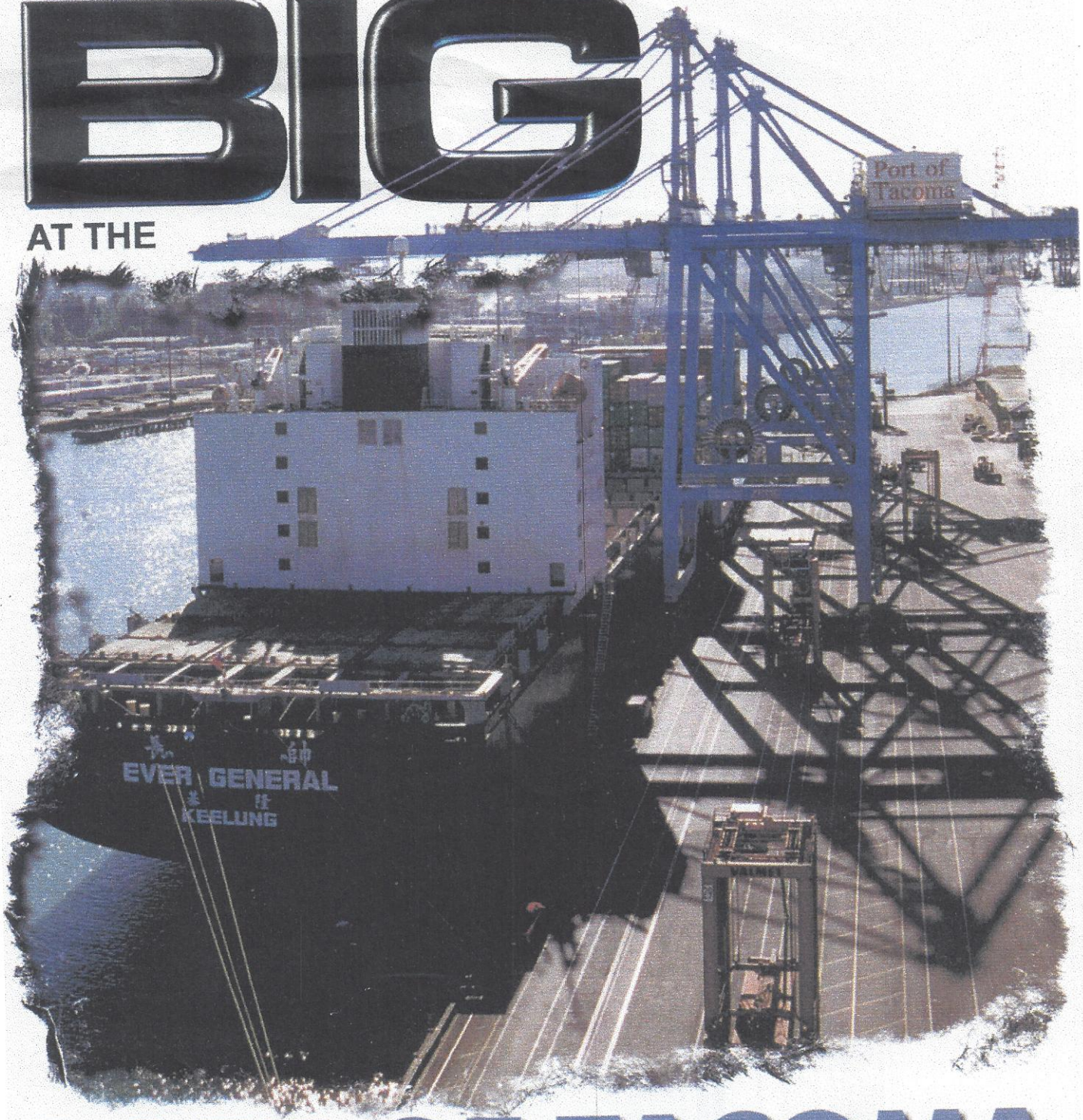
Effective Fluid Management Delivers BIG AT THE PORT OF TACOMA



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The Port of Tacoma is an active port authority that provides warehousing, trucking, shipping and long-shore support in Tacoma, Washington. The maintenance team is focused on managing a large fleet of mobile equipment that is leased out an average of 2,000 hours per year, generating about $200,000 per year per piece, in revenue.

With an eye on improving the operational profitability of each piece by extending the life of the equipment and reducing maintenance costs, the Port of Tacoma undertook an aggressive program of fluid condition management. The program combined effective removal of particulate contamination to achieve new and aggressive target cleanliness levels with the monitoring feedback of oil analysis to ensure that targets were met and maintained. This article describes the program's implementation, reports the results, and highlights the synergy created by the strong partnership with a key vendor, in this case, Hydraulic Repair and Design of Kent, Washington.

Kalmar Side Pick

The equipment under review includes two Drott straddle carriers and two Kalmar side picks. The straddle carriers each have two 75 gallon tanks running 4,000 psi hydraulics with Dynapower piston pumps. The side picks each have 80 gallon tanks and are fitted with Vickers piston pumps operating at 2,900 psi. All systems run Chevron AW MV ISO 46 hydraulic oil, a 46 cSt @ 40° C. multigrade oil with an anti-wear additive package.

