TRANSPETRO	**ESPECIFICAÇÃO TÉCNICA**	Nº:	**ET-4300.03-6500-392-PTD-001**
	CLIENTE: **TP/DDT/DTSSPCO/UO-SPPCO/CO/S**		FOLHA: **1** de **83**
	PROGRAMA:		**INTEGRA-3294**
	ÁREA: **REPLAN - REFINARIA PLANALTO**		
	TÍTULO: **UNIDADE DE LUBRIFICAÇÃO FORÇADA - B-4082C**		**TP/DDT/ENGDT/ PPL/DPL2/DP3**
			INTERNA

ÍNDICE DE REVISÕES

REV.	DESCRIÇÃO E/OU FOLHAS ATINGIDAS
#1	1ª VERSÃO PRELIMINAR, EFETUADA ANTES DA EMISSÃO ORIGINAL (REV.0)

	REV. #1	REV. A	REV. B	REV. C	REV. D	REV. E
DATA	03/03/2026					
EXECUÇÃO	H. HAMADA					
VERIFICAÇÃO	E. ARAÚJO					
APROVAÇÃO	R. SANTOS					

DE ACORDO COM O PE-1TP-00365 ELABORAÇÃO, EMISSÃO E REVISÃO DE DOCUMENTOS TÉCNICOS DE ENGENHARIA, AS INFORMAÇÕES DESTE DOCUMENTO SÃO DE PROPRIEDADE DA TRANSPETRO, SENDO PROIBIDA A UTILIZAÇÃO FORA DA SUA FINALIDADE.

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1. OBJETIVO

Esta Especificação Técnica (ET) estabelece os critérios e requisitos mínimos para o fornecimento de uma nova Unidade de Lubrificação Forçada do conjunto moto-bomba existente B-4082C a ser instalado na área 400 da REPLAN em Paulínia-SP

Nota 1: Como o projeto original da UFL é antigo e obsoleto, caberá o proponente a ofertar um REVAMP do projeto original atendendo os requisitos deste documento. Caso hajam desvios, estes deverão estar explicitados na proposta em forma de lista de desvios.

2. DOCUMENTOS DE REFERÊNCIA

Documento	Revisão	Título
REPLAN / 400-31-142	B	Desenho de conjunto – Unidade de Lubrificação Forçada – B-4082A/BC
REPLAN / 400-28-25	H	Fluxograma de Engenharia B-4082A/B/C Óleo Combustível
ENP-49607	1	Desenho da Placa de Identificação da bomba à ser Lubrificada (B-4082C)
FC-49607	0	Desenho de Conjunto da moto-bomba à ser Lubrificada (B-4082C)
ASX-49607	-	Desenho de Corte da bomba à ser Lubrificada (B-4082C)
-	-	Manual de Instalação, Operação e Manutenção da bomba B-4082C

Nota 2: Divergências entre os documentos supracitados, deverá prevalecer o desenho de conjunto da unidade de lubrificação (REPLAN / 400-31-142).

Nota 3: Todos os documentos citados neste item 2, estarão como anexo desta especificação técnica.

3. NORMAS APLICÁVEIS

Em complementação aos requisitos desta ET, o projeto, materiais, fabricação, inspeção e testes devem atender a última revisão ou adenda dos códigos, normas regulamentadoras, padrões e especificações abaixo relacionadas.

Toda e qualquer norma mencionada em qualquer um dos documentos de referência ou em qualquer um dos padrões a seguir é aplicável.

3.1. CÓDIGOS e NORMAS NACIONAIS / INTERNACIONAIS

Norma	Descrição	Revisão
API RP 520	Sizing, Selection and Installation of Pressure - Relieving Devices in Refineries	Última Edição
API STD 614	Lubrication, Shaft-sealing and Oil-control Systems and Auxiliaries. Part 1 – General Requirements Part 2 - Special-purpose oil systems	Última Edição
API STD 670	Machinery Protection Systems	Última Edição
ASME B16.5	Pipe Flanges and Flange Fittings	Última Edição
ASME Sec. VIII, Div I	Boiler and Pressure Vessel	Última Edição
TEMA	TEMA – Tubular Heat Exchanger	Última Edição
TEMA	Standards of Tubular Exchanger Manufacturers Association.	Última Edição
AWS D1.1	Structural Welding Code - Steel	Última Edição
ASTM	American Society for Testing and Materials	Última Edição
NBR NM-ISO 13852	Segurança de Máquinas - Distâncias de segurança para impedir o acesso a zonas de perigo pelos membros superiores	Última Edição
NBR NM-ISO 13854	Segurança de Máquinas - Folgas mínimas para evitar esmagamento de partes do corpo humano	Última Edição
NR-10	Norma Regulamentadora – Ministério do Trabalho: Instalações e Serviços em Eletricidade	Última Edição
NR-12	Norma Regulamentadora – Ministério do Trabalho: Máquinas e Equipamentos	Última Edição
NR-13	Norma Regulamentadora – Ministério do Trabalho: Caldeiras e Vasos de Pressão	Última Edição
NR-15	Norma Regulamentadora – Ministério do Trabalho: Atividades e Operações Insalubres	Última Edição
NR-17	Norma Regulamentadora – Ministério do Trabalho : Ergonomia	Ultima Edição

3.2. NORMAS PETROBRAS

NORMAS	Descrição	Revisão
N-0002	Revestimento Anticorrosivo de Equipamentos Industriais	P
N-0013	Requisitos Tecnicos para Servicos de Pintura	M
N-0057	Projeto Mecanico de Tubulacoes Industriais	H
N-0058	Símbolos Gráficos p/ Fluxogramas de Processo e de Engenharia	C

NORMAS	Descrição	Revisão
N-0075	Abreviaturas p/ Projetos Industriais	E
N-0133	Soldagem	P
N-0300	Detalhes de Aterramento Empregando-se Conectores Mecanicos	D
N-0381	Execução de Desenhos e Outros Documentos Técnicos em Geral	M
N-0466	Projeto de Trocador de Calor – Casco e Tubo	K
N-1596	Ensaio Não Destrutivo – Liquido Penetrante	J
N-1597	Ensaio Não Destrutivo Visual	H
N-1692	Apresentação de Projetos de Tubulação	D
N-1735	Pintura de Maquinas, Equipamentos Elétricos e Instrumentos	H
N-1882	Critérios para Elaboração de Projetos de Instrumentação	F
N-1883	Apresentação de Projetos de Instrumentação /Automação	F
N-1931	Material de Tubulação para Instrumentação	F
N-2595	Critérios de Projeto, Operação e Manutenção de Sistemas Instrumentados de Segurança em Unidades Industriais	D

4. REQUISITOS GERAIS

A Unidade de Lubrificação deverá ser dimensionada, projetada e fabricada conforme o API STD – 614 – Lubrication, Shaft-sealing, and Oil-control Systems & Auxiliary, Parte 1 (General Requirements) e Parte 2 (Special Purpose Oil Systems). Os requisitos desta ET e documentos referenciados são de caráter mínimo, sendo o Fornecedor o único responsável pelo atendimento e garantia de todas as características construtivas e de desempenho da unidade, incluindo a garantia de desempenho dos equipamentos e de seus subfornecedores. Qualquer divergência com esta ET e suas referências deverá ser claramente indicada na Proposta Técnica, com a devida justificativa ou alternativa, devendo ser incorporada na lista de Desvios e Esclarecimentos.

A Unidade de Lubrificação deverá ser montado sobre skid existente da bomba B-4082C in loco na área 400 da Refinaria do Planalto - REPLAN, para atendimento ao conjunto moto-bomba existente. Todas as interligações internas à unidade e desta para o conjunto moto-bomba, incluindo os componentes elétricos, tubulações, instrumentos e adequação das telas de controle e monitoramento no supervisório, fazem parte do escopo de fornecimento. O arranjo dos

equipamentos deve ser de fácil acesso para a operação e manutenção em atendimento a NR-17.

Todos os componentes deverão ter placas de identificação próprias, fabricada em aço inox AISI 304.

Os equipamentos pressurizados devem ser providos de válvulas de segurança, com as respectivas placas de identificação.

Todo o projeto, especificação dos instrumentos e acessórios conforme os requisitos da N-1882 Rev. F e Critérios para Elaboração de Projetos de Instrumentação.

O Fornecedor deverá disponibilizar toda a documentação técnica necessária para a configuração, operação e manutenção dos subsistemas fornecidos e respectivas interfaces.

Equipamentos com partes rotativas expostas devem possuir proteções de modo a impedir acidentes atendendo aos critérios das normas NBR NM-ISO 13852, NBR NM-ISO 13854 e NR-12.

5. ESCOPO DE FORNECIMENTO

O escopo de fornecimento deverá incluir os projetos Hidráulico, Mecânico, Elétrico e Instrumentação, incluído dimensionamento de todos os equipamentos, válvulas, tubulações e instrumentos com a emissão das Folha de Dados e/ou Especificações dos equipamentos, instrumentos, motores, diagramas, desenhos do conjunto, isométricos, e todos os documentos necessários, incluindo a seleção e a especificação dos materiais de tubulação, instrumentação e elétrica.



Foto 1: Bomba B-4082A em operação (Modelo idêntico a bomba B-4082C)

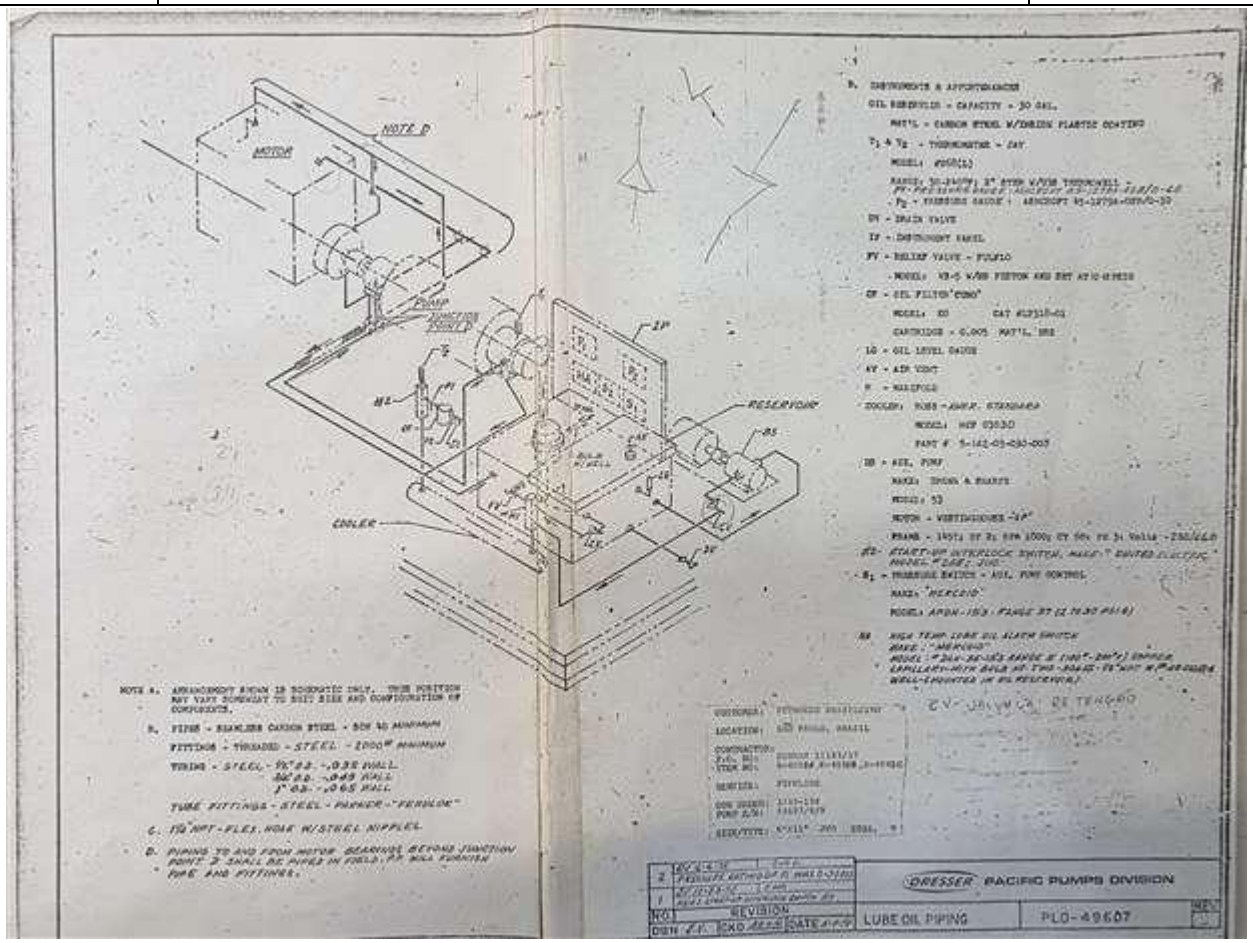


Foto 2: Desenho REPLAN / 400-31-142 Unidade de Lubrificação Forçada (Projeto original)

