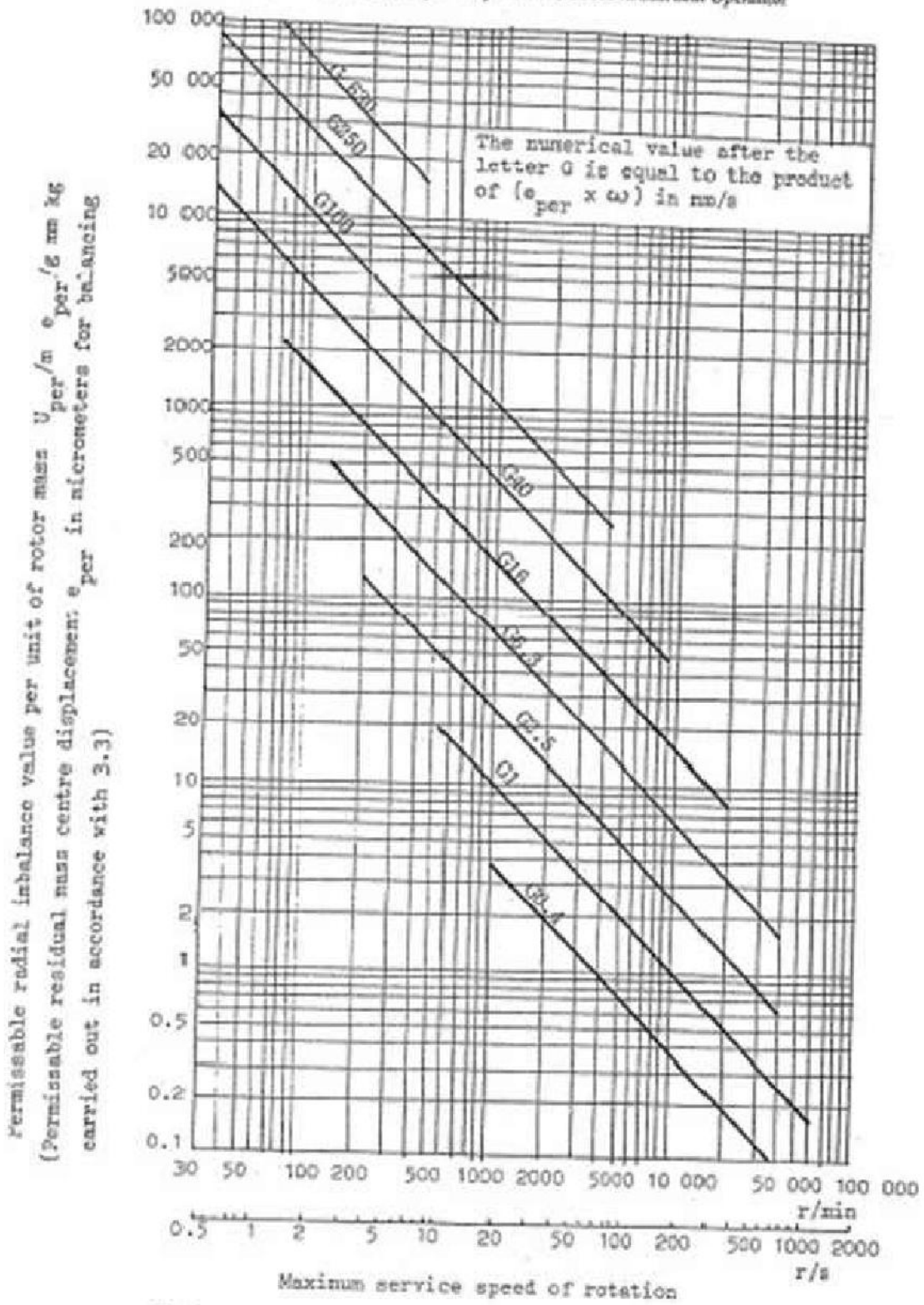
"XTERNAL SYMPTOMS OF SEAL FAILURE

A useful indication of the cause of a seal problem can often be obtained by analysis of the symptoms experienced in service. These may suggest either the remedy directly or at least the direction of subsequent failure diagnosis. On critical duties, instrumentation may be available to give further assistance or portable devices can be used for condition checking.

