JUSTIFYING THE REINSTALLATION AND UPGRADING OF PROBLEM ANSI PUMPS AT AN OPERATING CHEMICAL PLANT

by

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ABSTRACT

Many facilities do not obtain the expected life out of ANSI and other centrifugal pumps, seals, and bearings that need to be obtained to be competitive in today's market place. The analysis of this situation leads to two industry wide flaws. The first problem is that many of the pumps were never initially installed correctly. This shortcut on the initial installation leads to a lifetime of high and unnecessary maintenance costs, along with the process leaks, excess emissions, and wasted man-hours spent on fighting a losing battle. And a lifetime is accurate, as some centrifugal pumps have been in service for over 33 years. Once a pump is misinstalled, it is very difficult to get approval to spend the time, effort, and dollars to reinstall a pump that is already operating, albeit at a high maintenance cost. Production will most always take precedence. With typical chemical plants operating over 330 days a year, time is limited for such "unimportant" projects as pump reinstallation. This is why correctly installing an ANSI, or any pump, initially is so critical to troublefree operation.

The second flaw is that many of the mechanical seals are operating in stuffing boxes designed for packing. The new technology in current ANSI pumps designed to operate using mechanical seals is worth the conversion cost. End users need to know the benefits of the new seal chambers on the market. It is documented that converting to the four degree taper seal chamber alone has increased seal life three fold on specific applications.

Enacting a solution to poor pump installations is a long and tedious mission, but one that can be accomplished. It does require using sound engineering principals to justify the costs needed to remedy the problem. A user might need to test

principles that other end users already take for common practice. The twelve steps that were used to justify the reinstallation and upgrading of current problem pumps are reviewed herein. Several of the steps are worked on simultaneously.

KNOW YOUR CURRENT SITUATION

Before any project can be implemented, there must be enough data to justify the cost of the solution. For this justification, the most important data are the pump maintenance costs and the number of repairs made per year per pump. For this study, maintenance costs include a detailed list of repair parts and labor man-hours for each repair made to each pump. These data are tracked on a yearly basis. The number of repairs per year is how many times in the past year that work was performed on the pump. Combining these data will give the maintenance engineer the cost per repair per pump per year. It will also list what specific repair parts were used on each repair. This is important, because many small dollar repairs might indicate that only a minor adjustment is needed. A few high dollar repairs may indicate a more serious problem. By knowing what specific part failed, and was reinstalled during each repair, one can more quickly determine the root cause of the failure.

There are two main ways to track this information; manual or computerized. The scope of this presentation is not to advise on the type of maintenance management system used, but to stress the importance of collecting accurate information. Any solution will only be as good as the data that was gathered. Companies must decide which is best for their own situation. If the number of pumps is small, a manual system can work. For a larger number of pumps, a computerized system is a must. The important point is that the system keeps accurate information on the repair parts used, the man-hours consumed, and the number of repairs done. For this study, a computerized maintenance system is in place and there are five years of maintenance data for the 850 pumps on site. It was obvious at the beginning of the study that over 1,100 repairs and $638,000/year was excessive and needed to be addressed.

ANALYZE CURRENT SITUATION

The analysis of accurate data is the most critical aspect, if the plan of attack is to be correct in solving the problem. As a benchmark, the computerized maintenance system data of a plant wide mean time between failure (MTBF) average of about nine months for all pumps was much too low. The initial goal was to achieve a two year MTBF for the entire pump population in this study.

Additional field data were acquired to compliment the maintenance history data, and to try to find a common link for the short pump life that was seen. The main areas that were investigated were conditions that would hasten mechanical wear, such as cavitation, running off curve, insufficient $NPSH_R$, pipe strain, grouting, and misalignment. Areas such as vibration or oil analysis were not looked into at this time, because there was no

reference history data. The existence of repair history in the computer did allow investigation into previous repairs. The results indicated that many of the pumps had common problems that were related to the installation. This was obvious by visual inspection of many of the pumps. Removal of some other pumps also proved the point. Such causes were excessive pipe strain, pump motor misalignment, and lack of proper grouting or bases.

Another important point that came out of the analysis was that the mechanics were not doing enough field analysis. Most work orders simply state an end result, such as: the mechanical seal is leaking since the mechanical seal is the weak link in the pump system. It will usually be the first item to fail when adverse conditions related to poor installation or operation are present. But usually, seal failures are not the root cause of the problem. When one of the area foremen went on several repairs and did a more indepth field analysis, other problems became obvious. On many occasions, excessive radial play (up to 0.125 in on one instance) of the motor shaft was the root cause of the seal failure. Other problems were loose hold down bolts, the possibility of being submersed during heavy rains, old technology, lack of proper instrumentation, poor accessibility, and general deterioration, as many of the pump stations were installed over 20 years ago. Being hard to access may not appear to be inducive to poor pump life. However, the quality of work is directly related to the work environment. If a mechanic has a problem getting to a pump and is hindered by the surroundings, the quality of his work may not be as high as it would be on a pump that is easy to access and work on.

