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Tank 41 Moveable Pump System
Material Compatibility Report (U)

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EXECUTIVE SUMMARY

SRTC has designed a variable height pumping system for removal of low curie salt solution in High Level Waste (HLW) Tank 41.

The harsh environment of Tank 41 can degrade many materials. The materials used in the Tank 41 Movable Pump System were chosen to provide a balance between schedule impact, cost, and resistance to degradation in service. In some cases materials were coated to increase their resistance to degradation, and in other cases replacement parts of more suitable materials were used. The materials used in the Tank 41 Moveable Pump system have a low chance of failure based on the material selected, the specific use for each material, and the four year design goal.

This report documents the evaluation of the materials of construction for the service conditions.

INTRODUCTION

A variable height pumping system has been designed by SRTC for removing low curie salt solution from Tank 41 (reference 1). The system was constructed using primarily commercial grade components in order to expedite schedule and minimize cost. During the design of the system, it was recognized that material compatibility would impact service life. The Materials Technology Section of SRTC evaluated the materials of construction for compatibility with the assumed Tank 41 environment. In order to expedite the selection and procurement of vendor-supplied components, material acceptability was evaluated piecemeal as components were being considered for inclusion in the design. The primary means of documenting acceptability was e-mail communication. This report is a compilation of the communications during the design phase regarding material compatibility.

ASSUMPTIONS

Service Conditions

The assumed service conditions in Tank 41 are as follows:

pH: 14+
Temperature range: 30-50 °C
Radiation level: 660 Rad/hr or 2.2 curie/gallon
Cesium 37 gamma photopeak at 661 KeV

The specific resistance of many of the materials to Tank 41 chemistry is not well known due to the non-homogeneous nature of the waste. It was assumed that resistance of materials to 30-50% NaOH solutions was sufficient to evaluate material compatibility. This is a reasonable and often conservative approach since the hydroxide concentration of the HLW is generally lower and the high pH is considered the dominant chemical factor. Other waste constituents are considered to be less aggressive to both metallic and non-metallic components.

The resistance of components to chemical degradation is highly dependent upon the actual degree and frequency of chemical exposure. Components subject to continuous immersion require greater chemical resistance than components subject to less frequent exposure. Some chemical effects can also be temporary. It is assumed that these effects will not significantly alter the conclusions of acceptability for use.

It was assumed that radiation resistance of materials in the tank would be similar to that observed in high dose-rate testing. It is common practice to conduct radiation exposure tests at much higher rates (e.g. 1.0×10^6 R/hr) than will be encountered in actual service. These test data are generally useful in evaluating the relative radiation resistance of materials, though high-dose rate testing is known to exclude the longer-term effects of oxidation and other degradation mechanisms. Accelerated testing also ignores possible long-term synergistic effects of fluid exposure. It is assumed that these effects will not significantly alter the conclusions of acceptability for use.

Life Expectancy

The minimum time that the equipment is to operate is three months and the maximum is four years. Assuming the exposure rate of 660 R/hr to be continuous, the minimum and maximum absorbed doses for the components in question are 1.4×10^6 rads over a three month period and 2.3×10^7 rads over a four year period. This also assumes that all radiation in the field is completely absorbed equally by all materials involved and that the dose rate is the same at all levels. Different materials are known to absorb radiation to varying degrees in a given radiation field, but these variations are not considered significant.

Accurate prediction of component service life based solely on generic radiation and chemical resistance data is difficult. Actual performance depends upon many design and usage-related factors as well as material properties. Variation in material composition can also affect chemical and radiation resistance. It was assumed that the data used will bound the actual service conditions.

Chemical resistance ratings for materials are generally based on relatively short term exposures (often 90 days or less). Although most chemical incompatibilities are well detected within such periods, true long-term chemical resistance is much less defined, particularly for non-homogeneous chemical wastes in combination with radiation exposure. It was assumed that during the four-year maximum service life of the equipment, the chemical resistance would be similar to that indicated by short term testing.

