1/21/97

ANALYSIS OF TA-48 WASTE BOXES

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INTRODUCTION

The Medical Radioisotope Production (MRP) Program at Technical Area (TA)-48 of Los Alamos National Laboratory produces about 1,000 cubic feet of waste annually. Historically, all of this waste has been managed as radioactive and disposed of at the Laboratory's low-level radioactive waste disposal facility at TA-54, Area G, despite the fact that as much as 50 percent of the waste is not contaminated at measureable levels. This is a conservative best management practice, but it is not an efficient use of waste management monies, nor of radioactive waste disposal capacity. To reduce the volume of radioactive waste, the MRP Program implemented a pilot project called "Green is Clean," which combines

- waste avoidance practices,
- uncontaminated "Green" waste segregation,
- Green waste verification, and
- cradle-to-grave tracking.

The Green is Clean Pilot Project is managed by the Laboratory's Solid Waste Operations Group of the Environmental Management Division (EM-SWO). It implements the Department of Energy's "Response to Questions and Clarification of Requirements and Processes: DOE 5400.5, Section II.5 and Chapter IV Implementation (Requirements Relating to Residual Radioactive Material." That guidance allows for application of Authorized Release Limits (ARLs) for "Green" waste, provided that radiation measurement protocols ensure that the ARLs are not exceeded. This document was developed by the MRP for EM-SWO to provide the technical rationale ensuring both effective waste segregation on the basis of process knowledge, and accurate waste verification using appropriately qualified radiation detection protocols.

PROCESS KNOWLEDGE

The MRP is engaged in separation of radioactive isotopes from irradiated targets for the purpose of supplying the medical community with isotopes used in the diagnosis and treatment of various diseases. The MRP utilizes 13 "hot cells" at TA-48 to perform the chemical separations and packaging of final product. The targets from which the isotopes are extracted are irradiated at the Los Alamos Neutron Science Center (LANSCE) accelerator and various other national and international accelerators. The targets are designed to specifically generate the desired spallation products. No other materials are admitted into the hot cell areas. Based on the knowledge of target materials and incident beam power, and on the exclusion of all other materials from hot cells, the MRP has ensured that waste leaving the facility will contain only isotopes generated as a result of program production or controlled processes. All waste generated within the hot cells is managed as radioactive. "Green" waste generated outside of the hot cells can be controlled to ensure that it does not become contaminated. To verify that that "Green" waste has not become contaminated, measurement protocols are qualified to ensure that the ARLs are detectable for every radioisotope potentially (but inadvertently) present in Green waste. Process knowledge enables this to be accomplished.

Table I contains a listing of all isotopes expected to be generated as a result of MRP operations. This list is based on process knowledge including irradiation beam characteristics, target material(s), and chemical separations.

VERIFICATION INSTRUMENT QUALIFICATION

The Canberra Waste Activity Monitor, WAM-10 is a system of six plastic scintillator plates arranged in the walls of a counting chamber. This provides a nearly 4π counting geometry. The associated software provides for storage of operating and calibration parameters and provides password protected access to calibration functions. Procedures for operation and calibration of the instrument have been developed and approved.

A calibration study has shown that a typical waste box contains enough naturally occurring radioactivity that a box of "clean" office trash produces a counting rate significantly greater than background. To preclude disposing of such clean trash as contaminated, a "Background Box" of typical office and lab trash was prepared. This phantom is placed in the counter each time a background count is obtained.

A calibration box was prepared using Ba-133. This isotope was chosen based upon:

- availability
- long half-life, 10.54y
- low-energy x-rays
  - 30.625 keV, 35.6%
  - 30.973 keV, 65.7%
  - 34.967 keV, 18.0%
- gamma rays of moderate energy
  - 80.989 keV, 34.2%
  - 302.851 keV, 18.4%
  - 355.999 keV, 62.2%

An uncalibrated solution of Ba-133 in 1.25N HCl was used to create five sources in 20ml scintillation vials. Each vial was packed to the 5ml level with absorbent paper and 0.5ml of the Ba-133 solution was added to the paper. The vials were then capped and sealed with silicone sealant. This preparation technique was employed to avoid placing "loose" liquid into the calibration box. Additionally, the TA-48 counting facility uses a 5ml volume in this 20ml vial as its certified "Type 2" geometry. These five vials were labeled as Ba-133-1 through Ba-133-5.

The vials were counted on shelves 1 and 5 of counter #55 and shelf 1 of counter #18. These positions are calibrated for the scintillation vial geometry using NIST traceable standards. The results for each vial (in nCi) are tabulated below.

