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U.S. Nuclear Regulatory Commission
ATTN: Mrs. Deborah A. DeMarco
Two White Flint North
11545 Rockville Pike
Mail Stop T8A23
Washington, DC 20555

Subject: Programmatic Review of Poster

Dear Mrs. DeMarco:

The enclosed poster is being submitted for programmatic review. This poster will be submitted for presentation at the Material Research Society, to be held August 27–September 1, 2000, in Sydney, Australia. The title of this poster is:

> "PRETREAT: A Graphical User Interface-Based Spreadsheet Model for Hanford Tank Waste Pretreatment Processes" by L. Yang, R. Pabalan, V. Jain, and G. Cragnolino

This poster is a product of the CNWRA and does not necessarily reflect the view(s) or regulatory position of the NRC.

Please advise me of the results of your programmatic review. Your cooperation in this matter is appreciated.

Sincerely,

Budhi Sagar
Technical Director

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Enclosure

cc:	J. Linehan	M. Tokar	W. Patrick	G. Cragnolino
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PRETREAT: A Graphical User Interface-Based Spreadsheet Model for Hanford Tank Waste Pretreatment Processes

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INTRODUCTION

The U.S. Department of Energy (DOE) will remediate 204,000 m^3 of high-level radioactive waste (HLW) stored in 177 aging underground storage tanks at the Hanford (Washington, U.S.A.) site. The remediation will consist of waste retrieval, pretreatment, immobilization, and disposal. The retrieved tank wastes will be chemically separated into HLW and low-activity waste (LAW). Both will be solidified into glass forms. The LAW stream will be pretreated prior to solidification to reduce the concentrations of ^{137}Cs, ^{90}Sr, ^{99}Tc, and transuranic (TRU) elements so the LAW glass complies with the required radioactivity limits and is suitable for on-site disposal.

Assessments of potential radiological, chemical, and criticality hazards and of strategies for mitigating these hazards require a knowledge of the chemical compositions and radionuclide concentrations of the waste streams at each stage of the LAW pretreatment process. To aid these assessments, PRETREAT, a mass-balance model for Hanford tank waste pretreatment processes, was developed using Microsoft Excel. More than 30 worksheets are used in PRETREAT to represent the pretreatment flowsheet. A graphical user interface was implemented using Visual Basic to (i) guide the user in navigating through the worksheets, (ii) minimize the tendency to input incomplete information on the worksheet, and (iii) enforce certain rules to prevent incorrect data entry, e.g., in cells requiring equations or specific data types.

LOW-ACTIVITY WASTE PRETREATMENT FLOWSHEET

Figure 1 shows a flow diagram of PRETREAT. There are seven process units in the flowsheet:

(1) Feed Receipt—feeds received from the DOE and from HLW stream processing are mixed with recycled streams

(2) LAW Evaporator—removes excess water

(3) Precipitation/Ultrafiltration—precipitates and filters out ^{90}Sr and TRU

(4) Cs Ion Exchange—removes ^{137}Cs

(5) Tc Ion Exchange—removes ^{99}Tc

(6) Melter Feed Evaporator—removes excess water from the final feed to the melter

(7) Melter—converts LAW and glass-forming materials into glass product

As shown in Figure 1, the incoming feed stream of each unit, except the Feed unit, separates into two output streams. The partitioning of waste components in the two output streams are calculated in Excel from known or assumed decontamination or separation factors.