Symptom	*Possible causes*	*Recommendations/remarks*
Seal squeals during operation	Inadequate amount of liquid to lubricate seal faces. (Note that not all dry seals squeal.)	If not in use, a bypass flush line may be required. If already in use, the line or associated restrictions, e.g., orifices in the gland plate, may need to be enlarged.
Carbon dust accumulating on outside of seal area	Inadequate amount of liquid to lubricate seal faces.	See above.
	Liquid film vaporising/flashing between seal faces. In some cases this leaves a residue which grinds away the carbon–graphite seal ring.	Pressure in seal chamber may be excessively high for the type of seal and the fluid being sealed. See below for actions against vaporisation.
Seal spits and sputters in operation (often called popping)	Product vaporising/flashing across the seal faces.	Remedial action is aimed at providing a positive liquid condition of the product at all times. (1) Increase seal chamber pressure if it is possible to remain in seal operating envelope. (2) Check for proper balance design with seal manufacturer. (3) Change to a seal design not requiring so much product temperature margin (δT). (4) If not in use, a bypass flush line will be required. (5) If already in use, the bypass flush line or associated restrictions may need to be enlarged. (6) Increase cooling of seal faces. (7) Check for seal interface cooling with seal manufacturer. *Note* that a review of balance design requires accurate measurement of seal chamber pressure, temperature, and specific gravity of product.
Seal leaks and ices seal plate	Product vaporising/flashing across the seal faces.	For remedial action, see above. *Note* that icing may score seal faces (especially carbon–graphite). They should therefore either be relapped or renewed before starting up after the vaporising condition has been rectified.
Seal drips steadily	If possible, first determine the source of the leakage. Heavy leakage is normally from the faces rather than 'O' rings, etc.	
	Primary seal concerns: Faces not flat. Faces cracked, chipped or blistered. Distortion of seal faces for thermal or mechanical reasons (usually determined from wear pattern on faces).	Typical actions for such concerns are as follows. (1) Check for incorrect installation dimensions. (2) Check for improper seals or materials being used in the application. (3) Check gland gasket for proper compression. (4) Check for gland plate distortion because of over torquing of gland bolts (this can cause faces to become distorted). (5) Clean out any foreign particles between seal faces. Relap faces or renew. (6) Check for any installation or similar damage and renew if necessary. (7) Check for squareness of stuffing box to shaft and similar equipment condition concerns. (See Chapter 9, section 9.2.)

Mid-life failure checks

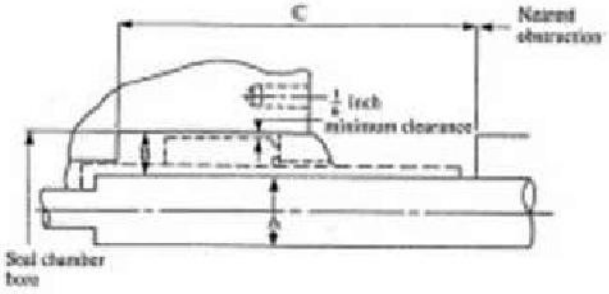
Topic	*Checklist*
Seal faces	Examination for: overall corrosion; leaching; abnormal grooving; erosion damage; excessive pitting, galling, and spalling; thermal damage such as waviness, heat checks, cracks, blisters, deposition of solid materials, and overall thermal discolouration. Wear profile check by: naked eye examination; use of low incidence angle light to highlight features; 10× magnification, then 50×; measurement to determine the amount of wear.
Secondary seals	Examination for: extrusion; chemical attack on both seal and its interface surfaces; excessive volume damage; excessive compression set; hardening and cracking.
Drive mechanism	Examination for: failure; excessive wear. Check for loss of secondary seal interference when used for drive purposes, e.g., static seals and bellows.



Maximum permissable residual specific inbalance corresponding to various quality grades, *G*
(Extract from *ISO 1940/1 Balance quality of rigid bodies*)

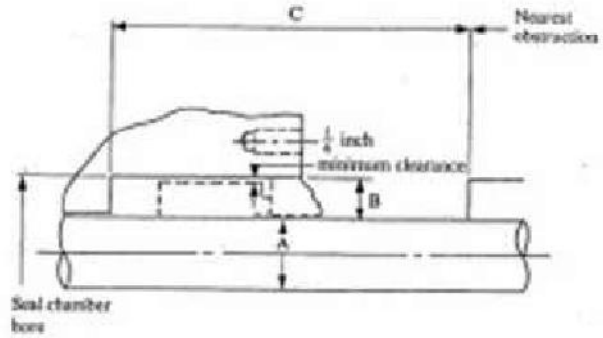
انواع طراحی های استافینگ باکس برای پمپ های مختلف طبق API-۶۱۰

(Extract from *API 610 Centrifugal pumps for general refinery service* 7th Edition. Reprinted courtesy of the American Petroleum Institute)



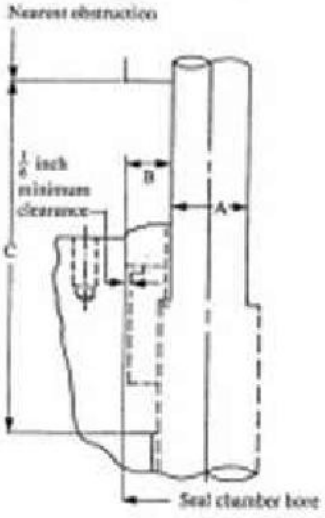
(a) Minimum dimensions for seal chambers on overhung pumps furnished with sleeve shafts