Knowledge of Materials

The documentation supporting the Movable Pump System is located in SRTC Engineered Equipment and Systems (EES) Job folder number 22859. This Job Folder can be accessed from SRTC-EES document control located in bldg. 730-A, phone # 5-3066. The documentation includes design drawings, calculations, and vendor supplied documents relating to the pumping system. Since many of the items are standard, off-the-shelf components, the materials of construction are not controlled to the same degree as materials used in nuclear service. Many of the materials are generically described, without knowledge of specific formulations or compounds.

DISCUSSION OF COMPATIBILITY

The specific components that comprise the moveable pump system are detailed in the Appendix. The following paragraphs provide a summary of radiation, chemical, and temperature resistance for each of the components or materials proposed for the moveable pump system, as well as recommendations for alternatives where appropriate:

Stainless Steel

300 series, 400 series, and 18-8 stainless steels are used in the following components: pump structural members, piping, connector assembly, pumps, motors, pump shrouds, cable carrier, position sensor, wheels, rails, hose fittings, flow meter, winch, winch drive system, valves, and various fasteners. These components will be exposed to radiation, waste solution, and the temperature in Tank 41.

Type 420 stainless steel is a 12-14% chromium martensitic (heat-treatable/hardenable) stainless steel. Type 304 (or 18-8) stainless steel contains approximately 18% chromium and 8% nickel. The corrosion resistance of the martensitic grades is lower than that of the austenitic (300 series) grades. This is generally of concern in oxidizing environments, mineral acids, etc., but much less of a concern in the alkaline waste environment. The corrosion rates of Type 420 and other straight chromium grades in alkaline solutions at low temperatures (<100°F) are generally less than 20 mils/year, which is considered acceptable for this application. Type 300 series stainless steels (including 18-8) are highly compatible with the environment.

Carbon Steel

Carbon steel and 4140 (Cr-Mo steel) are used in pump motors, position sensor, winch, gear box, and the winch drive system. They will be exposed to the radiation, waste solution, and temperature in Tank 41.

Since Tank 41 is made from carbon steel, it is reasonable to assume that components made from carbon steel are also acceptable for the Tank 41 service environment. Note that localized conditions (such as heating of pump equipment) can affect corrosion rates.

Stainless Steel Over Cast Iron

The pump motor uses a cast iron casing sealed within a stainless steel cover. It will be exposed to radiation, caustic, and the temperature in Tank 41.

The corrosion rates of most cast irons in caustic/HLW environments at ambient temperatures are similar to that of carbon steel. The specific resistance depends upon the type of cast iron used and the exact service conditions. High-chromium cast irons, normally used for abrasion resistance and dilute acid service, are not as resistant as other types in strong alkaline service. The literature indicates that high-chromium cast irons are not suitable or recommended for alkaline service, but details are limited. Cast irons with high nickel content are superior to unalloyed cast irons for caustic service. High-silicon cast irons are suitable for room temperature solutions, but at elevated temperature in concentrated solutions, the silicon can be selectively attacked. Ductile iron is susceptible to cracking in strong caustic solutions, whereas gray iron is not. These problems and variations in corrosion resistance are of more concern where temperatures are higher than expected in the Tank 41 environment. Given the expected operating temperature, all cast irons except high chromium cast irons are suitable for use.

NBR (Nitrile Rubber) or Viton®

NBR or Viton® seals are used in the pumps and wheels. The seals will be exposed to radiation, caustic, and the temperature in Tank 41.

NBR or Viton® seals are considered generally suitable for the Tank 41 application. EPDM (ethylene-propylene diene monomer) is recommended for superior resistance to caustic solutions and for superior resistance to compression set in radiation environments. Viton® is generally preferred for acid environments and high-temperature resistance, but is only moderately resistant to strong caustic solutions. DuPont generically rates the material as “B” for limited use (with 10-30% swelling or changes in properties expected, generally acceptable for static seals) for low to moderate temperatures, with lower resistance at high temperatures (greater than 50°C). There are variations in published references. The PDL Handbook (reference 2) indicates moderate resistance of Viton® to 46.5% NaOH at 38 °C for 180 days, but much lower resistance after 1095 days. Nitrile (NBR) is moderately resistant to strong NaOH solutions, but is much more susceptible to aging and oxidation than Viton® and most other elastomers. Viton® fluoroelastomers also tend to exhibit more severe compression set than other elastomers due to radiation exposure. Viton® is usually limited to a total dose of 1.0 x 10^7 rads, particularly for dynamic seals.