	Ba-133-1	Ba-133-2	Ba-133-3	Ba-133-4	Ba-133-5
Ctr 55 Sh 1	149.7	158.9	140.0	152.2	138.6
Ctr 55 Sh 5	144.1	151.0	137.9	146.1	137.4
Ctr 18 Sh 1	141.4	159.5	137.5	145.5	134.6
Avg	145.1	156.5	138.5	147.9	136.9

Total Activity = Σ Avg = 724.9 ± 7.9 nCi

The vials were placed in a standard waste box stuffed with paper. Ba-133-2 was placed in approximately the center of the box, Ba-133-1 and Ba-133-5 were placed near opposite corners of the top of the box and the other two vials were placed in opposite corners of the bottom of the box, opposite from the vials at the top of the box.

The final mass of the box, plastic bag liner, sources and paper contents is 5.60 kg. This yields a specific activity of Ba-133 in the box at 129.4 pCi/g.

A decay correction chart was developed and placed in the instrument logbook.

Background Data

Data on the background count rate was collected over several months and is compiled in Table III. Initially, it was recognized that the background rates were erratic and due primarily to two detectors. Vendor servicing was performed in December 1996 when gain adjustments were made to the two suspect PMT's and their associated AMP/SCA boards. Subsequent background data was lower and more consistent, but still exhibited a randomness which was greater than would be expected from mere statistical fluctuation.

The average and standard deviation values shown on Table III are based upon the data generated after vendor servicing. All count times were two minutes. At a count rate of 97767 cpm (195534 total counts), one would expect a standard deviation of:

$$\frac{\sqrt{(195534)}}{2} = 221 \text{ cpm}$$

or 0.22%. The fact that the data exhibit a 3.2% standard deviation suggests that factors such as time-of-day, temperature, barometric pressure, etc. have a significant influence on background count rate.

A review of the data and associated statistics indicates that of 42 counts obtained, one exceeds the 2 SD level. Establishing a release level of two standard deviations above average background would provide a level at which a small number of boxes at background levels may be discarded as suspect waste, but boxes at counting rates less than the two standard deviation limit cannot be distinguished statistically from background.
Table II lists the MRP radioisotopes and the ARLs (pCi/g) developed by EM-SWO, and also the ARLs converted to total activity (nCi) assuming a nomial waste box (6 kg). The total activity values are then compared to predicted counting rates in the WAM-10 for each isotope at its nCi ARL. A "Y" in the final column indicates that the instrument can detect at or below the total activity ARL, while a "N" indicates that instrument cannot detect that level of activity. The calculations used in constructing this table are below.

Efficiency - The counting efficiency (in counts per disintegration) for Ba-133. Ba-133 was the isotope selected for calibration of the WAM-10. Preparation of the calibration source is detailed below. The typical counting efficiency for this box is 0.18.

$$\text{Eff} = \frac{\text{(Countrate of Ba-133 standard) - (Background Countrate)}}{\text{(2.22 dpm/pCi)(Decay-corrected activity of Ba-133 in pCi)}}$$

Confidence Factor (CF) - The sample statistical confidence factor. The WAM-10 default value is 1.645.

Minimum Detectable Counting Rate (MDCR) - The minimum counting rate which can be discerned from background.

$$\text{MDCR} = \text{CF} \sqrt{\text{(Background Countrate/Sample CL + Background Countrate/Bkg CL)}}$$

Minimum Detectable Activity (MDA) - The minimum activity which can be discerned from background.

$$\text{MDA} = \frac{\text{MDCR}}{\text{(Eff) (2.22)}}$$

Worker Concentration Limit -

Intruder Concentration Limit -

Final Concentration Limit - This is the lesser of the Worker Concentration Limit and the Intruder Concentration Limit.

Assuming 6 kg Box (nCi) - The Final Concentration Limit is converted to total activity in a typical 6 kg waste box.

$$nCi = FCL * 6000\ g * nCi/1000\ pCi$$

Average Energy keV - This is the average gamma energy of all emissions greater than 30 keV. The steel liner of the WAM-10 has shown to be impenetrable to gamma rays less than 50 keV.

Total Gamma Abundance - This is the total gamma emission abundance for all energies above 30 keV.

Half Life - The half-life of each isotope in days or years is listed for reference.