FORMULATE PLAN

From the above analysis, it became necessary to address the installations of the pumps. This was attacked in two steps. The first step was to put an end to misinstalling any new pump stations. This would put an end to future pump problems related to installation. A pump installation procedure was formulated for ANSI and other horizontal pumps using past experience, OEM manuals, and problem solving techniques. The second step was adapting the procedure to the current pumps that were misinstalled, and reinstalling them to the new standard. This required justifying the addition of man power, tools, products, and needed equipment to do the reinstallations.

Specific items addressed in the installation procedure were proper pump pad, number of pumps per pad, pad location for ease of maintenance, pump connectors/pipe strain, hold down bolts, grouting, alignment, and immediate piping to and from the pump (APPENDIX 1).

The analysis also indicated a need to address an upgrade in the pump technology and the need to consolidate the variety of pumps used at the plant. Seal chambers (vs stuffing boxes) were coming on the market, and were of interest. It was long overdue that the stuffing boxes be replaced by properly designed seal chambers. Also, other items, such as the enclosed bearing housing would be beneficial at a locality with the majority of pumps being located outside. These items were being addressed in conjunction with the installation procedures (APPENDIX 2). A separate installation procedure and consolidation plan was written for vertical pumps but is not covered herein.

INITIATE TRIAL

Before the installation procedure was presented to the engineering standards committee for acceptance, it needed to be tested to ensure that it was cost effective and would work as planned. Two sets of pumps were chosen to be reinstalled to test the new procedure. These pumps had about average maintenance cost and number of repairs, but were available for reinstallation. During a one week shutdown, the four pumps were reinstalled,

using the new procedure. No new maintenance, operational procedures, or technologies were enacted, as not to bias the test. The reinstallation had only the week of the shut down to be completed, and was completed on time. The reinstallation followed the criteria listed in APPENDIX 1. Having the reinstallation competed on time did not a indicate a successful reinstallation. A reduction in maintenance costs and number of repairs would be the true measure for success, and as it turned out, this was a successful reinstallation. Maintenance costs and number of repairs for the four pumps are contained in Table 1 for the three years before the reinstallation, and for the three years after. One point that is not listed that will be one of the measures of future success is a reduction in vibration levels. Although no vibration data were gathered on these four pumps, people familiar with the pumps stated that the pumps operated much more smoothly than before. From this reinstallation, only one minor modification was made to the procedure. This had to do with the four hold down bolts per pump that were used. The way the hold down bolts were installed caused a problem when a prefabbed suction header was installed. One set of the hold down bolts were inadvertently placed about one half in forward of the other set on one pair of pumps. This caused the header to need modifications to fit correctly. This problem was corrected by either fabricating a bracket that was true and held all eight hold down bolts, or ensuring that all bolts were true before pouring the cement or epoxy.

Table 1. Before and After Cost and Repair Frequency of First Four Pumps Reinstalled.

In April of 1990, the following pumps were modified to test the then unpublished installation standard. Their costs and repair frequencies are as follows:

PUMP COSTS	1988	1989	1990	1991	1992	1993
Pump 01	323	740	5697	0	102	102
Pump 02	2135	2052	4412	0	79	1562
Pump 03	716	3546	9979	88	480	284
Pump 04	976	3624	12270	211	0	0
TOTAL	4150	9962	32358	299	661	1948
PUMP REPAIRS	1988	1989	1990	1991	1992	1993
Pump 01	4	1	4	0	1	3
Pump 02	4	3	5	0	1	1
Pump 03	1	3	9	1	1	4
Pump 04	2	4	9	2	0	1
TOTAL	11	11	27	3	3	9

The Goal of the Maintenance Department, through the Proper Pump Installation and Maintenance, is to Receive Two Years of Operations from the Pumps before Maintenance is Needed. The above illustration show that by only reinstalling the pump correctly, and not changing operations, maintenance, or technology, this is achievable. Total costs for the three years before vs the three years after is $46,470 vs $2908, a 94 percent reduction in costs. The repair frequency went form 49 repairs to 15, a reduction of 69 percent. The user would expect similar figures from the reinstallation of other problem pump sites.