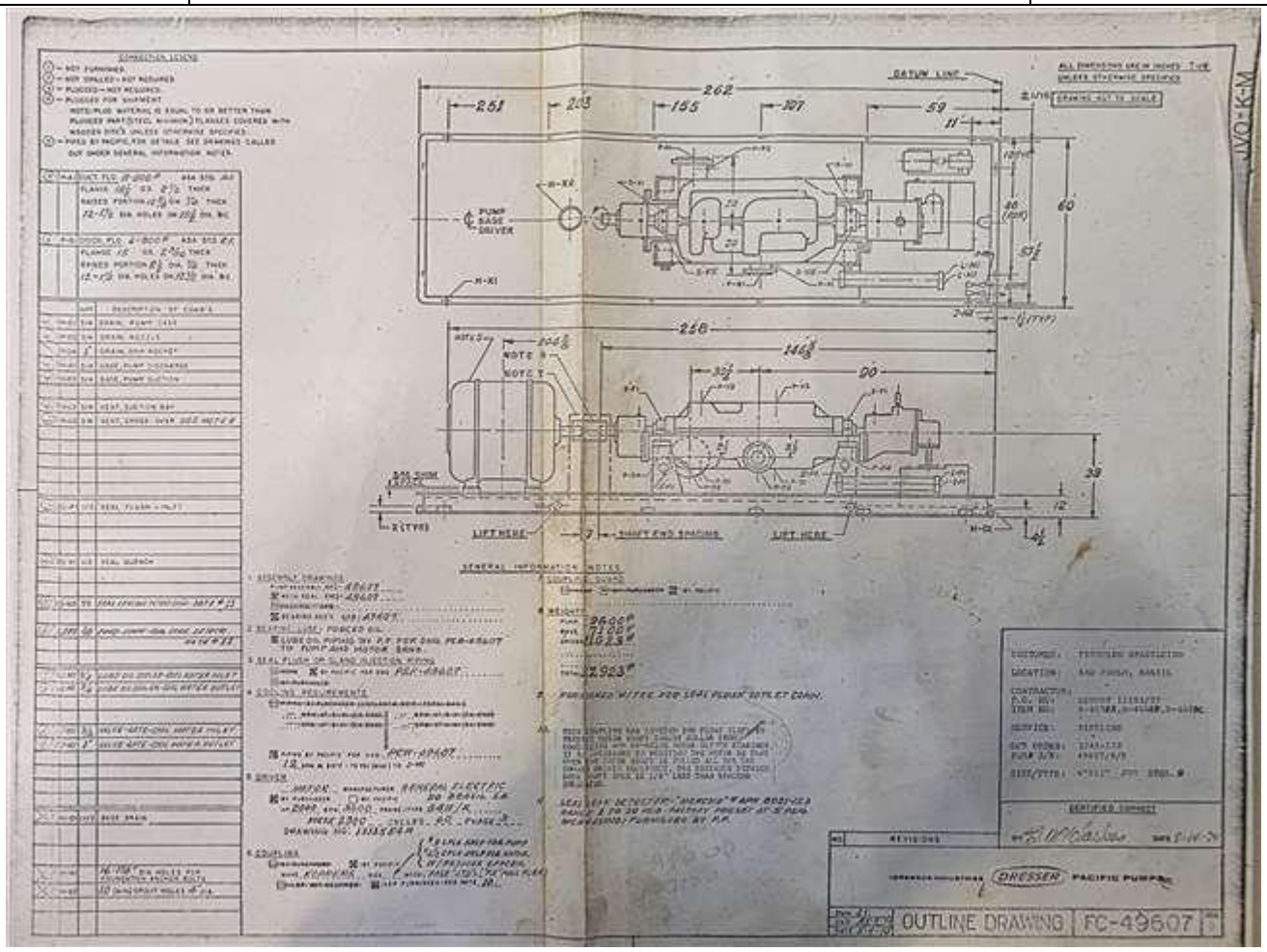


Foto 3: Desenho de conjunto da bomba B-4082C

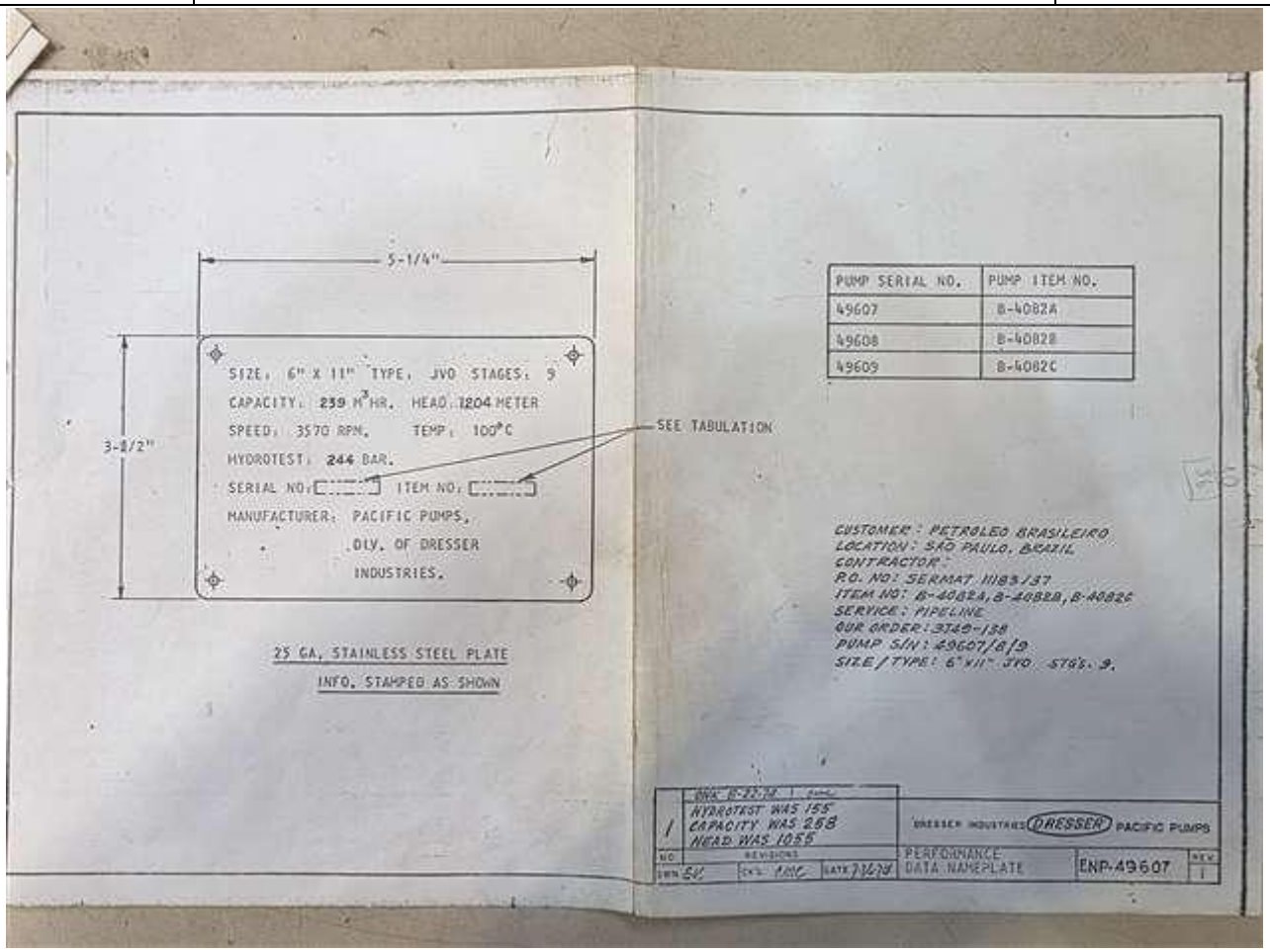


Foto 4: Desenho da placa de identificação da bomba B-4082C



Foto 5: Foto da plaqueta do motor da bomba a ser lubrificada B-4082C



Foto 6: Foto das plaquetas do motor da bomba a ser lubrificada B-4082C

5.1. RESERVATÓRIO DE ARMAZENAMENTO DE ÓLEO

- Volume, dimensões do reservatório a serem definidas pelo Fornecedor.

  Nota: O reservatório da unidade original que será substituído tem capacidade de 30 gal.

- O revestimento interno, se necessário, deverá ser especificado pelo Fornecedor.

5.2. BOMBA

- Quantidade: 01;
- A bomba deverá ser acionada por motor elétrico;
- As bombas devem ter filtro na sucção conforme requisito da API 614;
- O motor de acionamento da bomba deve ter torque suficiente para assegurar rápida entrada da bomba em regime normal, para prevenir desarme do sistema por baixa pressão de óleo.



Foto 6: Foto da plaqueta do conjunto do motor da bomba da unidade de lubrificação (Projeto Original)

5.3. TROCADORES DE CALOR

- Quantidade: 01;
- Trocadores tipo casco e tubos, pela TEMA com feixe tubular removível, sem desconectar as linhas de óleo do lado do casco;
- A pressão do lado do óleo deve ser maior que lado da água;
- Materiais em contato com óleo devem ser em inox 304L;
- Não usar componentes de Cobre e/ou suas ligas.

5.4. FILTRO DE ÓLEO

- Os Filtros devem ser tipo Cartucho. As partes em contato com o óleo lubrificante deverão ser em inox 304L;
- Os filtros devem ser projetados e fabricados para operação na pressão de descarga máxima;

5.5. INSTRUMENTAÇÃO DA UNIDADE

- Conforme API-614, N-1882 e documentos de referência. O proponente poderá propor em seu projeto, a instrumentação necessária baseada no seu know-how, indicando os desvios em comparação com a API-614.

5.6. TUBULAÇÕES

- Inclui todas as tubulações / tubings e acessórios para as interligações dos equipamentos da nova ULF, com os consumidores de óleo lubrificante.
- Deverão ser fabricadas em aço inox AISI 304L;
- Flanges soltos tipo “Lap-joint” não são permitidos.

5.7. REQUISITOS ADICIONAIS

- A Unidade deve ter pontos de amostragem de óleo no reservatório, após os filtros e na linha de retorno de óleo dos equipamentos;
- A unidade de lubrificação será montada em área classificada ZONA 2, GRUPO IIA, T3
- O arranjo dos pontos de amostra de óleo deve ser tal que permita coleta com a Unidade em operação;
- Exceto para a bomba, o óleo da unidade não deve ter contato com partes em aço carbono;
- Pintura e revestimento conforme: N-002 / N-0013 / N-1735;
- Instalação e montagem no local de operação;
- Procedimentos de Comissionamento e Partida;
- Supervisão de Comissionamento e Partida;

- Assistência Técnica na elaboração de planos de manutenção;
- Embalagem e Preparação para Transporte Rodoviário.

6. DADOS DE PROJETO

Todos os dados necessários e informações para o dimensionamento e projeto da Unidade de Lubrificação deverão ser obtidas a partir da documentação indicadas no item 2 deste documento e através de contato com a equipe da Transpetro / REPLAN

O Fornecedor deverá apresentar na Proposta Técnica, fluxograma preliminar da Unidade de Lubrificação proposta com a especificação dos componentes com as condições de projeto, características construtivas, componentes e acessórios tais como: válvulas de alívio, válvulas reguladoras, dimensões, etc.

A Unidade deverá operar com nível de ruído máximo de 85dBA, a distância de 1m em qualquer direção, conforme NR-15.

6.1. ESPECIFICAÇÕES E CARACTERÍSTICAS DO ÓLEO

As informações a seguir deverão ser adquiridas em conjunto com a equipe da REPLAN durante a etapa de projeto executivo (detalhamento):

- Especificação do óleo: ISO VG 46
- Viscosidade do óleo: 48 cst @ 40 ºC
- Densidade do óleo: 0,8 g/cm³ @ 15 ºC
- Grau de filtragem do óleo: __ µm
- Vazão do óleo: __ l/min
- Pressão do óleo: __ kgf/cm² g
- Temperatura do óleo: __ °C

Nota: 4 O óleo informado é o utilizado atualmente nas bombas B-4082A/B, porém no projeto do proponente poderá ser considerado outro óleo lubrificante.

6.2. UTILIDADES

Fornecedor deverá informar na proposta o consumo previsto para as seguintes utilidades (quando necessário):

- Água de resfriamento;
- Ar de Instrumentos;
- Ar de Serviço;
- Nitrogênio;
- Energia Elétrica.

7. DOCUMENTAÇÃO TÉCNICA

Deverá ser fornecida, para aprovação, toda a documentação necessária para a validação e qualificação da instalação, inclusive de subfornecedores.

Antes do início da fabricação, o Fornecedor deverá enviar os documentos para aprovação e/ou comentários da Petrobras, caso contrário, deverá executar todas as alterações solicitadas SEM qualquer ônus para a Transpetro.

Deverá ser fornecido Manual de Instalação, Operação e Manutenção para a Unidade de Lubrificação da Moto-bomba.

8. REQUISITOS DE INSPEÇÃO, TESTES E CERTIFICAÇÃO

Todos os testes deverão ser feitos de acordo com o plano de inspeção/testes, conforme os padrões estabelecidos pela Petrobras Códigos, Normas, e especificações aplicáveis. O roteiro de inspeção e testes deve ser apresentado e aprovado pela Transpetro.

A Unidade deverá ser testada na fábrica, antes do embarque. O Fornecedor arcará com todos os ônus decorrentes de ajustes adicionais que porventura possam vir a ser necessários no campo.

A Transpetro reserva-se o direito de testemunhar e/ou inspecionar todos os equipamentos e materiais durante a fase de recebimento de matéria-prima, fabricação, testes, embalagem e embarque, bem como auditar e diligenciar a

qualquer momento o processo de Controle da Qualidade e fabricação no Fornecedor e subfornecedores.

Para equipamentos ou partes importadas, se aplicável, o Fornecedor deverá indicar claramente os desvios no Plano de Inspeção e confirmar a garantia e o fornecimento dos respectivos certificados.

A aceitação dos testes efetuados na fábrica não deverá constituir uma dispensa dos requisitos a serem atendidos no campo nas condições de operação.

9. SOBRESSALENTES

9.1. SOBRESSALENTES PARA PARTIDA

Deverão ser fornecidos, com o equipamento, os seguintes sobressalentes mínimos para a partida da Unidade, sem limitar-se à:

- Conjunto de juntas;
- Elementos filtrantes.

9.2. LISTA DE SOBRESSALENTES PARA 02 ANOS DE OPERAÇÃO

Deverá ser fornecida, junto com a Proposta Técnica, Lista de Sobressalentes recomendados para 2 anos de operação, com preço em separado.

10. GARANTIAS DE PERFORMANCE

O Fornecedor deverá garantir no mínimo, o atendimento aos valores qualitativos e quantitativos especificados nesta Especificação Técnica.

O período de garantia deverá ser confirmado pelo Fornecedor na Proposta Técnica, sendo que deverá ser de no mínimo 18 (dezoito) meses de operação ou 24 (vinte e quatro) meses da data de embarque.

O Fornecedor deverá garantir que todos os materiais e procedimentos empregados na fabricação dos equipamentos são novos da melhor qualidade na sua classe e estão livres de falhas.

Ocorrendo defeitos de projeto, materiais ou fabricação durante o período de garantia, o Fornecedor será notificado do defeito e fará os reparos necessários ou substituirá o equipamento sem ônus para a Transpetro.

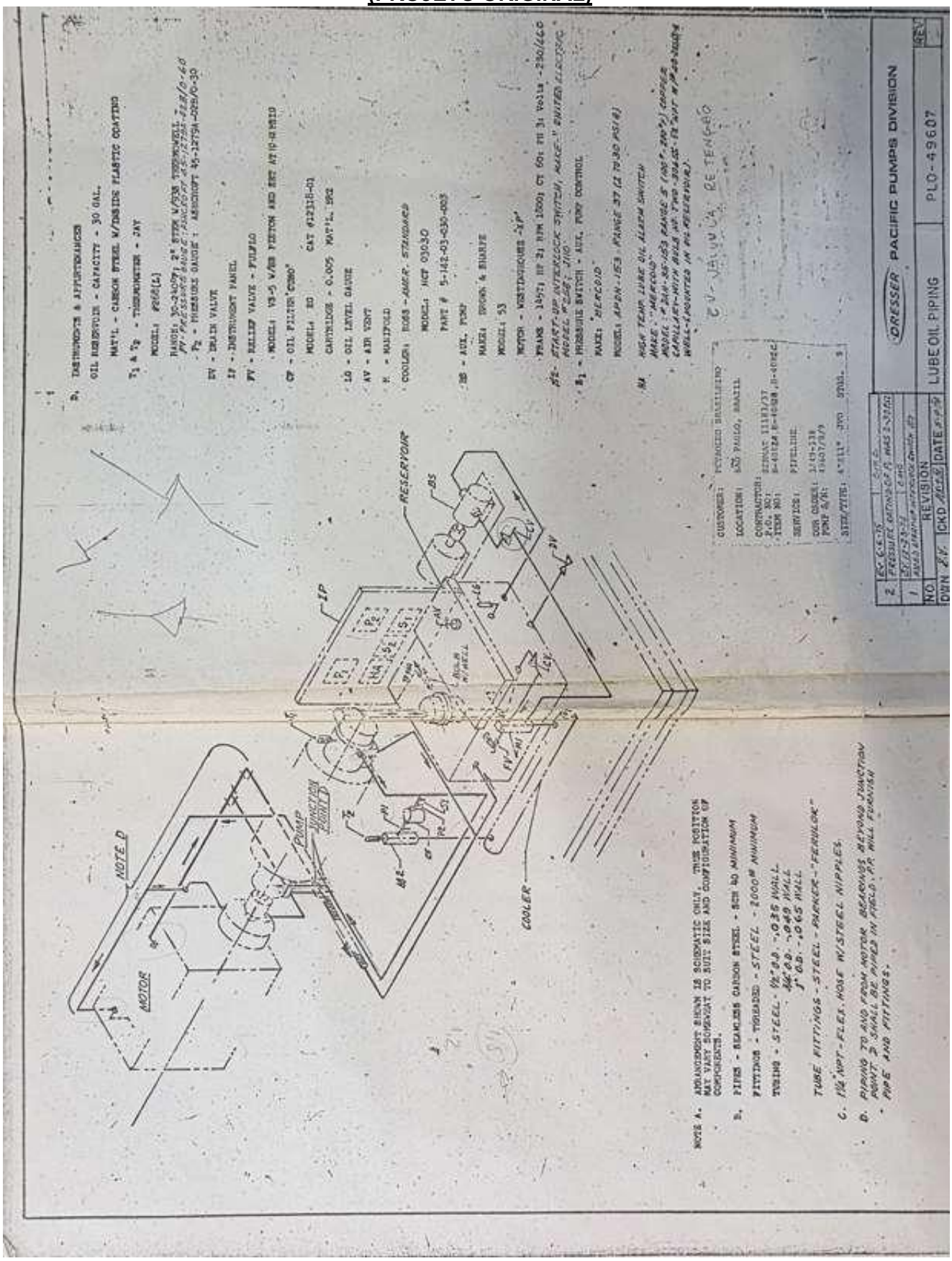
11. RESPONSABILIDADES DO FORNECEDOR

O atendimento as condições indicadas nesta especificação e a simples observância das exigências ou recomendações desta Especificação Técnica e normas não pode, entretanto, em nenhum caso diminuir nem isentar a responsabilidade do fornecedor, que continua tendo a total responsabilidade pelo projeto, fabricação, montagem e desempenho de todo o fornecimento. Execução dos serviços de mão de obra dentro dos melhores padrões de Engenharia e qualidade.

