PROCESSING OF SUMP SLUDGES AT THE COMMONWEALTH EDISON BYRON NUCLEAR GENERATING STATION

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ABSTRACT

A basic criterion for the disposal of radioactive waste by shallow land burial is that the material must not contain free liquids. In addition, burial sites' requirements regarding radioactive waste containing oils, even though solidified, are restrictive. At Commonwealth Edison Byron Nuclear Generating Station, a methodology for processing "treated waste sludges", originating form the turbine building's floor drains was developed and implemented. As a result of this effort, 322 drums of oil and water sludge were processed. A "dry cake", i.e., no free liquids, was produced, packaged, and readied for disposal. The dry cake contained less than 2% oil. The liquid phases resulting from the processing of the "treated waste sludge" were oil (that was to be processed for disposal as non-radioactive) and filtrate containing less than 5 ppm total suspended solids (TSS) and oil/grease. The filtrate TSS was below the Station's National Pollution Discharge Elimination System (NPDES) permit release limits.

INTRODUCTION

Commonwealth Edison Company Byron Nuclear Station is located in northern Illinois near the village of Byron, northwest of the city of Chicago. The Byron Nuclear Station is a dual unit 1120 Mega Watt pressurized water reactor.

Waste waters associated with the Byron Nuclear Station's turbine building equipment and floor drains are received in a series of collection tanks. Polymers are added to the waste water to facilitate proper floccing of suspended solids. This "treated waste sludge material" is pumped outside to a series of five settling ponds where it undergoes solar evaporation. Periodically, sludges are removed from the settling ponds and analyzed prior to disposal. In the past, analysis routinely indicated that the sludges were non-radioactive and non-hazardous, and, therefore, the sludges could be disposed of in a sanitary landfill.

In the spring of 1987, radiological analyses were performed on treated waste sludge material awaiting disposal. The analyses indicated that the sludge contained radioactive contaminants slightly above background and therefore, processing prior to disposal would be required.

In the nuclear industry, radioactive sludges are routinely processed for disposal by cement solidification, producing a solid liquid-free matrix. This classical cement solidification process can be fouled by the presence of oil. The Byron Station's "treated waste" sludges contained large amounts of oils and therefore, without considerable pre-treatment to remove the oils, cement solidification could not easily be performed.

Impell Corporation has developed a fully engineered backflushable, dry cake discharge filter system. This filter system has the capability of processing waste streams to a "dry cake", i.e., no free liquids. Before the Byron project, this filter system was utilized at several nuclear facilities to remove the solids from oil free aqueous liquids and in the oil fields of California, processing drilling muds. Due to the filter's ability to effectively remove solids from aqueous waste streams and it's ability to process oil laden material, the dry backflushable filter system was selected to process the "treated waste sludge" at the Byron Nuclear Station awaiting disposal.

SLUDGE CHARACTERISTICS, QUANTITY AND LOCATION

Two distinct waste streams, "treated waste sludge" and "treated waste sludge with failed floc agent", were awaiting processing at the Byron Nuclear Station. Although analysis performed on these waste streams were similar, their physical characteristics were different.

The "treated waste sludge" which contained high levels of oil and solids, had a rancid smell and the solids had a heavy oil laden mud appearance. The "treated waste sludge with failed floc agent" contained a lesser amount of oils and had a slimy consistency. Figure (1) shows a typical drum of "treated waste sludge". The type, quantity and

Fig. 1. Typical Drum of Waste Sludge.

Type	Quantity	Location
Treated Waste Sludge	~4,650 gallons	Contained in 93 Drums labeled "Rows 1, 2, 4, & 5"
Failed Floc Sludge	~3,450 gallons	Contained in 69 Drums labeled "TR Pond 2, 3, 4 and Eq Tank"
Treated Waste Sludge	~8,000 gallons	Contained in Solar Evaporation Ponds

location of waste materials awaiting processing were as follows:

Analysis performed on these waste streams included the following:

Determination	Results
British Thermal Units	19200 BTU/1b
Chlorine, Organic	0.2%
Flash Point (Pensky-Marten)	>140F°
Density	0.873 g/cc
pH of soil in water	5.0 - 6.0
Solids, Total of 103°C	60%
Sodium (Na)	54 mg/kg
EP Toxicity Package	< EPA Action Levels