SET UP STANDARD AND
USE ON NEW INSTALLATIONS

The finalized procedure was then submitted to the engineering standards committee and accepted as an engineering standard. This was very important, because as a standard, it put an end to poor installations from this point in time forward. As new pumps sites are installed, they are now being installed properly. Attention could now be aimed at step two of the plan; reinstalling the existing poorly installed pumps.

As the installation standard is accepted, it is important to have the new items now needed in stores. These would include, but not be limited to, pump connectors, welded fittings, grout,

alignment kits, and updated pump parts, i.e., seal chambers, bearing isolators, sleeveless shafts, and updated glands.

TRAIN AND COMMUNICATE TO WORK FORCE AND OTHERS

This is an important step throughout the entire process. It is listed at this point, because this is where many changes start to occur. All new pumps sites are now installed in a different manner. Proper pump pads need to be poured. Pump connectors or proper piping that eliminates stress needs to be installed. Proper suction piping needs to be addressed. Gauges are now required on the pump. Steam purges are added on several sites, using a different type of steam reducing valves that proved to be very reliable. It is critical that the work force be trained either formally or informally, and be able to do the installation correctly, both physically, and in planning new sites. Included in the work force to be trained are corporate engineering, plant engineering, maintenance workers, purchasing, and outside contractors. Also, with new pump technology now at hand, the work force needs to be informed and trained in these areas. Several questions will arise on the taper bore seal chamber, and why it is now being used, and what are it's benefits. New types of bearing guards (oil seals) are being used. The bulb type constant level oilers are being phased out and "bull's eyes" and/or column sight gauges are being phased in. Sealed bearings are being tried in certain test areas. Several brands of pumps are being phased out, and some new brands are being added. Mechanics will feel uncomfortable working on the new pump brands for the first time. New master bills of materials are being formulated for the new pumps, and the current pumps bills of material are being updated.

Along with the training of inhouse personnel, the vendors also need to be updated on the new standards. Having standardized on the four degree taper bore seal chamber at such an early time frame, many of the pump OEMs did not stock the part. Because the bulb type oiler hole is in a different location than where the bull's eye sight glass is located, additional bearing housings need to be stocked. New glands need to be purchased because of the different gland bolt circle diameter. The case discharge tap was usually an option, and now needs to be added on all orders. All of these features also need to be applied to the spare part inventory as well as the pump assemblies. Letters will need to be sent to all of the pump OEMs, mechanical seal manufactures, and the associated distributors, stating the new standards that are now to be applied to the company, and what additional stocking would need to be done by the distributors.

CONTINUE REFINEMENTS

This is another step that is used throughout the entire process. Because new pump sites are being added throughout the plant that are not being directly supervised by the originator of the standard, a better view of the mistakes that are prone to happen is more clearly observed. One of the more obvious errors encountered on several of the new installations was that grouting was not being done correctly. This problem was addressed, and corrected. The other aspects of the standard were being followed, and needed little attention or modification at this time. On the pump standardizing side, only one error was noticed up to this point. By going to the new bearing guards, on oversight was made by not realizing that one of the pump brands required different shafts. This was detected on our repair analysis that caught several failures being caused by a lack of oil. This problem was addressed and corrected. Procedures continue to be refined as needed. One main refinement that was made before step two of the plan was fully enacted was adding the option of using epoxy for the entire pump pad. This saves time on reinstal-

lations, and eliminate the cost of coating the pads with a chemical resistant coating. The initial cost is slightly higher, but results in a better product in the long run. Continuing checks are made to see if the current pump vendors are living up to expectations. A main check on this is internal complaints, such as missed delivery dates, high prices, or poor service. The author looks at other vendors' auxiliary parts (bases, couplings, etc.) that they feel are superior and would be beneficial. Keeping in contact with the pump manufactures and vendors helps keep communication open. Users continue to look at ways to improve the entire installation. This process is not static and requires continual refinements.

MAINTAIN DATA

One of the many reports that can be produced from the computerized maintenance system is a plant pump report. This report lists every pump at the facility by each plant, starting with the highest maintenance dollar pump for the prior year for that plant. Also listed are the associated costs for the next previous year, and the current year-to-date costs. The number of repairs for each pump is also listed for each year. An illustration is shown in Table 2. A plant pump report is run about two times a year, but it can be run at any time. It keeps track of what pumps are still problems, and how the plant as a whole is doing. A surprising number on the first four pumps reinstalled is that, without changing operations, maintenance, or technology, total costs for the three years before *vs* the three years after the reinstallation is $46,470 *vs* $2908, *a 94 percent reduction in costs*. The repair frequency for the same three year period went form 49 repairs to 15, *a reduction of 69 percent*, (Table 1). These are hard data that took six years to obtain and were used for justification of additional man power and tools for further reinstallations of existing problem pumps. It is expected to see similar figures from the reinstallation of other problem pump sites, as shown in Table 3.

