SEA KING RSW CONVERSION PROJECT

Building a quality fish producing vessel for Bristol Bay

F/V Sea King, 90% tanked

A Special Report to the Bristol Bay Drift Fleet from the BBRSDA and

Meghan and Timothy Gervais, owners, F/V Sea King

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OVERVIEW OF THE SEA KING DEMONSTRATION PROJECT

The Sea King demonstration project was a cooperative agreement between the BBRSDA and the Gervais family, to install a high performance quality platform on a Rawson gillnetter, the F/V Sea King. A submerged refrigerated sea water (RSW) system was successfully installed on a vessel type that in years past has been considered too small and unworthy of such an upgrade.

The BBRSDA furnished $15,000 toward this demonstration, which was used to offset transportation and storage costs of the Sea King to the Seattle area in the winter of 2009 – 2010. The Gervais family paid for all equipment, material, and labor costs associated with the conversion, while providing the BBRSDA with technical, operational, and financial cost/benefit analysis of the project. This report fulfills that obligation. The majority of work was performed at Colony Wharf Shipyard in Bellingham, WA with final completion at the PAF Marine yard in Dillingham, AK.

INTRODUCTION

We purchased Sea King in the spring of 2009. It was already set up with a flush deck, tankable holds, and a low hour Tier II diesel. It was a simple and economical boat that could operate with a slush ice system without having to utilize slush bags. It worked OK for that purpose. Approximately 80% of 2009 deliveries were below 40^{o} F. There was significant travel and radio time expended to locate and secure ice from tenders and the ice barge, however. Sometimes ice was not available or only in limited supply. Ice handling and ice management during a busy opening required some effort also. Consequently, 20% of our 2009 harvest was delivered non-refrigerated.

The holds were temporarily insulated with Nomar ½" XPE foam with an R value = 4. The XPE foam was critical to maintain temperatures that season and extremely economical. Still a lot of cold was lost due to conductivity through the hull below waterline. By the end of the 2009 we had determined without a doubt to have insulation sprayed into the holds and sealed with fiberglass. This would provide a highly effective thermal barrier and be faster to clean properly. We could have continued to use slush ice in the foamed/glassed holds but the advent of the BBRSDA RSW Discount Program in August 2009 represented real and significant value to us. We immediately started planning to install a hydraulic IMS 7½ ton RSW unit in Sea King.

In late September Buck Gibbons of the BBRSDA contacted us with a suggestion that we install a belt-driven Pacific West RSW unit as a low cost demonstration project for small boat operators. Although not initially excited with the proposal, we eventually agreed to go ahead with the project in the hope that we might induce other small boat operators to improve their chilling performance. The higher percentage of Bristol Bay fish that are chilled will benefit everyone. After consulting with David Nowell at Pacific West, we eventually opted for a hydraulic drive, for improved compressor speed adjustment control and more flexibility in mounting location of the RSW unit itself.

SYSTEM DESIGN

Prior to starting our upgrade we thought carefully about the results we wanted to achieve, in order to design an optimal fishing and chilling platform and be effective in Bristol Bay. Our goals were to catch, pick, bleed and chill rapidly – while handling with care – and to do this with every fish on every day of the Bristol Bay season. These results were achieved with submerged RSW, good insulation, good sanitation, proper product flow, and a good attitude about quality.

Figure 1: Submerged RSW fish (left) and spray drizzle RSW fish (right)

TANKING Submerged RSW provides rapid chilling through full contact with the entire fish surface. This keeps bacterial count low and minimizes enzymatic deterioration. An additional benefit of submerged RSW is that it keeps the fish in the holds from getting crushed and bent. Proper slush icing produces the same results. We are trying to maximize the percentage of our fish going to the fillet line. Submerged RSW requires tanking down (flooding with water) the fish holds. This water is heavy, so we need a system to zone or isolate the fish holds that are not currently needed. This is achieved on the supply side by ball valves on each individual hold. Spray bars are not required in a tanked system, because a single-source flow of approximately 10 gpm creates adequate mixing for an entire 1800 lb. hold to reach and remain at system temperature (34^{o} F). The maximum individual hold capacity on Sea King is 1200 lbs. Each hold has two brailers.

The return side utilizes 2” expansion plugs in the bottom of each hold that are removed as needed in succession to bring additional hold capacity online with the RSW circulation system. Potentially, a knife valve system could be designed for the return side flows.