Radioactive Material Weighted Averages

Isotope	Quantity
Mn-54	7.8E-07 μCi/ml
Co-60	8.4E-06 μCi/ml
Cs-134	5.5E-07 μCi/ml
Cs-137	1.5E-06 μCi/ml

METHODOLOGY

Since the "backflushable filter" had not previously been used to process an identical type of material as Byron's "treated waste sludge", a detailed methodology was developed to assure that: 1) the filter system could process the waste materials and 2) the material would be processed in an efficient and safe manner. The methodology included the following phases: a graphic depiction of the methodology is located in Fig. 2.

Waste Analysis and Characterization

Drum Sampling

Initial Filterability Testing

Analysis of Initial Test Effluents

Bench Scale Testing

Analysis of Bench Scale Tests Filtrate and "Dry Cake"

Full Scale Processing

Continued Analysis of Full Scale Processing Filtrate and "Dry Cake"

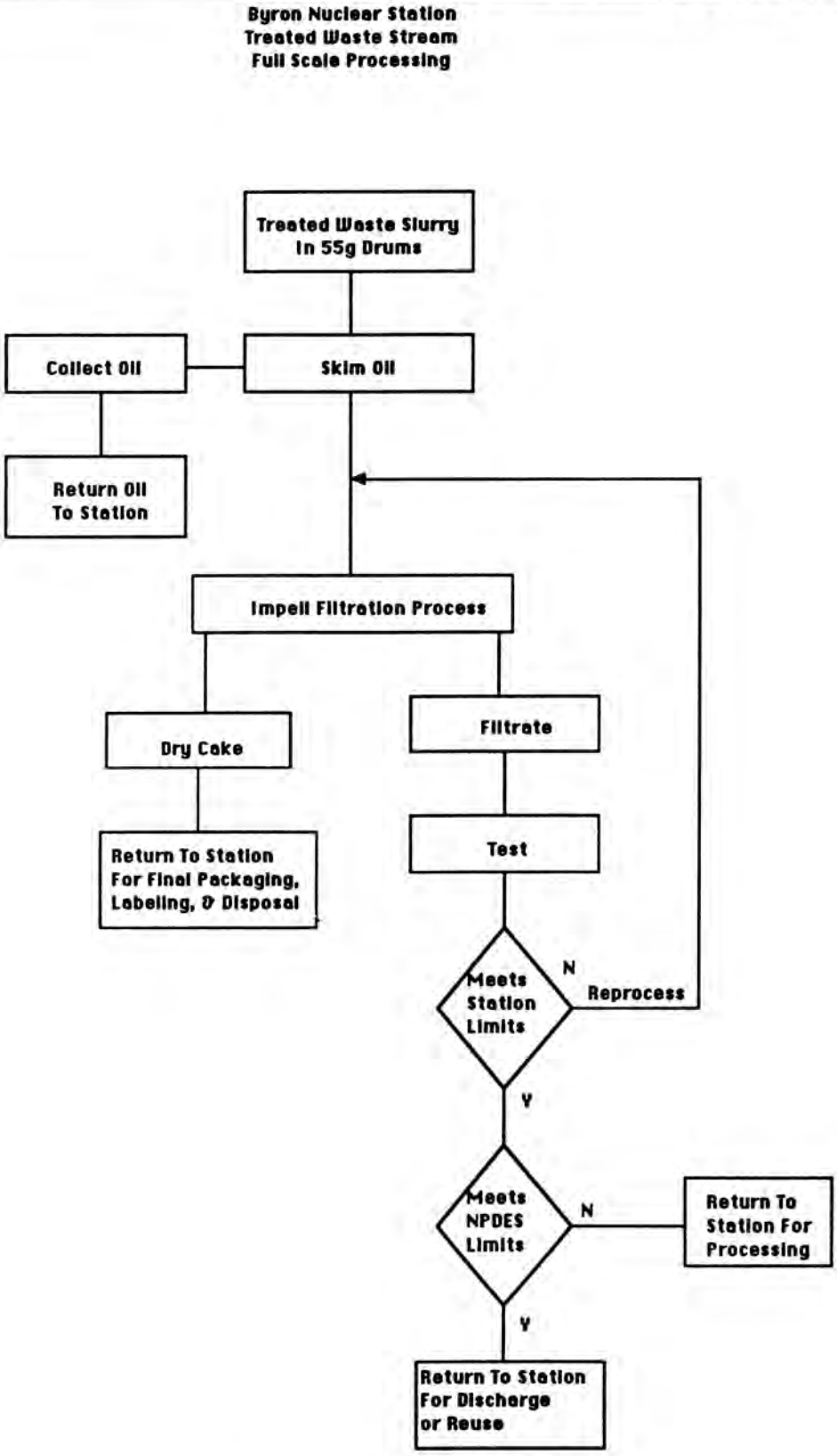
WASTE ANALYSIS, CHARACTERIZATION AND DRUM SAMPLING