CPM - This is the theoretical counting rate for each isotope at the Final Concentration Limit in a typical 6 kg waste box.

$$CPM = \frac{(nCi)\ (Ba\text{-}133\ eff)\ (2200\ dpm/nCi)\ (Total\ gamma\ abn)}{(Ba\text{-}133\ gamma\ abn)}$$

where: Ba-133 eff = 0.18 (assumed)
Total gamma abn = all gamma rays > 30 keV for each isotope
Ba-133 gamma abn = 2.6091; all Ba-133 gamma rays > 30 keV

Detect at Final Concentration Limit? - If the theoretical counting rate for each isotope is less than the minimum detectable counting rate (MDCR), then "N" appears in this column. The lower portion of Table II contains isotopes which are pure beta emitters or emitters of x-rays or weak gamma rays. These are flagged "N" since the WAM-10 cannot detect these.

Process Knowledge for Verifying Undetectable Isotopes

The discussion below provides a process-knowledge justification for verifying Green waste for undetectable radioisotopes, those for which an "N" appears in the last column of Table II.

^{208}Bi

This isotope is co-produced with ^{207}Bi. Assuming an atom for atom production rate, the maximum amount of ^{207}Bi permitted in the waste box (2.7 nCi) would be equivalent to 0.0023 nCi of ^{208}Bi which is well below the maximum of 0.8 nCi of ^{208}Bi permitted. The ARL for ^{207}Bi is several times the mimimum detectable level. Therefore if the ^{207}Bi is below its ARL, then the ^{208}Bi level ia also below its ARL.

^{113m}Cd

This isotope is co-produced with ^{109}Cd. Based on a measured production rate of 10 atoms ^{109}Cd per atom of ^{113m}Cd , the maximum amount of ^{109}Cd permitted in the waste box (18.9 mCi) would be equivalent to 175 nCi of ^{113m}Cd . This is 3 times the ARL. The ARL for ^{109}Cd is several hundred times the mimimum detection level. Therefore, if the ^{109}Cd ARL is set at 10% of the maximum, the ^{113m}Cd is below the ARL. Waste boxes that contain greater than 0.5 mCi of ^{109}Cd would not be considered candidates for disposal as clean waste and ^{113m}Cd, if present, would be less than 4.7 nCi, well below the ARL of 77 nCi. (Note: The MRP program stopped producing ^{109}Cd as of 11/96.)

$^{97}Tc/^{99}Tc$

These isotopes are co-produced with ^{95m}Tc. Assuming an atom for atom production rate, the maximum amount of ^{95m}Tc permitted in the waste box (3 nCi) would be equivalent to 1.9 E-7 nCi of ^{97}Tc and 2.26 E-6 nCi of ^{99}Tc which are well below the maximum of 801 nCi of ^{97}Tc and 176 nCi of ^{99}Tc permitted. The ARL for ^{95m}Tc is several times the mimimum detectable level. Therefore if the ^{95m}Tc ARL is not exceeded, then the ^{97}Tc and ^{99}Tc ARLs are not exceeded.

^{41}Ca

This isotope has never been found in the targets irradiated at LANSCE. The most likely production would be in the zinc oxide targets irradiated to produce ^{67}Cu. The ARL of ^{41}Ca (292nCi) per box corresponds to 3.44 mg of Ca. It is not possible to produce this mass of ^{41}Ca in a 5-7 day irradiation in our targets.

^{36}Cl

This isotope has never been found in the targets irradiated at LANSCE. The most likely production would be in the potassium chloride targets irradiated to produce ^{32}Si and ^{26}Al. The chemistry performed to isolate these isotopes effectively separates all of the chlorine isotopes produced within the hot cell. This waste is not removed from the hot cell and placed in the waste stream counted in the WAM-10.

$^{145}Sm/^{145}Pm$

These isotopes have been produced in the past, however there are no plans to resume production. A small amount is currently stored in Cell 12. There are no plans to remove it for analysis and radiation readings indicate that this material will require disposal as low-level/high activity waste.

^{55}Fe

Experimental data have indicated that production of ^{55}Fe is one half of that of ^{59}Fe on an activity basis. The limit for disposal for ^{59}Fe is 3.2 nCi per box. This equates to 1.6 nCi of ^{55}Fe which is well below the ARL of 410000 nCi ^{55}Fe per box. Samples containing iron isotopes are rarely removed from the hot cell and other radioisotopes present in these samples would require disposal as a known radioactive waste.

^{148}Gd

We curently have an inventory of this isotope in prepackaged vials. Any waste associated with additional use of this isotope will automatically be treated as radioactive due to the detection difficulty.