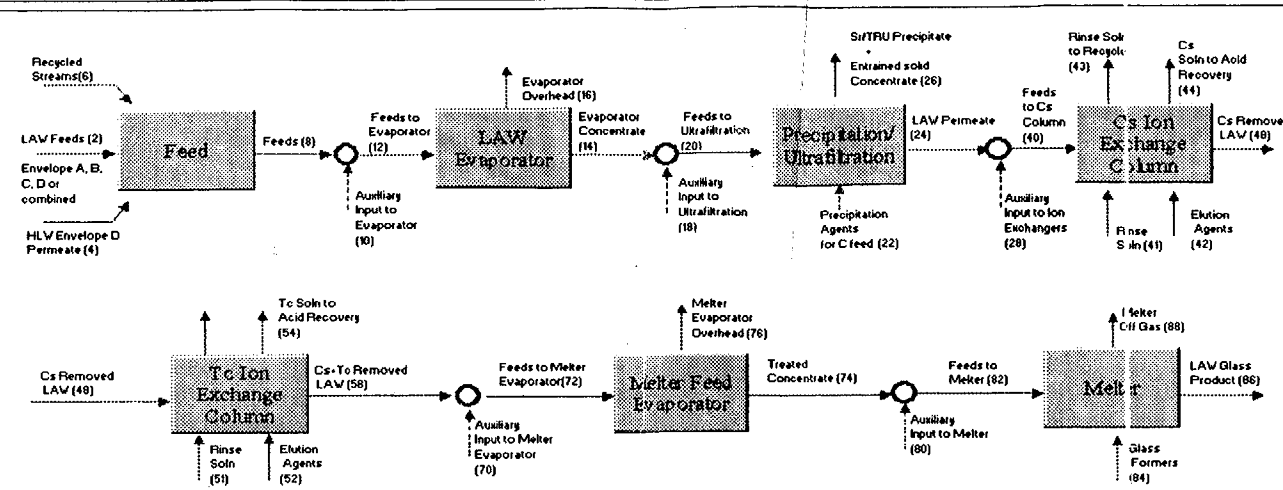

Figure 1. PRETREAT flow diagram representation of the Hanford LAW pretreatment process flowsheet. The process stream numbers given in parentheses are used for reference (see Tables 1 and 2).

Stream No	12		14		15	
Stream Name	Feeds to LAW Evaporator		LAW Concentrate		Evaporator Overhead	
Stream Temp	20		20		20	
Feed A (%)	0		0		0	
Feed B (%)	100		100		100	
Feed C (%)	0		0		0	
Feed D (%)	0		0		0	
Mass Flow, g/d	1.9177E+06		1.4886E+06		4.2865E+07	
Volume Flow, L/d	1.5000E+06		1.0714E+06		4.2857E+04	
Density, g/L	1.2785E+03		1.3896E+03		1.0007E+03	
Activity Flow, Bq/d	1.2816E+16		1.2803E+16		1.2816E+13	
Component	Mass, g/L	Altivity, Bq/L	Mass, g/L	Altivity, Bq/L	Mass, g/L	Altivity, Bq/L
INORGANICS						
Ag	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Al	7.7760E+00	0	1.0876E+01	0	2.7216E-02	0
Am/Am241,242	0	8.2500E+05	0	1.1536E+06	0	2.8876E+03
As	0.0000E+00	0	0.0000E+00	0	0.0000E+00	0
B	0	0	0	0	0	0
Ba/Ba137	5.5195E-06	4.1200E+10	7.7166E-06	5.7622E+10	1.9318E-07	1.4420E+08
Be	0	0	0	0	0	0
Bi	0	0	0	0	0	0
C (as CO3)	0	7.5500E+04	0	1.0559E+05	0	2.8425E+02
Ca	1.9960E-03	0	2.7916E-03	0	6.9860E-06	0
Cd	2.3997E-03	0	3.3563E-03	0	8.3991E-06	0
Ce	0	0	0	0	0	0
Cl	1.4857E-01	0	2.0779E-01	0	5.1999E-04	0
Cr	1.1752E+00	0	1.6436E+00	0	4.1132E-03	0
Cs/Cs137,134	0.0000E+00	4.4050E+10	0.0000E+00	6.1606E+10	0.0000E+00	1.5418E+08
Cu	0	0	0	0	0	0
....	....	....	....	....	....	....
Sm/Sm151	0	0	0	0	0	0
Sr/Sr90	3.3157E-06	8.5000E+07	4.6373E-06	1.1888E+08	1.1605E-07	2.9750E+06
Tc/Tc99	0	1.4900E+07	0	2.0839E+07	0	5.2150E+04
Th/Th232,229	0	0	0	0	0	0
Ti	0	0	0	0	0	0
U/U233~238	1.0424E+00	1.2950E+04	1.4580E+00	1.8112E+04	3.6485E-03	4.5325E+01
Y/Y90	0	8.5000E+07	0	1.1888E+08	0	2.9750E+06
Others Inorg.	0	0	0	0	0	0
ORGANICS						
Acetate	0	0	0	0	0	0
....	......	......	......	......	......	......
NTA	0	0	0	0	0	0
Oxalate	0	0	0	0	0	0
TBP	0	0	0	0	0	0
Other Organics	0	0	0	0	0	0
	0	0	0	0	0	0
SUM	1.2785E+03	8.5487E+10	1.3896E+03	1.1949E+11	1.0007E+03	2.9903E+08
Total TRU	0	1.4200E+06	0	1.9860E+06	0	4.9700E+03
TIC	8.7000E+00	0	1.2168E+01	0	3.0450E-02	0
TOC	1.9560E+00	0	2.7357E+00	0	6.8460E-03	0
Total solids	5.0000E+00	0	7.0000E+00	0	0.0000E+00	0
Pu239/241 in solids	0	0	0	0	0	0
U235 in solids	1.0424E+00	0	1.4594E+00	0	0.0000E+00	0

