Instructions to Participants Regarding the Practical Exercise

R2D2P Workshop on Costing
30 March - 3 April 2009
Quezon City, Philippines

Purpose and Objectives of the Workshop and the Practical Exercise

Cost calculation is a demanding, time consuming activity. It will not be possible to carry out a cost calculation for the PRR-1 within the two days allocated to the 'costing' exercise. Therefore three distinct elements of the whole reactor have been selected to train workshop participants on cost calculation. The purpose of the exercise is to experience how the theoretical content of the workshop lectures is to be applied in practice. This is a step of fundamental importance as it is the move from 'receptive' to 'active' training. Experiencing cost assessment in the context of the practical details of an existing facility is the challenge of this exercise.

The exercise focuses on the "bottom up" approach to detailed costing of decommissioning, and as such involves your input of the manpower, equipment, radiological and other assumptions for each task required for decommissioning. Through the accompanying lectures, you will see how this process fits together with cost components that cannot be estimated in such a direct manner.

A word of caution: although we (especially your PNRI hosts) have gone to great lengths to make the exercise as realistic as possible, please be aware that we have had to simplify the task "procedures" you will follow to make it possible to complete the steps included in the costing in the time available. You will be invited to comment on how you might improve these procedures if you were to apply them "for real". You should not treat these procedures as complete references that can be applied "as is" to your own decommissioning situation.

We wish you success in your team-endeavour to prepare a cost calculation for one part of the overall facility. You will hear, after the team presentations of the results, how an expert would have resolved one such case.

Field Areas and Work Groups

Three locations have been selected in the PRR-1 to be the field areas of the practical exercise on costing. The participants will be divided into three work groups, each work group to be assigned to one field area. At least one participant from the Philippines will be assigned to each work group.

The field areas are:
a. N-16 Decay Room
b. Cooling Tower
c. Temporary Waste Store

Work to be Done by the Participants

The participants are expected to do the following:

a. Visit their assigned field area and familiarize themselves with its physical situation.

b. Formulate a plan of the activities needed to dismantle and remove the objects in their assigned field area.

c. Use a spreadsheet to prepare a detailed work breakdown and a cost estimate.

d. Present a group report at the conclusion of the exercise.

Each work group will be provided a work place and an LCD projector, but are expected to provide their own laptop computers.

The participants will be allowed to take their own photos of the field areas with their own digital cameras to help with their work.

Safety Precautions

The PNRI will ensure that there is no radiation hazard or surface contamination in the field areas and in the routes the participants will take to them. The field areas and the routes will be delineated with barrier tapes. The participants are not allowed to cross the tapes. The participants are also not allowed to touch any object in the field areas as an additional precaution. PNRI personnel with appropriate protective clothing (e.g. disposable gloves) will move small objects if requested by the participants.

Although no radiation exposure is expected, all of the participants will be issued personal radiation dose monitors. The PNRI will also have portable electronic dose rate monitors at hand.

The PNRI will try to minimize physical hazards in the field areas, but some physical hazards such as falls and bumps may remain. The participants are encouraged to stay alert and not take any risk in moving around the field areas.

The PNRI will issue hard hats but the participants should bring and wear work clothing and shoes that will be suitable for an environment with a temperature in the high 30s Celsius and relative humidity around 75%. The outdoor areas are also exposed to intense tropical sunlight, so sunblock lotion and sunglasses should be brought and used by those with sensitive skin and eyes.

The PNRI will provide emergency lighting and a delineated safe exit route in the indoor field area, which is totally enclosed and window-less.

The PNRI will provide a small tent in the outdoor field areas for shelter in case it rains.

Resources Provided in the Next Pages

INTRODUCTIONS TO THE FIELD AREAS

Page

Introduction to the N-16 Decay Room

Description

The N-16 Decay Room is an underground room with a floor about 1.4 m below the floor of the reactor bay, which is itself 3.8 m below ground level. The room is 4.3 m wide by 4.4 m long by 3.4 m high and contains the N-16 Decay Tank and associated reactor cooling system components. The only access to the room is from the reactor bay, to the equipment room housing the mechanical components of the reactor's cooling system and down a short stairway, through doors about 3 ft (0.9 m) wide.

The N-16 Decay Tank is a pressure vessel with an internal volume of 3000 U.S. gallons (11.4 m^3). The N-16 Decay Tank is connected between the core outlet and the suction intake of the primary pump in the reactor's primary coolant loop. The function of the N-16 Decay Tank is to delay the arrival of the hot reactor coolant in the reactor's equipment room by 70 to 100 seconds (depending on the coolant flow rate). This allows the N-16 in the coolant (formed from O-16 in the coolant in the reactor core by the (n,p) reaction) to greatly decay (half-life 7.14 s), reducing the radiation dose rate in the equipment room to a level low enough such that personnel can enter the equipment room while the reactor is operating. The N-16 Decay Room is heavily shielded by thick concrete walls from the other rooms in the reactor's basement.

The N-16 Decay Tank has a diameter of 96 inches (2.44 m) and a height also of 96 inches. The tank is mounted 12 inches (0.30 m) above the floor by 4 steel legs welded to its side. Aside from the 8-inch flanged connections for the reactor coolant, the N-16 Decay Tank has a 20-inch manhole and a 6-inch inspection port on its side. These openings are closed with blind flanges when the tank is in use. The tank also has a 1/2-inch top vent, a 1-inch bottom drain, and two 1-1/4-inch instrumentation taps on its side.

The N-16 Decay Tank is made of 1/4-inch-thick carbon steel. The tank is lined internally with a phenolic coating (trade name Phenolene 300) for corrosion protection, and coated externally with enamel paint. The dry weight of the tank is 3634 pounds (1652 kg).

The piping components attached to the N-16 Decay Tank are: an electrically-operated 8-inch knife gate valve, an 8-inch pipe section penetrating the wall to the adjacent equipment room, small-diameter drain pipe and valves connected to an underfloor run to the building sump, small-diameter pipe and valves connected to the tank vent, and various small-diameter pipe and detectors connected to the instrumentation taps.

Contamination

Radiation surveys of the exterior of the N-16 Tank and the room have not shown any contamination. The interior of the tank has not been accessible for regular surveys, but significant contamination of the interior is thought to be unlikely, thanks to the reactor never having a fuel cladding failure, using aluminum almost entirely as the core's structural material, and the consistently high purity of the primary coolant. A small stainless-steel metal object was found inside the tank during a maintenance shutdown many years ago (and since removed), which was activated with Co-60. The object probably was originally part of an irradiation rig, came loose and was carried by the coolant to the tank where it stayed.