Shaft diameter A	Minimum radial dimension B	Minimum total length C
<2.000	1.000	5.750
2.125-3.000	1.125	6.500
>3.000	1.250	7.000



(b) Minimum dimensions for seal chambers on horizontal overhung pumps without shaft sleeve

Shaft diameter A	Minimum radial dimension B	Minimum total length C
<2.050	0.875	5.750
>2.250-3.250	1.100	6.500
>3.250	1.125	7.000



(c) Minimum dimensions for seal chambers on vertical in-line pumps without sleeve shafts

Shaft diameter A	Minimum radial dimension B	Minimum total length C
≤2.250	0.875	5.750
2.250-3.250	1.100	6.500
>3.250	1.125	7.000

(dimensions in inches)

Data Requirement for Seal Selection

The information requested will enable seal installation drawings to be produced for order. If a full cartridge is required please give details of sleeve ends and locking arrangements together with pump assembly/maintenance instructions, wherever possible please provide detail drawings of the seal chamber/existing chamber connections/shaft and sleeve. These will assist first time installation drawing accuracy and quick response to your enquiry.

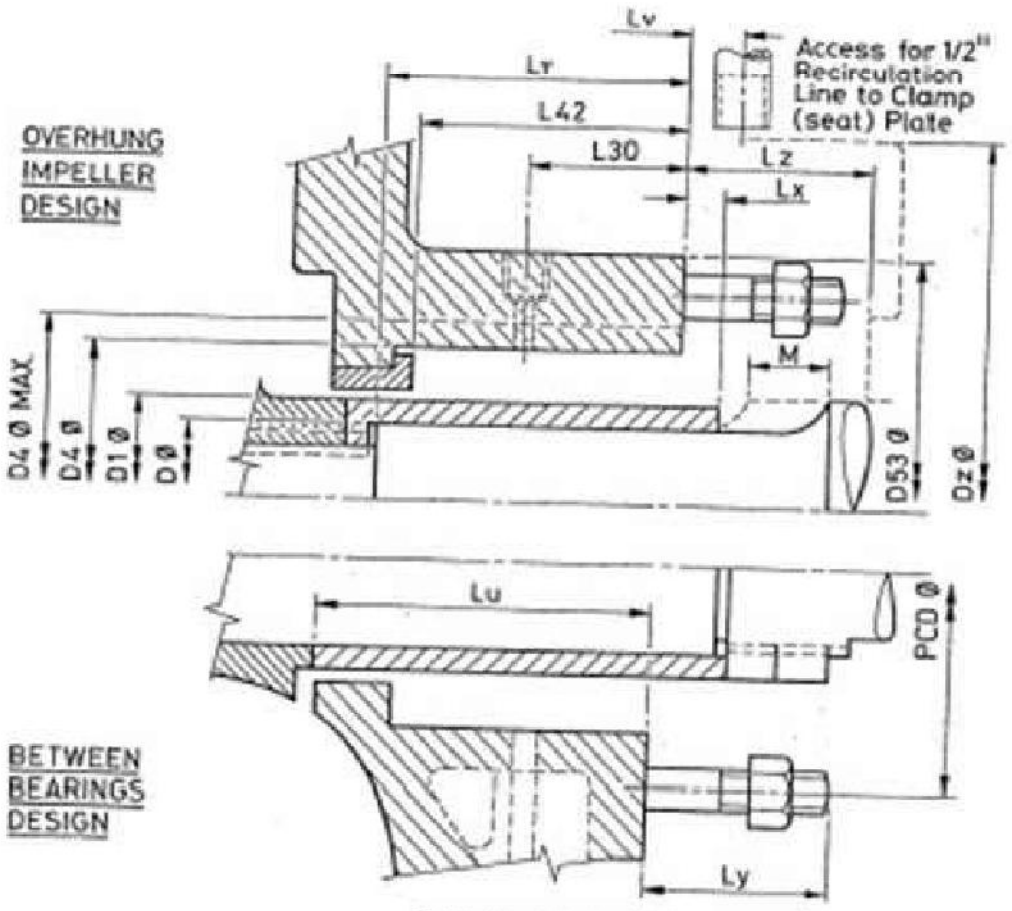
The following dimensions relate to the sketch below. The upper half represents a typical overhung impeller centrifugal pump. The lower half is for a between bearing pump. For other types of pump please produce a working sketch.

All dimensions in mm/ins

D1 Shaft or sleeve *.....
D Shaft Ø under sleeve *.....
D4 Seal chamber bore *.....
D4+ Max. seal chamber bore *.....
D53 Spigot *.....
L42 Seal chamber depth .....
Lx Sleeve extension .....
Ly Stud protrude .....
Lv Max..... Min .....
Pump ref. drawings.....
.....
Other dimensions .....