A preliminary review of the machines' contamination levels revealed unsatisfactory readings across the board. An analysis of the required cleanliness levels found a tremendous gap between current and desired fluid cleanliness (see table 1). Table 1 also provides a research-based estimate of the life extension available by reducing particulate contamination from present concentrations to the targeted levels. This life extension opportunity justifies the decision to proceed with the program.

To achieve the new target cleanliness levels, upgraded filtration was required. Relying upon the results of previous evaluations of different filtration options, a depth-type kidney loop filtration system supplied by Hydraulic Repair & Design Company was selected and installed on each of the systems. These polishing systems are low flow rate filters that have a very high particle capture efficiency, and will remove up to a gallon of undissolved water. Because of the considerable depth of these filters, a highly cleaned, or polished, fluid can be achieved. The clean-up process at the Port of Tacoma was effective. After deploying the new filtration, all systems quickly met or exceeded their respective cleanliness targets.

The new cleanliness levels were ensured

	Original Cleanliness Level	Target Cleanliness Level	Expected Life Extension
Drott Strad #1524	ISO 20/15	ISO 14/11	4 X
Drott Strad #1525	ISO 21/16	ISO 14/11	5 X
Kalmar Side Pick #1253	ISO 21/15	ISO 15/13	3.5 X
Kalmar Side Pick #1254	ISO 21/16	ISO 15/13	3.5 X

Table 1 - Original vs. target cleanliness levels with associated estimates in component life extension.

	Before Cleanup	After Cleanup	Percent Reduction
Drott Strad #1524	$45.52/hour	$1.22/hour	97.30%
Drott Strad #1525	$15.99/hour	$8.89/hour	44.40%
Kalmar Side Pick #1253	$2.22/hour	$0.77/hour	65.30%
Kalmar Side Pick #1254	$3.01/hour	$0.86/hour	71.40%

Table 2 - Repair costs per hour of operation.

with a combined effort of on-site and off-site oil analysis. The Port of Tacoma employs routine on-site analysis to ensure lubricant condition control. Samples not conforming to targets/limits are submitted to the oil analysis laboratory at Hydraulic Repair and Design for more extensive analysis and troubleshooting.

Program Savings. Program savings is where the rubber meets the road.

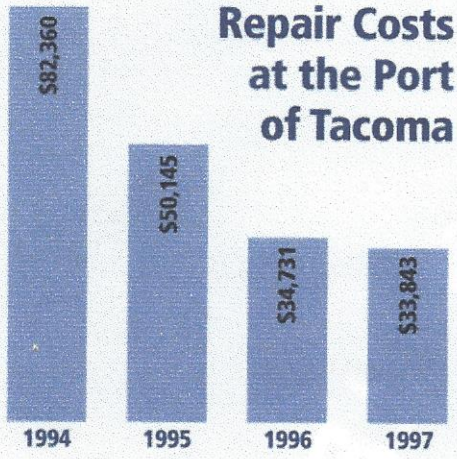

Figure 1 - Reduced hydraulic component purchases and repair at the Port of Tacoma

The initial engineering analysis suggested that up to 80% of the wear-related failures could be eliminated by employing aggressive contamination control. The repair cost data confirms the theoretical estimates. Table 2 illustrates the repair costs per hour before and after initiating contamination control for each of the pieces of equipment under evaluation. Straddle carrier #1524 delivered a whopping 97% reduction in the maintenance costs per hour of operation. The side picks responded more consistently with 65% and 70% reductions respectively. The average reduction in maintenance costs for all pieces, calculated by comparing the sum of the before cleanup costs to the sum of the after cleanup costs, was just over 82%.

The data clearly suggests that the decision to move ahead with contamination control was a good one. Another excellent measure for determining success is the change in hydraulic component purchases over time. Hydraulic Repair and Design supplies the Port of Tacoma with 90% of its hydraulic components. Figure 1 illustrates a significant 59% reduction in the purchase of components over the course of the program's implementation, providing further evidence of the programs success. None of these figures incorporate lost production related savings. When these costs are factored in, the yield from the modest fluid management investment becomes even more impressive indeed. Likewise, properly operating equipment is generally safer to operators, kinder to the environment, and produces a higher quality product.

Most improvements come at a cost. This program is no exception. The investment required for each system ranged from $1,400 each for the side picks to $4,000 and $5,000 respectively for the straddle carriers. The payback time ranged from 2 months for straddle carrier #1524 to 14 months for the side pick #1254. These payback times are impressive without any footnote, but one must remember that downtime, safety and environment costs are not included in the calculations.

Moving On to Diesel Engines... Given the excellent results from managing hydraulic fluids, the program is under expansion to include additional equipment. The twin diesel engines on the 21 straddle carriers have been outfitted with fine filtration to extend their mean-time-between-overhaul from the current level of 7,200 operating hours, to a theorized 21,600

Valmet Straddle Carrier

hours. The filtration improvements have accomplished several things.