^{150}Gd

This isotope was probably co-produced with the ^{148}Gd. Treatment will therefore be the same. We have not identified ^{150}Gd in our ^{148}Gd inventory, probably because the levels are so low. Assuming a production rate of one atom of ^{148}Gd to one atom of ^{150}Gd there would be 1 nCi of ^{150}Gd per 1 mCi of ^{148}Gd.

^{93}Mo

This isotope may be produced in the molybdenum targets used to produce ^{82}Sr. The molybdenum target solutions are never processed for other radioisotopes. There is sufficient residual radioactivty from these isotopes that all molybdenum waste would have to be treated as low-level/high activity waste.

$^{59}Ni/^{63}Ni$

These isotopes have never been found in the targets irradiated at LANSCE. The most likely production would be in the zinc oxide targets irradiated to produce ^{67}Cu. Specific chemistry has been performed on zinc oxide targets to determine Ni isotope production. These experiments did not detect evidence of any measurable production of either ^{59}Ni or ^{63}Ni. The limits of 33 mCi of ^{59}Ni and 15.7 mCi 0f ^{63}Ni per box are well above that potentially made in our targets.

^{33}P

This isotope is recovered from the KCl targets irradiated to produce ^{32}Si and ^{26}Al. It is always contaminated with the ^{32}P daughter of ^{32}Si. Initial ratio is 5/1 on initial production of ^{32}P. The ^{32}Si and ^{26}Al isotopes are so valuable that every effort is made to recover all of them for inventory. The ^{32}P produced has significant economic value and efforts are being made to recover and isotopically separate the two phosphorus isotopes.

^{205}Pb

This isotope is produced in the lead targets irradiated in the 1970's for ^{195}Au production. We have 2 of these targets that will be processed for ^{207}Bi. The lead isotopes will not be separated from the other isotopes produced and will be treated as low-level high activty waste and disposed of from the hot cell as mixed waste.

^{193}Pt

This isotope is produced in the lead targets irradiated in the 1970's for ^{195}Au production. We have 2 of these targets that will be processed for ^{207}Bi. The platinum isotopes will not be separated from the other isotopes produced and will be treated as low-level high activty waste and disposed of from the hot cell in barrels.

^{32}Si

This isotope is recovered from the KCl targets irradiated to produce ^{32}Si and ^{26}Al. It is always contaminated with the ^{32}P daughter of ^{32}Si.

^{90}Sr

This isotope may be produced with ^{82}Sr and ^{85}Sr in the Mo metal targets. All waste from these targets is treated as high activity waste from the hot cells.

^{49}V

This isotope is normally associated with ^{48}V which has easily detected gammas.

RECOMMENDATION

It is our recommendation that a release limit of two standard deviations above background be established. Background counts should be collected before and after each "batch" of boxes counted. These count rates will be logged and trended. Any boxes which do not exceed two standrd deviations above background should be discarded as cold waste.

TABLE I

Ag-108m/Ag-108	Hf-178m	Re-183
Ag-110m/Ag110	Hg-194/Au-194	Re-184
Al-26	La-137	Re-184m/Re-184
As-73	Lu-173	Rh-101
As-74	Lu-174	Rh-102
Be-7	Lu-174m/Lu-174	Rh-102/mRh-102
Bi-207	Mn-54	Se-75
Bi-208	Mo-93	Si-32
Ca-41	Na-22	Sn-113/In-113m
Cd-109/Ag-109	Nb-91	Sr-82/Rb-82
Cd-113m	Nb-91m	Sr-85
Cl-36	Nb-92	Sr-90
Co-56	Nb-93m	Ta-179
Co-57	Nb-94	Ta-182
Co-58	Nb-95	Tb-157
Co-60	Ni-59	Tb-158
Cr-51	Ni-63	Tc-95m/Tc-95
Dy-154/Pm-145	Os-185	Tc-97
Eu-150	P-33	Tc-97m
Eu-152	Pb-202/Tl-202	Tc-98
Eu-154	Pb-205	Tc-99
Fe-55	Pm-145	Ti-44/Sc-44
Fe-59	Po-209	V-48
Gd-148	Pt-193	V-49
Gd-150	Rb-83	Zn-65
Ge-68/Ga-68	Rb-84	Zr-88/Y-88
Hf-172/Lu-172	Rb-86	Zr-95/Nb-95