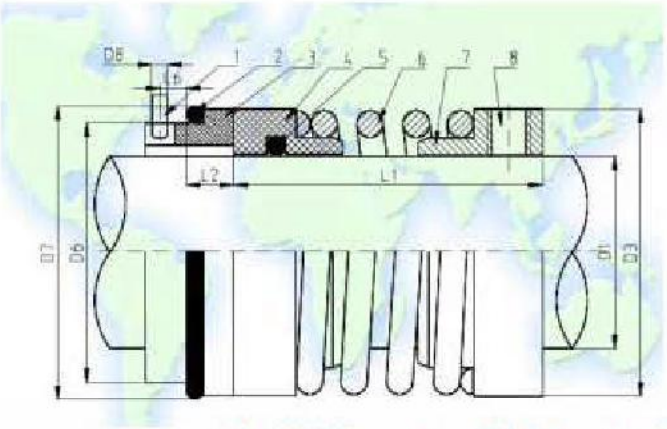
Lr Nearest obstruction (axial) .....
Dz Nearest obstruction (radial).....
No of seal plate bolts ..... Size .....
PCD ..... °Offset from vertical C/L .....
M Max shaft movement (assembly) .....
(operation).....
L1 Chamber face to shaft step.....
Lo Chamber face to sleeve end .....
L30 Chamber face to connection C/L.....
Connection size .....
C/L Shaft distance (twin screw pumps) .....

* Tolerances required
+ For stationary mounted installations provide max. possible chamber bore for the working pressure.



Seal installation dimensions.

مکانیکال سیل نوع Flexibox



قطعات مکانیکال سیلFlexibox شامل

۱-کربن رینگ(Statinary Seal Ring)

۲-اورینگ کربن(Stationary Seal Ring Packing)

۳-پیچ های نگه دارنده (Set Screw)

3A- گلند(Gland Or Sealplate)

3B-پیچ های نگه دارنده(Set Screw)

3D-بوش گلندSafty)(Bush)

٤-اورینگ گلند(Gland Packing)

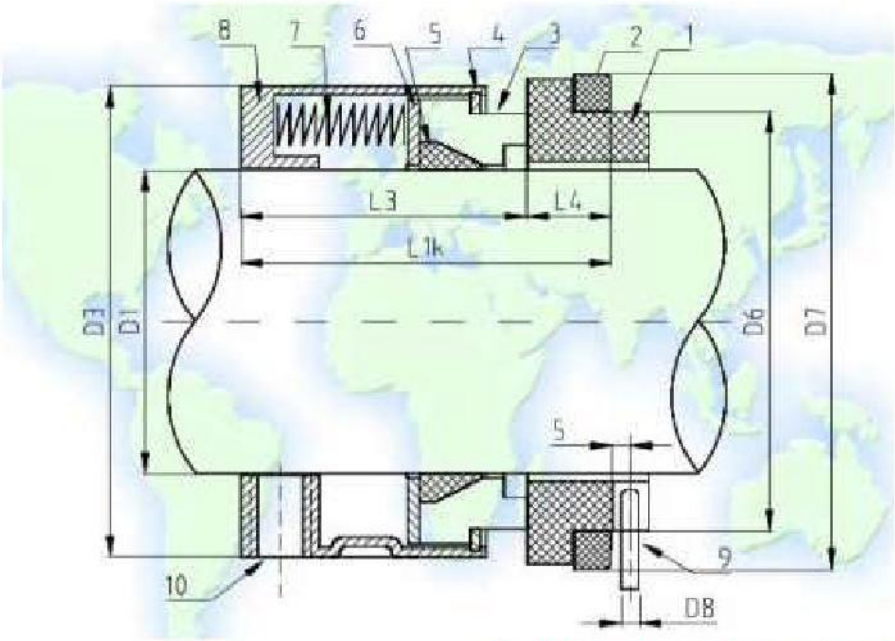
٥-رتوری(Rotory Seal Ring)

٦-اورینگ رتوری(Rotory Seal Ring Packing)

٧-فنرSpring)

٨-سیلیو(Sleeve)

۱۰-اورینگ سیلیو(Sleeve Packing)



قطعات مکانیکال سیل نوع Sealol

۲-سیلیو (Sleeve)

۳-گسکت بلوز (Flat Gasket)

٤-پیچ نگهدارنده (Screw)

۵-مهره نگهدارنده (Nut Compression)

۶-پکینگ (Shaft Packing)

۷-پیچ نگهدارنده (Socket Set Screw)

۸-پکینگ سیل پلیت (Gland Packing)

۹-سیل پلیت (Gland)

