ADVANCED LIQUID PROCESSING

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ABSTRACT

Over the past several years, many technologies have been utilized to remove radioactive and chemical contaminants from liquid waste streams of nuclear generating stations. While each technology has specific applications where the efficiencies for removal of a certain isotope is high, no single technology can provide; the desired contaminant removal while achieving operational, economical and volume reduction goals.

This paper discusses how the blending of several technologies has achieved these desired goals at an operating nuclear generating station.

BACKGROUND

Millstone Unit 1 is a 654 megawatt, Boiling Water Reactor. Millstone generates normal BWR liquid waste streams: Condensate, Reactor Water Clean-up (RWCU), Fuel Pool Water Clean-up and Equipment Floor Drain System. Standard in plant systems provided waste treatment and volume reduction of these streams. Two primary methods were utilized: Ion Exchange/Filtration and evaporation.

While the condensate, RWCU and FPCU were and are operating well, the Equipment/Floor Drain System was not. The evaporators encountered significant operating and maintenance difficulties and the evaporator waste bottoms required secondary treatment in order to meet disposal sites requirements. Thus the area of our concentration was the Liquid Floor Drain Collection System.

ALPS

Chem-Nuclear Systems, Inc. has been providing mobile liquid treatment services since 1978. During this period most liquid waste treatment has been performed at PWRs. This potential application on a BWR waste stream presented several options. Our first approach was to potentially supply our GEODE™ System. This mobile evaporator/solidification system has the ability to effectively volume reduce the primary liquid waste while stabilizing the "bottoms" to the requirements of the Branch Technical Position on waste form. After review, it was determined that Millstone's water generation rates were far too great for the capacity of a GEODE system.

At this point, another key factor emerged which enabled us to examine alternate technologies. Millstone Station previously had been a "zero" release plant for chemical and radioisotopic effluents. This position was a philosophical one which was re-assessed and abandoned in light of current day political, economical and operational requirements.

We evaluated the Floor Drain Collection System influent water qualities; (3-3087 _ TOC: 27.9, TSS: 396, Conductivity: 8250, pH: 7.5, Total Activity: 6.5E-3, CS^{137} : 2.9E-3, CO^{60} : 3.3E-3. Effluent requirements were established as the limits in 10 CFR 20, Appendix B, Table II and not to exceed 45 mg/liter suspended solids.

Upon completion of the waste evaluation phase, we began testing to develop a responsive, economical and operational system to meet plant conditions. This resulted in the determination that a variety of proven technologies/components would be required. The Chem-Nuclear ALPS (R) (Advanced Liquid Processing System) became the answer to this need.

The basic technologies/components encompassed within Chem-Nuclear's ALPS which can be used as options, dependent on physical and radiochemical constituents, are:

- mechanical filtration (bag, cartridge)
- chemical pretreatment for flocculating, coagulation and precipitating
- organic ion exchange resin
- various carbons
- ion specific filtration/exchange materials
- pH adjustment/chem addition systems
- ultra filtration
- hollow fibre filtration

The Chem-Nuclear ALPS System operating at Millstone Station is comprised of the following:

- roughing prefiltration
- chemical pretreatment
- hi-flow ion specific vessels
- oganic ion exchange vessels
- post filter

A variety of experimentation has been performed to optimize wastewater throughput and minimize secondary waste generation. Initially, it was felt that cobalt removal would be a major concern in that previous experience showed it difficult to remove with standard systems. To effectively remove the cobalt, we opted for in line chemical pretreatment to render the cobalt removable via submicron filtration.

Secondary to cobalt was cesium removal. Numerous studies have been performed at Three Mild Island (1), West Valley (2), BNFL (3), Oak Ridge National Labs (4), and Millstone Unit II (5) which show zeolite materials with an affinity for removal of cesium from various wastewater streams. A proprietary zeolite material with the desired characteristics was exhaustively tested and

eventually utilized. The zeolite material was placed in service in re-useable/sluicable stainless steel pressure vessels (ASME Code Stamped) capable of containing any granular/powder media available today. A downflow approach is used with cross sectional flow-rates up to 7.1 gal/Ft^3 @ 50 gpm. The vessel sizes are determined primarily by physical constraints but generally are 24, 30 or 36 inches in diameter and 72 inches in height. Media retention elements are used on both influent and effluent distribution headers. Vessel shielding for this installation was via individual 2" (pb) lead shields for vessels and filter housings.

The next stage of the system removed the remaining minority radioisotopes. Our vast experience with organic ion exchange medias, cation, anion and mixed beds simplified the material selection while insuring optimum performance under operating conditions.

The last stage of this system includes submicron cartridge filters which are used to remove any remaining free flowing chemically pretreated cobalt, as well as media fines and submicron particles. Effluent liquid is processed to final holdup tanks for complete analysis prior to discharge to the environment.

PERFORMANCE OF THE SYSTEM

Prior to installation and operation of the Chem-Nuclear ALPS System, Millstone Unit 1 generated an average 3,500 Ft^3 of evaporator bottoms per year which, in turn, was solidified to produce roughly 6,500 Ft^3 of disposable waste. Additionally, maintenance and operation of the two evaporators was costly in both dollars and exposure.

The following shows the impact of the Chem-Nuclear ALPS System:

	1987	1988
Total Gallons	1,682,543	3,310,760
Waste media burial volume (approx.)	200 Ft^3	310 Ft^3
Gallons/cubic feet of expended media	8,412.72	10,679.80

SUMMARY

Millstone Unit 1 has greatly benefited from the combining of several distinct technologies to selectively treat a complex waste stream. Key to this has been extensive plant support of testing and implementation programs. Ongoing testing for the future is now under way to potentially improve this operation even further.

REFERENCES

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