Sea King has 5 fish holds on each side of the vessel. The system can operate in any configuration from 2 to 10 holds tanked-and-circulated, as long as it is balanced, side to side. A critical design aspect for a tanked hold system is the ability to restrict flow to either the port or starboard side to prevent listing. This is achieved with a balancing valve system. The 2" supply side is plumbed through the deck where it tees to 1½" lines, port and starboard. This is where we installed ball valves – easy for the crew to access from deck – toi make slight flow adjustments and balance water levels in the holds. These adjustments take about 20 seconds and are usually required about every ½ hour.

All RSW systems are unique, but the conventional Bristol Bay practice of using a spray bar system and cooling fish with a drizzle of chilled water often results in "fantasy RSW." The operator has an RSW system on board, and presumably working, but is the system providing rapid chilling to the harvested product? Stringent quality control checks at delivery can verify that the processor is receiving the quality that they are paying for.

INSULATION Much of the poor RSW performance in Bristol Bay is the result of poor insulation. Currently available 7½ ton RSW units are quite capable of chilling a 15,000 lbs. harvest over an 8 hour opening, *so long as there is adequate insulation*. The area of the engine room bulkhead, and hull contact below the water line can rob massive amounts of cold from your system. Good insulation will allow your system to spend its energy chilling your harvest instead of chilling the water of Bristol Bay. Chilling with ice or RSW requires energy/diesel fuel. Adequate insulation makes our system perform better, reduces our carbon footprint, saves money, and lessens ocean acidification.

Figure 2: Foam applied and start of fiberglass lay-up to seal Sea King's fish holds

Aluminum boats have a higher potential for cold loss than fiberglass boats, due to the higher thermal conductivity of aluminum. If the watertight seal to the insulation is breeched and water is in the insulation the thermal insulation properties are lost. Waterlogged foam can also result in serious galvanic corrosion from deoxygenated water rotting through an aluminum hull. So it always makes sense to insulate well and seal the insulation well with fiberglass or polyurea coating.

Sea King received 2" of spray foam on the bottom and hull sides of the fish holds. This was covered with fiberglass. Spray foam of 1" thickness may be sufficient but we opted for the higher amount. One evening during the 2010 season, Sea King was not able to deliver to the tender; delivery would wait until the next day. The RSW system and vessel were shut down with the circulation water at 33° F. Seven hours later the system was put back online having only increased in temperature 1 ½° F. At some point I feel it would be beneficial for the BBRSDA or Sea Grant to do a serious study of insulation types and their effectiveness.

A favorable situation is that the hold configuration and insulation design can be identical for a slush or RSW operator. This allows the vessel owner to move forward on these projects in a phase-in manner,

without tearing out the previous work. We're telling our friends they can insulate, slush-ice for a year or two, then add an RSW unit later. The additional foam and fiberglass cap also added strength and support to our relatively thin Rawson hull.

SANITATION A very important component of our quality program is good sanitation. Our plumbing and hold design maximizes the speed and effectiveness of the cleanup/wash-down process. Efficiency helps keep morale high and frees the crew so they can spend spare time eating or sleeping. After delivery, all blood and gurry is washed or pumped overboard, brailers are cleaned, and the bacteria count is very low.

While participating in 2010's pink salmon fishery I noticed an unfortunate number of boats adding ice directly to their slush holds after delivery. No doubt these operators are recycling their slush water for another period to make their ice last longer. This is bad practice, as the next fish caught will be placed in a slush hold with an elevated bacteria level. Bacteria grow exponentially and numerous quality problems ensue. *Poor quality is detrimental to everyone in Bristol Bay.*

When we purchased Sea King it had standard non-sealing hatch covers. Dirt, oil, fuel, blood, and wash-down water could all fall or drip into the fish hold, potentially contaminating fish. The more significant situation was wash-down water dripping into the slushed holds and elevating the slush water temperature. Deck wash-downs between sets had to be greatly reduced in order to maintain slushing temperatures. Vessels engaged in a bleeding program get a fair amount of blood on deck, so we made the expensive ($5,500) modification of building up hatch combings, installing drain gutters, and putting combing overlaps on the hatches. This process seems simple but it is labor and skill intensive with all the corners, angles, and confined spaces involved with a retrofit. The new deck configuration lets all wash down water go overboard through the scuppers and not into the fish holds. Fish hold openings are designed with minimal overhangs and smooth edges. This minimizes crushing as brailers are pulled out during the offloading process.

Now that a flush deck mold has been built through a different BBRSDA program, these important features are available to Bristol Bay permit holders at a much-reduced cost.