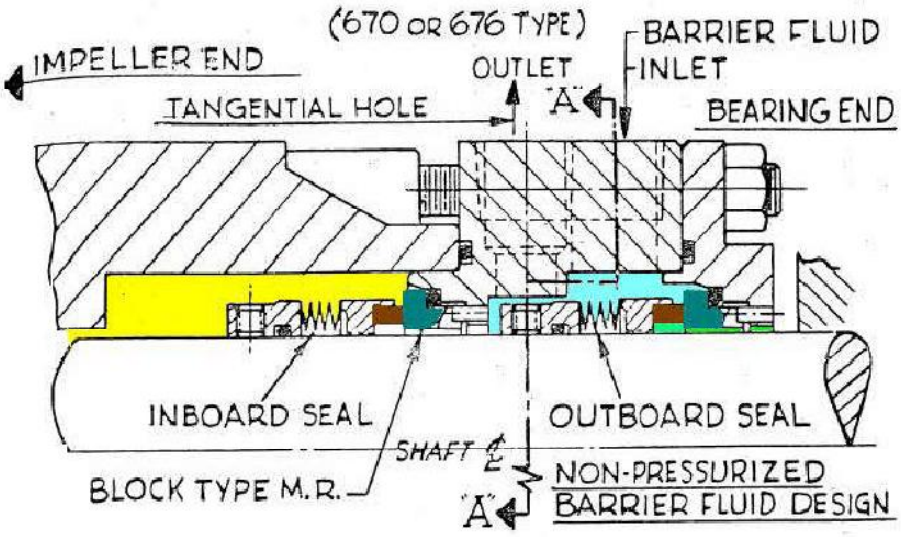
۱۰-سطح سخت (Mating Ring)

۱۱-بوش گلند (Bushing)

۱۲-پیچ (Screw)

۱۳-محکم کننده پکینگ (Packing Follower)

مکانیکال سیل دوبله



قطعات مکا نیکال سیل دوبله شامل

S1 سیلیو (Shaft Sleeve)

S11 سیل پلیت (Seal Plate)

S13 گسکت (Gasket)

S14 اب بند (Seal Face)

S18 گسکت (Gasket)

S18-1 گسکت (Gasket)

S19 گسکت (Gasket)

S57 پیچ تنظیم (Set Screw)

S79 بلوز (Bellows Assy)

S90 پمپ (Pumping Ring)

S111 رینگ (Snap Ring)

S142 رینگ نگهدارنده (Retiner Ring)

S152 گسکت

قطعات مکانیکال

سیل بلوزی درجه حرارت پایین شامل

S1:سیلبو(Shaft Sleeve)

S11:سیل پلیت(Seal Plate)

S13:گسکت(Gasket)

S14:اب بند(Seal Face)

S79:بلوز(Bellows Assy)

S152:اورینگ(0-Ring)

S18:گسکت(Gasket)

S19:گسکت(Gasket)

S40:پیچ(Cap Screw)

S57:پیچ(Set Screw)

S58:قسمت محرک(Drive Collar)

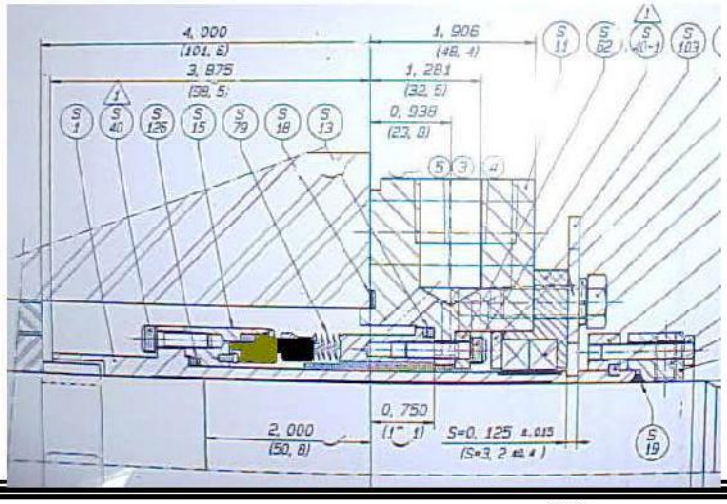
S95:اب بند (Lip Seal)

S103:لبه تنظیم کننده(Setting Plate)

S111:رینگ نگهدارنده(Snap Ring)

مکانیکال سیل بلوز ثابت

(Stationary Mechanical Seal)



S1:سیلبو(Shaft Sleeve)

S7:پکینگ(Packing Ring)

S11:سیل پلیت(Seal Plate)

S13:گسکت(Gasket)

S14:اب بند(Seal Face)

S18:گسکت(Gasket)

S19:گسکت(Gasket)

S40:پیچ(Cap Screw)

S44:رینگ پشتیبان(Back Up Ring)

S57:پیچ(Set Screw)

S58:قسمت محرک(Drive Collar)

S62:سیستم کک زدا(Anti Coke Device)

S79:بلوز(Bellows Assy)

S94:رینگ دو تکه(Split Ring)