The waste analysis listed above in the "Sludge Characterization" Section were reviewed pursuant to 40 CFR 261 requirements. As a result of the review, the waste was characterized as radioactive waste (not mixed).

Ten percent of the containers used to store the "treated waste sludge" material were sampled using the "COLIWASA" (sludge judge) method described in Samplers and Sampling Procedures for Hazardous Waste Streams, EPA 600/2-80-018, January, 1986.

INITIAL FILTERABILITY TESTING

In this phase, samples of the "treated waste sludge" were passed through various sizes of millipore filter paper,



10

Fig. 2. Graphic Depiction of Methodology.

ranging in size from 5 to 25 micron and sieve trays of 100 and 250 micron size. Diatomaceous earth was used as a filter enhancer to help aid the filtering process. The goal of this phase of methodology was to ascertain the filterability of the waste material. The Initial Filterability Testing phase produced the following data. The larger micron size sieve trays were used to pre-filter waste samples, as necessary.

Additional observations made during initial testing were:

	Visual Inspection				% Particulate Size (micron)				
Sample	% Oil	% Water	% Solids	Filterability	250	100	25	5	.45
TR Pond 2	30	50	20	good	60	10	5	5	20
TR Pond 3	10	70	20	good	60	10	5	5	20
TR Pond 4	10	70	20	good	60	10	5	5	20
Eq Tank	5	75	20	good	60	10	5	5	20
Rows 1&2	20	55	25	good	--	--	75	5	20
Rows 4&5	20	55	25	good	--	--	75	5	20

- Oil was skimmed from samples prior to filtering.
- Iron oxide appeared to be present in all effluents, distinguished by an orange-red appearance.
- A pre-coat of diatomaceous earth (DE) removed the iron oxide completely.
- Wastes from TR Ponds and the Equalization Tank (Eq Tank) had good filterability, after pre-filtering with sieve trays.
- Sludge residue showed large amounts of oil.

Four filtrate samples produced during initial testing were analyzed for total suspended solids (TSS). The results of the analysis are as follows:

Sample	Filter Size	TSS (ppm)
Rows 1&2	25 micron	263
Rows 4&5	.45 micron	148
TR Pond 2, 3, 4 & Eq Tank	.25 micron	200
TR Pond 2, 3, 4 & Eq Tank	.45 micron w/DE	28

BENCH SCALE TESTING

In this phase, samples of the sludge are processed in a "bench scale" backflushable filter. The goals of the testing were to: (1) remove solids and contaminates from the sludges to a low enough level where the resulting filtrate would meet the requirements of the Station's NPDES permit, (2) develop full scale processing parameters for the treatment of the sludge using the full size backflushable filter and (3) validate the initial testing's conclusions.

Two 55-gallon drums of "treated waste sludge", one having good filterability characteristics without pre-filtering and the other having good filterability characteristics with pre-filtering, based on initial testing results were selected at random. The random drums came from Row 2 and the equalization tank. A small Impell backflushable unit was used for bench scale testing purposes.

Samples from Row 2's 55-gallon drum (good filterability characteristics without pre-filtering) were diluted with approximately 2:1 water to sludge mix and then processed through the bench scale backflushable filter unit. The filtrate from this processing procedure had an orange/red color, indicating iron oxide. The filtrate was processed a second time, producing a second filtrate containing approximately 4 ppm of total suspended solids, no orange/red color was evident. The filter cake produced as a result of this processing effort contained a large concentration of oil.

