USTUR 070: Preparation of Tracers and Tracking Standard Solutions

Purpose	Tracer preparation and solution tracking	**Method Number**	USTUR 070
Original Date	10/10/95	**Author**	USTUR Radiochemistry Staff
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1. Preparation of Radioisotopic Solutions using Dilution by Volume

1.1. Isotopic solutions used for spiking samples and QA/QC samples as well as for the preparation of electrodeposited secondary calibration standards are prepared by dilution of the material by volume in an appropriate solvent.

1.1.1. Standard Solution Nomenclature

Standard solutions are numbered sequentially by order of date of preparation. The following format is used:

UTR XXXX-X

The first four digits are the sequential number for the initial standard solution made, ranging from 0001 to 9999. The digit (or digits) after the dash is (are) the sequential number for a dilution made of the standard solution. If further serial dilutions are made, additional "-X" are added. For example: UTR 0011-2-3 means that a second aliquot of UTR 0011 was diluted to a known volume and a third aliquot of the dilution was diluted to some known volume.

1.1.2. Dilution Volume

Isotopic standards used as tracers or for spiking samples are generally diluted to approximately 20 dpm/mL. Using the weight and concentration of the standard listed on the standard certificate, determine which volumetric flask (i.e. 100 mL, 200 mL, etc.) should be used. If necessary, do a serial dilution, making first a stock solution, then the actual working solution. Use a class A glass pipette for any dilutions. The entire amount of solution contained in an ampule should be used as detailed below.

Dilute the standard with the same type and concentration of acid which is listed on the certificate.

1.1.3. Dilution of Standard

CAUTION: For safety reasons, tracers are always prepared in the presence of at least one individual.

From the standard certificate, determine if there is an exact weight of solution in the ampule or only an approximate weight.

1.1.3.1. For standards with an exact weight of solution do the following steps to dilute:

1) Wipe of the neck of ampule to remove any foreign material.

2) Holding the ampule in a folded paper town to protect your hand, use a triangular file to etch a groove in the ampule neck.

3) Wrap the entire ampule in a paper towel, hold the ampule securely, place thumb on ampule top directly above the etched groove. Press away from you to snap off the ampule top. If it does not snap easily, file the groove deeper. Do not try to snap the ampule top off with a large amount of force.

4) Using a glass disposable pipette, transfer the standard solution into the appropriate volumetric flask, taking care not to lose any droplets.

5) Using the appropriate acid, add a few milliliters to the ampule and again transfer the solution to the flask.

6) Rinse the ampule at least three more times, adding each rinse to the flask. Wash the inside walls down and rinse the pipette. Finally, use a small amount of acid to rinse the inside of the ampule top and add to flask. Dispose of ampule in a radioactive sharps container.

7) Bring the volumetric flask to volume, mix thoroughly, then store the solution in labeled plastic narrow-mouthed bottles.

1.1.3.2. For standards with an approximate weight of solution:

1) Follow steps 1-3 in 1.1.3.1. to open the ampule.

2) Use a 20 mL syringe with an 18 gauge 1 1/2" long needle. Carefully draw up the entire standard into the syringe.

3) Tip the syringe back so the end of the needle is higher than the barrel. Draw any liquid in the needle into the barrel.

4) Weigh the syringe on a tared 4-decimal place balance and record the weight.

5) Empty the syringe into the appropriate volumetric flask. Take care not to have any droplets of solution on the outside of the needle.

6) Again, draw any remaining solution in the needle into the barrel. Re-weigh the syringe and record as the tare weight.

7) Discard the ampule and syringe into a radioactive sharps container.

8) Subtract the tare weight from the weight recorded in step 4 to determine the exact amount of standard solution.

1.1.4. Labeling of Standard Solution Containers

1) The isotope prepared (i.e. Pu-242), the matrix (i.e. 4 N HNO_3), and the concentration in dpm/mL is written on the label.

2) The USTUR standard number (from section 1.1.1.) is placed in the upper right-hand corner of label.

3) The date of preparation and preparer's initials are respectively placed in the lower left-hand and lower right-hand corners.

4) If there are multiple bottles for a given solution, use the upper left-hand corner to record 1 of X (total bottles), 2 of X, etc. on each bottle.

1.2. An Excel spreadsheet is used for preparation of these diluted standards (see Figure 1). A description of the entry into this form are as follows:

1.2.1. Enter the identification number of the material to be diluted. This material shall be referred to hereafter as the Parent material.

1.2.2. Enter the radionuclide of interest for which the standard is to be prepared.

1.2.3. Enter the chemical form of the Parent material (i.e. solid, 4 M HCl, etc.).

1.2.4. Enter the unit activity (activity per gram or per mL) of the parent material as well as the activity unit and the 1 sigma error associated with the unit activity.