First, the average ISO Cleanliness Code has been reduced from an ISO 19/16 to an ISO 15/12 over the operation of the machine between changes. In theory, this extends the life of the engine by a factor of three. Additionally, oil change intervals have been extended

	Standard Filtration	Improved Filtration
Typical Average ISO Cleanliness Code	19/16	15/12
Mean-Hours-Between-Rebuild	7,200 Hours	None Failed
Max-Hours-to Rebuild	9,000 Hours	13,000 Hours No Sign of Trouble
Theoretical Life Extension Factor	N/A	3X
Theoretical New Mean Life (Hours)	N/A	21,600 Hours (est.)
Average Engine Rebuild Cost	$10,000	$10,000
Annualized Engine Rebuild Costs per Engine	$2,800/Year	$925/Year (est.)
Annualized Engine Rebuild Costs per Unit	$5,600	$1,850
Annual Filtration Costs	$78	$188
Annual Lubricant Costs	$510	$153
Annual Oil Analysis Costs	$902	$451
Annual Service Inspection Costs	$21,488	$16,000

Table 3 - Summary of engine performance improvements from contamination control.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Increased Revenue/Decreased Costs						
Decreased Annual Rebuild Costs	$ -	$78,750	$78,750	$78,750	$78,750	$78,750
Decreased Lubricant Costs	$ -	$7,497	$7,497	$7,497	$7,497	$ 7,497
Decreased Monitoring Costs	$ -	$9,471	$9,471	$9,471	$9,471	$ 9,471
Decreased Service Inspection Costs	$ -	$115,248	$115,248	$115,248	$115,248	$115,248
Total Profit Improvement	$ -	$210,966	$210,966	$210,966	$210,966	$210,966
Implementation Costs						
Installation Costs	$31,500	$ -	$ -	$ -	$ -	$ -
Increased Filtration Costs	$ -	$2,310	$2,310	$2,310	$2,310	$2,310
Total Implementation Costs	$ 31,500	$2,310	$2,310	$2,310	$2,310	$2,310
Project Operating Profit	$(31,500)	$208,656	$208,656	$208,656	$208,656	$208,656
Discount Rate (K=13%)	1.00	0.88	0.78	0.69	0.61	0.54
Discounted Project Operating Profit	$(31,500)	$184,651	$163,408	$144,609	$127,973	$113,250

Table 4 - Investment analysis resulting from contamination control on diesel engines.

Summary:
Net Present Value = $702,391
Internal Rate of Return = 662%
Discounted Payback = 2.04 Months

to 750 or 1,000 hours from a previous 250 hours of operation. At 1,000 hours with the new filtration, the oil is in better condition than the 250 hour oil with the standard filtration. Table 3 summarizes the improvements and cost variations realized from the engine contamination control program.

The engines are at about 13,000 hours with no sign of problems. The previous maximum life on an engine was 9,000 hours. Looking at the condition of the engines during inspection, the estimated improvement to 21,600 hours between rebuilds appears to be within reach. In fact, those numbers may be exceeded.

A bird's eye financial review of the enhanced profit generated by the employment of fine filtration on the diesel engines is available in Table 4. Controlling lubricant contamination in engines provides an astounding 662% internal rate of return! Justifying the project's expansion to all the engines and hydraulic systems at the Port of Tacoma is now a breeze.

A very telling statistic is the ratio of savings to gross annual revenue per machine. The savings generated per machine from contamination control is $9,936. Each machine generates around $200,000 per year in gross revenue. Because cost reductions go directly to the bottom line, contamination control improved the bottom line profitability of each machine by 4.97% on total revenue. For all 21 straddle carriers, the engine project alone will add an additional $208,656 to the bottom line earnings at the Port of Tacoma. It would take a substantial increase in production to yield similar bottom line performance after fuel and other operations costs are subtracted. That kind of savings proves that proactive maintenance can indeed generate a substantial profit to the organization. When the hydraulic system savings are factored in, the financial impact is even more impressive.

These benefits are based in sound engineering and the physical laws that govern friction and wear. If proactive conditions are maintained, these savings become an annuity to the organization, recurring year in, year out. If, however, rigorous contamination control is lost, due to sloppy procedures, or cost cutting, the wear rates will return to their original levels. Lubrication management, like human health management, requires a permanent lifestyle adjustment. Temporary adjustments yield only temporary benefits.

Conclusions. Aggressive monitoring and control of fluid health and contamination levels by the staff at the Port of Tacoma, paired with a strong partnership with the vendor, has yielded an impressive return on investment. A modest investment has produced increased reliability and reduced the costs associated with operating the equipment. These improvements go right to the bottom line of the organization, proving that maintenance, when proactive, can deliver seriously enhanced profits to the organization.

It is critical to recognize that achieving these savings depends upon the regular use of particle counting to ensure that cleanliness targets are maintained. Conventional oil analysis is important for scheduling oil changes, but particle contamination control, utilizing regular particle counting, delivers the big increase in bottom line performance.