Valox® (NBR/PBT)

Valox® (polybutylene terephthalate/PBT, GE Plastics) is used as a seal in the pumps. It will be exposed to radiation, caustic, and the temperature in Tank 41.

Valox® PBT is resistant to weak alkalies but is generally not recommended for strong caustic solutions, particularly for long-term exposures (greater than 90 days). Data on the radiation resistance of Valox® is limited, but the material is used in medical devices and sterilized by gamma radiation at doses up to 10 Mrad with minimal changes in mechanical properties. If the Valox® fails, it will likely fail by stress-cracking rather than material loss or dissolution. Since the internal pump components are stainless steel, a crack in the pump seal will not cause a catastrophic pump failure and thus the Valox® is acceptable for this application.

Copper

Copper is used as a conductor in the electrical cables. It will be exposed to radiation and the temperature in Tank 41. In the absence of chemical exposure, copper conductors are suitable.

Polyester with Polyamide-imide Overcoat

Polyester with a polyamide-imide overcoat is used as a wire insulator in the pump motors. This material is not expected to see any chemical exposures and is considered suitable. If chemical exposure is possible, the resistance of the material is dependent upon the polyester type. Radiation resistance of polyesters also varies with specific formulation, but is considered adequate for the static wire insulation application.

Cross-Linked Polyethylene or Neoprene

Cross-linked polyethylene (XLPE) or neoprene (polychloroprene) materials are used as wire insulators in the pump motors. The pump vendor stated either could be used in the pump. The motor wire insulator will be exposed to radiation and the temperature in Tank 41, but not the tank chemistry. Either material is considered suitable for the application, with cross-linked polyethylene preferred for superior radiation resistance and because it contains no chlorine.

Tefzel®

Tefzel® is used as a seal and insulation in the pump motors. It will be exposed to radiation, caustic, and the temperature in Tank 41.

Tefzel® is DuPont's ETFE (ethylene-tetrafluoroethylene copolymer), which is similar in some respects to Teflon and other fluoropolymers. The mechanical properties and radiation resistance of Tefzel® /ETFE is superior to that of Teflon PTFE, although resistance to heat and certain chemicals is lower. Tefzel® ETFE is generally very functional in a radiation field up to an absorbed dose of at least 1.0×10^7 rads, with a 25% loss in elongation typically observed at 2.0×10^7 rads and a 50% loss at 3.0×10^7 rads. Serious reduction in flex life (more critical for cable insulation) due to limited elongation is observed at 1.0×10^8 rads. ETFE is considered very suitable for HLW service. For the expected service conditions, changes in mechanical properties are expected to be minimal.

Tefzel® ETFE is suitable for 50% sodium hydroxide up to 230°F (110°C) and Tefzel® ETFE is currently the valve seat material used in the HLW transfer line ball valves (McCanna). No problems with its use in HLW applications have been identified.

Epoxy (chemical resistant)

A chemical resistant epoxy (compound unspecified) is used in the pump motors as a cable potting compound. It will be exposed to radiation, caustic, and the temperature in Tank 41.

Epoxy adhesives are likely to exhibit a good combination of resistance to alkaline solutions and high radiation, based on the general resistance of epoxy resins to such conditions.

EPDM and Santoprene®

EPDM is used in the pump shrouds seals. Santoprene® is used as insulation on motor cables. Both materials will be exposed to radiation, caustic, and the temperature in Tank 41.

As previously discussed, EPDM-type compounds are considered suitable for the application. Santoprene® is a polyolefin-based thermoplastic elastomer (TPE/TPO) produced by Advanced Elastomer Systems (AES) and is similar to EPDM in many ways. Chemical resistance data from AES indicates excellent resistance to strong caustic solutions, based on 165-hr immersion tests in 50% NaOH at 23°C. Longer-term chemical resistance data is not available, and radiation resistance is considered comparable to that of EPDM.

ABS

ABS (acrylonitrile-butadiene-styrene) is used in the pump shroud seals. It will be exposed to radiation, caustic, and the temperature in Tank 41.