TABLE II

Assume CL = 10
Bkg CR = 100000
Eff = 0.18
CF = 1.645

MDCR = 232.64 cpm
MDA = 582.18 pCi

Ba-133 - 404 keV 2.6091

Radionuclide	ARL Limit (pCi/g)	ARL per 6 kg Box (nCi)	Avg Energy keV	Total Gamma Abn	Half Life (d)	Half Life (y)	CPM	Detect at FCL?
Ag-108m/Ag-108	2.906E-01	1.7	1680.00	3.4965		127	934	
Ag-110m/Ag110	2.457E-01	1.5	2739.00	3.2395	249.76		731	
Al-26	1.429E-01	0.9	1839.60	2.6648		720000	350	
As-73	6.453E+04	387204.7	53.44	0.1050	80.3		6226796	
As-74	9.229E-01	5.5	467.00	1.3459	17.78		1141	
Be-7	1.358E+01	81.5	49.60	0.1042	53.29		1300	
Bi-207	4.458E-01	2.7	1539.00	2.5466		32.2	1043	
Bi-208	1.417E-01	0.8	2668.00	1.6539		3.68E+05	215	N
Cd-109/Ag-109	3.154E+03	18922.5	88.03	0.0360	462.6		104331	
Cd-113m	1.283E+01	77.0	263.71	0.0230		13.7	271	
Co-56	1.886E-01	1.1	3378.00	2.9019	77.7		503	
Co-57	1.435E+01	86.1	125.20	0.9638	271.77		12708	
Co-58	7.035E-01	4.2	824.00	1.0078	70.916		652	
Co-60	2.585E-01	1.6	2504.40	1.9990		5.271	475	
Cr-51	2.709E+01	162.5	320.08	0.0983	27.7		2447	
Eu-150	2.867E+03	17199.7	1501.00	3.6468		35.8	9606552	
Eu-152	6.141E-01	3.7	1162.00	2.4672		13.33	1392	
Eu-154	5.080E-01	3.0	1253.00	1.9732		8.8	921	
Fe-59	5.306E-01	3.2	1188.00	1.0416	44.496		508	
Ge-68/Ga-68	7.603E-01	4.6	38.00	1.8136	270.8		1267	
Hf-172/Lu-172	3.442E+03	20649.9	105.00	4.9065		1.87	15517624	
Hf-178m	9.051E+02	5430.7	2200.00	1.4389		31	1196789	
Hg-194/Au-194	4.453E-01	2.7	1051.00	2.1368		520	874	
La-137	1.514E+04	90827.8	25.30	0.7581		6.00E+04	10545813	
Lu-173	3.439E+04	206369.1	103.00	1.0996		1.37	34754753	
Lu-174	2.973E+04	178379.9	132.00	0.9499		3.31	25951266	
Lu-174m/Lu-174	1.997E+04	119803.9	60.10	1.8244	142		33475413	
Mn-54	8.364E-01	5.0	834.83	0.9998	312.2		768	
Na-22	2.772E-01	1.7	1274.53	2.7874		2.602	710	
Nb-91	2.567E+02	1540.5	10.27	0.0033		680	779	
Nb-91m	1.857E+01	111.4	51.00	0.0456	62		778	
Nb-92	2.476E-01	1.5	1505.90	2.0000		3.60E+07	455	
Nb-94	2.498E-01	1.5	1571.50	1.9971		20300	458	
Nb-95	8.377E-01	5.0	764.31	0.9983	34.97		768	
Os-185	1.114E+00	6.7	713.00	1.7213	93.6		1763	
Pb-202/Tl-202	1.130E+00	6.8	467.00	1.7061		5.30E+04	1772	
Pm-145	1.076E+02	645.4	33.10	0.8196		17.7	81020	
Po-209	1.652E+02	991.2	3.10	0.0078		102	1184	
Rb-83	1.443E+00	8.7	507.00	0.9362	86.2		1241	
Rb-84	8.146E-01	4.9	622.00	1.2105	32.87		906	
Rb-86	7.443E+00	44.7	1076.69	0.0878	18.66		600	
Re-183	1.536E+01	92.1	150.00	1.6204	70		22867	
Re-184	7.820E-01	4.7	893.00	2.0336	38		1461	
Re-184m/Re-184	1.032E+00	6.2	390.00	3.2549	165		3085	
Rh-101	1.542E+04	92539.0	300.00	1.5990		3.3	22662514	
Rh-102	4.349E+03	26093.3	2162.00	3.1737		2.9	12683245	
Rh-102/mRh-102	1.035E+04	62128.7	355.00	1.0764	207		10242382	
Se-75	2.083E+00	12.5	392.00	1.7974	119.77		3441	
Sn-113/In-113m	2.794E+00	16.8	280.00	0.6582	115.09		1690	
Sr-82/Rb-82	6.524E-01	3.9	2530.00	3.5566	25.55		2132	
Sr-85	1.425E+00	8.6	518.30	0.9928	64.84		1300	