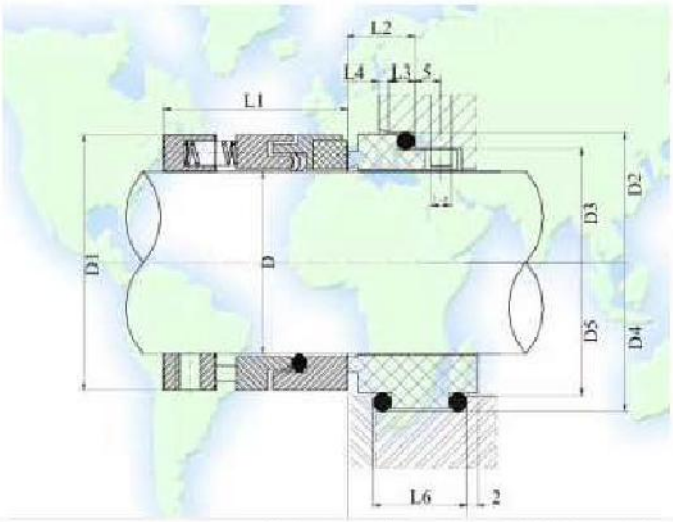
S103:ورقه تنظیم(Setting Plate)

S115:واشر قفلی(Lock Washer)

S126:گسکت(Gasket)

S129:لبه تنظیم(Adjusting Collar)

مکانیکال سیل چند فنری



قطعات مکانیکال سیل چندفنری شامل:

S1:سیلیو(Shaft Sleeve)

S11:گلند(Seal Plate)

S13:گسکت(Gasket)

S14:سطح اب بند (Seal Face)

S15:سطح اب بند(Seal Face)

S16:فنر(Coil Spring)

S17:نگهدارنده فنر(Spring Holder)

S18: گسکت(Gasket)

S19: گسکت(Gasket)

S24:بوشینگ(Flange Bushing)

S40:پیچ(Cap Screw)

S54:رینگ نگهدارنده(Retaining Ring)

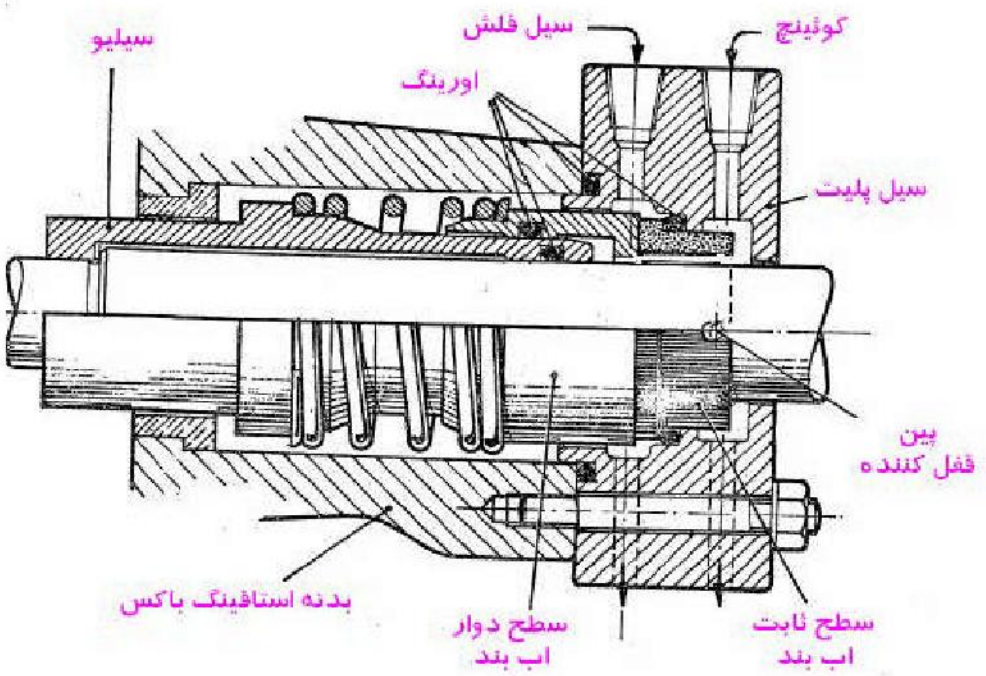
S57:پیچ(Set Screw)

S58:سیستم محرک(Drive Collar)

S103:ورقه تنظیم(Setting Plate)

S4:اب بند(U-Cup)

S60:محرک اب بند(U-Cup Follower)



اب بندهای تماسی –اب بندهای فاصله ای شامل دیفلاکتورها لابیرینتهای روغن لابیرینت های بخار (واب بندهای بخاری)لابیرینت های هوا –رینگ های فرسایشی -بوش ها –رینگ های فلزی شامل انواع سیل رینگ های روغنی کمپرسورهای گریزازمرکز

۱-اب بندهای تماسی

الف- کاسه نمد ها(Oil Seal)

ب- گردگیرها(Lip Seal)

۲-اب بندهای فاصله ای

الف-دیفلاکتورها(Deflectors)

ب-لابیرینت ها(Labyrinths)

ج-رینگ های فلزی(Seal Rings)

الف-رینگ های فرسایشی(Wearing Rings)

ب بوش ها(Bushs)

ج-رینگ های روغنی(Seal Rings)