All references reviewed indicate that the ABS seal/plug material is highly resistant to the strong alkaline nature of the HLW solutions. ABS also has very good radiation resistance, higher than that of many common thermoplastics due to the aromatic styrene group. As with most polymers, specific radiation and chemical resistance truly depends upon formulation. ABS compounds are often blended with other polymers (SBR, nylon, polycarbonate, etc.) to achieve a better balance of properties. Of these, ABS blends containing polycarbonate (Lexan®) are less resistant to the waste chemistry because Lexan® is not resistant to strong caustic solutions.

PelSeal 3169

PelSeal 3169 is used to seal the access pipe. This is located outside the tank boundary and should not come in contact with the caustic solution, but will see the radiation field.

The majority of PelSeal sealants (mostly fluoroelastomer/Viton®-based) contain high levels of solvent (mostly methyl ethyl ketone, MEK) until fully cured, which can take an extended period of time depending upon thickness, ventilation during curing, etc. Higher temperature curing may accelerate the cure and limit the amount of time for solvent evaporation (too fast may also be detrimental). Therefore, the MEK will be flammable during application and curing.

This product has previously been used at SRS for various sealing applications, primarily for resistance to acids, not alkaline solutions. However, the manufacturer recommends the product for caustic exposure. In absence of chemical exposure, this product is recommended.

Molybdenum-disulfate

Molybdenum-disulfate is used as a pipe thread sealant. It will be exposed to the radiation, caustic, and temperature in Tank 41.

Any nuclear grade thread lubricant with a molybdenum-disulfide base is acceptable such as Fel-Pro C100 or Moly-Kote® brand dispersions. Teflon-based thread lubricants are not acceptable on any of the Tank 41 pump assembly threaded connections.

Nylon

Nylon is used in the position sensor bushings and the wheel bearing seals. It will be exposed to radiation, limited amounts of caustic, and the temperature in Tank 41.

Nylons (polyamides) have been used in components exposed to HLW without known or documented problems. The bushings are therefore considered resistant and likely to remain functional. Some references indicate that long-term immersion exposure to strong caustic/alkaline solutions is detrimental, with actual resistance dependent upon the specific grade and formulation.

Kevlar® and Hytrel®

Kevlar® and Hytrel® is used in the position sensor belt and in the position sensor cable. It will be exposed to the radiation, limited amounts of caustic, and the temperature in Tank 41.

Kevlar® (aromatic polyamide) is considerably more resistant to radiation than its aliphatic counterpart, nylon (polyamide). Similar chemically to nylon, Kevlar® will be affected by strong caustic over long periods. The amount of degradation will depend upon the nature of exposure, which is assumed to be limited based on the application and the assumption that the Kevlar® is used for reinforcement.

The Hytrel® polymer is a Dupont thermoplastic polyester elastomer (specific type not identified). Note that DuPont's Hytrel® web site and general properties guide indicates that Hytrel® is not suitable for concentrated alkalies, but no specific data is provided. The

DuPont design guide also indicates very little change in properties at 15 Mrad or 1.5 x 10^7 rads.

The functionality of the component is acceptable due the low probability of chemical exposure. EPDM would be recommended over Hytrel® if available and for more severe chemical exposure.

Silicone Oil

Silicone oil will be used to lubricate the position sensor spring. It will be exposed to radiation and temperatures in Tank 41.

The silicone oil (type unknown) is considered satisfactory, particularly in the absence of elevated temperatures. Silicones are also resistant to oxidation, which tends to accelerate radiation damage. Generic data indicates that methyl silicones are affected at lower doses (1.0 x 10^6 – 1.0 x 10^7 rads) than methylphenyl silicones, presumably due to the aromatic phenyl groups being more resistant to radiation. Changes in properties are to be expected but the oil should remain functional. The gel point and impact upon spring performance is unknown.

Polyurethane

Polyurethane is used in the position sensor cable insulation and the flow meter liner. It will be exposed to the radiation, caustic, and temperature in Tank 41.