Table 2. Typical Example of an Annual Pump Report.

Plant 01		1992	1993	1994
Pump Name	Equip.#	Repairs/ $	Repairs/ $	Repairs/ $
Top Still Pump B	21222	06 / 8,887	03 / 1,765	00 / 00
Bottom Still Pump A	21666	00 / 00	01 / 1,733	00 / 00
Middle Reflux Pump B	21555	02 / 1,350	02 / 1,686	00 / 00
Spare Spray Pump	21888	01 / 80	01 / 1,562	00 / 00
Top Still Pump A	21777	07 / 4,242	02 / 1,554	02 / 106
East Make-up Feed A	21111	00 / 00	02 / 1,539	01 / 53
West Make-up Feed B	21999	02 / 1,095	05 / 1,534	01 / 648
Top Still Pump A	21333	00 / 00	01 / 1,438	01 / 388
East Make-up Feed B	21444	01 / 561	02 / 1,360	00 / 00
Plant Totals	Total Pumps	1992 Repairs/ $	1993 Repairs/ $	1994 Repairs/ $
	09	19/16,215	19,14,171	05/1195

ANALYZE PUMP TECHNOLOGY

As stated earlier, not only was the pump installation studied, but also the pump technology, and a reduction of pump vendors. During this same time period, work was progressing on upgrading the technology of the pumps and reducing the number of brands of pumps in the plant. Points that were looked at were the amount of each brand of pump currently onsite, vender's past reliability, cost, OEM location, and new brands that would benefit the company. Having nine brands of ANSI pumps onsite, it was manageable reducing that number to three. It was standardized on what were felt were the best three brands of pumps for the production requirements. While standardizing on the pump brands, the company also standardized on pump features.

Table 3. Costs and Repair Frequency for Various Pumps.

REINSTALLED CORRECTLY IN MID 1993					
	1990	1991	1992	1993	07-94
Pump 05	6,930	975	1,879	6,252	53
Pump 06	2,288.	3,985	2,197	819	00
Pump 07	2,620	7,515	5,157	5,035	106
TOTAL COSTS	11,838	12,475	9,233	12,106	169

INITIALLY INSTALLED CORRECTLY					
Install date	1990	1991	1992	1993	07-94
Pump 08 (04-90) 00		00	00	00	00
Pump 09 (10-90) 00		00	00	00	00
Pump 10 (10-90) 00		00	00	00	1328
Pump 11 (10-88) 00		808	00	00	00
TOTAL COSTS 00		808	00	00	1328

ADDED NEW TECHNOLOGY -4 DEGREE TAPER BORE SEAL CHAMBER					
		repairs/dollars spent			
	1990	1991	1992	1993	08-94
Pump 12 (05-93) 1/793		2/2361	1/3213	2/2153	0/0
Pump 13 (05-90) 3/6484		3/159	4/2402	1/2	0/0
TOTALS	4/7277	5/2520	5/5615	3/2155	0/0

REPLACED BECAUSE ORIGINAL PUMPS WERE MISAPPLIED PUMP COSTS BEFORE REPLACEMENT					
	1990	1991	1992	06-93	TOT
Pump 14	3,142	18,723	11,649	30,363	63,877
Pump 15	.0.	8,934	28,710	32,896	70,540
TOTAL COSTS	3142	27,657	40,359	63,259	134,417

PUMP COSTS AFTER REPLACEMENT			
	07-93	1994	TOT
Pump 14	2,064	7,188	9,252*
Pump 15	0.0	2,383	2,383**
TOTAL COSTS	2,064	9,571	11,635

COST/REPAIR REDUCTION	
Pump 14	87.3%/83% TO DATE
Pump 15	96.7%/98% TO DATE

*$7658 of this cost was due to improper suction piping. This problem was corrected and there
has been no pump related problems since (about 230 hours operation).
**There was over 2100 hours of operation when an elastomer failed. The pump had 0 cost and
was still pumping, but was pulled for repair.

Most important of the features was the four degree taper bore seal chamber. Other items also included in the standardizing were sealed bearing housing, bulls eye sight glass, case and discharge tap, grout hole, and motor jacking bolts on the base, as stated in APPENDIX 2.

Another item addressed when standardizing the pumps was requiring the seal manufacturer (the plant is about 95 percent sole sourced) to make one seal gland fit all three pump lines. This took much communication between the seal manufacturer, the pump manufacturers, and the end user. It was worth all of the effort. For the three types of mechanical seals used per shaft size, there is now only one gland. The gland has flush, vent, and drain ports. The gland also fits all three brands of pumps that are now used. This allowed the phase out of about nine various glands from stores. It is also more convenient for the mechanics, as only one gland is needed per seal size. Changes needed to be made in the stationary seal face of some of the seals that did not fit the new gland.