PRODUCT FLOW: Sea King operated with a padded deck in the 2010 season. This was effective at cushioning the salmon as they came out of the net. Due to our success with a Salmon Slide on our other vessel, F/V Dreamboat, the Sea King will also operate with a Salmon Slide in the future. The crew liked it, the salmon liked it, our processor is willing to pay a 1½ cents/lb. premium for its use, and it concentrates the salmon in a specific area for bleeding. Freshly landed salmon don't flop around on a Salmon Slide as much as they do on a hard deck, so the fish are getting into the hold with less bruising. It will be beneficial if the entire Bristol Bay fleet utilizes Salmon Slides.

QUALITY ATTITUDE: We did not invent any of the above practices or systems. We are just normal fishermen that take pride in our harvest. We pay attention to and incorporate most of the practices that result in a quality product. It is an evolving process. Undoubtedly Sea King will be making money with quality in 2020 by utilizing techniques and research that are not available today. We will also figure out ways of adapting other quality techniques to the high volume Bristol Bay fishery.

Quality is not only a function of vessel design and fishing technique; it is instilled into our operation as a way of life. Crewmembers are hired based on their desire to participate in a high quality environment. Crew contracts specifically identify quality awareness as a job function. The entire crew knows that their income is enhanced from proper handling and respect for the salmon. The majority of Bristol Bay fishermen will be receiving $1.80 less per fish than Sea King in 2010 and 2011. Is your crew going to be whining about bleeding, or competing to see who can bleed the fastest?

It is our opinion that unchilled fish represent a form of wanton waste. Nature has presented us with the finest surviving salmon run in the world. Do your part by not degrading it. Not only is it the right thing to do, it makes money. It creates demand from processors and consumers. It is the only way to compete with farmed salmon production. Even canned production can have far reaching quality improvements from at-sea chilling. If you ever have the opportunity to taste premium quality canned salmon you will be impressed with the positive experience.

RSW SPECIFICS

Our original plan was to place the Pacific West unit in the lazarette. It could not quite fit there, however, and still leave access for maintenance. So we ended up pulling out a 200-gallon fiberglass fuel tank located between the fish holds under the sliding reel, and placed the RSW unit there. New crosslinked polyethylene tanks were installed on the port and starboard stern quarter.

Figure 3: Just prior to 200-gallon tank removal

A variable volume, pressure compensated 4.88 in^3 Eaton 420 hydraulic pump powers the RSW unit. The pump is driven off of a PTO adapter on the Twin Disc 506 reduction gear. The hydraulic flow is routed through a three-circuit pressure compensated manifold with manual flow control adjustments on each circuit. Individual circuits for the anchor winch, deck hydraulics, and RSW operation are controlled with 12-volt solenoids. Currently we are operating the entire hydraulic system at 20 gpm @ 1500 psi for a draw of 17½ hp against the 200 hp John Deere 6.8L main. The RSW unit itself uses 8 hp rotating the Freon compressor at 1600 rpm. It is possible to speed up the compressor to 3000 rpm but that much chilling power was unnecessary and would require more fuel and horsepower.

A keel cooler provides cooling for the freon circuit with the freon circulated directly through it. Pre-RSW fuel consumption was approximately 15 gals/day. Now Sea King burns 23 gals./day on average, while fishing and chilling. The added fuel cost of 250 gallons per season is less than the ice bill of $2844 incurred during slush ice operation in 2009.

The average delivery temperature in 2010 was 34.88° F. The highest delivery temperature was 36° F and the low temperature was 34° F. This was Meghan's second season as a skipper and her first year running an RSW system. The only operational difficulties were a faulty pressure gauge that blew out and some minor leaks on the hydraulic system from Chinese fittings. Overall it was significantly less effort than running a slush ice operation.

Figure 4: Pac-West unit in place with zone plumbing

ECONOMICS

No quality regime can have lasting impact if it is not economically feasible. Economic value varies based on pounds harvested and refrigeration premium paid.