Dismantling Constraints

All the contents of the N-16 Decay Room are to be removed, except the 8-inch flanged pipe stub on the wall that runs to the reactor pool.

The tank would have to be cut into pieces to be removed through the doors. However, flame cutting is not allowed because it will generate toxic fumes by burning the tank's internal phenolic coating. Mechanical cutting using power tools is allowed.

The underfloor run of the tank's drain pipe to the sump is also to be completely removed.

The pipe section running to the primary pump in the next room is grouted into the wall, but should be completely removed by breaking the grout.

The room and the external surfaces of the objects inside the room must undergo a radiation survey before dismantling starts. Any wetted part of the reactor's primary coolant loop must be scanned for contamination during dismantling. This includes the internal surfaces of the tank and its attached piping and components. Smear samples should be taken of small internal surfaces that are not amenable to scanning, such as small pipes.

Waste Disposal

It is assumed that the decommissioning waste from the reactor's primary cooling system will be carried unsorted to a collection area 200 meters away, where it will undergo clearance measurements. The costing for decommissioning the N-16 Decay Room will end with transport to the collection area.

However, powered transport equipment such as a forklift will not be able to negotiate the route inside the reactor building to the N-16 Decay Room. It is assumed that waste will have to be manually carried a distance of about 50 meters from the N-16 Decay Room to a staging area where the load will be transferred to a forklift, which will transport the waste the rest of the way to the collection area.

If an object is contaminated, it should be wrapped and taped in plastic sheeting before being transported.

Introduction to the Cooling Tower

Description

The Cooling Tower is part of the secondary loop of the reactor cooling system. It sits on a concrete pad that is 5.8 m square on the ground about 7.5 m north from the exterior wall of the reactor building.

The main member of the Cooling Tower group of reactor components is an induced draft cross-flow type cooling tower with vertical air discharge, Model CFT(2)2421CRK by the Baltimore Aircoil Company. Inside the cooling tower, hot water from the secondary side of the reactor's heat exchanger is sprayed on the top of numerous vertically-hung sheets of PVC plastic. As the water falls vertically, atmospheric air is pulled horizontally across it by fans placed in the center of the cooling tower. Evaporation cools the water, which is collected at a basin that also serves as the base of the cooling tower. The cool water is returned to the heat exchanger to extract more heat generated by the reactor.

The cooling tower is 5.8 m long (at the sides, where air enters), 5.2 m wide (at the closed front and back), and 2.9 m tall. The cooling tower is made of galvanized and painted steel, and PVC plastic. It also contains two 20 HP electric motors, two belt drives, and two six-bladed aluminum fans each about 2.5 m in diameter. The dry weight of the cooling tower is about 6 tons.

The Cooling Tower group also contains the following:

a. two 40 HP electric motors driving two stainless-steel centrifugal pumps connected in parallel;

b. various lengths of 12-inch, 10-inch, 8-inch and 6-inch aluminum pipes and 2-inch galvanized iron pipes;

c. two 8-inch strainers, two 8-inch butterfly valves, two 8-inch check valves, four 6-inch butterfly valves, and various small valves (2-inch and 3/4-inch).

The 10-inch pipes carry water to and from the heat exchanger and the cooling tower. These pipes are in an open concrete trench sunk about 1.7 below ground level.

A 12-inch pipe carries the cool water from the basin of the cooling tower to the pump inlets. This pipe is in a pit under the cooling tower basin. The pumps and motors are in a deeper pit adjacent to the south end of the cooling tower. The pump outlets are connected by 8-inch pipes and a series of strainers, butterfly valves, and check valves to the 10-inch pipe that returns the water to the heat exchanger.

The 10-inch pipe that carries hot water from the heat exchanger turns from horizontal to vertical at the west side of the cooling tower. It turns to horizontal again over the cooling tower, and divides into four 6-inch pipes. The 6-inch pipes feed the hot water to the top of the cooling tower through butterfly valves.

The 2-inch pipes carry water to the basin of the cooling tower to make up for water lost by evaporation and spray, through and automatic float valve. Another set of 2-inch pipes are for draining the cooling tower basin through a valve, for periodic maintenance. The 3/4-inch pipes are for electrically-controlled release of some of the basin water when too much dissolved material builds up.

Contamination

No contamination has been detected in the secondary loop of the reactor cooling system.

Dismantling Constraints

All objects are to be removed, leaving the concrete pad, pump pit, and trenches bare.

Piping is to be dismantled by unbolting flanged connections. Most of the pipes will be released by just unbolting the flanges. The 12-inch pipes in the trench are to be released by breaking their grouted supports, including where the pipe penetrates the underground wall of the reactor's equipment room. The opening in the wall must be re-grouted shut after removing the pipes.

Damage to mechanical components that will reduce their resale value is to be avoided.

Waste Disposal

Waste that is believed to be free of contamination above clearance levels will be delivered to an enclosed collection area for subsequent clearance measurements. It is assumed that the collection area will be about 200 meters from the Cooling Tower.

The sorting categories are:

a. Mechanical components that may be reused

b. Metals, sorted separately:
   1. Aluminum
   2. Stainless Steel
   3. Galvanized Steel
   4. Carbon Steel
   5. Copper

c. Plastic

d. Glass

e. Non-recyclable waste

Introduction to the Temporary Waste Store

Description

The Temporary Waste Store is not a planned part of the reactor. Some years ago when the reactor's spent fuel elements were shipped out, some disused reactor parts that lined the truck entrance ramp were moved to near the reactor's cooling tower in order to allow a large forklift to enter the reactor building. The parts have stayed by the side of the cooling tower since, and have attracted the uncontrolled and unorganized dumping of junk from other sources.

Contamination

The original material in the Temporary Waste Store were obsolete components of the reactor's cooling system from both the primary and secondary loops and some cut-up ventilation ducts. These were scanned at the time they were removed from the reactor and were found to have no external surface contamination. However, the internal surfaces of the components were not scanned or sampled if not accessible.

The other material that were added to the heap are not from the reactor and are not believed to have any original contamination.

Dismantling Constraints

All of the waste material in the Temporary Waste Store must be removed.

It must be assumed that the possibility of contamination in the material that had wetted surfaces in the reactor's primary loop exists, and that these material had contaminated the other materials in the heap as well as the soil in the area. All the materials must therefore be scanned for surface contamination. In addition, the materials that were in the primary loop or ventilation system and have internal surfaces (such as an obsolete heat exchanger or air ducts) must have smear samples taken of their internal surfaces for laboratory analysis, being partly disassembled if necessary.