PHASE-OUT-PHASE-IN

This phase-in period included several points, and it was important not to be wasteful. The new pumps were phased in in a variety of ways. First, on the brands of pumps that were to be eliminated, the repair parts from stores were phased out . This was done by changing the reorder point from the current level to purchase on-request. Purchase on-request kept the part number in the stores system, but no physical parts would be held on the shelf once all parts were consumed.. To order a part, a foreman would give the stores supervisor a work order number and have him order that part against the work order. This permitted parts that ran out early to be ordered if there were still a majority of other parts for the phased out pumps in stores. This allowed the elimination of most of the parts at the same time and caused the least waste. When most of the phased out pump parts were used up, the parts reorder points were changed from purchase on-request to delete-at-zero. Delete-at-zero means exactly that. When the number units on the shelf of that specific part reached zero, the part number would be deleted out of the system. When those parts were deleted from stores, and a repair came up for a phased out pump, the pump would simply be replaced. When other pumps that were not being phased out were removed from service, but were still in good condition, that pump would be cleaned and stored aside. If the removed pump fit a spot where a phased out pump was being replaced, it would be determined if it could replace the phased out pump, or if a new pump would be ordered. If it could replace the pump, it was rebuilt and put back into service. If possible, the new requirements listed AP-PENDIX 2 were added to the pump or base at this time. This allowed the pump to fit the new installation standard as closely as possible. This system worked well, and many removed pumps were reinstalled in service in locations where a pump brand was phased out.

STICK TO PLAN

At times it seemed difficult to stick to the plan. Occasionally there were grumblings from the mechanics about the new pumps. This was mainly because the new brands of pumps were alien to the workers. There always seemed to be one part that was overlooked when adding parts to stores. This would cause only minor delays in repairs as the three pump vendors were instructed to carry more repair parts on their shelves until adequate stores inventory was established. This was very helpful at times and the vendors were willing to assist in this matter. At times it was tempting to only buy a minor part on a pump that was to be phased out. Steps were taken to ensure that this did not happen. If it was allowed to continually happen, the overall plan would suffer, and the desired pumps would never be phased out. There is a point where one must take a short term loss to ensure progress and long term gains.

REINSTALL POOR INSTALLATION

Five years have gone by since the initial reinstallation of the first four pumps. About 14 other sites have also been reinstalled. Additional data have been gathered that show the significant savings that can be had by reinstalling problem pump installations. Also, significant seal life improvement has been seen by only changing the stuffing boxes to the four degree tapered seal chambers on various pumps. Costs listed in Table 3 are associated with various pumps that have been installed correctly from the start, reinstalled, have had updated technology added to them, and have been replaced because of being misapplied. These data are solid documentation of the important need of proper initial pump installation being present if extended pump life is to be had. Secondly, it shows the importance of maintaining the latest technology available for the pumps and seals that are used in today's industrial plants. It is fruitless to do preventative maintenance (PMs) on poorly installed pumps, or try different types or brands of pumps to resolve a problem, unless the pump is properly installed.

CONCLUSION

Maintenance has approached upper management with these data, and a justification letter was written for the addition of

maintenance personnel whose primary purpose will be to reinstall existing problem pumps. The letter was favorably accepted by upper management. Included in the letter was a list of 39 pumps that will take first precedence at being reinstalled. As time and availability permits other pumps will be reinstalled. An example of costs associated with this type of justification is listed in Table 4. Reinstalling the initial 39 pumps shows a pay back between 1.1 and 2.0 years, depending on the amount of cost reduction actually seen (1.1 years for 90 percent reduction, 2.0 years for 50 percent). The cost of reinstallation includes material, labor, benefits, cost of lost production, and auxiliary equipment needs. It also assumes that the total cost to reinstall the 39 pumps will be had in the first year. It does not include the purchase of new or different pumps, if needed, as they would be purchased anyway. The additional people have been hired.

Table 4. Cost Justification of Additional Manpower to Reinstall Poorly Installed Pumps.

COSTS		
Labor-		
2 Mechanics	$ 75,000/Year	
Tractor	8,000-One Time	
Pump Reinstallation 39 × 6545=	255,300-One Time @ 6545 increments	
Total Costs	369,740	

Potential Savings-assuming $255,300 lump sum cost for reinstallation
Current Pump Costs Being Reduced (39 Listed @ $160,093/Yr.)