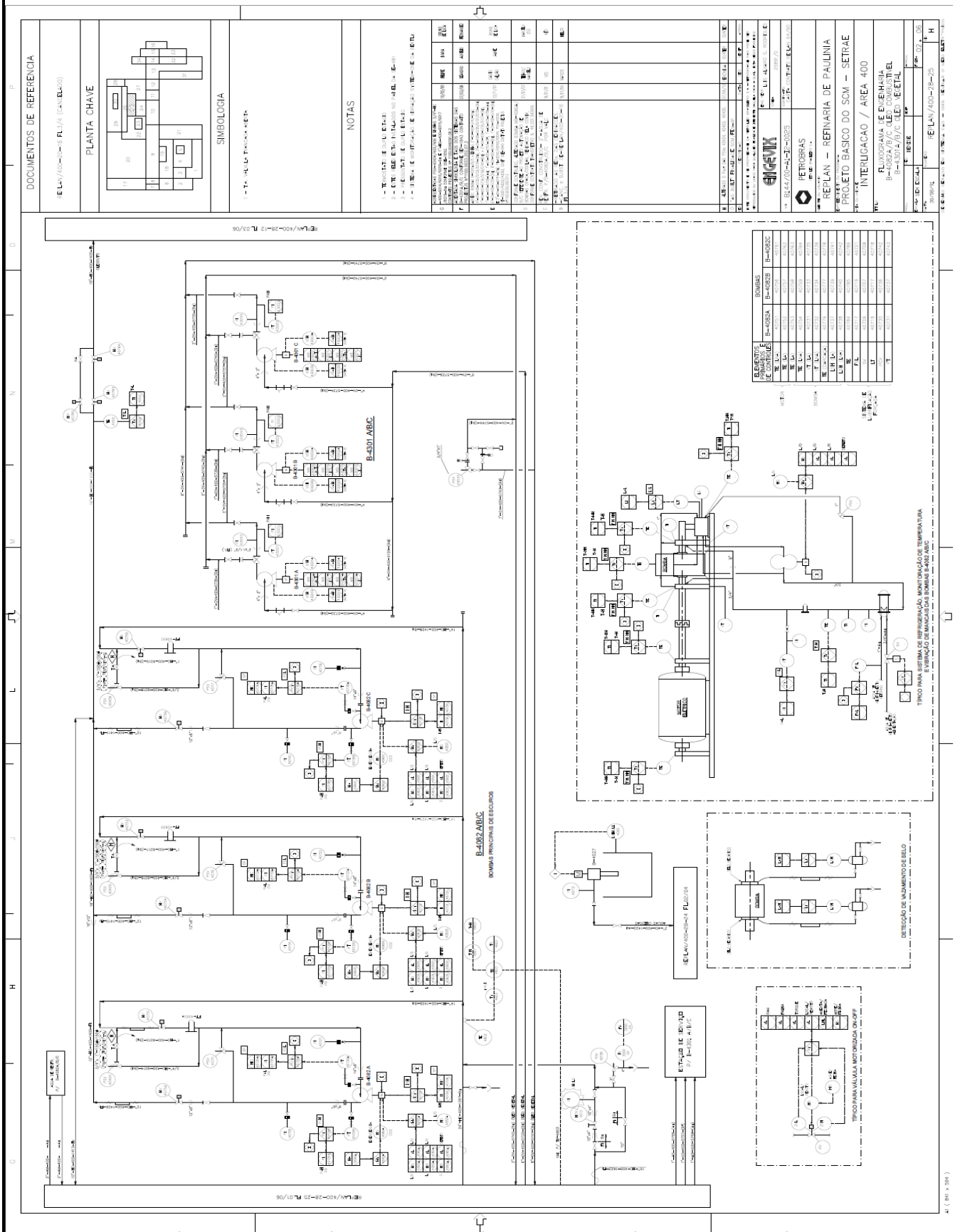
ANEXOS

DOCUMENTOS DE REFERÊNCIA

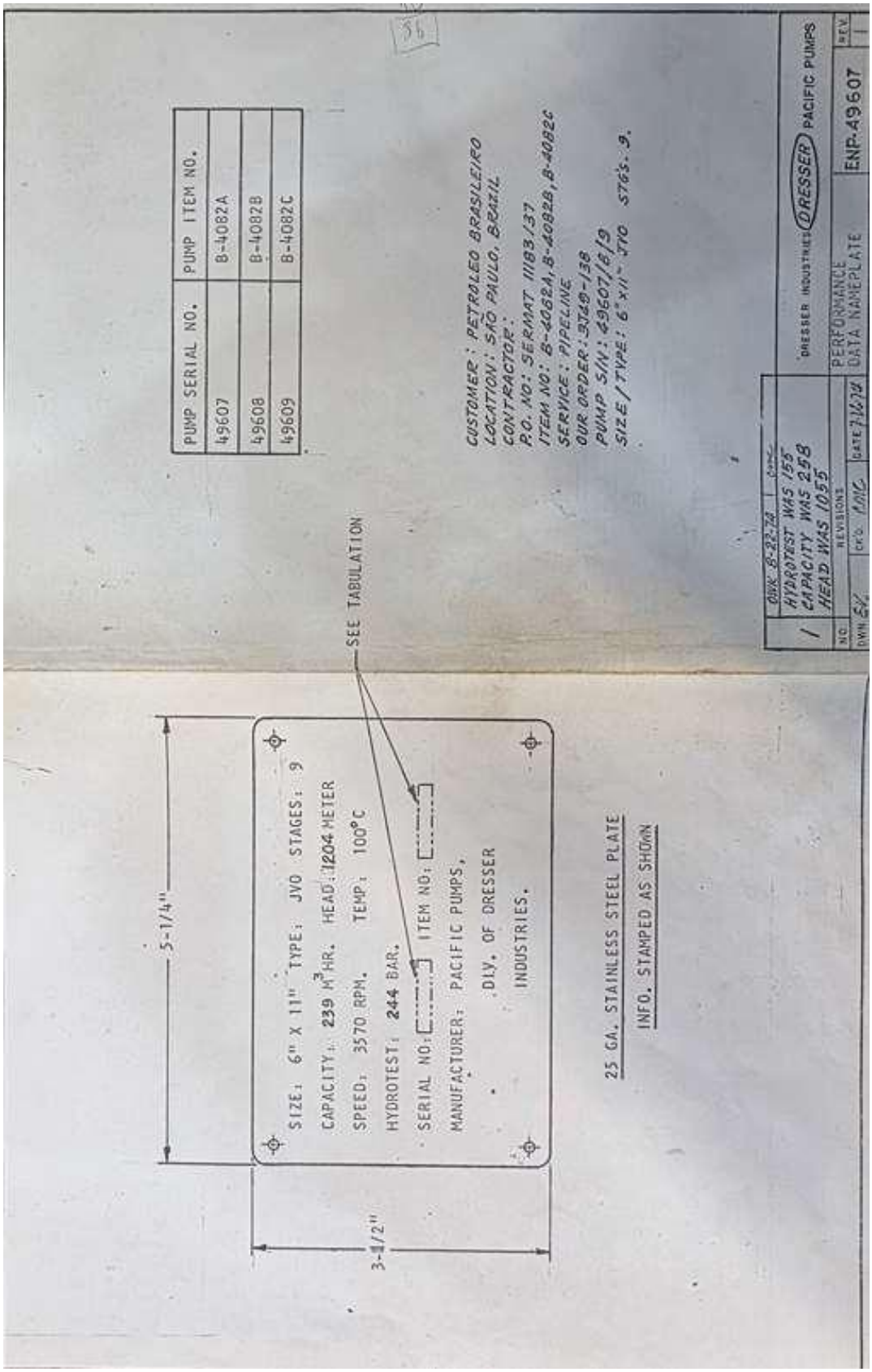
ANEXO 1: DESENHO DE CONJUNTO – UNIDADE DE LUBRIFICAÇÃO FORÇADA (PROJETO ORIGINAL)



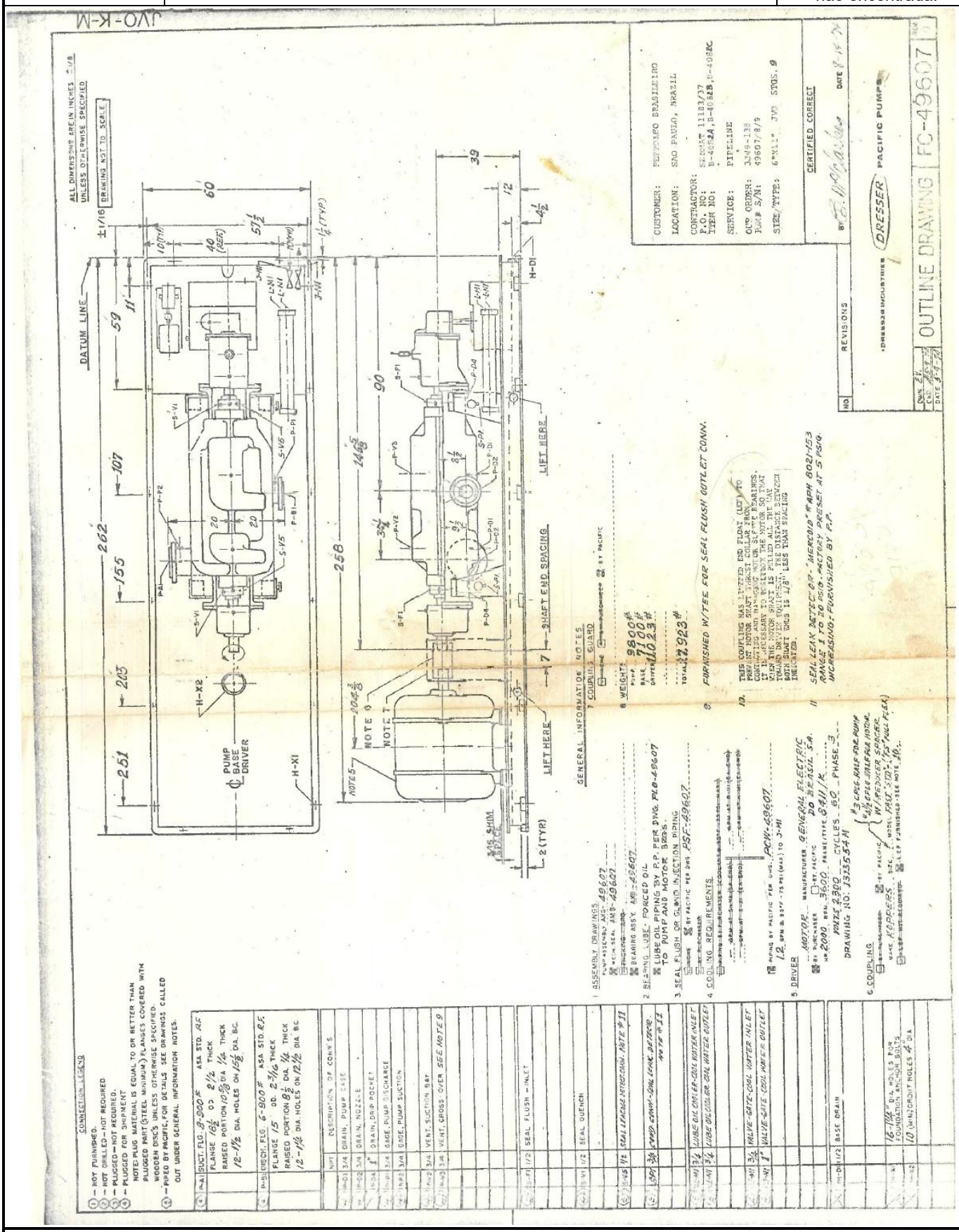
ANEXO 2: FLUXOGRAMA DE ENGENHARIA B-4082A/B/C ÓLEO COMBUSTÍVEL



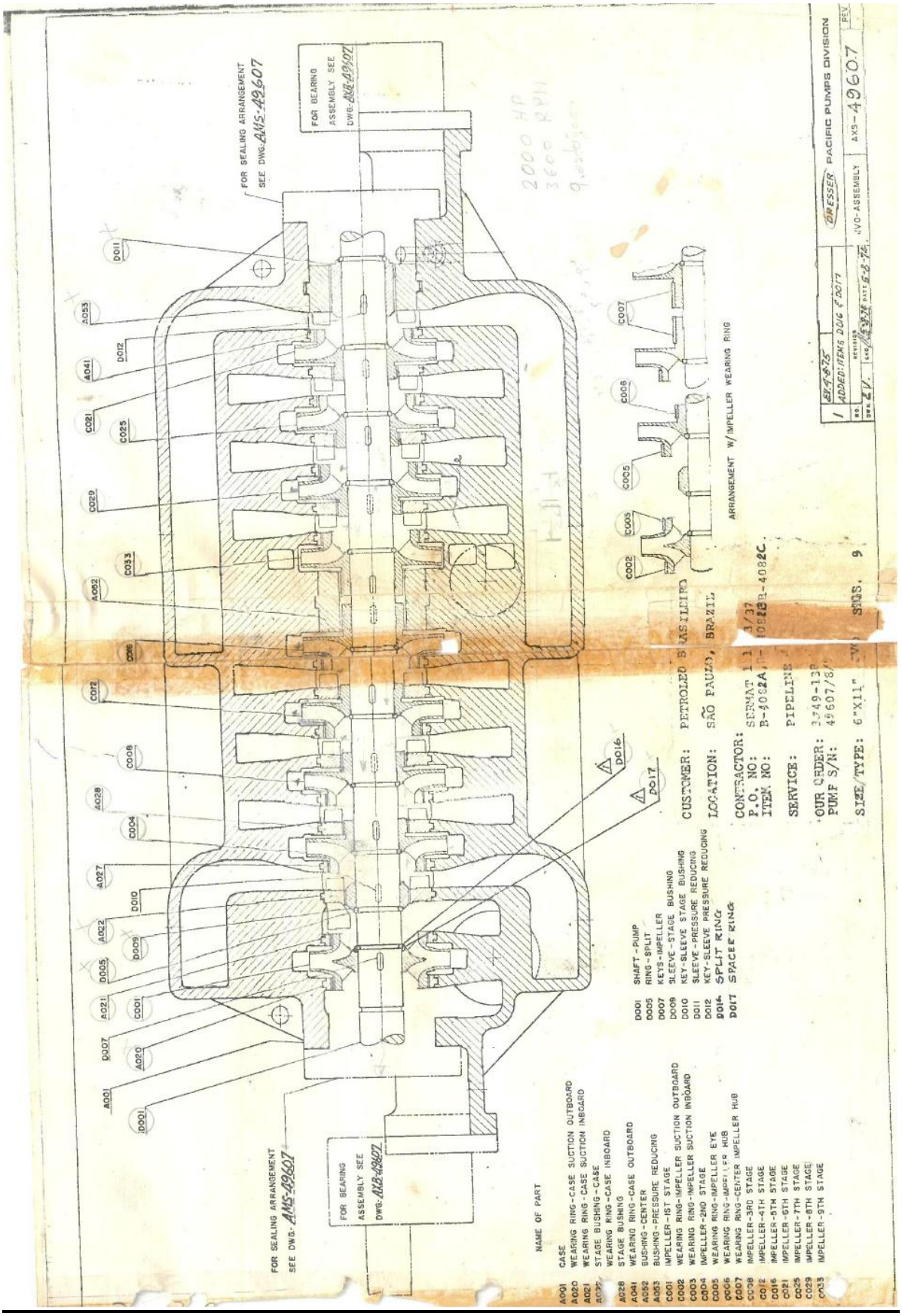
ANEXO 3: DESENHO DA PLACA DE IDENTIFICAÇÃO DA BOMBA B-4082C (À SER LUBRIFICADA)