Processing of waste material from the equalization tank's 55-gallon drum (good filterability characteristics with pre-filtering) was attempted with the backflushable filter. The backflushable filter clogged almost immediately upon the introduction of this material. Several attempts at processing this material were made, each produced similar results.

A large quantity of suspended solids (resembling fibrous material) was observed in the equalization tank's 55-gallon drum. Upon further investigation, it was determined that sludge originating from the equalization tank contained an abnormally large *amount of failed* polymer. It was believed that the increased level of polymer caused the bench scale testing equalization tank samples to clog the filter.

As a result of the initial and bench scale testing, it was determined that:

- The surface waste oil layer could be removed from the waste material prior to processing.
- Sludges from Rows 1, 2, 4, and 5 could be processed through the backflushable filter.
- A backflushable filter with an automated backwash cycle, via a programmable logic controller to control cake dryness, was the unit of preference for processing the "treated waste sludge". This unit contained 75 micron filter elements applicable for processing the high solids concentration seen in initial and bench scale testing.
- Sludges from TR Pond 2, 3, 4, and the Equalization Pond would need pre-treatment prior to processing. Three pre-treatment alternatives were considered. They were as follows:

1. The sludges could be strained twice through a basket strainer. The first straining would incorporate a 250 micron element, the second a 100 micron element. This methodology was tested in the "initial testing" phase.
2. Sodium hypochlorite (concentrated bleach) could be added to the sludge to break the bonding characteristics of the polymer, thus enhancing the material's filterability.
3. A combination of the two alternatives.

Before any of the alternatives were tried in full scale processing, each method was examined. The examination used the same protocol established in "initial testing" and was performed in conjunction with full scale processing of Rows 1, 2, 4, 5, and solar pond sludge material.

During full scale processing, failed floc sludge samples were pre-treated with sodium hypochlorite and filtered through various sizes of millipore filter paper. The testing results indicated that the sodium hypochlorite could break the bonding effects of the failed polymer. Sodium hypochlorite was added to each failed floc sludge drum as indicated by testing.

FULL SCALE PROCESSING

The Byron Nuclear Station's "treated waste sludges" were processed using the parameters and protocol developed in bench scale testing. Fig. (3) is the Impell Dry Backflushable Filter system in operation at Byron. Figure (4) is a schematic showing the process steps:

1. Oils were decanted from the sludge drums and stored in clean drums to await separate processing.
2. Drums of sludge material were pumped into a 1000-gallon portable tank and received a 1:1 water dilution. Approximately 500 gallons of water was used for dilution. The same water was cleaned in the filtering process and reused. No additional water was needed for dilution.
3. The water and sludge was mixed to a homogeneous intermediate product.
4. The intermediate product was introduced to the backflushable filter, pre-coated with diatomaceous earth. The water was then removed from the solids. The resulting filter cake was placed into drums and the filtrate was pumped into a 2000-gallon portable (filtrate) tank.
5. When the 2000-gallon filtrate tank was full, the sludge filtering operation was suspended. Oil in the filtrate tank was decanted and the tank's contents processed through the backflushable filter.
6. The filtrate produced in Step 5 was pumped to a filtrate storage liner (another 2000-gallon portable tank). Samples were drawn from this tank and analyzed. If the sample's results indicated that the filtrate was below the Station's administrative limits, the filtrate was discharge off-site. Filtrate with analytical results greater than the administrative limits were re-introduced to the backflushable filter for further processing.

The technical specifications of the backflushable filter system used at the Byron Nuclear Station are as follows:

Flow Rate:	15 GPM
Design Pressure:	150 lb
Clean Pressure Drop:	< 15 psi
Dirty Pressure Drop:	15 psi to 60 psi
Materials of Construction:	316 Stainless Steel Inconel 600 structural steel-coated carbon steel
Filter Rating:	75 micron
Operating Temperature:	400° to 220°
Process Controls:	Automatic

CONCLUSION

The processing of the "treated waste sludge" at Commonwealth Edison Byron Nuclear Station was a suc-

Fig. 3. Dry Backflushable Filter System at Byron.