The soil in the area will have to be scanned and samples taken for laboratory analysis.

Waste Disposal

It is assumed that all of the material that are identifiably from the reactor's primary coolant loop or ventilation system must be brought to a collection area about 200 meters away, where it will undergo a final survey and be cleared. Any contaminated material, whether from the primary loop or not, must be brought to the same collection area.

If an object is contaminated, it should be wrapped and taped in plastic sheeting before being transported.

Soil contaminated above the clearance area must be packaged in 200 -liter drums and brought to the Radwaste Storage Facility about 200 meters away.

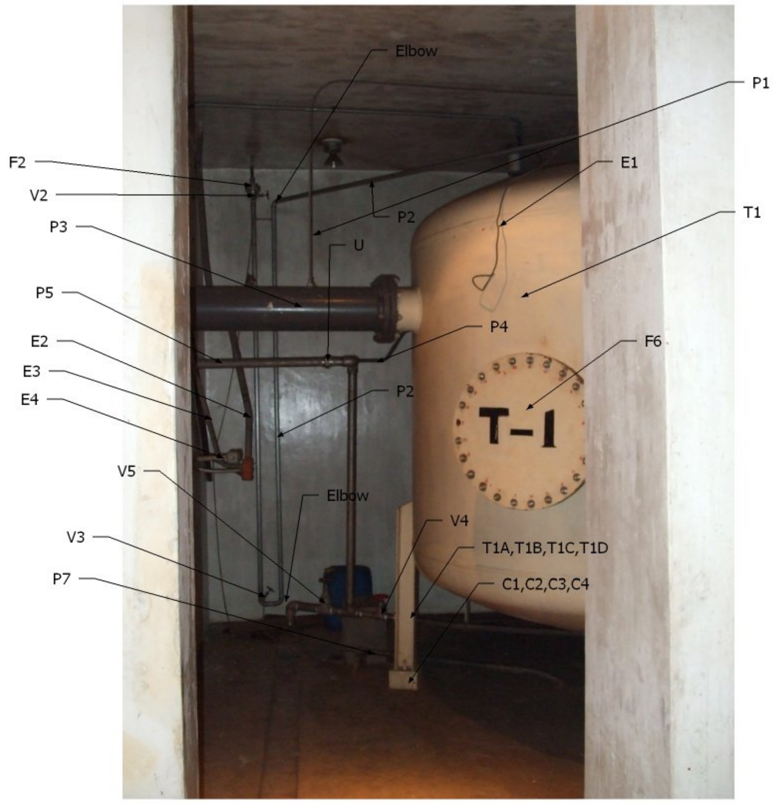
All uncontaminated waste must be presorted and delivered to another collection area 200 meters away.

The sorting categories are:

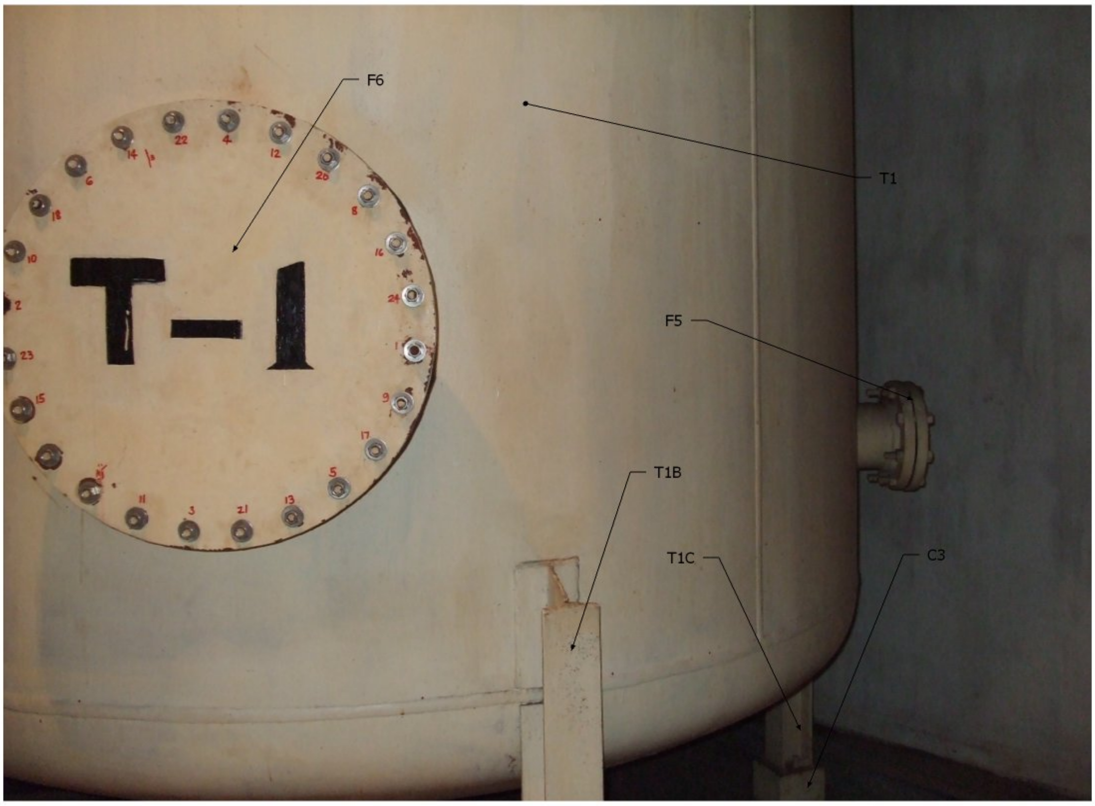
a. Mechanical components that may be reused (assumed none in this case)
b. Metals, sorted separately:
    1. Aluminum
    2. Stainless Steel
    3. Galvanized Steel
    4. Carbon Steel
    5. Copper
c. Plastic
d. Glass
e. Non-recyclable waste