ANEXO 4: DESENHO DE CONJUNTO DO CONJUNTO MOTO-BOMBA B-4082C (CONJUNTO A SER LUBRIFICADO)



ANEXO 5: DESENHO DE CORTE DA BOMBA B-4082C (À SER LUBRIFICADA)


DRESSER PACIFIC PUMPS DIVISION
AXS-49607
CUSTOMER: PETROLEO BRASILEIRO
LOCATION: SÃO PAULO, BRAZIL
CONTRACTOR:
P.O. NO:
ITEM NO:
SERVICE: PIPELINE
OUR ORDER:
PUMP S/N:
SIZE/TYPE: 6"X11"
ARRANGEMENT W/IMPELLER WEARING RING
FOR SEALING ARRANGEMENT SEE DWG. AMS-49607
FOR BEARING ASSEMBLY SEE DWG. AXB-49902
NAME OF PART
A001 CASE
A020 WEARING RING-CASE SUCTION OUTBOARD
A021 WEARING RING-CASE SUCTION INBOARD
A027 STAGE BUSHING-CASE
A028 WEARING RING-CASE INBOARD
A041 STAGE BUSHING
A052 WEARING RING-CASE OUTBOARD
A053 BUSHING-CENTER
C001 BUSHING-PRESSURE REDUCING
C002 IMPELLER-1ST STAGE
C003 WEARING RING-IMPELLER SUCTION OUTBOARD
C004 WEARING RING-IMPELLER SUCTION INBOARD
C005 IMPELLER-2ND STAGE
C006 WEARING RING-IMPELLER EYE
C007 WEARING RING-IMPELLER HUB
C008 WEARING RING-CENTER IMPELLER HUB
C012 IMPELLER-3RD STAGE
C016 IMPELLER-4TH STAGE
C021 IMPELLER-5TH STAGE
C025 IMPELLER-6TH STAGE
C029 IMPELLER-7TH STAGE
C033 IMPELLER-8TH STAGE
D001 SHAFT-PUMP
D005 RING-SPLIT
D007 KEYS-IMPELLER
D009 SLEEVE-STAGE BUSHING
D010 KEY-SLEEVE STAGE BUSHING
D011 SLEEVE-PRESSURE REDUCING
D012 KEY-SLEEVE PRESSURE REDUCING
D014 SPLIT RING
D017 SPACER RING

ANEXO 6: MANUAL DE INSTALAÇÃO, OPERAÇÃO E MANUTENÇÃO DA BOMBA B-4082C (À SER LUBRIFICADA)

PACIFIC®

INSTRUCTIONS FOR

INSTALLING, OPERATING AND MAINTAINING

PACIFIC PUMPS

TYPE JVO

THESE INSTRUCTIONS ARE INTENDED TO ASSIST YOU TO OBTAIN IN FULL, THE EFFICIENCY AND ECONOMY BUILT INTO EVERY PACIFIC PUMP. TO INSURE THIS INTENT, THESE INSTRUCTIONS SHOULD BE MADE READILY AVAILABLE TO PERSONNEL RESPONSIBLE FOR INSTALLING, OPERATING AND MAINTAINING YOUR PACIFIC PUMPS.

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PACIFIC PUMPS DIVISION
5715 BICKETT STREET, HUNTINGTON PARK, CALIFORNIA 9025

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SECTION I

INSTALLATION

A. LOCATION OF PUMP

1. The pump should be located as near to the liquid source as possible.

2. Head room should be provided for the use of hoisting equipment.

3. The unit should be accessible for inspection during operation.

4. It is necessary for satisfactory operation that sufficient net positive suction head (NPSH) be available at the pump suction flange. (Net positive suction head is the total head in feet absolute, determined at the suction nozzle and referred to datum, less the vapor pressure of the liquid in feet absolute.)

B. FOUNDATION (See Fig. 1)

Concrete foundations built on solid ground are the most satisfactory. Foundation bolts of the specified size should be located as shown on the foundation drawing. It is recommended that each bolt be fitted with a pipe sleeve approximately three diameters larger than the bolt and with a washer to support the head of the bolt in the sleeve. After the concrete is poured, the pipe sleeves remain in place while the bolts may be shifted for alignment with the holes in the baseplate.

A2

C. LEVELING BASEPLATE (See Fig. 2)

1. Locate leveling plates and shims on both sides of each foundation bolt and in the center at the pump end of the baseplate. Allow a minimum of one inch between the baseplate and the foundation for grouting.

2. Level baseplate across driver pads using shims at the foundation bolts on the driver end.

3. Level baseplate across pump pads using shims at the foundation bolts on the pump end.

4. Level baseplate lengthwise using shims at the center on the pump end.

5. Tighten nuts on the foundation bolts evenly but not too firmly.

D. GROUTING

1. Build forms to confine the grout. The forms must be securely anchored and shored.

2. Remove water and waste material from foundation bolt holes and clean off and dampen the foundation slab.

3. Pour grout through holes provided in the baseplate.

One recommended grout mixture is one part iron base aggregate, one part Portland cement and one part coarse, clean sand by weight. Approximately 1-3/4 to 2 gallons of clean water is required for each 100 pounds of mix. Use sufficient water to make the mix placeable. Other types of grout are available and should be considered on their own merit.

A3

4. Remove air pockets by working and rodding the grout through holes in the baseplate.

5. After grout is set, tighten nuts on the foundation bolts. Do not remove leveling plates and shims.

E. INSTALLING DRIVER ON BASEPLATE

1. Adjust the position of the driver so that the distance between the pump and driver shaft agrees with the callout on the foundation drawing.

2. If a motor with sleeve bearings is to be used, it must be mounted so that there is at least 1/8 inch clearance between the thrust collars on the motor shaft and the face of the bearings. The following procedure is usually recommended when the pump is connected directly to the motor:

   a. Measure the total lateral movement of the motor rotor. It should be approximately 1/2 inch.

   b. Pull the rotor all the way forward toward the pump.

   c. Move the rotor 1/8 inch back from the full forward position.

   d. Adjust the position of the driver so that the distance between the pump and driver shaft agrees with the callout on the foundation drawing.

3. Check alignment with a straight edge across the couplings. The driver will be 3/16 inch low before shimming.

4. See Coupling Section for additional instructions.

A4

F. ALIGNMENT OF DRIVERS MOUNTED AT FACTORY

1. It is always necessary to check, and correct if necessary, the alignment of the pump and driver shafts after the base has been grouted in at its permanent installation. This alignment check must be performed even though the pump and driver may have been mounted and aligned at the factory prior to shipment. The principal reasons for checking alignment after installation are as follows:

   a. Distortion of the base may have occurred as a result of handling during shipment or unloading.

   b. It is impractical to level base plates at the installation site as precisely as they are leveled at the factory when the drivers are mounted and aligned. Thus, minor distortion of the baseplate will occur when it is bolted to the foundation, which in turn will produce some misalignment.

   c. The factory alignment of pumps is made without piping loads imposed upon the inlet and discharge connections. When installation is complete an alignment adjustment is required to compensate for strain in the pump and bed plate caused by loads transmitted from the user's piping system.

   d. Factory alignment of pumps is performed at an average temperature of 75ºF (24ºC). Operation of pumps at less than or greater than this temperature causes alignment change due to thermal affects on pump pedestal position.

A5

Final alignment should be made with pumps at the actual operating temperature.

G. ALIGNING PUMP AND DRIVER (See Fig. 3)

1. Clamp a dial indicator on the driver half coupling. The indicator bracket must be rigid to insure accuracy of the dial indicator readings.

2. Set the indicator button on the face of the hub and align the faces parallel at all points.

3. Set the indicator button on the outside diameter of pump coupling hub and align the hubs to within .002 inch total indicator reading.

4. To obtain the proper alignment may require adding or taking away shim stock from under the driver feet. Hold down bolts should be snug before any indicating is done.

5. To check alignment, clamp the dial indicator to the pump half coupling and take readings on the outside diameter and the face of the driver coupling hub.
NOTE: If a steam turbine is used and is foot mounted, final alignment should be made with the turbine hot. If alignment is made with the turbine cold, the turbine should be set low by the distance specified by the turbine manufacturer. A suggested turbine setting is .008 inch low, or .016 inch total indicator reading.

A6

6. Scribe, drill and tap holes in the driver pads for the driver hold down bolts. Install the hold down bolts and draw up snugly, then re-check alignment.

H. PIPING

1. Both suction and discharge piping should be as short and direct as possible. There should be a minimum of bends and fittings and the bends should be made with a long radius, when possible.

2. Piping should be adequately supported near the pump to prevent strains being transmitted to the pump when tightening the flange bolts.

3. Piping flanges must be parallel to and on the same centerline as the pump flanges before bolting. If force is required to align flanges, something is wrong. When flanges do not mate without force, refit piping or adjust pipe hangers until alignment is achieved without force, failure to do so may cause pump failure and loss of warranty.

4. Pipes at the suction and discharge nozzles should be as large or larger than the openings in the pump.

I. SUCTION PIPING (See Figs. 4 through 6)

1. Suction lines must be free from pockets or high spots in which gas or vapors may be entrapped.

2. In horizontal lines leading to the pump, only eccentric reducers should be used.

3. The suction line must be free from air leaks and adequate provisions should be made for the expansion of hot lines.

4. It is recommended that a temporary screen be installed in the line at or near the suction nozzle to catch scale or other foreign material. A pressure gauge installed on each side of the screen may be used for measuring pressure drop across the screen.

5. When a strainer or foot valve is used on the inlet end of the suction line, the free area through the strainer or valve should be three to four times the area of the suction pipe.

J. DISCHARGE PIPING

1. On some installations, a check valve and a gate valve may be required in the discharge line. The check valve is used to prevent liquid from running back through the pump in case of failure of the driver. The gate valve is used in primming, starting and when shutting down the pump.

2. When valves are required in the discharge line, they should be located as near as possible to the pump.

3. In most applications, provisions should be made for recirculating a portion of the liquid to prevent over-heating of the pump while operating at reduced capacity.

A8

K. PIPING FOR SPARE PUMPS (See Fig. 7)

The operating and spare pumps in high temperature service should be piped as shown in Fig. 7, or as described in the installation drawings. During operation, hot liquid from the discharge of the operating pump circulates continuously through the by-pass to the spare pump and back to the suction of the operating pump.

L. AUXILIARY PIPING

When auxiliary piping is to be installed by the customer, the size and location of all pipe openings will be shown on the foundation drawing.

C A U T I O N

If unit is equipped with breakdown bushing assemblies and condensate is used for sealing, the condensate must be clean and free from scale, abrasive or other material that would either clog the clearance spaces or damage the bore of the breakdown bushings or the surface of the shaft sleeve. A filter or a fine mesh screen should be installed in the condensate feed line to the seals to insure clean condensate.

M. STUFFING BOXES

When installing packing, carefully read the instruction sheet included in the packing carton. The following procedures are generally recommended for packing installation:

A9

1. Install the first packing ring and tamp it to the bottom of the box. If required, a suitable lubricant may be applied to each ring.

2. Insert a split sleeve or equivalent number of metal rings and compress the packing ring by tightening the stuffing box gland firmly.

3. Back off the gland and remove the sleeve or metal rings. Repeat steps 1 and 2 above for each ring, making sure to stagger the joints 90°. If a lantern ring is used, install the lantern ring as shown on the assembly sectional drawing.

4. After the box is packed, tighten the gland firmly and evenly and let the packing stand for 5 to 10 minutes. Then, loosen the gland nuts and re-tighten finger tight.

5. If possible, rotate the shaft a few times by hand. If a lantern ring is used, make sure it is installed so that adequate lubricating liquid will pass freely to the rings.

6. Refer to Section II-A, Preparation for Operation, for additional stuffing box requirements.

N. CONNECTING PUMP AND DRIVER

1. After piping is connected, check alignment of pump and driver as outlined in Paragraph G.

2. When pump is in alignment, tighten driver hold down bolts.

A10

3. Check rotation of driver to be sure that it agrees with pump rotation.

4. Install spacer between pump and driver half couplings. For couplings which require lubrication, refer to the coupling manufacturer's manual for lubrication instructions.

A11

SECTION II

OPERATION

A. PREPARATION FOR OPERATION

1. Fill the oil reservoir to the indicated level with lubricating oil. A high grade turbine oil having a viscosity of 150 SSU at 100ºF is recommended.

2. Check metal tags or plates attached to coolers, filters and auxiliary equipment and follow instructions specified thereon.

3. Circulate water through the cooling system, if used. Inlet and drain connections on each pump are identified with metal tags.

4. Admit lubricating liquid to seals or packings that require lubrication.

5. Start the pump following instructions outlined in Paragraph B, below.

6. Check leakage from the seals or packings. If packing leakage is not adequate, a few light taps with a hammer on the gland will usually upset the packing sufficiently to increase the leakage to the required amount.

7. If leakage rate is more than required after the pump has run for 10 to 15 minutes, take up slightly on the gland nuts.

   NOTE: Do not overtighten the gland, as this will increase the rate of wear and may cause scoring of the shaft.

A12

Leakage will usually decrease after a few days of operation

8. In high temperature applications, it is advisable to re-check alignment after the pump has been warmed up.

B. STARTING

1. If pump is above the level of the liquid to be pumped, close the discharge valve. If the pump is below the level of the liquid, open the discharge valve 1½ to 2 turns.

2. Prime the pump. All air and vapor must be removed. The The pump case and suction pipe must be filled with liquid before the pump is started up.
   NOTE: Pumps that are modified to function as hydraulic turbines must also be primed and filled with liquid before starting. If two turbines are used on a single installation, both turbines must be primed.

3. If the pump is fitted with an external source seal or packing flushing line, open the line and admit flushing liquid to the seal chamber for 10 to 15 minutes.

4. Start the driver and bring the pump up to speed rapidly.
5. As soon as the pump is up to full speed, open the discharge valve slowly. Do not let the pump run with the discharge valve closed.

6. Check pressure gauges on each side of the temporary screen in the suction line. A pressure drop across the screen indicates it is becoming clogged with dirt or scale.

A13

In this case, the pump should be shut down and the screen cleaned or replaced. A clogged screen can cause damage to the pump.

7. The pump should be shut down if it fails to develop its rated discharge pressure at operating speed, or if bearings overheat or there is undue vibration or noise.

C. OPERATING AT REDUCED CAPACITY

If the pump is connected to a constant speed driver, capacity can be reduced by throttling the discharge. If the pump is connected to a variable speed driver, reduction of both the head and the capacity can be accomplished either by reducing the speed or by throttling the discharge.

When throttling the discharge, a by-pass connection may be used to by-pass sufficient liquid to prevent overheating and vaporization of the liquid in the pump.

D. OPERATING ROUTINE

1. Check bearing temperatures periodically. If there is overheating, check the oil level in the reservoir and the oil temperature. When ambient temperature is normal, the sump temperature should not exceed 165°F on pumps equipped with ball bearings. On pumps with Kingsbury or sleeve type bearings, the temperature at the cooler outlet should not exceed 140°F.

2. Check seals or packings for leakage.

3. Check circulation of the cooling system, if used, Cooling requirements will vary according to the ambient temperatures encountered.

4. Check suction and discharge pressure gauges. If the differential pressure drops critically, shut down the pump at once.

E. STOPPING

The pump should be shut down rapidly to keep liquid in the pump and prevent parts from seizing. After stopping thé driver, close the discharge valve and then the inlet valve, in that order. When Pumps are operating in parallel, it is sometimes necessary to close the discharge valve immediately after stopping the driver to prevent reverse rotation.