TABLE II (cont'd)

Radionuclide	ARL Limit (pCi/g)	ARL in 6 kg Box (nCi)	Avg Energy keV	Total Gamma Abn	Half Life (d)	Half Life (y)	CPM	Detect at FCL?
Ta-179	1.286E+05	771551.6	28.30	0.4680		1.79	55302604	
Ta-182	6.104E-01	3.7	1301.00	2.2904	115		1285	
Tb-157	4.540E+02	2724.0	9.55	0.1982		150	82688	
Tb-158	2.287E+03	13721.6	787.00	1.8641		150	3917497	
Tc-95m/Tc-95	4.980E-01	3.0	716.00	1.5326	61		701	
Tc-97m	3.636E+04	218138.7	96.51	0.0031	90.5		103569	
Tc-98	2.751E-01	1.7	1394.30	1.9950		4.20E+06	504	
Tc-99	2.935E+01	176.1	89.65	0.0000		2.13E+05	0	N
Ti-44/Sc-44	3.112E-01	1.9	138.40	4.7663		47.3	1363	
V-48	2.114E-01	1.3	2401.00	3.0869	15.976		600	
Zn-65	1.257E+00	7.5	569.30	0.5368	244.1		620	
Zr-88/Y-88	8.566E-01	5.1	391.90	2.9056	83.4		2287	
Zr-95/Nb-95	7.686E-01	4.6	733.00	2.2457	64.02		1586	
Ca-41	4.868E+01	292.1				103000		N
Cl-36	3.316E-01	2.0				301000		N
Dy-154/Pm-145	---					2.90E+06		N
Fe-55	6.838E+04	410286.7				2.73		N
Gd-148	8.603E+00	51.6				75		N
Gd-150	---					1.79E+06		N
Mo-93	1.748E+02	1048.7				3500		N
Nb-93m	---					13.6		N
Ni-59	5.652E+03	33913.9				75000		N
Ni-63	2.631E+03	15783.3				100.1		N
P-33	4.641E+04	278480.7			25.34			N
Pb-205	3.749E+03	22493.7				1.90E+07		N
Pt-193	3.256E+04	195334.9				50		N
Si-32	2.672E+00	16.0				104		N
Sr-90	3.093E+00	18.6				28.5		N
Tc-97	1.335E+02	801.2				2.60E+06		N
V-49	7.281E+05	4368538.3			330			N

TABLE III

Date	Bkg cpm	Date	Bkg cpm	Date	kg cpm		
9/30/96	95490	12/6/96	97987	12/17/96	97254		
9/30/96	93246	12/6/96	99789	12/17/96	98768		
9/30/96	92632	12/6/96	100186	1/3/97	102546	12/6/96 - 1/21/97	
9/30/96	95357	12/6/96	98120	1/3/97	100873		
10/1/96	100247	12/9/96	97364	1/7/97	95814	Avg.	97767
10/1/96	107045	12/9/96	99123	1/7/97	95753		
10/2/96	99421	12/9/96	101042	1/8/97	94582	1SD	3123
10/2/96	101357	12/9/96	98328	1/8/97	96277		
10/2/96	99326	12/10/96	98582	1/9/97	102723	2SD	6246
10/3/96	102593	12/10/96	98281	1/9/97	104404		
10/3/96	105933	12/10/96	99328	1/13/97	91195	3SD	9368
10/3/96	104896	12/11/96	98224	1/13/97	90799		
10/3/96	104852	12/11/96	100484	1/14/97	93653		
10/4/96	114362	12/11/96	99265	1/14/97	93791		
10/4/96	114813	12/11/96	99251	1/15/97	92721	Avg+1SD	100890
10/4/96	115253	12/11/96	99987	1/15/97	93312		
10/4/96	111261	12/12/96	98841	1/16/97	94820	Avg+2SD	104012
10/4/96	115476	12/12/96	100278	1/16/97	93012		
10/4/96	112221	12/12/96	99567	1/17/97	93837	Avg+3SD	107135
10/4/96	115099	12/12/96	101190	1/17/97	94481		
		12/16/96	98357	1/21/97	101089		
		12/16/96	99077	1/21/97	97382