Table 1. Example of a typical worksheet for a process unit. The example shown is for the low-activity waste evaporator unit. Only selected components are shown; the actual Excel worksheet tracks more than 70 components.

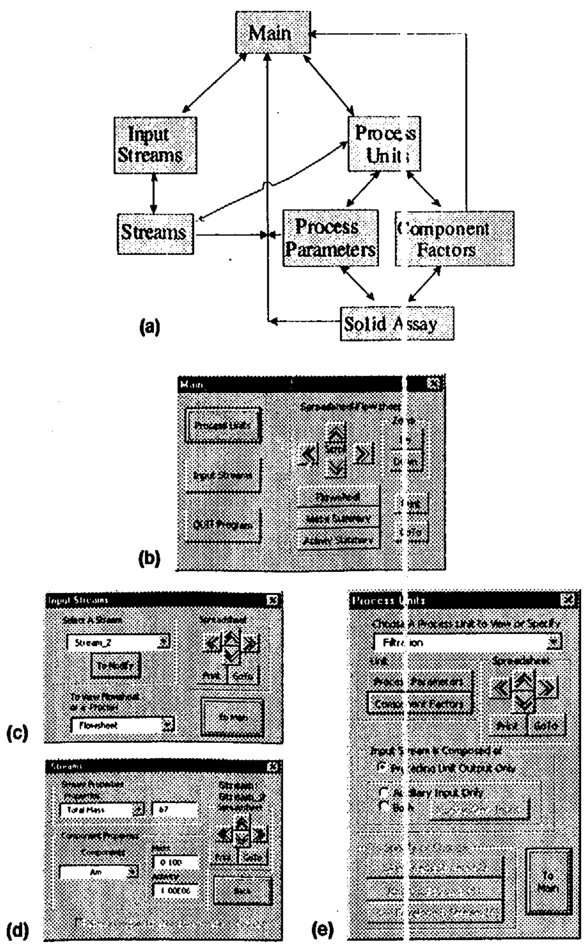

Figure 2. A graphical interface is implemented in PRETREAT to guide the user. Figure 2(a) shows the hierarchy and access directions of the PRETREAT user forms. Figures 2(b) to 2(e) are typical user forms of the graphical user interface.