1.2.5. Enter the reference date for the Parent Material Unit Activity.

1.2.6. Enter the Half-life of the radionuclide in years and the associated 1 sigma error.

1.2.7. Enter the identification for the solution to be prepared from the parent material. This diluted material shall be referred to hereafter as the Secondary solution.

1.2.8. Enter the description of the solvent to be used for preparing the Secondary solution.

1.2.9. Enter the name of the preparer.

1.2.10. Enter the date of preparation of the secondary solution.

1.2.11. Enter the quantity of Parent material used for dilution, the units of measurement (e.g. g or mL), and the 1 sigma error associated with the quantity measurement.

1.2.12. Enter the total volume to which the solution was prepared and the associated 1 sigma error.

1.2.13. The work sheet will then calculate the activity of the secondary solution prepared as well as the unit activity of the Secondary solution and its associated 1 sigma error. Note: neither of these activities have been decay corrected but instead represent what the activity of the solution would have been based on the Parent material reference date.

2. Radioactive Material Tracking

2.1. Radioactive solutions and solids purchased/and or prepared by the radiochemistry staff of the USTUR shall be tracked to indicate how the nuclide was used as well as the secondary solutions prepared from it. The USTUR Radionuclide Material Usage Form provides this capability (see Figures 2 and 3).

2.2. Entry into the USTUR Radionuclide Material Usage Form proceeds as follows:

2.2.1. Enter the identification number of the solution from the original certificate or the dilution Excel sheet.

2.2.2. Enter the identificaiton number of the Parent material. Enter 'original' if this is the original reference material.

2.2.3. Enter the source identification number supplied by the manufacturer if this is the original reference material.

2.2.4. Enter the Manufacturer or the preparer of the solution (i.e. NIST if they produced the original reference material, Dorothy Stuit if she did the dilution).

2.2.5. Enter the reference date for the activity from the certificate or the dilution form.

2.2.6. Enter the radionuclide of interest in the material from the certificate or the dilution form.

2.2.7. Enter the chemical form of the radionuclide (i.e. solid, 4 M HCl, etc.) from the certificate or the dilution form.

2.2.8. Enter the half-life and its associated 1 sigma error in years of the radionuclide from the certificate or the dilution form.

2.2.9. Enter the uncorrected unit activity and the associated 1 sigma error of the material from the certificate or the dilution form and the units of activity measurement (i.e. dpm/mL).

2.2.10. Enter the quantity of material originally present (i.e. 5 g, 100 mL, etc.) from the certificate or the dilution form.

2.2.11. Enter the solution identification, date of preparation, and the initials of the preparer for each secondary solution prepared from this material.

2.2.12. Re-enter the solution identification and radionuclide on the second page of the form (Figure 3), Solution Usage Histroy.

2.2.13. Enter the date, initials, quantity of material used, and the reason for use for each use of the material. Example, for 10 spikes of 0.5 mL each for tracer addition, put the date and 5 mL used. It is not necessary to track each individual spike.

3. Equations

$C_p \equiv$ Concentration of nuclide in parent material (dpm or Bq per g or mL)
$T_p \equiv$ Amount of parent material used (g or mL)
A_u = Uncorrected activity of parent material added = C_p x T_p
V_s = Total volume of secondary solution prepared (mL)
C_s = Concentration of nuclide in secondary solution (mL^{-1})

$$C_s = \frac{C_p \times T_p}{V_s}$$

$$\sigma_{C_s} = \left[\frac{\sigma^2_{C_p}}{C_p^2} + \frac{\sigma^2_{T_p}}{T_p^2} + \frac{\sigma^2_{V_s}}{V_s^2} \right]^{1/2} \cdot C_s$$

Figure 1

Standard Solution Preparation Sheet
Version 1.0
12/13/94

		units	1 sigma error
Parent Material ID			
Radionuclide			
Parent Chemical Form			
Parent Material Unit Activity (??/mL) or (??/g)			
Reference Date for Parent Material Unit Activity			
Half-life (years)			
Secondary Solution ID			
Solvent Description			
Prepared By			
Date of Secondary Solution Prep.			
Quantity of Parent Material Added			
Total Volume of Secondary Solution		mL	
Uncorrected ActivityAdded	0	0	
Uncorrected Unit Activity of Secondary Solution (??/mL)	#DIV/0!	0	#DIV/0!

SAMPLE NOTES

Figure 2

USTUR Radionuclide Material Usage Form

Material ID		Radionuclide	
Parent Material ID		Chemical Form	
Date Sol'n Prepared		Half-life (years)	
Standard/Source #		Uncorrected Unit Activity	
Manufacturer		1 Sigma Error in Unit Activity	
Activity Reference Date		Original Solution Volume (mL)	

* At time of preparation
* All errors are 1 sigma

Secondary Solutions Prepared

Solution ID	Date Prepared	Initials	Solution ID	Date Prepared	Initials

Figure 3

Solution Usage History
(page 2)

Solution ID		Radionuclide	

Date	Initials	Amount Used (g)	Reason