A15

SECTION III

TROUBLE SHOOTING INFORMATION

Operating troubles and their probable causes are as follows:

A. NO DISCHARGE → NÃO HÁ DESCARGA

1. Wrong direction of rotation.
2. Pump not primed.
3. Suction line not full of liquid.
4. Air or vapor in suction line.
5. Suction pipe not submerged enough.
6. Available NPSH not sufficient.
7. Pump not up to rated speed.
8. Too much system head.

B. INSUFFICIENT DISCHARGE → DESCARGA INSUFICIENTE

1. Wrong direction of rotation.
2. Suction line not full of liquid. LINHA DE SUCÇÃO NÃO ESTÁ CHEIA C/ LÍQUIDO
3. Air or vapor in suction line. AR OU VAPOR NA LINHA DE SUCÇÃO
4. Air leaks in suction line.
5. Suction line not submerged enough. LINHA DE SUCÇÃO NÃO SUBMERGIDA SUFICIENTE
6. Available NPSH not sufficient. NPSH MENOR QUE O NECESSÁRIO
7. Pump not up to rated speed.
8. Too much system head.
9. Suction screen clogged.

C. INSUFFICIENT PRESSURE PRESSÃO INSUFICIENTE

1. Air or vapor in liquid. AR OU VAPOR NO LÍQUIDO BOMBEADO.
2. Pump not up to rated speed.

A16

3. Discharge pressure too high. PRESSÃO DESCARGA
4. Wrong direction of rotation.
5. Mechanical defects.
   a. Wearing rings worn.
   b. Impeller damaged
   c. Internal leakage.
6. Suction screen clogged.

D. CAVITATION AND NOISE

1. Air or gas in liquid.
2. Suction line not filled with liquid.
3. Suction line not submerged enough.
4. Available NPSH not sufficient.
5. Suction screen clogged.

E. PUMP LOSES SUCTION AFTER STARTING

1. Suction line not full of liquid.
2. Air leaks in suction line.
3. Air or vapor in liquid.
4. Air or vapor in suction line.
5. Suction line not submerged enough.
6. Available NPSH not sufficient.
7. Suction screen clogged.

F. EXCESSIVE POWER CONSUMPTION

1. Speed too high.
2. Insufficient head.
3. Mechanical defects:
   a. Misalignment.
   b. Shaft bent.
   c. Rotating element dragging.

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G. BEARINGS OVERHEAT

1. Oil pressure too low.
2. Improper or poor grade of oil.
3. Dirt in bearings.
4. Dirt or moisture in oil.
5. Failure in oiling system.
6. Bearings too tight.
7. Misalignment.

H. VIBRATION

1. Suction line not full of liquid.
2. Air or vapor in suction line.
3. Misalignment.
4. Worn or loose bearings.
5. Rotating element out of balance.
6. Shaft bent.
7. Foundation not rigid.
8. Baseplate not fully grouted.
9. Vibration in the driver.
10. Wrong location of control valve.

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SECTION IV

GENERAL MAINTENANCE

A. INSPECTION

1. Pumping equipment will not maintain itself. The amount of maintenance required is not the same for all pumps, but will vary with service conditions. A pump handling clean, non-corrosive liquids requires far less maintenance than a pump of the same size and type handling gritty or corrosive liquids.

2. PERIODIC INSPECTION is cheap insurance against forced shutdowns caused by the failure of parts. Periodic inspection may be on a yearly or monthly schedule, depending upon the service, the more severe the service, the more frequent the inspection. Inspection should be thorough and include an accurate check of clearances between rotating and stationary parts, as well as the condition of all parts exposed to wear or to damage by grit or corrosion. Regular logging of suction and discharge pressures, flow rate and vibration readings are invaluable for determining the necessity for shutdown and maintenance.

3. REPLACEMENT PARTS if not stocked in your warehouse, should be ordered well in advance of the time they are required for installation. Periodic inspection will show when parts should be ordered in advance.

B. PARTS ORDERING

When ordering parts for spares or replacement, the following information must be given:

A19

1. Size, type and serial number of the unit from information on the nameplate.
2. Quantity of parts.
3. Part name and number as shown on the sectional drawing.
4. Complete shipping instructions.

A20

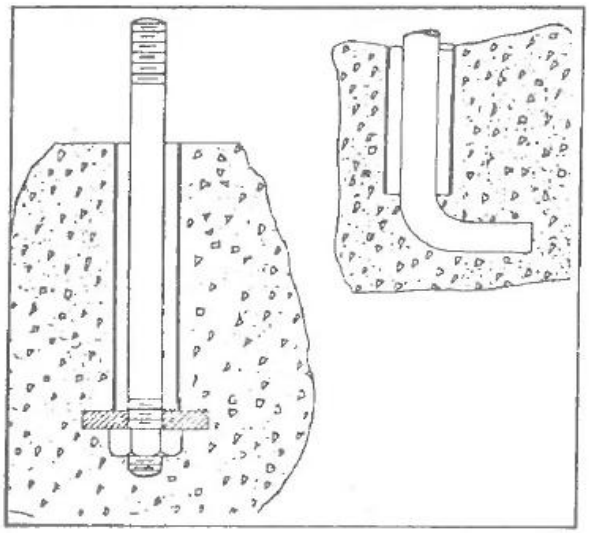

FIG. 1
FOUNDATION BOLTS

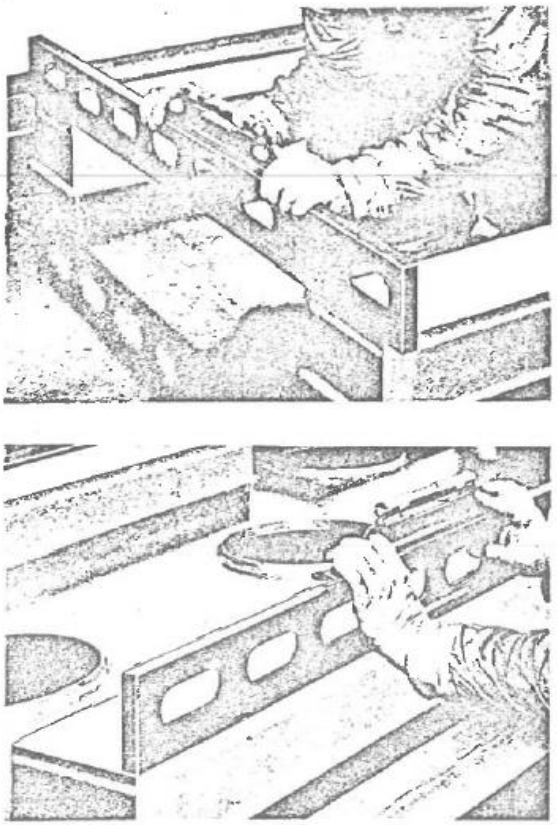

FIG. 2
LEVELING BASEPLATE

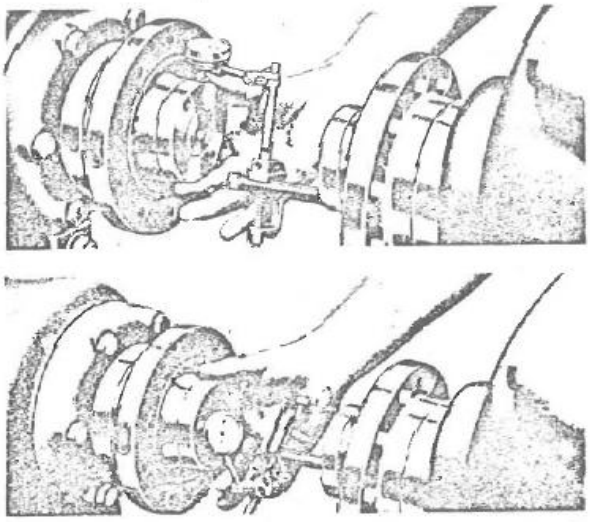

FIG. 3
ALIGNING PUMP AND DRIVER

A21

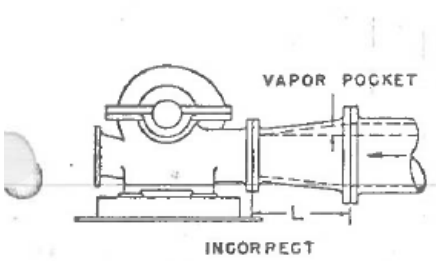

FIG. 4A
SUCTION PIPING

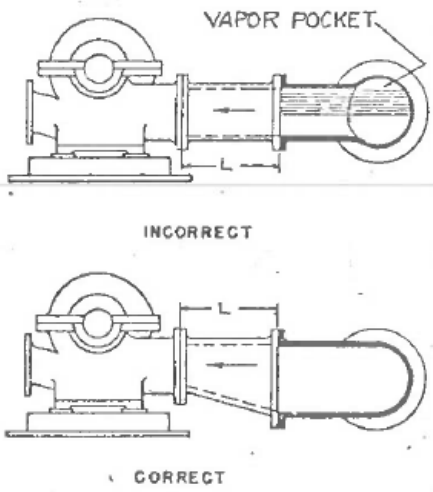

FIG. 4B
SUCTION PIPING

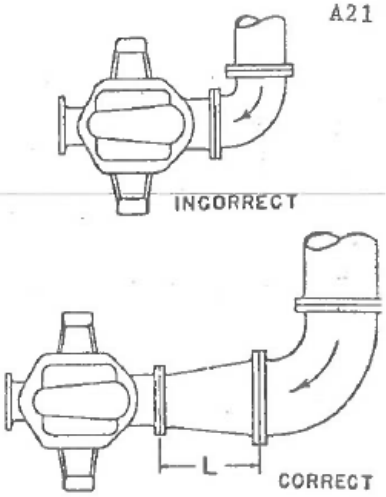

FIG. 5
SUCTION PIPING

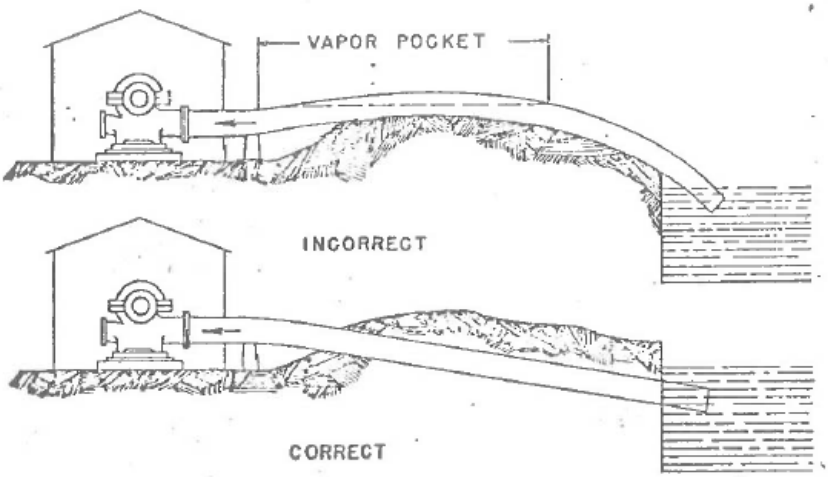

FIG. 6
SUCTION PIPING

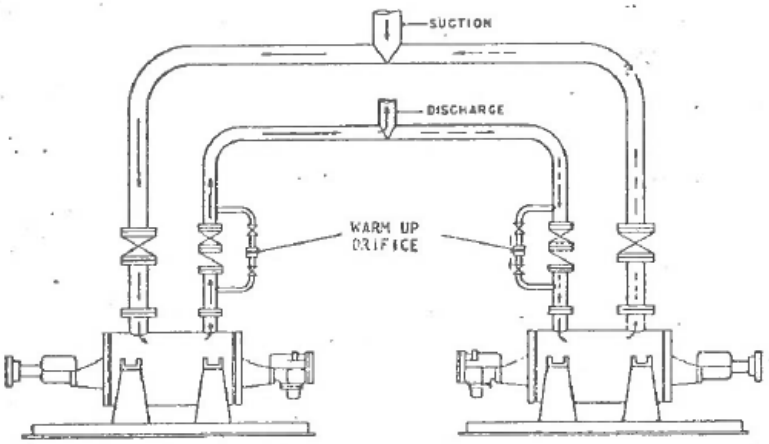

FIG. 7
PIPING FOR SPARE PUMPS IN HIGH TEMPERATURE SERVICE

PUMP -- TYPE JVO

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SECTION II - MAINTENANCE

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B. Disassembly — B2
C. Inspection, Replacement and Reconditioning — B5
D. Assembly — B6

B1

SECTION I

GENERAL INFORMATION

A. INTRODUCTION

1. Horizor tally Split Case — The suction and discharge nozzles are mounted in the lower half of the casing, allowing access to all internal parts without disturbing suction or discharge piping. The symmetry of the upper and lower case halves plus the centerline mounting of the casing combine to minimize distortion due to thermal growth.

2. Double Volute Design — Radial hydraulic balance is achieved over the complete performance range through the use of double, opposed, volutes.

3. Wide Hydraulic coverage---Each size of JVO is available with two or more impeller and volute combinations plus an odd or even number of stages plus three pressure ratings. The result is optimum performan ce over an unusually broad range of conditions.

4. Axial Hydraulic Balance — The impellers are mounted in opposed groups, allowing axial balance to be achieved without the use of high pressure, close tolerance axial balancing devices.

5. Double Suction — All sizes are available with double suction first stage impellers to minimize NPSH requirements.

6. Maximum Parts Interchangeability---By utilizing the latest pattern making techniques, the various combinations of volute, pressure rating, and number of stages for each size of pump are achieved with arrangements of basic case patterns. The broad hydraulic range of the JVO is thus obtained while at the same time achieving maximum interchangeability of internal parts such as shafts, wear rings, bearings, seals, etc.

7. Split Ring Impeller Mounting — The impellers are accurately centered and keyed to the shaft and mounted with a light shrink fit against fully retained split rings.

B2

A. INTRODUCTION (Continued)

8. Sealing Chambers---Sealing chambers are designed to accommodate soft packing or any current mechanical seal designs. Both sealing chambers operate at pump suction pressure and have integral water jackets.

SECTION II
MAINTENANCE

A. GENERAL

1. To insure that the pump is in good mechanical condition, it is recommended that a periodic inspection be made to check the condition of all parts exposed to wear or to damage by grit or corrosion. The inspection will indicate when parts should be replaced. Replacement parts should be ordered well in advance of the time they are required for your installation.

B. DISASSEMBLY

1. Disconnect auxiliary piping at points necessary to allow the removal of the upper half of pump case. Either tape over or tie a clean cloth over the end of each pipe to keep out dirt. It is not necessary to disconnect the pump inlet or the discharge piping or to move or disturb the position of either the pump or driver.

2. Remove shaft coupling guard, coupling spacer and pump half coupling -- see coupling section for additional coupling instructions.

3. Remove radial bearing assembly — see radial bearing section.

4. Remove thrust bearing assembly — see thrust bearing section.

5. Remove sealing assemblies (one at each end of pump) and sealing housings. — See sealing section.

B3

B. DISASSEMBLY (Continued)

6. To disassemble pump case (A00l):

   a. Remove case cap nuts and washers (if furnished).

   b. Remove case parting flange taper pins (one at each end of case, located diagonally).

   c. Lift off the top half of case.

   d. Two tapped holes for jackscrews are furnished in top half, however, jacking the case halves apart is not necessary with most pump applications.

7. Case stage bushing (A022); stage bushings (A028) and center bushing (A052) are axially split and should be removed before the pump internal assembly is lifted from the lower half of pump case (A00l.) These parts have anti-rotation locking dowels (see Fig. l) Rotate the parts so that the lower halves with the anti-rotation locking dowels are on top and the split faces of the parts are flush with the case lower half parting flange face. Lift off the exposed halves, then remove the remaining halves by rotating 180°. It is recommended that both halves of these parts be marked by stage number for easy identification prior to reassembly.