PHOTOGRAPHS OF THE FIELD AREAS

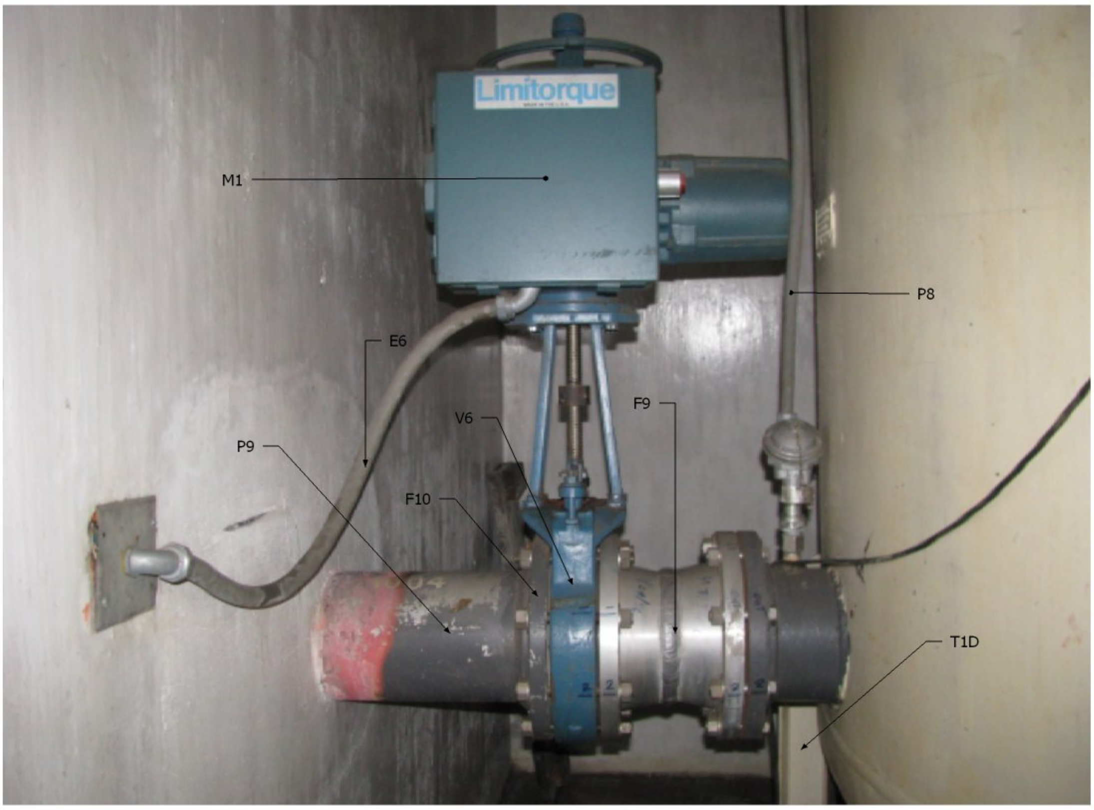
Photographs of the N-16 Decay Room



View of the N-16 Decay Room from its doorway.
See Component List for labels.



The N-16 Decay Tank, showing the its manhole and inspection port.
See Component List for labels.



The electrically-operated knife gate valve in the N-16 Decay Room.
See Component List for labels.

Photographs of the Cooling Tower

View of the north end of the Cooling Tower.
See Component List for labels.

View of the south end of the Cooling Tower.
See Component List for labels.

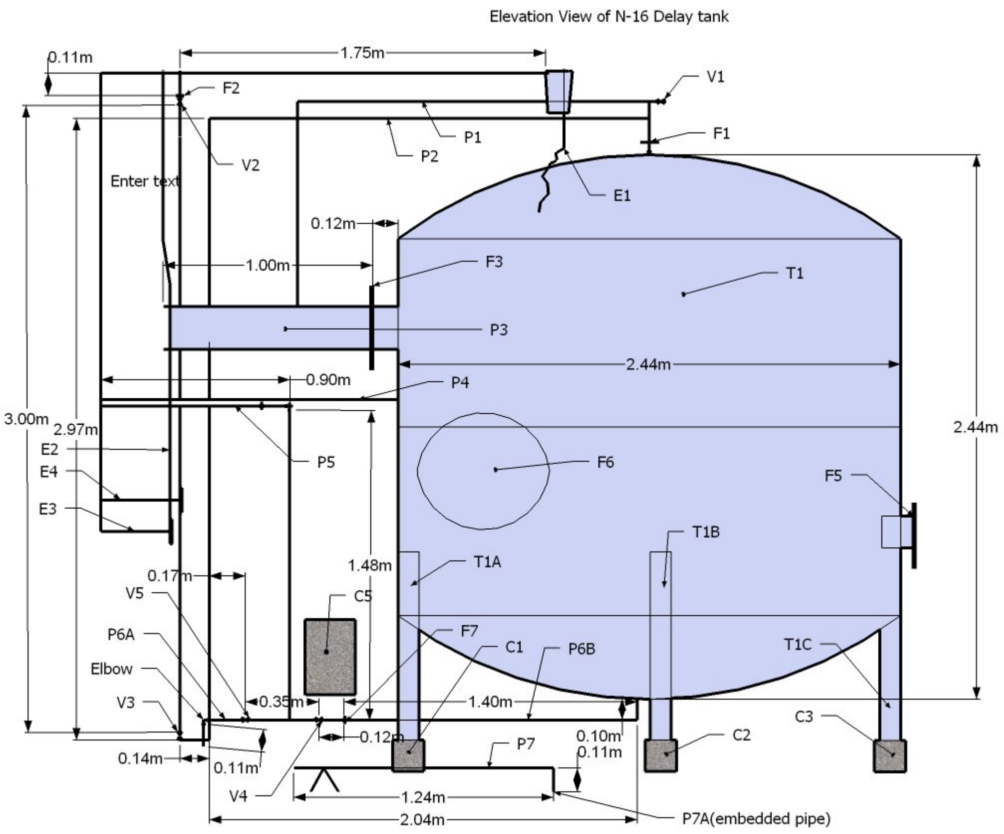
View inside the Cooling Tower.
See Component List for labels.