A 50% Reduction	80,046/Year-4.6 Year Payback	
A 75% Reduction	120,069/Year-3.1 Year Payback	
A 90% Reduction	144,083/Year-2.6 Year Payback	
Reduce Loss Production Due to Pumps		
A 50% Reduction	113,071/Year-3.3 Year Payback	
A 75% Reduction	169,606/Year-2.2 Year Payback	
A 90% Reduction	203,528/Year-1.8 Year Payback	
Total Payback		
At 50% Reduction	1.9 Years	
At 75% Reduction	1.3 Years	
At 90% Reduction	1.1 Years	

Full Base-30" Deep-18" High-Per Station	$ 3000.00
Epoxy Grout	$ 500.00
Flex Hoses-Per Pump	$ 450.00
Valves-Per Pump	$ 700.00
New Pipe-Per Station	$ 500.00
Labor$ 1395.00	
Total per Pump	$ 6545.00

This process is in its infancy. After training and the addition of needed tools, reinstallation on a large scale will begin. Data will then be gathered to accurately determine the true pay back. Two measures will be used to rate the success of the program.

• Vibration readings will be taken before and after reinstallation. Reduction in vibration levels indicate a success mechanically. Then, vibrations readings will become the main tool to do PMs on the pumps. It is not cost effective to do the PMs on the pumps until the pumps are installed correctly.

• Pump repair quantity and maintenance cost before reinstallation compared to post-reinstallation will be used to measure cost savings. Reduction in quantity and cost indicates a success.

APPENDIX 1 — HORIZONTAL PUMP INSTALLATION PROCEDURE

Overview

To have a pump that will give long life with a low maintenance history, many factors need to be addressed such as Pipe Strain, Solid Bases, Proper Grouting, Suction Piping, Placement of Valves, Proper Alignment, and Operation on the Pump Curve.

Followed this procedure when installing new pumps will help achieve this goal. Maintenance should become familiar with this procedure, and ALL vendors wishing to bid on pump installations should review it before any bid is accepted.

HORIZONTAL CENTRIFUGAL PUMP INSTALLATION

1.0 Purpose:

1.1 To ensure proper installation of horizontal centrifugal pumps.

2.0 Scope:

2.1 This document applies to all new centrifugal pump installations and modifications to existing pump installations.

3.0 References:

3.1 Vendor List: ABC
3.2 Horizontal Centrifugal Pump Standard Document DEF.
3.3 Coating Standard Document GHI
3.4 Piping Specifications Document JKL
3.5 Design of Small Branch Piping near Vibrating Equipment Document MNO

4.0 Definitions:

4.1 Pump Connector: A flexible device which allows for movement of piping due to thermal conditions without imparting strain to the casing of the pump.

4.2 Pump Pads (Concrete): Concrete foundation for the purpose of supporting and anchoring pump baseplates.

4.3 Pump Pads (Steel): Steel plate used for the purpose of supporting and anchoring pump baseplates. Typically used on elevated installations.

4.4 Pump Baseplates: Plates or channels typically constructed of steel or cast iron used for the purpose of mounting pumps and motors such that they are rigidly connected.

4.5 $NPSH_R$ (Net Positive Suction Head Required): Minimum required suction pressure in order to prevent pump cavitation.

5.0 Responsibilities:

5.1 It is the responsibility of the project manager to adhere to this standard.

6.0 Procedure:

6.1 Pump Bases
6.1.1 Ground Level Pump Pads
6.1.1.1 All ground level centrifugal pumps should be set on a level concrete pad constructed of 4000 psi in 28 days concrete.

6.1.1.2 The height of pump pads should be determined by the net positive suction head required ($NPSH_R$) by the pump. The maximum height of pump pads should be 18 in unless more height is required due to surrounding diking. When $NPSH_R$ conditions allow, considerations for maintenance, draining, and environmental conditions should be taken into account.

6.1.1.3 Pump pads should extend a minimum of 36 in below grade in order to extend below the frost line.

6.1.1.4 Pump pads should be sized such that they extend a minimum of 6.0 in on all sides of the pump baseplate.

6.1.1.5 Pump pads should have pump hold down bolts of a minimum 5/8 in diameter. (Larger bolts may be necessary for larger equipment).

6.1.1.6 Hold down bolts must be constructed of 316 stainless steel in an "L" fashion and be 14 in in length. Bolts must be installed in a 1 1/2 in Sch 40 pipe as per Figure A-1. Nuts should be carbon steel to prevent galling.