   To allow for easier rotating of bushings the internal assembly may be lifted slightly, (see next paragraph for lifting instructions), and some lubricant or solvent applied to the mating faces of bushings and lower half of case.

8. To lift out the pump internal assembly place two soft slings around the pump shaft. Locate one sling in front of the inboard impeller and the other sling in front of the outboard impeller. Use a spreader between slings of sufficient length to avoid damage to the impellers.

9. Remove pressure reducing bushing (A53) (see Fig. 2), and case wearing ring---suction---outboard (A020) by sliding from the pump shaft (D001).

10. Impellers (C001, C004, C008, etc.), stage bushing sleeve (D009) and pressure reducing sleeve (D0ll) are positioned on pump shaft (D00l) with a light locational interference fit. The pump shaft diameter is largest at the center. The shaft diameter decrease at each stage toward both

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B. DIASSEMBLY (Continued)

10. (Continued)

ends of the shaft. The impellers must be disassembled by heating all around. Heating must begin at the periphery of the impeller and heated toward the hub to avoid seizing to the shaft. After heating quickly push the impeller back to disengage the split ring (D005) and quickly pull the impeller from the pump shaft.

NOTE: That the split ring for the suction impeller (C001) is on the inside and the suction impeller may be pulled from the pump shaft without first disengaging the split ring.

11. Recommended practices:

a. Remove parts alternately one from each end to allow the pump shaft to cool between each removal operation operation.

b. Mark all parts by stage number.

c. Observe the direction of curvature of the impeller vanes in relation to the shaft so that impellers may be properly installed at assembly . (See Figure 3).

d. Case wearing ring — suction — inboard (A021); case wearing rings inboard (A027); case wearing ring outboard (A041); split rings (D005); impeller keys (D007); stage bushing sleeve key (G010) and pressure reducing sleeve key (D012) shall be removed as corresponding parts are dismantled.

12. Impeller wearing rings (C002, C003, C005, C006 and C007) — When furnished — are secured to the impellers by tack welds or with setscrews, depending on weld-ability of the mating materials.

See SECTION II-C for inspection and replacement of impeller wearing rings.

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C. INSPECTION, REPLACEMENT AND RECONDITIONING.

1. Before inspecting clean all parts thoroughly. Thick, gummy residue can be removed by steam cleaning. Scale or similar deposits can be removed by the aid of solvents.

2. After parts are thoroughly cleaned, they should be inspected and checked for wear and/or damage. Worn or corroded-eroded parts should be either reconditioned or replaced. We do not recommend reconditioning either rotating or stationary rings and bushings. Special equipment is required for grinding these parts to size. Replacement should always be made with new, factory built parts.

3. Rotating or stationary rings, bushings and similar parts should be replaced when the clearance between rotating and stationary parts has increased 50% and increased vibration or loss of performance is observed. See Running Clearances Chart.

4. Impeller wearing rings have a light shrink fit (0.002 max.) on impeller skirt or hub.

   Worn wearing rings which are welded to the impeller should be removed by turning on a lathe. Turning must be done at a very low speed with a carbide or similar tool.

   Worn wearing rings which are secured to the impeller by setscrews can be removed by first unscrewing the setscrews and then expanding wearing rings by heating and removing while hot.

   NOTE: Heating must be carefully done with a low flame to avoid warping the impeller.

5. To mount new wearing rings clean impeller skirts and hubs, expand wearing rings by heating to 200°F and fit on the impeller skirt or hub.

   When securing rings by tack welding, use inert gas shielded arc (TIG) process. Welds should be approximately 1/2 inch long by 1/8 inch deep at the interface between the wearing ring and impeller. Welds should not be spaced more than 3 inches apart, with a minimum of 3 welds on each part. A 200°F preheat is recommended for 17 chrome steel rings prior to welding.

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C. INSPECTION, REPLACEMENT AND RECONDITIONING (Continued)

5. (Continued)

Check the clearance between the newly mounted wearing ring and its mating part. Excessive clearance will cause excessive leakage; insufficient clearance may cause the rings to gall or seize.

6. Close fitting wearing parts should be replaced when the clearance exceeds that recommended on the Running Clearance Chart or the capacity of the pump drops off because of increased clearance.

7. Mount the bare shaft (D001) in centers or bearings and check for straightness with a dial indicator. Shaft must be straight within 0.0015 inch total indicator reading at all places.

D. ASSEMBLY

1. Install new gasket:

Before installing parts, it is recommended:

a. The interior of the case (A001) be washed and blow out with air to remove all foreign material.

b. A new gasket between case parting flanges be cut and positioned. The gasket should give a compressed thickness of 0.014" to 0.016". A gasket of greater thickness will not allow sufficient compression to prevent leakage between the stages. The procedure recommended for cutting a new gasket is:

1. Remove the top half of the case and remove the top half studs.
2. Place the gasket material on the flange of the top half casing and using a sharp knife, cut holes for flange bolts and dowel pins.
3. Shellac the flange face of the bottom half casing and place the rough gasket in position on the shellacked surface.

B7

D. ASSEMBLY (Continued)

1. (b) (Continued)

4. Thread the removed studs into top half, position the top half, tighten the flange bolting and allow sufficient time — at least 3 hours, for the gasket to set.

5. Remove top half casing and finish cutting gasket for cored passages and machined fit. Allow gasket to extend about 1/64 to 1/32 at both end faces of case (A001) which connect to packing or seal housing (B001/002) and housing gasket (B016).

2. Assemble Rotor:

a. It is recommended that the internal parts be assembled on an assembly frame.

b. See pump assembly drawing for reference.

c. The pump shaft outside diameter is largest at the center under the opposing impellers, the diameters decrease at each stage toward both ends.

Impellers (C001, C004, C008, etc.), stage bushing sleeve (D009) and pressure reducing sleeve (D011) are positioned on the pump shaft (D001) with a light locational interference fit.

d. To facilitate assembly the bore of each part should be expanded by heating the part to approximately 400°F in an oil bath or oven.

Position the pump shaft (D001) so that the keyseat for the discharge impeller is on top.

e. Insert impeller key (D007) into keyseat. Slide heat-expanded center impeller onto the pump shaft. The impeller key should fit into the keyway in the impeller. The impeller should be stopped when the split ring groove in the pump shaft is exposed. Insert split ring (D005). into the groove and pull the impeller back against the split ring. Now the impeller is properly positioned and the split ring is locked.

NOTE: This operation must be done very quick to avoid seizure to the shaft.

BE

2. Assemble Rotor (COntinued)

f. Place case wearing ring – outboard (A041) onto the impeller.

g. Turn the shaft and impeller assembly so that the keyseat for the next outboard impeller is on top and assemble impeller key, impeller, split ring and case wearing ring – outboard as previously described.

h. Repeat above procedure until all outboard impeller keys, impellers, split rings and case wearing rings have been mounted.

i. Mount pressure reducing sleeve key (D012), pressure reducing sleeve (D011) and split ring (D005) applying the previous instructions.

j. To mount the inboard impeller keys, impellers (except suction impeller), split rings and case wearing rings (A027) begin at the center and apply previous instructions.

k. Mount stage bushing sleeve key (D010), stage bushing sleeve (D009) and split ring (D005) and apply previous instructions.

l. Place case wearing ring (A027) on impeller – 2nd stage (C004).

m. Slide case wearing ring – suction inboard (A021) on pump shaft and place temporarily on stage bushing sleeve (D009).

n. Mount the suction impeller key (D007) and split ring (D005) and slide the heat-expanded suction impeller (C001) into position.

o. Position the case wearing ring – suction outboard (A020) and case wearing ring-suction inboard (A021) on suction impeller (C001).

3. CHECK CONCENTRICITY – ROTATING ELEMENT

Mount the assembled rotating element in centers on rollers (as shown in figure 4). Revolve the shaft slowly by hand and with the indicator dial set at "O". Take readings on the circumference of the pressure reducing sleeve and impeller wearing surfaces.

3. Check Concentricity---Rotating Element (Continued.)

If the readings at all points do not indicate more than 0.0015 total indicated runout (T.I.R.) the assembly is within allowable tolerance and may be installed in the pump case. However, should the readings at any point vary more than 0.0015 total indicated runout, the assembly is not accurate and should not be installed in the pump until the cause for the inaccuracy has been found and corrected. The possible causes for inaccuracy may be as follows:

a. Shaft not straight,

b. Abutting faces of components not square with centerline of shaft

c. Burrs or dirt on close fitting parts.

4. INSTALL PRESSURE REDUCING BUSHING

Slide pressure reducing bushing (A053) on thrust end of shaft and carefully slide over pressure reducing sleeve (D011).

5. TO INSTALL INTERNAL ASSEMBLY

a. Lift the pump internal assembly into the case by placing a soft sling around the pump shaft on either end, outside of the suction impeller on the suction end and outside of the pressure reducing sleeve and bushing on the thrust end. Use a spreader between the slings of sufficient length to avoid damage to the impeller and bushing. Lift and then carefully lower the internal assembly into the pump case being very careful to align and guide the wearing rings and bushings into the circumferential grooves provided in the case.

b. Install the upper half of stage bushings (A022, A028 – etc.) and center bushing (A052) by fitting the bushing tongue into the case circumferential grooves and rotate 180° so that the split faces of the parts are flush with the lower half case parting flange face.

c. Install the lower half of stage bushings (A022, A028 – etc.) and center bushing (A052) by placing face down so that the lower half of the bushing mates with the upper half. Rotate the complete bushing until anti-rotation locking dowels fit into milled slots provided in lower half case.

BIO

6. INSTALL PUMP UPPER HALF CASE (A001).
   a. Lift the upper half of case by the lifting lugs provided and lower down over internal elements being very careful to align with studs and bushings (A022, A028, A052 — etc.) for proper case fit.
   b. Install the case parting flange taper pins (one at each end of the case located diagonally).
   c. Install stud washers, if furnished, and capnuts. Tighten capnuts beginning on one side near the center, then proceed to the capnut on the opposite side of the case and alternate from side to side progressing outward toward each end of the pump case until all cap nuts are tightened.
7. INSTALL SEAL HOUSINGS AND SEAL ASSEMBLIES — See Seal Section.
8. INSTALL THRUST BEARING ASSEMBLY — See Thrust Bearing Section.
9. INSTALL RADIAL BEARING ASSEMBLY — See Radial Bearing Section.
10. INSTALL COUPLING — See Coupling Section.