Photographs of the Temporary Waste Store

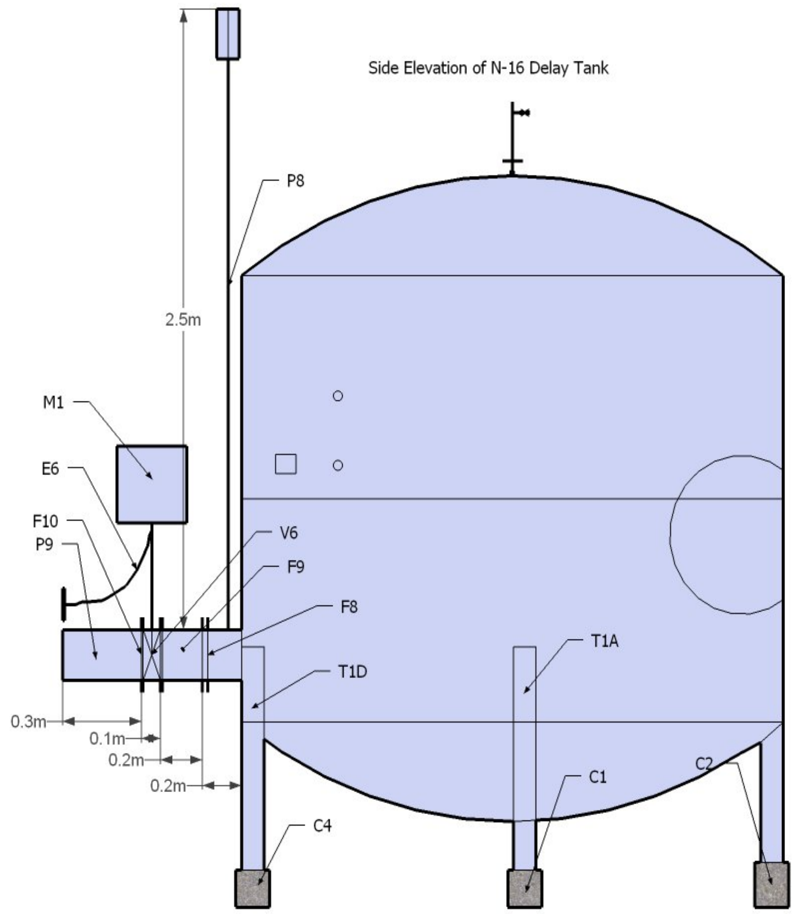
View of the Temporary Waste Store.
Note the Cooling Tower in the background.

Another view of the Temporary Waste Store.

LAYOUT DRAWINGS OF THE FIELD AREAS

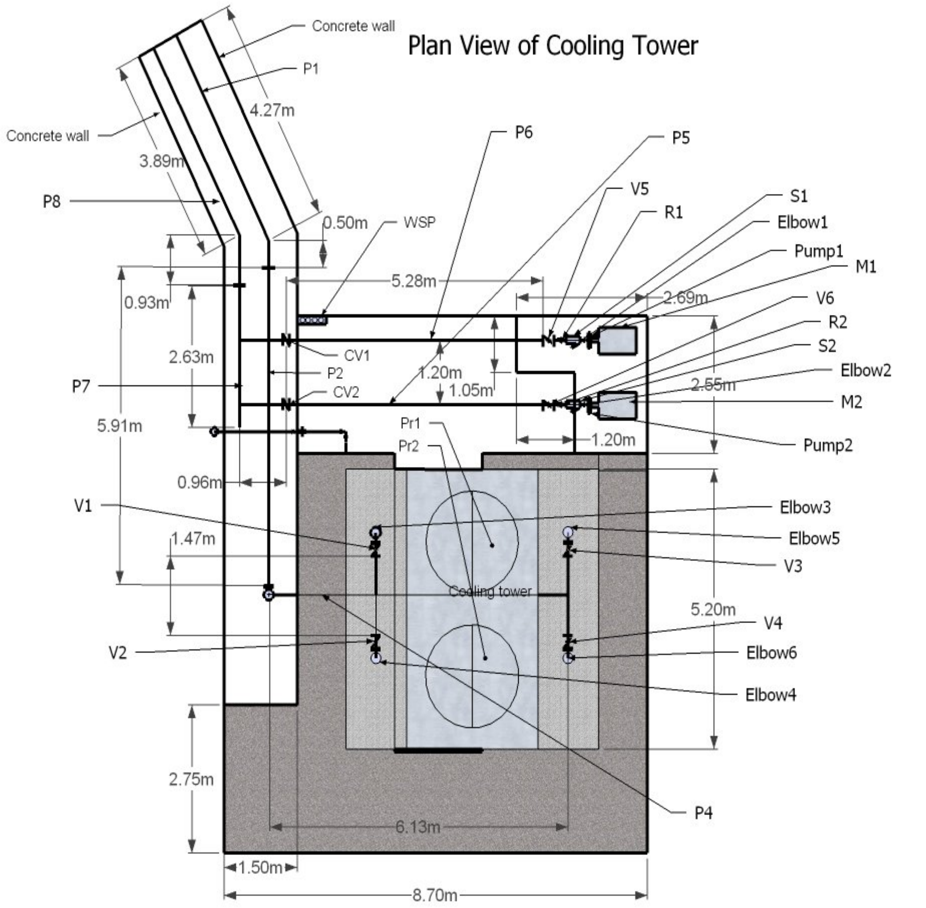


Elevation View of N-16 Delay tank
1.75m
0.11m
F2
V1
F1
P1
P2
V2
E1
Enter text
0.12m
1.00m
F3
T1
P3
2.44m
0.90m
P4
3.00m
2.97m
E2
E4
E3
P5
F6
F5
2.44m
T1B
0.17m
1.48m
T1A
V5
C5
P6A
F7
C1
P6B
T1C
Elbow
0.35m
1.40m
V3
0.12m
0.10m
C2
C3
0.14m
0.11m
P7
0.11m
V4
1.24m
P7A(embedded pipe)
2.04m