RESULTS

Table 2. Calculated radionuclide activities for selected waste streams

Stream Properties								
Stream No.	2	12	28	54	72	76	88	86
Envelope A (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Envelope B (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Envelope C (%)	100.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0
Envelope D (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mass Flow, g/d	4.15E+07	4.15E+07	3.71E+07	2.21E+06	4.47E+07	1.24E+07	2.75E+07	3.03E+07
Volume Flow, L/d	3.00E+04	3.00E+04	2.56E+04	2.20E+03	3.28E+04	1.24E+04	n/a	n/a
Density, g/L	1.38E+03	1.38E+03	1.45E+03	1.00E+03	1.37E+03	1.00E+03	n/a	n/a
Activity Flow, Bq/d	5.56E+14	5.56E+14	5.56E+14	2.34E+10	2.25E+13	2.28E+10	2.29E+10	2.25E+13
Component	Activity, Bq/L							
Am/Am241,242	4.05E+06	4.05E+06	4.74E+06	2.77E+04	1.86E+06	4.93E+03	8.08E+07	8.08E+10
Ba/Ba137	7.03E+09	7.03E+09	8.23E+09	9.55E+06	6.42E+06	1.70E+06	2.10E+10	2.10E+13
C (TIC as CO3)	1.63E+04	1.63E+04	1.90E+04	2.21E+02	1.48E+04	3.94E+01	4.86E+05	4.85E+08
Cd	2.82E+06	2.82E+06	3.30E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co/Co60	3.79E+06	3.79E+06	4.43E+06	5.15E+02	3.46E+04	9.18E+01	1.13E+06	1.13E+09
Cs/Cs137,134	7.43E+09	7.43E+09	8.69E+09	5.56E+04	3.74E+06	9.91E+03	1.22E+08	1.22E+11
Eu/Eu154,155	1.67E+07	1.67E+07	1.95E+07	4.54E+04	3.05E+06	8.08E+03	9.97E+07	9.96E+10
H2O/H3	2.27E+04	2.27E+04	2.27E+04	0.00E+00	1.73E+04	1.76E+04	3.50E+08	0.00E+00
I/I129	1.58E+04	1.58E+04	1.85E+04	2.15E+00	1.44E+02	3.83E-01	4.72E+03	4.72E+06
Np /Np-237	3.68E+05	3.68E+05	4.31E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni/Ni63,59	5.74E+06	5.74E+06	6.72E+06	7.80E+02	5.24E+04	1.39E+02	1.72E+06	1.71E+09
Pu/Pu239~241	8.69E+05	8.69E+05	1.02E+06	1.18E+02	7.93E+03	2.10E+01	2.60E+05	2.59E+08
Sb	6.28E+06	6.28E+06	7.35E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Se	1.62E+04	1.62E+04	1.90E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm/Sm151	3.66E+08	3.66E+08	4.28E+08	4.97E+04	3.34E+06	8.86E+03	1.09E+08	1.09E+11
Sr/Sr90	1.84E+09	1.84E+09	2.15E+09	2.49E+05	1.68E+07	4.44E+04	5.48E+08	5.48E+11
Tc/Tc99	2.84E+06	2.84E+06	3.32E+06	3.66E+05	1.30E+03	3.44E+00	4.24E+04	4.24E+07
Th/Th232,229	1.11E+03	1.11E+03	1.30E+03	1.51E-01	1.02E+01	2.69E-02	3.32E+02	3.32E+05
U/U233~238	1.34E+04	1.34E+04	1.57E+04	1.82E+00	1.23E+02	3.26E-01	4.01E+03	4.01E+06
Y/Y90	1.84E+09	1.84E+09	2.15E+09	2.49E+05	1.68E+07	4.44E+04	5.48E+08	5.48E+11
Zr	5.14E+05	5.14E+05	6.01E+05	8.98E+03	4.89E+05	1.24E+03	1.53E+07	1.53E+10
SUM	1.85E+10	1.85E+10	2.17E+10	1.06E+07	6.88E+08	1.84E+06	2.29E+10	2.25E+13

SUMMARY

A spreadsheet model, PRETREAT, was developed for mass-balance calculations of pretreatment processes proposed for the immobilization of Hanford nuclear waste. A user interface is implemented to allow convenient navigation through the large number of worksheets and cells of the spreadsheet model, specify model input values, make modifications to the process parameters, and view the model results. The applications of PRETREAT include estimation of radionuclide and chemical species concentrations in the waste streams at each stage of the pretreatment flowsheet, assessments of potential radiological, chemical, and criticality hazards, and identification of mitigating strategies for these hazards. The model also can be used to evaluate the sensitivity of model results to uncertainties in model parameters (e.g., decontamination or separation factors). PRETREAT handles the calculations for the entire pretreatment flowsheet for the complex Hanford nuclear wastes efficiently.

ACKNOWLEDGMENT

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