Pounds	Share	Chilling Premium			
		$0.10	$0.20	$0.30	$0.40
50,000	Gross	5,000	10,000	15,000	20,000
50,000	68% Net	3,400	6,800	10,200	13,600
80,000	100% Gross	8,000	16,000	24,000	32,000
80,000	68% Net	5,440	10,880	16,320	21,760
100,000	100% Gross	10,000	20,000	30,000	40,000
100,000	68% Net	6,800	13,600	20,400	27,200
125,000	100% Gross	12,500	25,000	37,500	50,000
125,000	68% Net	8,500	17,000	25,500	34,000
150,000	100% Gross	15,000	30,000	45,000	60,000
150,000	68% Net	10,200	20,400	30,600	40,800
200,000	100% Gross	20,000	40,000	60,000	80,000
200,000	68% Net	13,600	27,200	40,800	54,400

Figure 5: Owner/operator RSW revenues at various levels of harvest and chilling premium levels

Figure 5 illustrates gross RSW revenue, along with a 68% net owner/operator share. This is a situation where the crew takes home 32% of gross revenue. Fuel and tax deductions are left out for simplicity

(they average about 9% of gross revenue). So a boat catching 100,000 lbs. of reds and getting a $0.20 quality premium generates $20,000 of revenue above base price for the entire vessel. The owner/operator retains $13,600 of that $20,000.

In Sea King's case two different markets averaged out to a quality premium of $0.25 at 100,000 lbs. (arbitrary poundage). This gave us a quality premium revenue of $17,000 for 2010.

100,000 lbs. x $0.25/lb. = $25,000 $25,000 x 68% = $17,000 quality premium revenue

Sea King RSW Conversion Costs		
Fiberglass work	Hatches, combings and insulation	11,125
RSW unit	Pacific West 7 ½ ton hydraulic unit	14,600
Hydraulics	4.88 in^3 Eaton 420 pump, hoses, tank, and fittings	5,679
Fuel tanks	Cross-link polyethylene tanks	1,400
Insurance	Shipping rider on boat insurance	400
Labor	Contract labor (labor not performed by owners)	1,095
Miscellaneous	Additional costs and expenses	5,068
Total cost of Rawson vessel conversion		**$ 39,367**

Figure 6: Sea King RSW Conversion Costs

Figure 6 gives us the total project cost of $39,367. The payback period for this project is 2.32 years.

$39,367 / $17,000 = 2.32 years payback period

Figure 7 (below) shows calculated internal rates of return (IRR) for various harvest weights and quality premiums. An IRR calculates the return of future cash flows against an initial cash outlay, and the table shows approximate break-even seasons for each scenario.

RSW - Converted Vessel Cash Flow by Year, with Approximate Break-Even Seasons														
Lbs.	Premium	IRR	Invest	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Return
50k	0.10	-3%	-40,000	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	34,000
50k	0.20	11%	-40,000	6,800	6,800	6,800	6,800	6,800	6,800	6,800	6,800	6,800	6,800	68,000
50k	0.30	22%	-40,000	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	102,000
80k	0.10	6%	-40,000	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	54,000
80k	0.20	24%	-40,000	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	108,000
80k	0.30	44%	-40,000	18,200	18,200	18,200	18,200	18,200	18,200	18,200	18,200	18,200	18,200	182,000
100k	0.10	11%	-40,000	6,800	6,800	6,800	6,800	6,800	6,800	6,800	6,800	6,800	6,800	68,000
100k	0.20	32%	-40,000	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	136,000
100k	0.25	41%	-40,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	170,000
100k	0.30	50%	-40,000	20,400	20,400	20,400	20,400	20,400	20,400	20,400	20,400	20,400	20,400	204,000
125k	0.10	17%	-40,000	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	85,000
125k	0.20	41%	-40,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	170,000
125k	0.30	63%	-40,000	25,500	25,500	25,500	25,500	25,500	25,500	25,500	25,500	25,500	25,500	255,000
150k	0.10	22%	-40,000	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	102,000
150k	0.20	50%	-40,000	20,400	20,400	20,400	20,400	20,400	20,400	20,400	20,400	20,400	20,400	204,000
150k	0.30	76%	-40,000	30,600	30,600	30,600	30,600	30,600	30,600	30,600	30,600	30,600	30,600	306,000
200k	0.10	32%	-40,000	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	136,000
200k	0.20	68%	-40,000	27,200	27,200	27,200	27,200	27,200	27,200	27,200	27,200	27,200	27,200	272,000
200k	0.30	102%	-40,000	40,800	40,800	40,800	40,800	40,800	40,800	40,800	40,800	40,800	40,800	408,000

Figure 7: RSW-Converted Vessel Csh FLow by Year, with Approximte Break-Even Seasons

As you can see, Figure 7 reflects $40,000 of investment on all scenarios. It also shows cash flows for 10 years from the initial investment. Theoretically if the IRR is greater than your cost of capital (borrowing cost) for a project, one will profit from the investment.

Due to the cyclical nature of fishing, I would use a 20% IRR as a break point to go forward with an RSW installation. The Sea King example for $0.25 premium with 100,000 lbs. harvest shows an IRR = 41%. This is a healthy and profitable return. We also anticipate that our RSW premium to move from $0.25 to $0.30 in 2011.