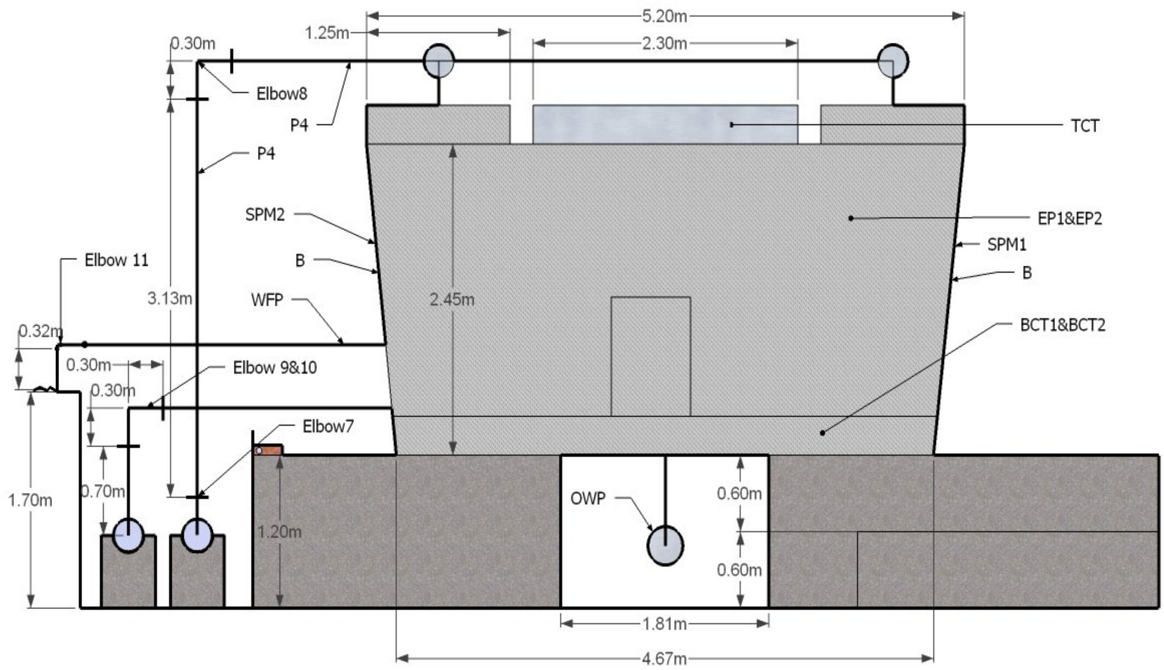


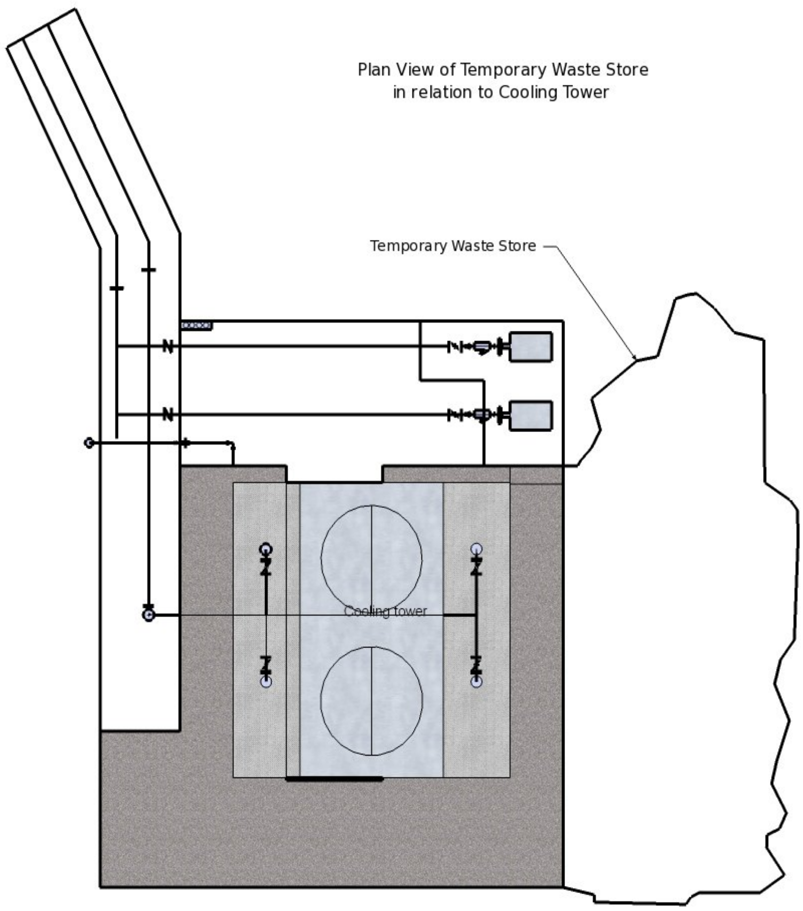
Side Elevation of N-16 Delay Tank
P8
2.5m
M1
E6
F10
P9
V6
F9
F8
T1A
T1D
0.3m
0.1m
0.2m
0.2m
C1
C2
C4

Plan View of Cooling Tower



Elevation View of Cooling Tower




Plan View of Temporary Waste Store
in relation to Cooling Tower
Temporary Waste Store
Cooling tower

COMPONENT LISTS

N-16 Decay Room Component List

Label	Name	Material	Mass (kg)	Dimensions
T1	N-16 Decay Tank	CS	1492	2.44 m dia X 2.44 high X 6.35 mm thick
T1A, T1B, T1C, T1D	Tank Legs	CS	40	
C1, C2, C3, C4	Tank Footings	Concrete	30	0.15 m X 0.15 m X 0.12 m
C5	Pedestal	Concrete	65	0.24 m X 0.30 m X 0.36 m
F5	6-inch Blind Flange	CS	5	0.28 m dia X 25 mm thick
F6	20-inch Blind Flange	CS	10	0.64 m dia X 20 mm thick
F8	8-inch Flange	CS	5	0.34 m dia X 25 mm thick
P1	Instrument Tube	SS	1	1/4” dia X 3 m long
P2	U-Tube	Al	5	1" Sch 40 X 10 m long (5 segments)
P3	Inlet Pipe	Al	20	8" Sch 40 X 1 m long
F3	8-inch Flange	CS	5	0.34 m dia X 25 mm thick
P4	Sampling Tube and Connector	Al	2	1/2" dia X 1.8 m long pipe & 1" dia X 0.20 m long connector
P5	Drain Pipe	SS	15	1-1/2" Sch 40 X 2.9 m long (3 segments)
F4	Flange	SS	1	1-1/2" size
P6A	Drain Pipe	SS	7	0.67 m long
P6B	Drain Pipe	Al	3	1" Sch 40 X 1.4 m long
V4	Gate Valve	SS	1	1" size
V5	Gate Valve	SS	1.5	1-1/2" size
P7	Old Drain Pipe	GI	1.5	1" Sch 40 X 1.3 m long
P8	Instrumentation Cable	Plastic and Cu	2	3/4" dia X 2.5 m long
F1,F2	Flange	Al	0.5	1" size
F7	Flange	SS	0.5	1" size
F9	Tank Inlet Pipe	Al	8	8” Sch 40 X 0.22 m long
F10	Flange	Al	5	8" size
P9	Tank Outlet Pipe		10	8" Sch 40 X 0.35 m long
E1	Instrumentation Conduit and Cable	GI, Plastic and Cu	0.25	0.30 m long (conduit) & 2 m long (cable)