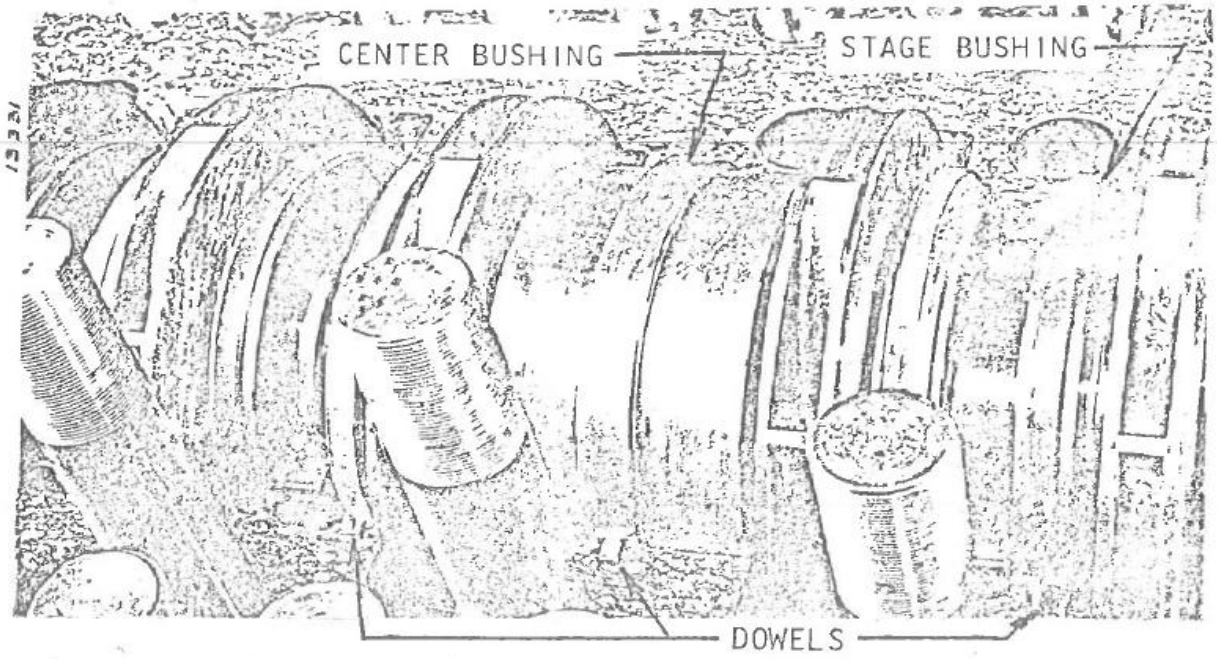

FIG. 1

STAGE BUSHINGS AND CENTER BUSHING

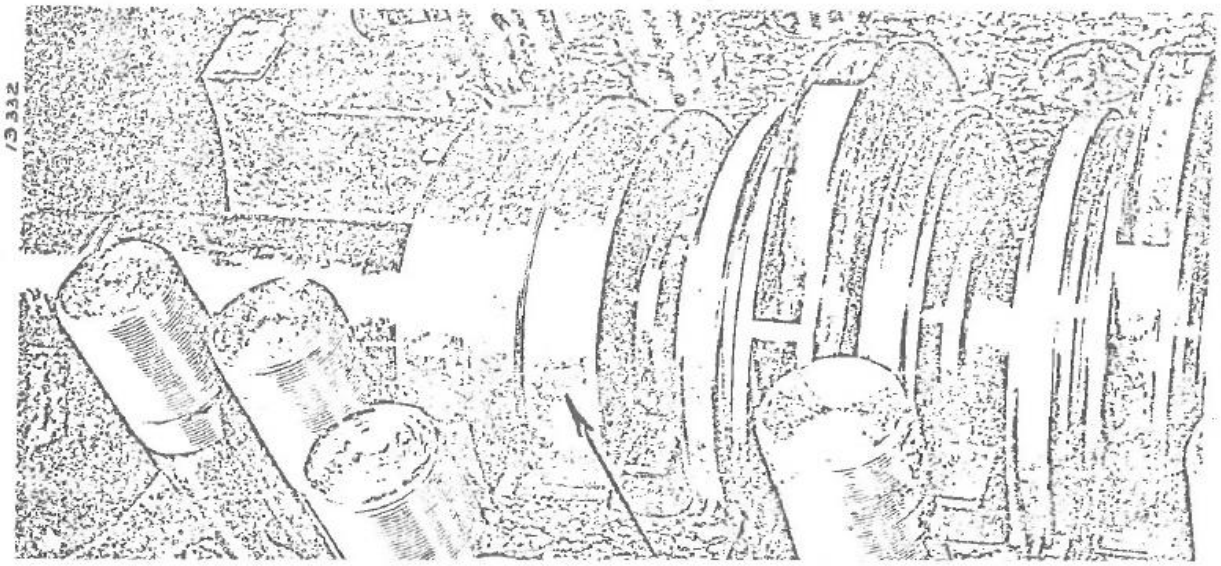

FIG. 2

PRESSURE REDUCING BUSHING

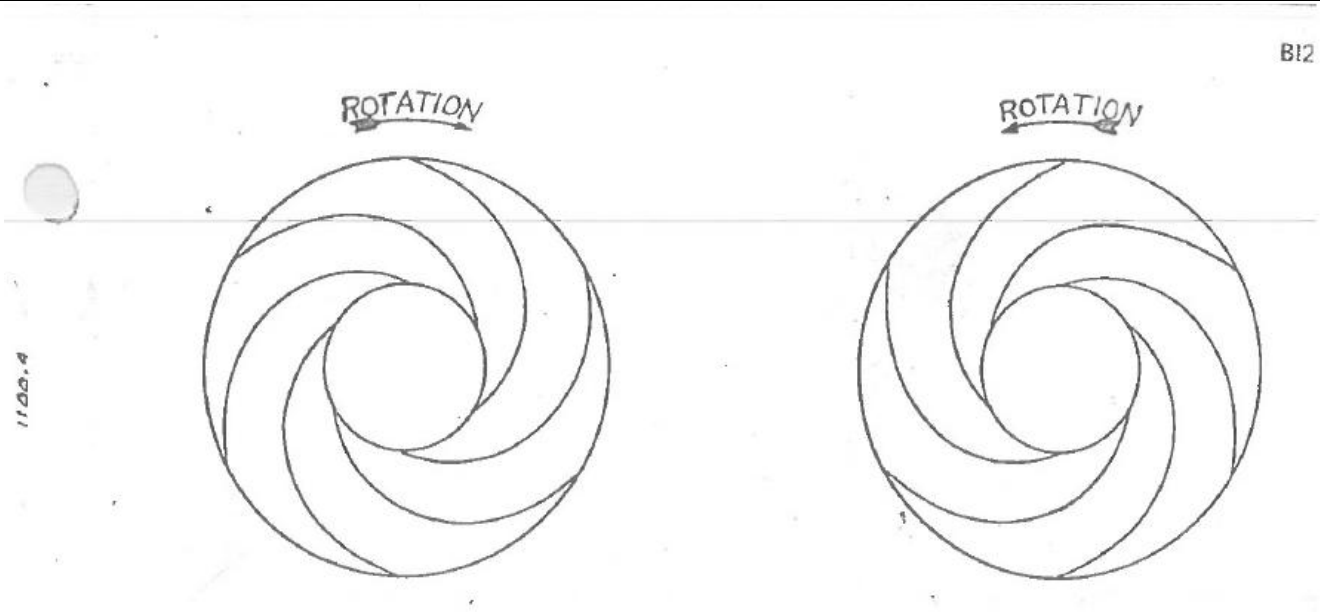

FIG. 3

DIRECTION OF ROTATION

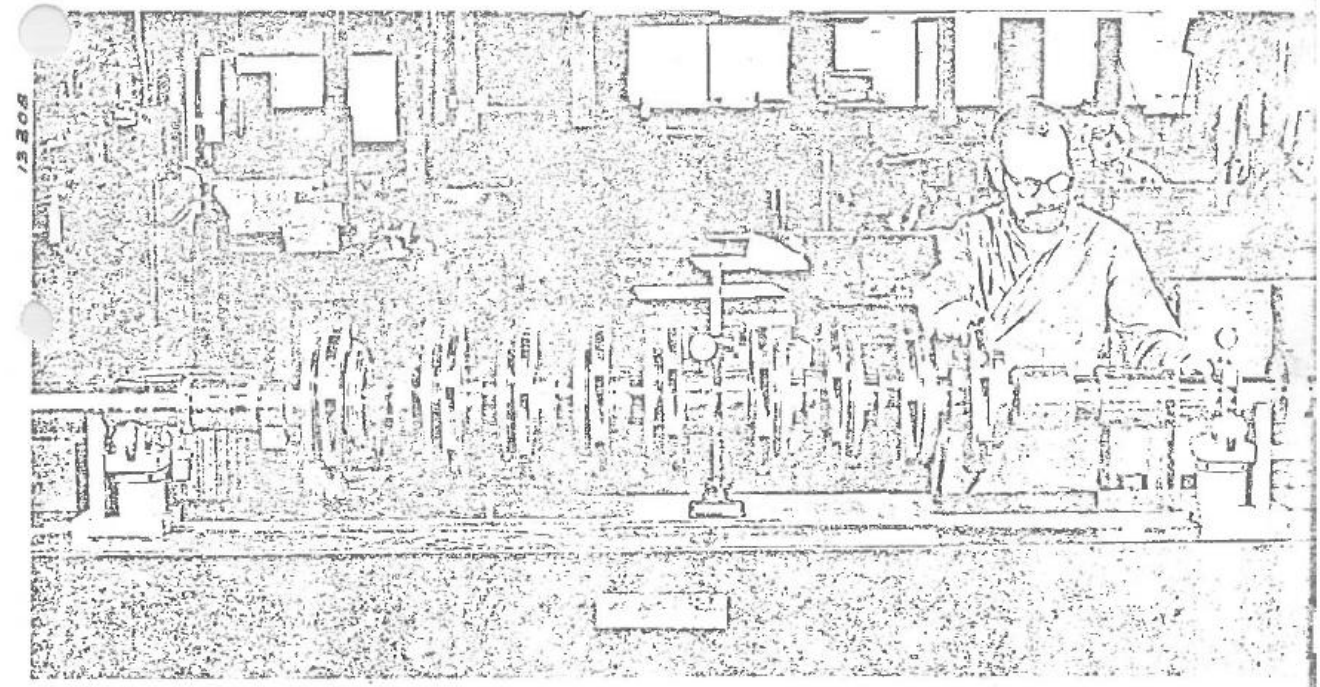

FIG. 4

CHECK OF CONCENTRICITY

C O U P L I N G S

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3.	Disassembly	C3

CI

COUPLINGS

1. GENERAL INTRODUCTION:

1.1 The flexible coupling types mostly used on Pacific Pumps' Products are: (a) Gear Type (FAST, ZURN, WALDRON, etc.) and (b) Disc Type (THOMAS, ZURN, METASTREAM, etc.). The coupling make, model and size used for your equipment is called out on the outline drawing.

1.2 Couplings may be furnished with or without spacers. A spacer type coupling next to pump is recommended, as it permits the pump half coupling and sealing components to be removed or installed without disturbing the position of pump or driver. See outline drawing (FC) for the distance between shaft ends.

1.3 Use of limited and float (LEF) couplings--(Fig. 1.) are required for most electric motors with sleeve bearings. The thrust bearings on the pump (or fluid drive etc.) will prevent the thrust collars on the motor shaft from touching the motor bearing faces. This will prevent overheating or damage to the motor bearings.

When Thomas or similar disc type flexible couplings are used, the coupling should be set to allow the motor rotor to operate at the position designated by the motor manufacturer. When fitting a half coupling to either a motor or a pump shaft, be sure the face of the coupling hub is flush with the end of the shaft.

Gear type couplings in limited end float service need additional restricting devices: for coupling without spacers the most common method is to attach a spacer button to the shaft of either driving or driven machine. For gear type couplings with spacers thrust plates are usually attached to the spacer.

2. INSTALLATION

2.1 Reasonable care in initial assembly and aligning permits couplings to operate to full capacity and still allow for slight future misalignments.

C2

2. INSTALLATION (COntinued)

2.2 To mount coupling on shaft:

a. Inspect shaft and hub bore, making sure they are free from burrs. Lubricate shaft surface with light oil.

b. Make sure the key fits the shaft and hub. Keyways are cut to give a tight fit on sides and clearance over or under the key. Insert key into shaft keyway. Check to see whether the coupling has parts which must be positioned with match marks before hub is mounted on shaft (i.e. coupling sleeve for gear type couplings), and make sure that these parts are positioned properly.

c. Coupling hubs are bored for a light interference fit. Expand the hub with heat: use a hot oil bath, soft open flame, or an oven at 300°F. Do not apply open flame to hub teeth and do not spot heat hub — install hub on shaft. Align end of coupling hub with end of shaft.

d. Taper bored hubs have an interference fit of approximately 0.0005 inch per inch of shaft diameter. This can be accomplished by heating hub to approximately 200°F and mounting on the shaft by applying pressure manually. Secure hub by tightening the shaft nut.

2.3 Alignment of pump and driver shall be made with the coupling halves mounted---see corresponding pump installation section for alignment instructions. Recheck alignment after all foundation bolts and mechanical connections are tightened.

2.4 Final assembly of coupling: (a) make sure that all gaskets and "O" rings are fitted properly. (b) Insert spacer, if furnished; center member for disc type couplings. (c) Insert and tighten the bolts, lockwashers and nuts provided.

2.5 Dynamically balanced couplings must be assembled with parts in the same relative position as furnished. When parts are match-marked, special care shall be taken to fit parts as marked.

2. INSTALLATION (Continued)

2.6 Lubrication is required for gear type couplings. Generally, for applications with ambient temperatures below 150°F, grease or oil may be used. Lubricant should be checked at approximately six (6) month intervals for the average industrial application.

2.7 Make sure that coupling guard is mounted and fastened before starting the equipment.

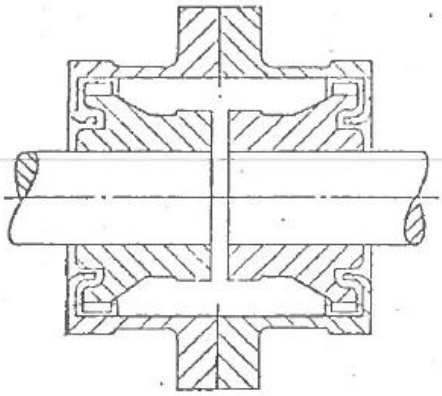
CAUTION: All rotating shafts and couplings are potentially dangerous and must be properly guarded.

3. DISASSEMBLY:

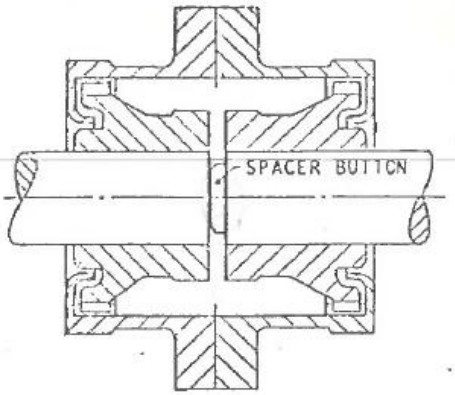
3.1 Remove spacer (if furnished) by removing nuts, washers, lock-washers, bolts, as applicable.

3.2 Remove coupling halves from shafts by using pulling tools. It may be necessary to use heat for removal. Apply heat evenly for 5-10 minutes to the outside of the hub with a soft flame torch. Do not apply open flame to the hub teeth.

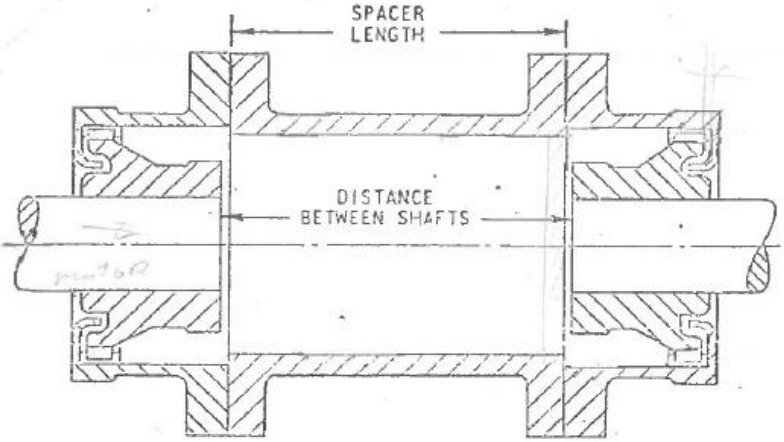
C4



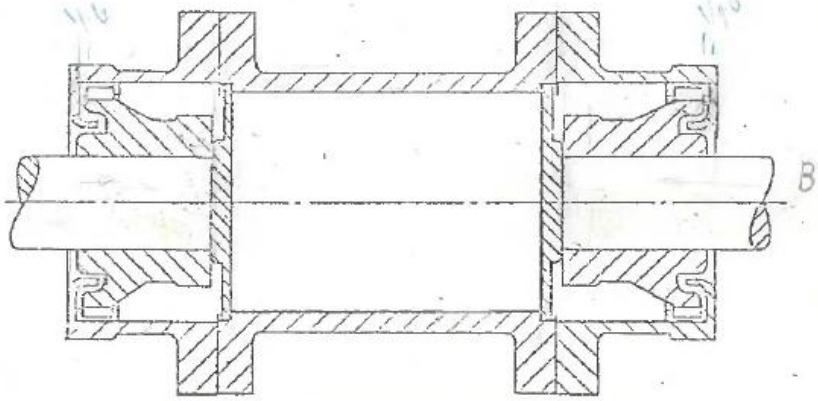
COUPLING WITHOUT SPACER



LIMITED END FLOAT COUPLING



COUPLING WITH STANDARD SPACER



COUPLING WITH LIMITED END FLOAT SPACER

FIG 1

TYPICAL GEAR TYPE
GOUPLINGS

RADIAL BEARING

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2.	Inspection and Replacement	D1
3.	Reassembly	D2

D

RADIAL SLEEVE BEARINGS WITH PRESSURE LUBRICATION

1. DIASSEMBLY:

Note: Coupling has to be removed prior to dismantling the Radial Sleeve Bearing – see coupling section in this Manual.

1.1 Disconnect lube oil inlet and return lines.

1.2 Loosen setscrew holding deflector ring (7) and slide the deflector ring back, away from bearing housing (13).

1.3 Unbolt parting flange capscrews and lift off top half bearing housing (13) with top half stationary oil baffles (48) and (552).

1.4 Lift off top half sleeve bearing (63).

1.5 When necessary, remove taper pins and nuts, then pull off bottom half bearing housing (13) with bottom halves of stationary oil baffles (48) and (552), and sleeve bearing (63).

1.6 Slide deflector ring (7) off pump shaft (1).

2. INSPECTION & REPLACEMENT:

2.1 Inspect parts for wear and damage and replace if necessary.

2.2 Recondition bearing sleeves (63) by removing with a scraper any surface imperfections on the babbited faces.

2.3 Bearing sleeves (63) should be replaced when worn beyond the following limits:

D2

2. INSPECTION & REPLACEMENT (Continued)

2.3 (Continued)

Shaft (1) Dia.	Normal Dia. Clearance	Recommended Max. Operating Clear.
1.000 - 1.500	.0030 - .0045	.006
1.500 - 1.750	.0035 - .0050	.007
1.750 - 3.000	.0040 - .0055	.008
3.000 - 4.000	.0050 - .0070	.010
4.000 - 5.000	.0060 - .0080	.012
5.000 - 6.000	.0070 - .0090	.014
6.000 - 7.000	.0080 - .0100	.016
7.000 - 8.000	.0090 - .0110	.018

2.4 Replacement bearing sleeves (63) are supplied without Dowel holes for locking the sleeves in place. The holes must be drilled at assembly, using the holes provided in the top half bearing housing (13) as guide.

2.5 The holes for temperature probes — if furnished — must be drilled at assembly. Use the existing holes in bearing housing (13) as guide and see the drilling drawing in this manual for drill size and depth.

3. REASSEMBLY

3.1 Always oil all bearing and mating surfaces just prior to assembly, being very careful to keep surfaces clean of all foreign particles, such as dust, scale and lint, to prevent damage to bearing surfaces.

3.2 Slide deflector ring (7) over pump shaft (1) against the first obstruction (sealing component). Do not tighten the setscrews.

D3

3. REASSEMBLY: (Continued)

3.3 Install (if previously removed) bottom half of bearing housing (13) with lower half of stationary oil baffle (48 and 552) in place. Line up taper pin holes in bearing housing flange with holes in pump drip pocket flange. Install taper pins and tighten nuts firmly (approximately 50 Ft. Lb. Wrench torque).

3.4 Install bottom half of bearing sleeve (63) by rotating around pump shaft (1) into housing (13).

3.5 Install dowels for positioning of sleeve halves, place top half of bearing sleeve (63) into position and insert dowel on top of bearing sleeve (63).

3.6 Place top half of oil baffle (48 and 552) into position.

3.7 Insert dowel at each end into top half of bearing housing (13), for holding oil baffles (48 and 552), and install a 1/64" asbestos parting flange gasket. Bolt bearing housing (13) lower and upper halves together.

3.8 Slide deflector ring (7) into position and tighten the set screw. Maintain 1/32" to 1/16" clearance between deflector ring (7) and bearing housing (13).