6.1.1.7 The maximum number of pumps per pump pads is two, and the minimum distance between pump baseplates on pump pads supporting two pumps should be 10 in (Figure A-2).
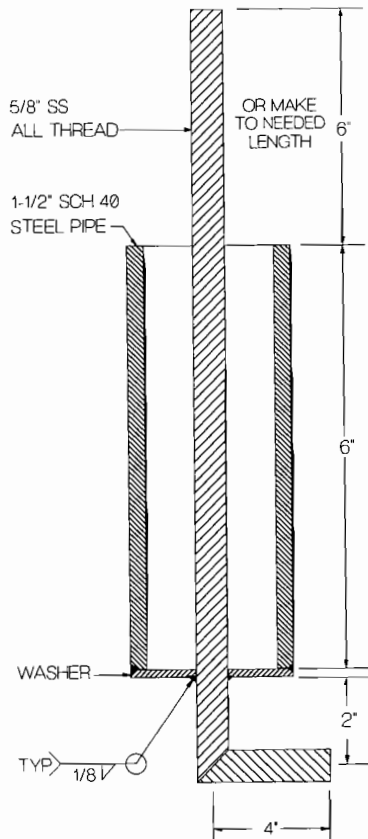
Figure A-1. Typical Hold Down Bolt.

Figure A-2. Typical Pump Pad Spacing.

6.1.1.9 Pump pads in a common row should be separated by a minimum of 20 in (Figure A-2).

6.1.1.10 Pump pads in common rows should be maintained at a common height when $NPSH_R$ conditions allow.

6.1.1.11 Pump hold down bolts on pads supporting two pumps should be aligned. (Figure A-2)

6.1.1.12 Location of pumps should take into account ease of maintenance and aesthetics.

6.1.1.13 All concrete pump bases should be coated with a chemical and weather resistant coating. See coating standard. Document GHI.

6.1.4 Elevated Pump Pads

6.1.4.1 Pump baseplate should be stitch welded to a minimum of 3/4 in thick steel plate.

6.1.4.2 Steel plate should be a minimum of three in larger than pump baseplate on all sides.

6.1.4.3 Stitch welds should be between two and four in in length and have a spacing of between one and three in.

6.1.4.4 The steel plate should be securely attached to the plant steel structure by welding or bolting.

6.1.4.5 Pump should be positioned over existing "I" beams or new "I" beams should be installed.

6.1.4.6 Pump positioning should take into account ease of accessibility for maintenance and operation.

6.2 Pump Grouting

6.2.1 The space between the pump installation and the pump baseplate must be filled with a nonshrink grout.

6.3 Pump Piping—Immediate Area

6.3.1 All piping must be adequately supported and fitted such that it imparts no strain on the pump casing.

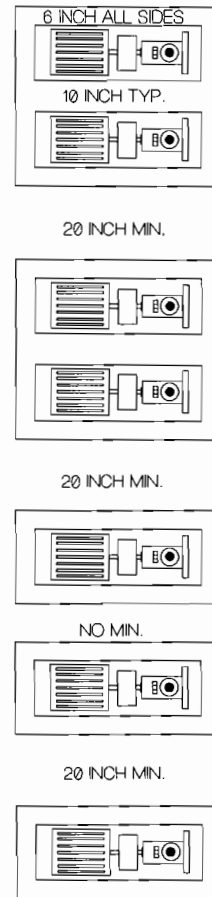6.3.2 Suction piping should be designed to minimize pressure drop and in all cases $NPSH_R$ conditions must be met.

6.3.3 All pumps should be equipped with suction and discharge valves as shown in Figure A-3.

6.3.4 Pump connectors should be used. Pump connector length will be determined by the Piping Standard Document JKL.

6.4 Gauges

6.4.1 All pumps must have gauges installed on the suction piping and discharge piping (Figure A-3).

6.4.2 Gauges should be installed such that they are in the vertical position and that they face the most accessible operation point. (i.e. start/stop switch) All gauges should be installed with valves positioned such that they can be replaced. See Figure A-3. Gauges should have a working range of no more than twice the expected pressure.

6.5 Alignment

6.5.1 Before operation, the pump must be aligned to the company's tolerance using the indicator reverse, or laser method. Final readings must be filed in the equipment file.

6.6 Rotation

6.6.1 Prior to operation of the pump, the motor rotation must be verified to be correct. This verification must be performed with the pump un-coupled from the motor.