E2	Electrical Conduit	GI, Plastic and Cu	3	1" size X 5 m long (3 segments)
E3	Electrical Conduit	GI, Plastic and Cu	5	1/2" size X 10 m long (5 segments)
E4	Electrical Conduit	GI, Plastic and Cu	0.25	1/2" size X 0.38 m long
E5	Instrumentation Cable and Connector	SS, plastic and Cu	1	3 m long
E6	Control Cable	Plastic and Cu	1.5	3/4" dia X 1 m long
Electrica l Wire	Electrical Wire	Plastic and Cu	5	40 m long (total)
Elbows	Elbows	SS	0.5	1-1/2" size (5 pcs)
Tee	Tee	SS	2	1-1/2" size
CR	Reducing Coupling	SS	2	1-1/2" X 1" size
U	Union	SS	0.5	1-1/2" size
V1, V2, V3	U-Tube	SS	0.75	1/4" size tubing

Cooling Tower Component List

Label	Name	Material	Mass (kg)	Dimensions
P1	10-inch Pipe	Al	71	10” Sch 40, 4.77 m long
P2	10-inch-Pipe	Al	89	10” Sch 40, 5.91 long
P3	10-inch Pipe	Al	46	10” Sch 40, 3,1 m long
P4	10-inch Pipe	Al	183	10” Sch 40, 12.2 m long
Elbow1, Elbow2, Elbow3, Elbow4, Elbow5	6-inch Elbow	Al	4	6” Sch 40 size
Elbow6, Elbow7, Elbow8, Elbow9, Elbow10	10-inch Elbow	Al	9	10-inch Sch 40 size
P5	8-inch Pipe	Al	104	8” Sch 40, 6.94 m long
P6	8-inch Pipe	Al	104	8” Sch 40, 6.94 m long
CV1, CV2	8-inch Check Valve	SS	10	8-inch size
P7	10-inch Pipe	Al	39	10” Sch 40, 2.63 m long
P8	10-inch Pipe	Al	72	10” Sch 40, 4.82 m long
V1, V2, V3, V4, V5, V6	6-inch Butterfly Valve	SS	20	6-inch size
S1, S2	6-inch Strainers	SS/CS	25	6-inch size
Pump1, Pump2	Centrifugal Pump	SS/CS	200	
M1, M2	Pump Motor	SS/CS/Cu	200	
R1, R2	10-inch to 6-inch Reducer	Al	10	
TCT	Cooling Tower Top Assembly	GI	1500	
SPM1, SPM2	Cooling Tower Side Panel (Mesh)	GI	100	
EP1, EP2	Cooling Tower End Panels	GI	400	
Pr1, Pr2	Cooling Tower Fan	Al	200	
M3, M4	Fan Motor	CS/Cu	200	
B	Cooling Tower Fill	Plastic	400	
SCT1, SCT2	Cooling Tower Frame	GI	500	
BCT1, BCT2	Cooling Tower Basin	GI	750	
OWP	12-inch Pipe	Al	78	12” Sch 40, 5.25 m long
WFP	2-inch Pipe	GI	49	2" size, 10 m long
WSP	3/4-inch Pipe	GI	5	3/4” size, 2 m long
Electrical Wires	Electrical Wires	Cu/Plastic	20	10 m long (total)

Temporary Waste Store Component List

Name	Material	Mass (kg)	Remarks
Heat Exchanger	Al, CS	600(Al) 50(CS)	From reactor's old primary cooling loop
Heat Exchanger Tube Bundle	Al, CS	300(Al) 25(CS)	From reactor's old primary cooling loop
8-inch Pipe Assembly	Al	110	From reactor's old primary cooling loop; 7m total length
8-inch Pipe Assembly	Al	35	From reactor's old secondary cooling loop; 2m total length
8-inch Pipe Assembly	Al	20	From reactor's old secondary cooling loop; 1m total length
Scrap Ducts	GI	10	From reactor's old ventilation system
Disassembled Fan Shroud	GI	100	From reactor's old cooling tower
Scrap Water Pipe	GI	10	Not from reactor; 3" size, 3 m total length
Scrap Electrical Tubing	GI	10	Not from reactor; in bag
Scrap Metal Sheets	CS	50	Not from reactor; 5 sq m
Scrap Metal	CS	5	Not from reactor; discarded air conditioner cover
Plastic Pipe	Plastic	2	Not from reactor
Stainless Steel Boxes	SS	100	Not from reactor; discarded machine shop project
Waste Drum	GI	30	Not from reactor

DETAILED PROCEDURES FOR SOME ACTIVITIES

Procedure for Dismantling of Piping

1 Personnel required

One Graduate Engineer (over-all supervisor).
Two Technicians (to lead specific tasks).
Other manpower of other ranks as needed.

2 Equipment or tools required

Wrenches and other hand tools.
Mechanical and flame cutting equipment.
A-frame and manual chain hoist.
Forklift as needed.
Portable radiation contamination monitor.
Sample-taking equipment as needed.
Plastic sheets and tape as needed.

3 Action steps

3.1 Step 1

Do a radiation survey of the work area and the piping to be dismantled. Survey accessible internal surfaces of open pipe ends and components as well.

If the accessible internal surface is a wetted part of the reactor's primary coolant circuit, take smear samples as well.

If contamination is found in this or any other step, take appropriate radiation-protection measures in subsequent steps.

3.2 Step 2

Completely drain the piping. Open drain valves if present or if not, partially open the lowest flanged or threaded connection to allow any liquid to escape.

Take a sample of any liquid that drains out and have it analyzed for radioactivity.

Collect all the liquid that drains out and store until determined not to be contaminated.

3.3 Step 3

Support or connect lifting equipment to heavy pipe sections and components in preparation to disconnecting.

3.4 Step 4

Disconnect flanged pipe sections by unbolting.

Disconnect threaded connections by unscrewing if easily yielding, or by cutting if not.

3.5 Step 5

If a hitherto inaccessible internal surface is exposed, do a radiation survey of the newly-exposed surface before proceeding.

If the newly-exposed surface is a wetted part of the reactor's primary coolant circuit, take smear samples as well.

3.6 Step 6

Completely free and separate individual pipe sections and components and lower or raise them to ground level.

Break pipe sections from grouted supports, including those through walls.

3.7 Step 7

Completely wrap contaminated pipe sections and components in plastic sheets and tape securely.

3.8 Step 8

Transport the dismantled pipe sections and components to the appropriate collection areas.

Procedure for Scanning Surfaces for Beta Contamination

1 Personnel required

One Technician or higher (to take measurements).
One Skilled Worker or higher (to record measurements).

2 Equipment or tools required

Calibrated portable rate meter with thin-window gas-proportional or scintillator detector.
Beta check source.

3 Action steps

3.1 Step 1

Perform pre-operational functional check according to the instrument's work instructions.