Polyurethanes are primarily used for solvent/oil resistance as well as high abrasion resistance and toughness. The resistance of polyurethane elastomers to strong alkaline solutions is less than that of most other elastomers and known to vary with type and formulation. The specific type of polyurethane used in these components was not identified. Polyether-based urethanes are more resistant to hydrolysis effects than polyester-based urethanes, and thermoplastic polyurethanes differ slightly from conventional thermosetting polyurethane rubber. In some cases, resistance of polyurethanes to dilute solutions is lower than that to more concentrated solutions due to hydrolysis effects. Most references indicate marginal acceptability of polyurethanes in strong alkaline solutions. The radiation resistance of polyurethanes is known to be generically high compared to most other elastomers. However, in absence of vendor information on the specific type used, polyurethanes may be acceptable but cannot be strongly recommended.

The position sensor cable insulation will have limited exposure to the waste, so for this application it is acceptable. The flow meter liner will be constantly exposed to the waste. If the liner fails, the stainless steel tube will be exposed, which is acceptable. The vendor stated the meter should function without the liner, but some accuracy may be lost.

Polyester

Polyester is used as a binder in the position sensor cable. It will be exposed to the radiation and possibly minor exposure to the waste.

The radiation and chemical resistance of polyesters is known to vary with specific type and formulation, and there are many different types. Bisphenol A-fumarate types are more resistant to strong alkaline solutions than isophthalic, halogenated (chlorendic), and PET or PBT-types. The type used and the property retention required in the cable application is unknown. Based on generic data and in absence of severe chemical exposures, polyester is considered acceptable.

UHMWPE

UHMWPE (ultra-high-molecular-weight-polyethylene) is used in the discharge and IW flush hoses as well as a set material in the drain valve. It will be exposed to radiation, caustic, and the temperature in Tank 41.

UHMWPE is generically rated for 50% NaOH up to 170 °F. The radiation resistance of UHMWPE is also considered adequate for the application, with acceptable property changes observed at 1.0×10^7 rads for most formulations. For static applications, higher doses of radiation can be tolerated.

PVC

PVC (polyvinyl chloride) is used as wire insulation in the flow meter. It will be exposed to the radiation and temperatures in Tank 41.

PVC is resistant to the radiation and temperatures expected in the waste tanks and has been used in contact with HLW in other applications (conductivity probe cables, etc.). A potential problem with PVC in radiation environments (or at elevated temperature) is that it breaks down by evolving HCl gas, which can react with moisture to form HCl, which can rapidly attack copper, carbon steel, and even stainless steel. The rate of evolution of HCl from PVC in radiation is not well-defined and depends on dose rate, temperature, specific compound, etc., but it is a known phenomenon. In the absence of moisture, acidic residues are not expected to be a problem.

Even if present, the high pH of the waste solution may tend to neutralize the acidic residue. EPR or EPDM types of insulation would be equally suitable if readily available, without the concern over HCl evolution.

Sherwin-Williams Macropoxy® 646

Sherwin-Williams Macropoxy® 646 will be used to coat the flow meter aluminum housing. It will be exposed to the radiation, possible caustic drops, and temperature in Tank 41.

Sherwin-Williams Macropoxy® 646 is an immersion-grade epoxy coating. Epoxies are generally resistant to caustic solutions and to radiation. This product has previously been tested per ASTM D4082 for radiation resistance and passed for nuclear plant specifications. Performance of the coating will be dependent upon the quality and degree of surface preparation performed either by the equipment vendor or site personnel. Coating defects and mechanical damage will also expose the aluminum substrate to the high pH environment, which will rapidly attack the aluminum.

ASTM A-200 Neoprene

ASTM A-200 neoprene is used as the flow meter gasket material. It will be exposed to the radiation, caustic, and temperature in Tank 41.

Neoprene is moderately resistant to caustic solutions and has a low chance of failure. Generic data indicates that neoprene is suitable for 50% NaOH at low to moderate temperatures. Radiation resistance of neoprene is approximately the same as nitrile and most other elastomers, with the amount of degradation that can be tolerated dependent upon the property retention required. Static applications can tolerate more damage than dynamic applications where frequent or severe flexing occurs. Radiation resistance depends upon formulation and use of antioxidants but neoprene should be functional. The elongation of neoprene (generic) appears to drop to less than 50% of the original value at 5.0×10^7 rads. An EPDM or EPR gasket would be superior and recommended if readily available.