۳- پکینگ ها

الف-پکینگ های نوع فشاری(Compression Packings)

ب-پکینگ های نوع اتوماتیک(Automatic Packings)

۱ V-Ringها

۲-U-Cup ها

۳-O-Ringها

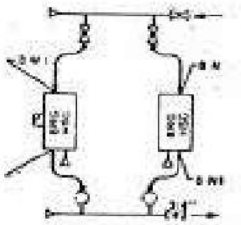
پ-پکینگ های نوع شناور(Floating Packings)

۱-پیستون رینگ ها(Piston Rings)

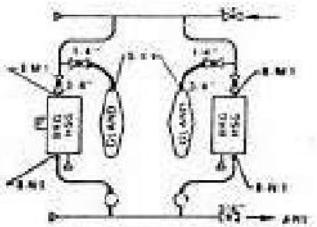
۲- پکینگ رینگ های کمپرسورهای رفت وبرگشتی

۳- آب بندهای ذغالیCarbon Seal Ring

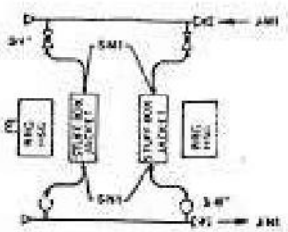
Items for comparison	Gland packing	Mechanical seal
What wears and from where leakage occurs	Gland packing on the inner circumference side and shaft or sleeve on the outer circumference side	Sliding surface on the main
What wear causes	Inside fluid leaks through a gap produced between gland packing and shaft sleeve.	No gap is produced between sliding surfaces because a spring works to compensate a sliding surface as it wears.
What to do against caused wear	Tighten more the gland packing with a bolt.	No maintenance is required.
Leakage level	1 L/h. or more in some cases, causing a great loss.	Within 3 ml /h. as a guide
Power consumption	High power consumption as sliding surface area (or friction area) is large	Low power consumption as sliding surface area (or friction area) is narrow
Seal's service life	3 to 12 months. The sleeve also needs renewing when the seal is renewed.	2 or 3 years on the average in case of a rotary seal. 5 or 6 years on the average in case of a stationary seal.
Difference in cost	Initial cost is low. But maintenance cost will be higher if daily additional tightening and the renewal frequency of sleeves are taken into account.	Initial cost is high compared with gland packing. But maintenance is low, resulting in a low cost as a whole.
Scope of application	A narrow scope of application because packing are not suitable for high pressure temperature peripheral speed and slurry specifications.	A wide scope of application because seals are suitable for high pressure, temperature, peripheral speed, and slurry specifications.,