We completed this job at $5,000 over budget. The two main factors with the cost overrun were having to redo the fuel tanks and not estimating enough time for working in the confined space of a Rawson. For other vessel owners, installation costs and time spent will probably be reduced, as Sea King and other small boat RSW conversions will provide invaluable lessons-learned that other fishermen will benefit from. Even if the Sea King had been $15,000 over budget the IRR would still have been a profitable 32%.

The most significant information in Table 2 is showing is that $0.10 quality premiums are only profitable for boats harvesting over 150,000 lbs. A $0.20 quality premium makes RSW profitable for boats harvesting above 78,000 lbs. A $0.30 quality premium makes RSW profitable for everyone.

Under the current situation, high level harvesters and mid-range harvesters with higher quality premiums are making money with their RSW investment. 100,000 lb. harvesters have little economic incentive to install RSW with only a $0.10 price premium. When the sockeye price was $0.50/lb. a $0.10 quality premium was significant; but with current base price levels at $0.95/lb. the quality premium should be near $0.20 to maintain the same percentage. Meanwhile, RSW system prices have increased due to increased costs of component materials. It would be worthwhile to have more information as to

the amount of value added to delivered product, due to various quality practices such as bleeding, rapid chilling, and good handling.

Please note that economic calculations do not include chum production, as quality premiums are not paid on those fish at this time. Six weeks of installation labor by owner is also not factored in the economic evaluation. Two of those six weeks were spent trying to figure out how best to install the system.

BARRIERS TO ENTRY

As we meet with various operators who are considering an RSW or slushing operation, two main issues are prevalent. Operators are intimidated either by the perceived cost or the mechanical complexity of an RSW system. The preceding economic discussion fairly supports the economic issue. The appropriate question operators need to evaluate is "How much money and value are you losing by delivering dry, junk fish?" To be able to fish an RSW vessel for $100,000 or less is achievable, and it's smart business. We feel that a $0.10 price premium for chilling is inadequate.

Mechanically, an RSW vessel is more complex. Operating and maintaining an RSW system is not difficult, however, and well within the capacity of most Bristol Bay fishermen. RSW technologies have been specifically designed for and proven in the Bristol Bay fishery. If a Bristol Bay fisherman complains about how poorly their RSW chills it is because they have a design, installation, or mechanical problem with their system. To build their knowledge base, I highly recommend that operators make it a priority to take or retake a Marine Refrigeration Workshop from Integrated Marine Systems in cooperation with Alaska Sea Grant and Washington Sea Grant.

For a variety of reasons, some percentage of operators will need to keep their vessels as simple as possible. Those boats are perfect candidates for slush ice platforms. The identical Sea King fish hold, insulation, zoning, and drain designs are appropriate for these operators. They can produce great slushed fish if enough ice is available.

SUMMARY

We met our goal of having every fish for 2010 chilled properly, averaging 34.88^{o} F (according to processor quality control testing). Overall quality control opinion of our fish quality was excellent. Submerged RSW, bleeding, and good handling are the main components of the quality program. With the addition of a Salmon Slide, we estimate that Sea King fish will be in the top 3% of quality for the Bristol Bay fleet.

Our project cost was $39,367 not accounting for shipping costs and our sweat equity during system design and installation. This results in a profitable IRR of 41% ,and a payback period of 2.32 years. The installation was challenging, due to the limited amount of below deck space on a Rawson gillnetter, but these difficulties are manageable with good planning. RSW operational

effort was significantly less than for slush ice. We definitely encourage and support slush ice operation for some operators, however.

Further research that may be helpful includes:

1. Insulation effectiveness and cost;
2. Quantitative value derived from bleeding and chilling;
3. Quality control assessment; and
4. Tagging programs to promote accountability.

Bleeding potential gives our fleet the opportunity to move quality of the Bristol Bay pack past seine-caught fish. Our Bristol Bay operation has only been employing quality practices since 2007 and we have much to learn. The systems and techniques Sea King is utilizing are adoptable and profitable for most Bristol Bay operators. We encourage all Bristol Bay fishermen to contribute and share your experience and ideas for improving Bay wide quality standards. The Bristol Bay salmon pack is greatly undervalued because the entire fleet does not employ quality-harvesting techniques continuously.

IN APPRECIATION

The Gervais family would like to acknowledge to the following individuals and entities that assisted us with the Sea King RSW conversion.

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