30 and 90 Weight Oil

30 and 90 Weight Oil is used to lubricate the winch. It will be exposed to the radiation and temperature in Tank 41.

Assuming no exposure to the chemistry or elevated temperatures (less than 200°F), the primary concern with lubrication is radiation resistance. Radiation effects are generally more severe for elastomers than lubricants, so the radiation stability of the lubricant is considered less of an issue. At the total radiation dose expected (2.3×10^7 rads), any common gear oil is considered satisfactory. At this dose, lubricants based on silicones, phosphate esters, and polyolefin-based fluids are more significantly affected than other types. Certain additives may also be present that can be a problem. Compounds with silicone antifoam agents, EP additives (usually containing halogens that can produce acids), and phosphate ester compounds (antiwear additives) should be avoided. Polyalkylene glycols (PAGs) are common gear oils and exhibit good resistance to gelation (stiffening) to 1.0 x 10^8 rads and higher. Polyphenyl ethers and alkylaromatics (alkyl benzenes) are stable to higher doses. Polyphenyls are among the most stable organic lubricants and functional up to 5.0 x 10^8 rads (gelation point). Most mineral oils are suitable to 1.0 x 10^8 rads with some stiffening and gelation expected, which can usually be tolerated for low frequency, low load applications.

Bronze

Bronze is used as a bushing in the winch drive system. It will be exposed to radiation and outdoor temperatures.

In the absence of chemical exposure, all bronzes are acceptable for the application. Normal oxidation due to outdoor exposure is acceptable. If chemical exposure is possible, low zinc bronzes or aluminum bronzes should be used.

Neolube #100

Neolube #100 is used as a pipe thread sealant. It will be exposed to the radiation, caustic, and temperatures in Tank 41. Neolube #100 is considered acceptable for this application.

CONCLUSIONS AND RECOMMENDATIONS

The materials used in the Movable Pump System are acceptable for use in the assumed service conditions. This is based upon a combination of previous use in SRS high level waste service and literature surveys for resistance to the anticipated environment. It was recognized that the materials selected represented a compromise between schedule impact, cost, and resistance to degradation in service

During the evaluation process, unacceptable materials were either substituted, or protected by coatings so that the system function would not be impaired. In some cases, materials were only generically identified, with specific formulation and resistance to the service environment unknown.

Components and materials used in this application should be examined if possible at intermittent periods or following long-term HLW exposure, with any deterioration observed documented. Service history of materials in actual HLW applications is limited and would be considered valuable information for future projects.

REFERENCES

[1] Tank 41 Moveable Pump System, Rev. 4, 6/26/02, located in EES Document Control, Bldg. 730-A, Job Folder 22859.

[2] PDL Handbook Series, Volume II, 2nd Edition, Chemical Resistance – TPEs, Thermosets, and Rubbers

APPENDIX – COMPONENT LISTING

The list below details the components of the pumping system that will be installed in Tank 41 and their acceptability for use. The control cabinet components are not included, since they will not be exposed to the harsh environment. The components, vendor, and model number are shown in boldface type. Beneath each listed component are the parts that comprise the component. Notes about the acceptability of the components are provided at the end of the tabulation. Materials that are not acceptable have been substituted or modified as noted.