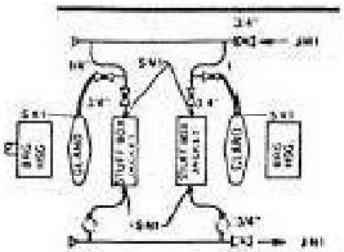
PLAN A-2



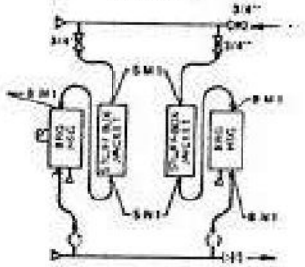
PLAN B-2



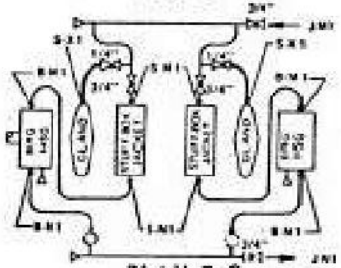
PLAN C-2



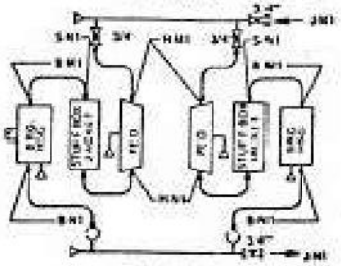
PLAN D-2



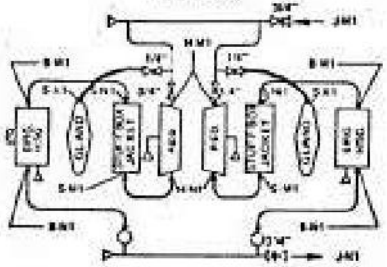
PLAN E-2



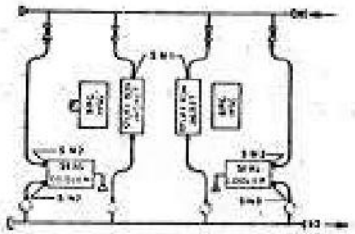
PLAN F-2



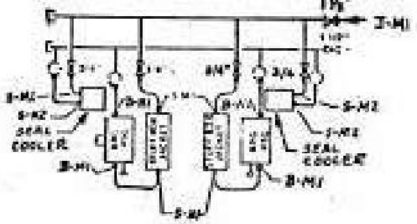
PLAN G-2



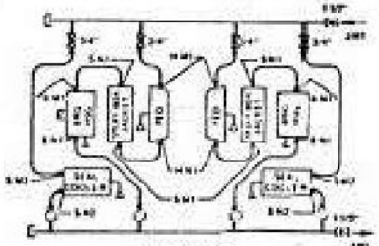
PLAN H-2



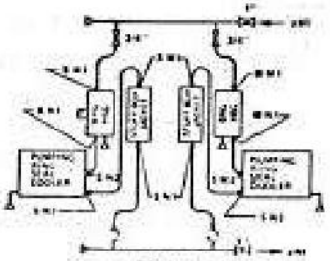
PLAN J-2



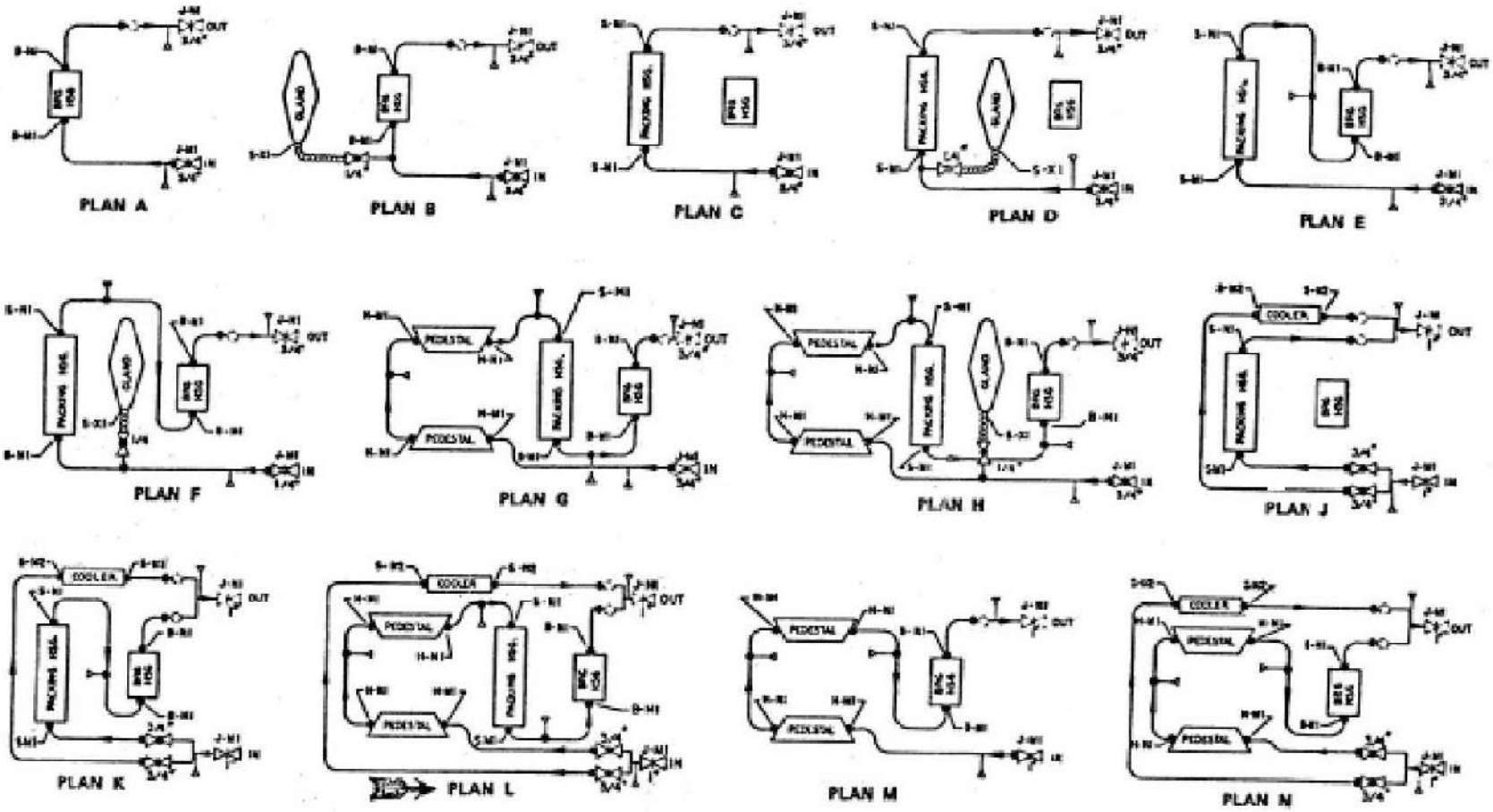
PLAN K-2



PLAN L-2



PLAN X-2


PLAN A
PLAN B
PLAN C
PLAN D
PLAN E
PLAN F
PLAN G
PLAN H
PLAN J
PLAN K
PLAN L
PLAN M
PLAN N