3.9 Connect lube oil piping to bearing housing (13).

THRUST BEARING

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EI

THRUST BEARING
WITH PRESSURE LUBRICATION
BASE MOUNTED OIL RESERVOIR

1. DISASSEMBLY:

1.1 Disconnect lube oil piping connected to bearing housing (62) and gear pump housing (91). Oil piping connected to reservoir need not be disconnected. Remove the cover of oil reservoir and disconnect the oil suction and discharge lines from gear pump housing (91). Remove all instruments from bearing housing (61) including thermometer (547).

1.2 Loosen setscrews holding oil reservoir cover plate (320) to gear pump housing (91).

1.3 Unbolt capscrews holding gear pump housing (91) to end cover (61) and slide gear pump assembly (Part No's. 91, 93, 99, 100, 101, 102, 103, 173, 205, 206) down and out of end cover (61).

1.4 Disconnect end cover (61) by unbolting the cap screws holding end cover (61) to bearing housing (62).

1.5 Remove oil reservoir cover plate (320) with seal ring (672) and oil reservoir cover gasket (673).

1.6 Dismantle lube oil gear pump assembly:

a. Unfasten locknut and washer (173) and slide worm gear 103, worm gear thrust collar (93) and worm gear key (205) from gear pump shaft (99).

b. Unbolt capscrews and remove gear pump cover (102), pump gear (100), gear pump shaft (99); pump gear key (101) and idler gear and shaft (206).

1.7 Unfasten locknut and washer (95) and remove worm (96) and worm key (94) from pump shaft (1).

1.8 Loosen setscrew holding deflector ring (7) and slide the deflector ring back from bearing housing (62).

E2

1. DISASSEMBLY (Continued)

1.9 Unbolt parting flange capscrews and lift off top half bearing housing (62) with top half stationary oil baffle (48).

1.10 Slide outer retainer plate (326) with, if provided, seal ring (674), retainer (49) and oil seal ring (55) from pump shaft (1).

1.11 Remove outer kingsbury bearing assembly (54). Unbolt socket head capscrew and unscrew thrust nut (59). Slide thrust collar (57) and thrust collar spacer (76) from shaft (1) and remove thrust collar key (309). Slide inner kingsbury bearing assembly (54) and inner retainer plate (89) from shaft.

1.12 Lift off top half sleeve bearing (51). Roll out lower half bearing sleeve (51). Slight upward force on the shaft may be necessary to roll bearing.

1.13 Remove taper pins and nuts, then pull off bottom half bearing housing (62) with bottom halves of stationary oil baffle (48).

NOTE: In most cases it will not be necessary to remove the bottom half bearing housing.

1.14 Slide deflector ring (7) off pump shaft (1).

2. INSPECTION AND REPLACEMENT

2.1 Inspect parts for wear and damage and replace if necessary.

2.2 Recondition bearing sleeve (51) and kingsbury shoes (54) by removing with a scraper any surface imperfections on the babbited faces. Recondition thrust collar (57) by removing slight imperfections or rust on collar surfaces with a fine oil stone. Grossly scratched bearing surfaces on the thrust collar will require part replacement.

E3

2. INSPECTION AND REPLACEMENT (Continued)

2.3 Bearing sleeves (51) should be replaced when worn beyond the following limits.

Shaft (1) Dia.	Normal Dia. Clearance	Recommended Max. Operating Clear.
1.000 - 1.500	.0030 - .0045	.006
	0,07 0,11	0,15
1.500 - 1.750	.0035 - .0050	.007
		0,17
1.750 - 3.000	.0040 - .0055	.008
		0,20
3.000 - 4.000	.0050 - .0070	.010
		0,25
4.000 - 5.000	.0060 - .0080	.012
		0,30
5.000 - 6.000	.0070 - .0090	.014
		0,35
6.000 - 7.000	.0080 - .0100	.016
		0,40
7.000 - 8.000	.0090 - .0110	.018
		0,45

2.4 Replacement bearing sleeves (51) are supplied without dowel holes for locking the sleeves in place. The holes must be drilled at assembly, using the holes provided in the top half bearing housing (13) as a guide.

2.5 The holes for temperature probes — if furnished — must be drilled at assembly, use the existing holes in bearing housing (62) as a guide and the drilling drawing in this manual for drill size and depth.

2.6 Kingsbury shoes (54) shall be replaced when worn.

3. REASSEMBLY:

3.1 Always oil all bearing and mating surfaces just prior to assembly, being very careful to keep surfaces clean of all foreign particles, such as dust, scale and lint, to prevent damage to bearing surfaces.

3.2 Slide deflector ring (7) over pump shaft (1) against the first obstruction (sealing component). Do not tighten the setscrew.

E4

3. REASSEMBLY (Continued)

3.3 If lower half of thrust bearing housing (62) was removed install with bottom half of stationary oil baffle (48) in place. Line up taper pin holes in bearing housing flange with holes in pump drip pocket flange. Install taper pins and tighten nuts firmly. (Approximately 50 Ft. Lb. wrench torque).

3.4 Install bottom half of bearing sleeve (51) by rotating around pump shaft (1) into housing (62). Install dowels for positioning of sleeve halves, place top half of sleeve bearing (51) into position and insert dowel at top of bearing sleeve (51).

3.5 Slide on inner retainer plate (89) and inner Kingsbury bearing assembly (54). Slide on thrust collar spacer (76). Install thrust collar key (309). Slide on thrust collar (57). Fit thrust nut (59) firmly. Align hole in thrust nut (59) with hole in thrust collar (57) and fasten socket head capscrew. This should be a snug fit.

NOTE: The thrust collar must be square with the pump shaft. Maximum total indicator reading should be 0.002 inches when rotating shaft.

3.6 Slide on outer Kingsbury bearing assembly (54) and outer retainer plate (326) with, if provided, seal ring (674), retainer (49) and oil seal ring (55) installed.

3.7 Insert worm key (94) into pump shaft (1), slide on worm (96) and secure with worm locknut and washer (95).

3.8 All thrust bearings require axial end play to allow for oil film expansion. Normal end play is established at the factory and should not require any adjustment. However, if damage has occurred or a worn condition is suspected it should be measured prior to installing the top half of the thrust bearing housing.

3. REASSEMBLY (Continued)

3.8

a. With the end cover (61) assembled, the bearing end play can be measured with a dial indicator placed against the coupling end of the shaft (1). Before measuring loosen set screws and move deflector rings away from thrust and radial gearing housing. Push the shaft firmly one way against the thrust bearing and note the indicator reading. The difference between the two readings should be within the following limits.

Outside Diameter of Thrust Collar	Limits of Axial Shaft Play – Inches Min.	Max.
5	0.009	0.013
127.00	0,22	0,33
6	0.010	0.014
152.40	0,25	0,35
7	0.011	0.015
177,80	0,27	0,38
8	0.012	0.016
203.20	0,30 →	0,40

b. When the bearing end play is greater than that shown in above table, the end cover gasket has to be replaced with an appropriately thinner gasket. Repeat paragraph 3.8(a) above. Minimum compressed gasket thickness should not be less than 0.005 inch. If proper end play cannot be obtained in this manner, then proceed with the following.

c. Remove the end cover (61) and remachine the end cover rim (gasket surface) by turning it down equivalent to the amount of excessive end play.

d. When the bearing end play is less than the above limits, the parting flange gasket has to be replaced with an appropriately thicker gasket. Repeat paragraph 3.8(a) above. Maximum compressed gasket thickness should not exceed 0.031 inch. If proper end play cannot be obtained in this manner, then proceed as follows.

e. Remove the end cover (61) and remachine the end cover surface (area contacting retainer plate) (326) by turning it down sufficiently to give the proper end play.

3. REASSEMBLY (COntinued)

3. 8

f. After the proper end play has been established, remove the end cover (61).

3. 9 Place top half of oil baffle (48) into position. Insert dowel into top half of bearing housing (62), for holding oil baffle (48) and install a 1/64" asbestos parting flange gasket. Bolt bearing housing (62) lower and upper halves together.

3.10 The lube oil gear pump should be built up as a separate assembly unit: Install gear pump shaft (99) and worm gear thrust collar (93) into gear pump housing (99); slide worm (96) on gear pump shaft (99) and secure with gear locknut and washer (173); install pump gear key (101) into gear pump shaft (99) and slide on pump gear (100); slide in idler gear and shaft assembly (206) and bolt on gear pump cover (102).

3.11 Place assembled gear pump unit into oil reservoir resting at bottom of reservoir. Position oil reservoir cover gasket (673) and oil reservoir cover plate (320) with oil reservoir cover seal ring (672). Place gasket on mating surface of gear pump housing (91) to end cover (61).

3.12 Bolt on end cover (61) with flange gasket in place. Raise assembled gear pump unit (3.11 above) into place, being careful to easily mesh worm gear (103) with worm (96). Bolt gear pump housing (91) to end cover (61).

3.13 Position oil reservoir cover gasket (673), slide oil reservoir cover plate (320) with oil reservoir cover seal ring (672) into position and secure cover plate (320) with setscrews to gear pump housing (61).

3.14 Slide thrust end deflector ring (7) into position and tighten the setscrew. Maintain 1/32" to 1/16" clearance between deflector ring (7) and bearing housing (62).

E7

3. REASSEMBLY (Continued)

3.15 Connect oil suction and discharge lines to gear pump housing (91); and close the maintenance opening in oil reservoir by securing cover and gasket with machine screws.

3.16 Connect oil piping to thrust bearing housing (62) and mount thermometer (547) and all other instruments furnished.

MECHANICAL SEALS

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2. INSPECTION AND REPLACEMENT F3
3. REASSEMBLY F4

F1

MECHANICAL SEALS

WITH FOLLOWING CONSTRUCTION FEATURES:

(a) Seal: Cartridge type with piggy-back pumping ring.

(b) Shaft sleeve sealing: "O" Ring with compression nut.

(c) Adaption to case: - SEAL housing.

(PP Ref: Form C17271)

1. DISASSEMBLY:

NOTE: Coupling and bearings have to be removed prior to disassembly of mechanical seals.
For instructions see appropriate sections in this Manual.

1.1 Pumps are shipped with mechanical seals installed. See assembly drawings as called out in manual index.

1.2 Loosen the retainer plate (G009) locking cap screws and turn retainer plate (G009) into groove in seal shaft sleeve (G012). (= same as "setting position"). Tighten the locking capscrew.

1.3 Remove the cup point socket head setscrews from compression nut (G014 or G016) and using a pin or adjustable hook spanner unscrew compression nut (G014 or G016) and remove from pump shaft.

1.4 Remove the socket head capscrews from seal plate (G004) and pull the assembly consisting of: mechanical seal; seal plate (G004); seal shaft sleeve (G012); seal plate gasket (G006); seal seat dowel (G011); shaft sleeve gasket (G013); seal key (G017) and retainer plate (G009) from pump shaft.

F2

1.5 Take the assembly (as called out per 1.4 above) to a clean work area. Special care should be exercised when disassembling seals to insure that seal seat and seal washer, (see Seal Manufacturers Assembly Drawing for identification), do not become scratched, marred or otherwise damaged.

1.6 Loosen the retainer plate (G009) locking capscrew and disengage retainer plate (G009) from seal shaft sleeve (G012).

1.7 Remove from seal plate (G004) the Seal shaft sleeve (G012) with mechanical seal rotating assembly. The Seal Plate Gasket (G006), mechanical seal stationary seat and seat sealing ring and Seal seat dowel (G011) is press-fit into seal plate (G006) and need not be removed unless damaged.

1.8 See mechanical seal manufacturer's assembly drawing for reference. Slide the mechanical seal rotating assembly from seal shaft sleeve (G012). Remove seal key(s) (G017) and shaft sleeve gasket (G013).

1.9 Some types of mechanical seals have the springs, sealing devices and washer locked by a snap ring in the retainer as a separate assembly. For minor overhaul and inspection, it is not necessary to dismantle the separate retainer assembly if the seal washer is in satisfactory condition. If dismantling is required, see seal manufacturer's assembly drawing for parts identification and proceed as follows: Remove pressure on the snap ring by applying hand pressure to the face of the seal washer.

F3

With a small screwdriver, pry snap ring out of the groove in retainer. Remove snap ring and slowly release pressure on the seal washer. Remove washer from retainer and disengage the washer sealing and back-up rings. Remove spring disc and spring(s) from retainer.

1.10 It is not necessary to remove the seal housings, B001 and B002 for mechanical seal inspections. When pump case disassembly is required, the seal housings (B001 and B002) must be dismantled: - Disconnect piping and remove socket head cap-screws from seal housing. Remove seal housings (B001 and B002)and seal housing gaskets (B016).

1.11 Remove shaft sleeve key (G018) by removing the flat head machine screw and lifting shaft sleeve key (G018) from its keyseat.

2. INSPECTION AND REPLACEMENT:

2.1 Clean all parts thoroughly and inspect for wear and damage.

2.2 Carefully inspect the lapped faces of the seal faces. If any cracks, mars, scratches, or wear is visible, replace the damaged part.

2.3 Inspect all "O" rings, gaskets and packing rings. Frayed, cut, cracked or flattened rings must be replaced. It is a good policy always to replace all "O" rings, gaskets and packing rings when a pump which has been in service is reassembled.

F4

3. REASSEMBLY

NOTE: Special care should be exercised when reassembling seals, to insure that the seal faces do not become scratched, marred or damaged.

3.1 Insert shaft sleeve key (G018) into keyseat in pump shaft and secure with flat head machine screw.

3.2 Position the seal housing gasket (B016) and mount the seal housing (B001 and B002) at proper end of the pump case. Fasten with socket head capscrews. There is no stand-off between the pump case and seal housing faces.

3.3 Insert shaft sleeve gasket (G013) into seal shaft sleeve (G012) groove and place seal key(s) (G017) into keyseats--see seal manufacturer's assembly drawing for reference and lubrication instructions. Slide the mechanical seal rotating assembly on seal shaft sleeve (G012). Some mechanical seals have seal retainers and pre-assembly of rotating parts is required: --place retainer on end;--insert springs;--insert spring disc;--lubricate back-up and sealing rings and position in washer:--place washer assembly into retainer;--place snap ring over washer;--apply hand pressure on face of washer;--force compressed snap ring into groove in retainer;--release pressure on washer;--slide retainer assembly on shaft sleeve (G012).

3.4 Press-fit stationary seal face dowel (G011) into seal plate (G004). Lubricate and place the seal seat sealing ring and seal seat into seal plate (G004), be sure that the groove in the seal seat will fit on seal seat dowel (G011).

F5

Mount seal plate gasket (G006) and fasten retainer plate (G009) into operating position.

3.5 Wipe the lapped sealing faces of the seal seat and washer perfectly clean, then oil both faces with clean light oil.

3.6 Insert "Shaft sleeve assembly", as prepared per 3.3, into seal plate (G004) assembly, as prepared in 3.4. Apply slight hand pressure to shaft sleeve (G012) until retainer plate groove in shaft sleeve (G012) is beyond outer edge of seal plate (G004). Engage retainer plate (G009) into the groove in shaft sleeve (G012) and lock into position by tightening the cap screw.

3.7 Fill the pump shaft threads with grease and slide "Seal plate assembly, as prepared per 3.6, on pump shaft and center into Seal Housing (B001 or B002). Be sure that the shaft sleeve (G012) keyway will slide over shaft sleeve key (G018). Fasten seal plate (G004) to seal housing (B001 or B002) with socket head cap screws. There should be no stand-off between gasket faces.

3.8 Clean pump shaft threads from excessive grease and screw compression nut (G014 or G016) on pump shaft; stop when compression nut (G014 or G016) slightly touches the outside end of seal shaft sleeve (G012), fasten the compression nut (G014 or G016) with cup point socket head capscrews to seal shaft sleeve (G012).

F6

3.9 Loosen the socket head capscrew; disengage retainer plate (G009) from the groove in seal shaft sleeve (G012); rotate retainer plate (G009) 180° into "operating position" and tighten the socket head capscrew.