Item	Material	Recommendation
Pumps (Low Flow - Grundfos model # 16S05-5 or 03016S05-5 High Flow – Grundfos model # 25S05-3 or 03025S05-3)		
Check Valve Housing	304 Stainless Steel	Acceptable
Check Valve	304 Stainless Steel	Acceptable
Diffuser Chamber	304 Stainless Steel	Acceptable
Impeller	304 Stainless Steel	Acceptable
Suction interconnector	304 Stainless Steel	Acceptable
Inlet Screen	304 Stainless Steel	Acceptable
Pump Shaft	304 Stainless Steel	Acceptable
Straps	304 Stainless Steel	Acceptable
Cable Guard	304 Stainless Steel	Acceptable
Priming inducer	304 Stainless Steel	Acceptable
Coupling	329/420/431 Stainless Steel	Acceptable
Check Valve Seat	NBR/304 Stainless Steel	Acceptable
Top Bearing	NBR/304 Stainless Steel	Acceptable
Impeller Seal ring	NBR/PBT (Valox®)	Acceptable (1)
Intermediate Bearing	NBR (nitrile rubber)	Acceptable
Pump Motors (Both motors: Franklin Electric, model # 96022910, 1 HP, 230 VAC, 3 Phase Cable: Franklin Motor Lead, 75 ft, w/Ground, double jacket)		
Cable Insulation	Santoprene®	Acceptable
Cable Conductor	Copper	Acceptable
Rotor	Carbon steel	Acceptable
Stator shell	301 Stainless Steel	Acceptable
Magnet wire insulation	Polyester w/polyamid-imide overcoat	Acceptable
Internal wire insulation	Cross-linked polyethylene or neoprene	Acceptable
Castings	304 Stainless Steel over cast iron	Acceptable
Fasteners	316 Stainless Steel	Acceptable
Seal	Viton®	Acceptable (2)
Seal cover	Tefzel®	Acceptable
Diaphragm	Viton®	Acceptable (2)
Diaphragm cover	316 Stainless Steel	Acceptable
Slinger	Viton®	Acceptable (2)
Lead wire	#12 AWG Tefzel®	Acceptable
Lead potting	Epoxy (chemical resistant)	Acceptable
Lead bushing	Viton®	Acceptable (2)

Lead jam nut	316 Stainless Steel	Acceptable
Lead sleeve	316 Stainless Steel	Acceptable
Pump Shrouds (4” SST Pipe)		
Body	304 Stainless Steel	Acceptable
Pump Shrouds Seals (Simmons model # 191ABSWS4X1)		
Seal	EPDM	Acceptable
Flanges	ABS	Acceptable
Discharge Manifold (1” SST Pipe)		
Pipe	304 Stainless Steel	Acceptable
Fittings	304 Stainless Steel	Acceptable
Cable Carrier (Gortrac model # SC-115)		
Body	304 Stainless Steel	Acceptable
Void Sealants (PelSeal® 3169-KIT)		
Access pipe sealant	PelSeal® 3169-KIT	Acceptable
Access pipe sealant	RTV Foam (silicone)	Not acceptable, not used
Thread Sealants (Fel-Pro C100)		
Fel-Pro C100	Molybdenum-disulfate	Acceptable
Moly-Kote	Molybdenum-disulfate	Acceptable
Neolube #100	Graphite based	Acceptable
Teflon	Teflon	Not acceptable, not used
Position Sensor (Celesco model # PT9101-0400-424-1130)		
Cable reel	Carbon Steel	Acceptable
Reel bushings	Nylon	Acceptable
Fasteners	18-8 stainless steel	Acceptable
Seals	Viton®	Acceptable (2)
Spring	Carbon steel	Acceptable
Belt	Kevlar®, Hytrel®	Acceptable
Connectors	Carbon steel	Acceptable
Cable	316 stainless steel	Acceptable
Electrical Connector	Aluminum (from vendor)	Not acceptable, replaced with next item.
Electrical Connector	Carbon steel	Acceptable
Oil for Spring	Silicone	Acceptable
Position Sensor Signal Cable (Celesco model # 96-03924-0015 – not used	**Elocab model # EHRK-32322-REV1)**	
Cable insulation	Polyurethane	Acceptable (3)
Braided support mesh	Kevlar®	Acceptable
Cable binders	Polyester	Acceptable
Electrical Connector	Carbon steel	Acceptable

Carriage Wheels and Rails (Bishop-Wisecarver model numbers: wheels W3SSX, Eccentric Bushing BX3SS, Concentric Bushing BXSS, Rails T3SS-8)

Wheels (inner & outer)	420 Stainless Steel	Acceptable
Ball Bearings	304 Stainless Steel	Acceptable
Bearing Retainer	304 Stainless Steel	Acceptable
Bearing Shield	304 Stainless Steel	Acceptable
Bearing Seal	NBR (nitrile rubber) & Nylon	Acceptable
Rails	420 stainless steel	Acceptable

Discharge Hose (Thermoid/HRD Industries, 1” Ultra-Chem 250 psi wp)

Jacket	EPDM	Acceptable
Reinforcement	Nylon w/steel wire helix	Acceptable
Tube	UHMWPE w/rubber backing	Acceptable