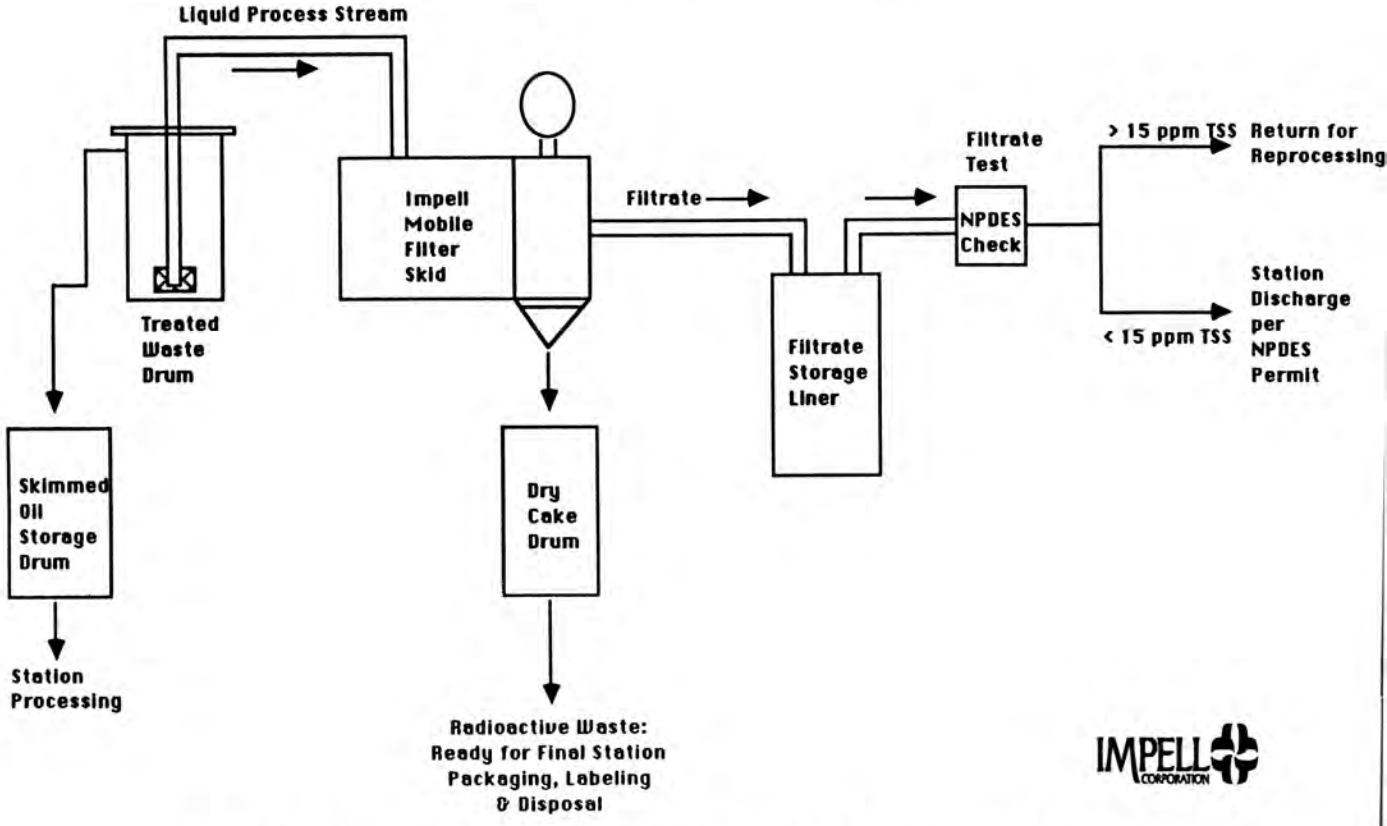


Fig. 4. Byron Nuclear Station - Treated Waste Sludge - Full Scale Processing Schematic.

cess. 322 drums of oil and water turbine building sludge, including failed polymer drums, were processed using the Impell dry backflushable filter system. A "dry cake", i.e., no free liquids, was produced, packaged, and readied for disposal. The filtrate produced was well below the Station's release limit of 15 ppm TSS and was discharged off-site. Due to the division of the original waste streams into three components (dry cake, oil, and filtrate), a waste volume reduction factor of 1.5:1 was achieved.