3.2 Step 2

Switch the instrument ON and select the appropriate time constant (if possible) before entering suspected contamination area or approaching suspected contamination surface.

3.3 Step 3

Measure and record background radiation level. Record actual lowest and highest values obtained. Recheck this level periodically to ensure that the detector has not become contaminated.

3.4 Step 4

Using the audio response of the monitor, sequentially sweep the surface with the contamination monitor moving at a steady rate across the surface. Pass the detector slowly over the surface maintaining the distance as close to the surface as possible, nominally less than 1 cm. Speed of detector movement varies with radionuclide of concern and the required observation interval, but is typically one-half to one detector width per second.

Traverse the surface at close intervals. Due to the short range of beta radiation and directional dependence of the detector, scanning intervals may overlap.

3.5 Step 5

When audio response indicates a reading of significance, pause and take a meter reading.

3.6 Step 6

Compare count rates to the established site action levels. Mark areas that meet or exceed action levels. Further investigation is necessary at these locations.

3.7 Step 7

After the entire surface has been scanned, record on a map the dimensions of any areas of concern, and record locations and levels of ambient gamma radiation and elevated gamma radiation.

Procedure for Scanning Surfaces for Gamma Contamination

1 Personnel required

One Technician or higher (to take measurements).
One Skilled Worker or higher (to record measurements).

2 Equipment or tools required

Calibrated portable rate meter with NaI scintillator detector.
Gamma check source.

3 Action steps

3.1 Step 1

Perform pre-operational functional check according to the instrument's work instructions.

3.2 Step 2

Switch the instrument ON and select the appropriate time constant (if possible) before entering suspected contamination area or approaching suspected contamination surface.

3.3 Step 3

Measure and record background radiation level. Record actual lowest and highest values obtained. Recheck this level periodically to ensure that the detector has not become contaminated.

3.4 Step 4

Using the audio response of the monitor, sequentially sweep the surface with the contamination monitor moving at a steady rate across the surface. Scanning is performed by swinging the detector in front of your body in a serpentine (S-pattern) manner while progressing.

Maintain the detector at a distance of around 1 to 4 cm from the surface. Speed of detector movement is typically at 0.5 m/s, however this rate may be adjusted depending on expected detector response and the desired investigation level.

3.5 Step 5

When audio response indicates a reading of significance, pause and take a meter reading.

3.6 Step 6

Compare count rates to the established site action levels. Mark areas that meet or exceed action levels. Further investigation is necessary at these locations.

3.7 Step 7

After the entire surface has been scanned, record on a map the dimensions of any areas of concern, and record locations and levels of ambient gamma radiation and elevated gamma radiation.

Procedure for Smear Sampling for Removable Surface Contamination

1 Personnel required

One Skilled Worker or higher (to take samples).
One Auxiliary Worker or higher (to record samples).

2 Equipment or tools required

Smear papers (Whatman 50 or equivalent), 47mm diameter, pre-numbered.
Cotton swabs.
Zip-lock plastic envelopes.
PPE gloves.
Portable contamination monitor.

3 Action steps

3.1 Step 1

Put on the gloves.

3.2 Step 2

Mark off a sampling area on the surface, 100 cm^2 (10 cm x 10 cm) if possible. The sampling location should be flat, smooth and stationary.

3.3 Step 3

Grab a smear paper by the edge, between the thumb and index finger. For small penetrations such as cracks or bolt holes, get a cotton swab instead.

3.4 Step 4

Carefully rub the smear medium over the marked area. Try not to apply so much pressure as to wear a hole or to roll the paper.

3.5 Step 5

Use a portable contamination monitor to measure the level of contamination on the smear.

Take care not to point the detector in the direction of any other source near the vicinity that may affect the reading .

If the background is too high for a measurement, either move to a lower background or use a special shielded smear sample holder to take the reading.

Record the reading.

3.6 Step 6

Place the smear in an individual envelope.

If a count higher than 250 cpm was detected, mark the smear envelope as such.

Smears having a count greater than 2500 cpm should be sealed in an appropriate container and marked to minimize potential cross contamination.

3.7 Step 7

Deliver the smears to the laboratory analyst.

Procedure for Shallow Soil Sampling

1 Personnel required

One Skilled Worker or higher (to take and record samples).
One Auxiliary Worker or higher (to assist).

2 Equipment or tools required

Soil core sampler.
Rubber mallet.
Plastic bottles with screw-on caps.
PPE gloves.
Portable contamination monitor.
Clean water in squeeze bottle with nozzle.

3 Action steps

3.1 Step 1

Put on the gloves.

3.2 Step 2

Number and record the sample location in a map.

3.3 Step 3

Use the portable contamination monitor to get a count reading on the soil surface. Record the count.

3.4 Step 4

Drive the core sampler vertically down on the soil to the 30 cm mark. If the sampler cannot be easily driven down by hand, install the sampler's head protector and use a rubber mallet to tap the sampler in.

3.5 Step 5

Withdraw the sampler, place its muzzle in an empty plastic bottle and use its bore rod to push the cored soil sample into the bottle. Do not contaminate the exterior of the bottle.

Cap the bottle. Mark the bottle with the sample number.

3.6 Step 6

Tap any remaining loose soil in the core sampler back into the hole in the ground. If the soil count in Step 2 was greater than 250 cpm, rinse the core sampler with clean water before taking another sample.

3.7 Step 7

Deliver the sample bottles to the laboratory analyst.

LOCAL COST RATES

Local Cost Rates
(in Philippine Pesos)

A. Labor rates per profession (per hour):

	Personal	Overhead
Manager	226	79
Senior Engineer	202	71
Graduate Engineer	175	61
Technician	152	53
Skilled Worker or Clerk	139	49
Auxiliary Worker	127	44

B. Contamination field measurement costs:

	Labor	Equipment	Time
Background (per measurement)	114	21	10 min
Surface γ or β scan, flat (per m^2)	114	21	10 min
Surface γ or β scan, pipe up to 2" dia (per m)	23	4	2 min
Surface γ or β scan, pipe up to 6" dia (per m)	57	10	5 min
(Pipe > 6" dia is to be considered as flat surface)			

C. Sample-taking costs (per sample):

	Labor	Consumables	Time
Smear	33	10	5 min
Soil	131	15	20 min

D. Laboratory analysis costs (per sample):

	Labor	Equipment	Time
Gamma counting	109	350	20 samples per day max
Smear counting	59	38	15 min per sample

E. Equipment costs (per hour):

Set of Personal Hand and Power Tools	50
2-ton Forklift	600
10-ton Crane	1800