Hose Fittings (Rubber and Gasket of America model numbers, Male Camlock 100-A-SS-NRW, Female Camlock w/gasket 100-C-SS-NRW, Clamp Dixon STBC150)

Male Camlock fittings	316 Stainless steel	Acceptable
Female Camlock fittings	316 Stainless steel	Acceptable
Gaskets	EPDM	Acceptable
Band clamp	Stainless steel	Acceptable

Flow Meter (Endress Hauser, model # 53W25-UL0B1RC2B3AB)

Liner	Polyurethane	Acceptable (4)
Tube	316 stainless steel	Acceptable
Coil Cable	Copper	Acceptable
Coil cable insulation	PVC	Acceptable
Signal Cable	Copper	Acceptable
Signal cable insulation	PVC	Acceptable
Flanges	Carbon Steel	Acceptable
Electrodes	316 stainless steel	Acceptable
Sensor housing	Aluminum	Not acceptable, coated with next item.
Epoxy coating	Sherwin-Williams Macropoxy® 646	Acceptable
Gaskets	ASTM A-200 Neoprene	Acceptable

Winch (Thern, model # 462PB)

Body	Carbon steel	Acceptable
Drum	Carbon steel	Acceptable
Crank	Carbon steel	Acceptable
Cable	Stainless steel	Acceptable
Fasteners	Carbon steel	Acceptable
Lubricant	30 & 90 weight oil	Acceptable

Winch Drive System (vendor and model numbers listed below)

Bushings, Berg # B7-47	Bronze	Acceptable
Seal, Berg # LMG-R-3	Steel & synthetic rubber	Acceptable, outside tank
Drive Socket	Carbon Steel	Acceptable
Impact Socket Extension	Carbon Steel	Acceptable
Locking Pin	304 Stainless Steel	Acceptable
Shaft Collar	304 Stainless Steel	Acceptable

Coupling, PIC # T22S-50	17-4 PH Stainless Steel	Acceptable, outside tank
Drive Shafts	304 Stainless Steel	Acceptable
Drive Shaft Sleeve	304 Stainless Steel	Acceptable
Mounting Parts	304 Stainless Steel	Acceptable
Gear Box, W.C. Branham # 4304-0115	Aluminum, 4140 SST	Acceptable, outside tank (5)
Hand Wheel, McMaster # 6328K55	Stainless Steel	Acceptable, outside tank
Roll Pin	Stainless Steel	Acceptable, outside tank
Backflush Valve (Hydroseal model # 15D3MOM30)		
28 Parts	300 series Stainless Steel	Acceptable
Body	CFBM = Cast 316 Stainless steel	Acceptable
O-rings	Viton®	Acceptable (2)
Drain Valve (Whitey model # SS-45EF8-SH)		
Body	Stainless steel	Acceptable
Handle	Stainless steel	Acceptable
Seat	UHMWPE	Acceptable
Pump Carriage Eye Bolt (McMaster Carr model #33045t820)		
Body	Stainless Steel	Acceptable
Pump Shroud Hanger (McMaster Carr model # 3006T47)		
Body	Stainless Steel	Acceptable
Fasteners		
Nuts, bolts, washers	Stainless Steel	Acceptable (6)
Band clamps	Stainless Steel	Acceptable

Notes:

(1) If the Valox® fails, it will likely fail by stress-cracking rather than material loss or dissolution. Since the internal pump components are stainless steel, a crack in the pump seal (not the motor) will not cause a catastrophic pump failure and thus the Valox® is acceptable for this application.

(2) The resistance of Viton® fluoroelastomers is known to be limited in strong caustic solutions, particularly at elevated temperatures. EPDM elastomers are preferred if available and if used in the absence of petroleum-based lubricants.

(3) The position sensor cable insulation will have limited exposure to the waste, so for this application it is acceptable.

(4) Flow meter vendor stated meter should function without the liner. The meter will loose a small amount of accuracy.

(5) The gearbox bearings, seals, and other internal components are not specified by the vendor. This was evaluated as acceptable since the gearbox is outside the tank.

(6) Stainless steel fasteners were used whenever possible. The fasteners internal to the commercial components are listed under each component when data was available.