7.0 Attachments

7.1 Figure A-1. Typical Pump Hold Down Bolts.

7.2 Figure A-2. Pump Row Pad Spacing.
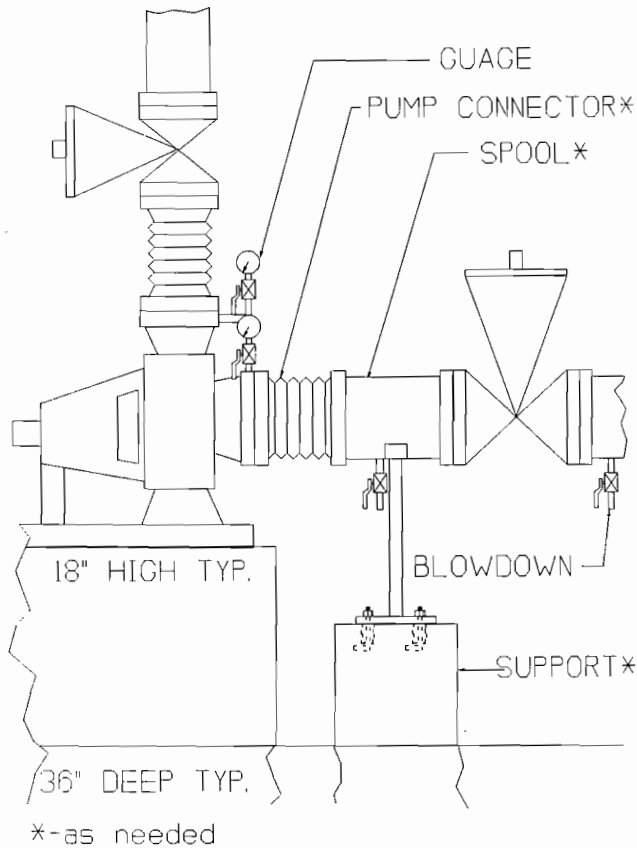
7.3 Figure 3. Typical Piping Arrangement at Pump.

Figure A-3. Typical Piping Arrangement to Pump.

APPENDIX 2—HORIZONTAL PUMP ORDERING GUIDELINE

1.0 Purpose:

1.1 To ensure uniformity and consistency on all horizontal centrifugal pumps.

1.2 To increase pump life.

2.0 Scope:

2.1 This document applies to all horizontal centrifugal pumps at this site.

3.0 References

3.1 ANSI-ASME B73.1M-1991

3.2 Approved vendor list document ABC.

3.3 Centrifugal pump installation standard 001.

3.4 Motor classification standard 002

4.0 Definitions:

4.1 Bulls eye sight glass: An oil level indicating device that screws into the side of the pump housing. It has a small sight glass at which height the oil level is to be maintained.

4.2 Constant level bottle oiler: An oil level maintaining device which resembles a small inverted glass bottle. It maintains oil level through a siphoning effect.

4.3 Expansion chamber: A device which attaches to the top of the pump bearing housing. It is sealed and has a rubber diaphragm that allows the expansion of the air in the bearing housing to occur during operation. It is also sealed to the atmosphere to keep out contaminants.

4.4 Tapered seal chamber: An enlarged seal chamber that has a four degree taper. It allows more fluid to circulate around the seal, and maintains a much lower and consistent temperatures around the seal. It also allows entrained gasses to vent out of the seal housing. Refer to ASME B73.1M-1991.

4.5 Discharge and suction ports: National Pipe Thread ports. One is on the discharge of the pump casing, and one is on the suction of the pump casing. They allow for the addition of gages, valves, seal flushing, casing drainage, and other necessary items.

4.6 Jacking bolt: A device attached to the motor base which allows precise movement of the motor during alignment. One bolt is located at each motor foot.

4.7 Grout hole: A hole placed in the center of the pump/motor base which allows grout to be added after the base is installed.

4.8 Bearing guards: Labyrinth type oil seals on the pump housing/shaft assembly.

5.0 Responsibility:

5.1 It is the responsibility of the project manager ordering the pump to ensure adherence to this standard.

5.2 It is the responsibility of purchasing to keep the pump vendors updated on this standard.

6.0 Procedure:

6.1 All new horizontal centrifugal pumps will meet ANSI or API standards.

6.2 All new horizontal centrifugal pumps will contain the following features:

6.2.1 A bulls eye oil level indicator. Do not install the bottle type constant level oiler.

6.2.2 An expansion chamber on the bearing housing.

6.2.3 The enlarged four degree tapered seal housing.

6.2.4 A discharge tap, and a suction tap in the pump casing. The taps will be plugged with pipe plugs made of the same material as the pump housing when shipped.

6.2.5 Bearing guards on the pump bearing housing. See vendor list ABC.

6.2.6 One jacking bolt be at each motor foot on motor/pump assemblies.

6.2.7 A four in grout hole located near the center of the pump base.

6.2.8 Use the following gland and seal codes on all pumps:

6.2.9.1 GLANDS-Consult with maintenance engineer.

6.2.9.2 SEALS-Consult the maintenance engineer.

6.3 All spare centrifugal pump parts are to incorporate the relevant features listed above.

7.0 Attachments: