THE CONSTRUCTION AND COMMISSIONING OF MINT'S LATEX IRRADIATOR

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Abstract

The construction and installation of MINT's automatic continuous latex irradiator is described. MINT co-operated with NUKEM to design the plant. Construction was done by local building consultants and local contractor. The installation of the plant includes local fabrication components and imported components. The plant is automatically controlled by a computer system. Features of plant is described.

CONSTRUCTION

* NORMAL BUILDING CONSTRUCTION

* STRONG FOUNDATIONS FOR THE HEAVY MASS CONCRETE - SHIELDING

* EMBEDDED PIPES

* OUTER SOURCE TANK
  INNER TANK CONSTRUCTION

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LATEX HANDLING & PROCESSING

- Fresh latex storage tank
- Formulation tank
- Pre-irradiated latex tank
- Irradiated latex collection tank
- Chemical tank
- Fresh water tank
- Slurries tank
  (ie. Mixture of soluble oil and water)

FORMULATION AREA

Storage and preprocessing of latex being carried out.

- ➔ Fresh latex storage
- ➔ Sampling (determine suitable dose required)
- ➔ Transfer for formulation
- ➔ Formulation
- ➔ Transfer to pre-irradiated tank
- ➔ Delay
- ➔ Start irradiation
- ➔ Sampling
- ➔ Irradiated latex storage.

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MATRIX PUMP

- Function - to transfer formulated latex (ie. Pre-irradiated tank) into irradiation bunker and out (ie. Irradiated latex collection tank), through Matrix pipe.
- Design - Positive displacement by means of piston pump and operated by hydraulic system (ie. approx. 25 litters/stroke).
- Easily regulated - by means of computer setting/control.
- Consist of -
    * Go-devil station (ie. Loading & Recovery Dosimetry ball, Cleaning ball and Separator)
    * Operating valve (ie. Manual & Automatic)

MATRIX PIPE

- Function - latex or liquid piping from Matrix pump to irradiation bunker and back.
- Design - made from Stainless Steel with internally electropolished (ie. Finest surface finish).
- Partly named Irradiation tube which special configuration/ layout, which is placed inside irradiation bunker.
- Irradiated material separated by special sealer named Separator.
- Cleaning by using Rubber foam ball (ie. Nicked name GO-DEVIL)-

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IRRADIATION BUNKER

- Function - biological shield (ie. to maintain surrounding doserate always at permissible level.
- Design - majority build by heavy density concrete (~ 2.3kgs/cm^3).
- Design to enclosed - max. 1 MCi of Co-60 radioactive source (ie. Current source strength - 1.4 KCi).
- 5 types of wall penetration;
    * Door - main entrance, equipped with metal cased concrete door plug (ie. Weight ~ 8000 kgs.). Manually operated, since low operation requirement.
    * Pipe labyrinth duct - services duct for matrix pipe and etc.
    * Ventilation duct - embedded below floor level.
    * Source loading & unloading tube - purposely for radioactive source loading & unloading facilities.
    * 4 Nos. Outer tubes - for future additional upgrading.

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RADIOACTIVE SOURCE

- Gamma source - Co-60.
- Positioned in horizontal source rack.
- Stored in metal tank surrounded by concrete, embedded below floor level.
- Max. source strength - 1 Mci.
- Current source strength - 1.4 Kci.
- Source rack operation - by means of hydraulic system to raised and lowered by gravity pull.
- Full loaded rack - ~ 3000 kgs.
- Cooled by using cold water circulation system, only during storage position.

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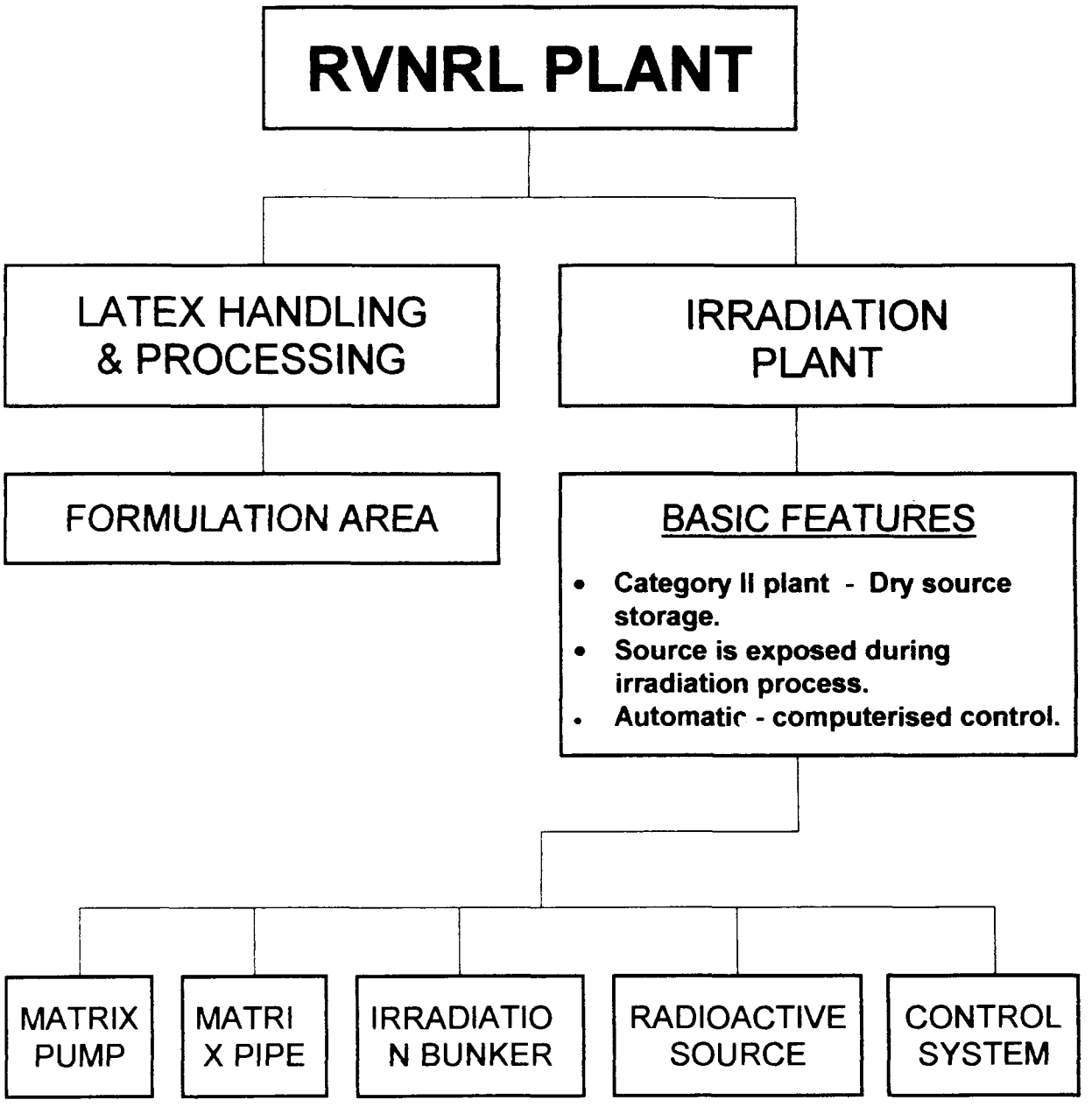

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CONTROL SYSTEM

- Computerized control system.
- Consist of;
  - * PC.
  - * Signal interface card.
  - * Monitor.
  - * LED display board.
  - * Contactor block.
  - * Power supply.
  - * Hydraulic power pack.
- Design;
  - * Easily parameter input to operate plant.
  - * Several interlock system for safety purposes.
  - * Built in feature for fail-safe operation.
  - * Plant condition & Operation parameter display.
  - * Parallel display and control panel.

DOSIMETRIC MEASUREMENT

* **DOSIMETERS**

TYPE	λ	RANGE (Kgy)
RED 4034	604	5-50
AMBER 3042	651	1-30

* **DOSIMETRY BALL MADE OF HDPE**
  fill with latex

* **8 - 15 Kgy**

* **ABSORBED DOSE**

* **DOSE DISTRIBUTION IN LATEX**

* **QUALITY CONTROL**

* **CALIBRATED AGAINST STANDARD FRICKE DOSIMETER(FERROUS SULPHATE)**

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TOWARDS EFFICIENT & ENVIRONMENT FRIENLDLY RVRNL PLANT

DOSE MEASUREMENTS AT THE RVNRL PILOT PLANT BY MEANS OF AMBER 3042 PERSPEX DOSIMETER

Parameters of the irradiation	Measured Dose (kGy)				
	First Stroke	Middle	Last Stroke	Avg	Dev (%)
Dose: 12 kGy No. of Stroke: 56 Density : 1 g cm-3(water) Volume : 0.5m3 Cycle time : 646 Sec. Operation time: 10.05 hrs.	12.21 ± 0.55	12.45 ± 0.20	12.87 ± 0.35	12.51 ± 0.95	4.3
Dose : 12.5 kGy No. Stroke : 18 Density: 0.95 gcm-3(latex) Volume : 0.463 m3 Cycle time 648 Operation time : 3.24 hrs	13.58 ±0.90	12.42 ±0.56	13.20 ±0.24	13.07 ±1.16	4.6

RVNRL PLANT

(COBALT 60)

INITIAL LOADING	DATE OF LOADING
144200 CURIES	14-Feb-96

TODAY

[redacted]

CURRENT SOURCE STRENGTH

136462

CURIES

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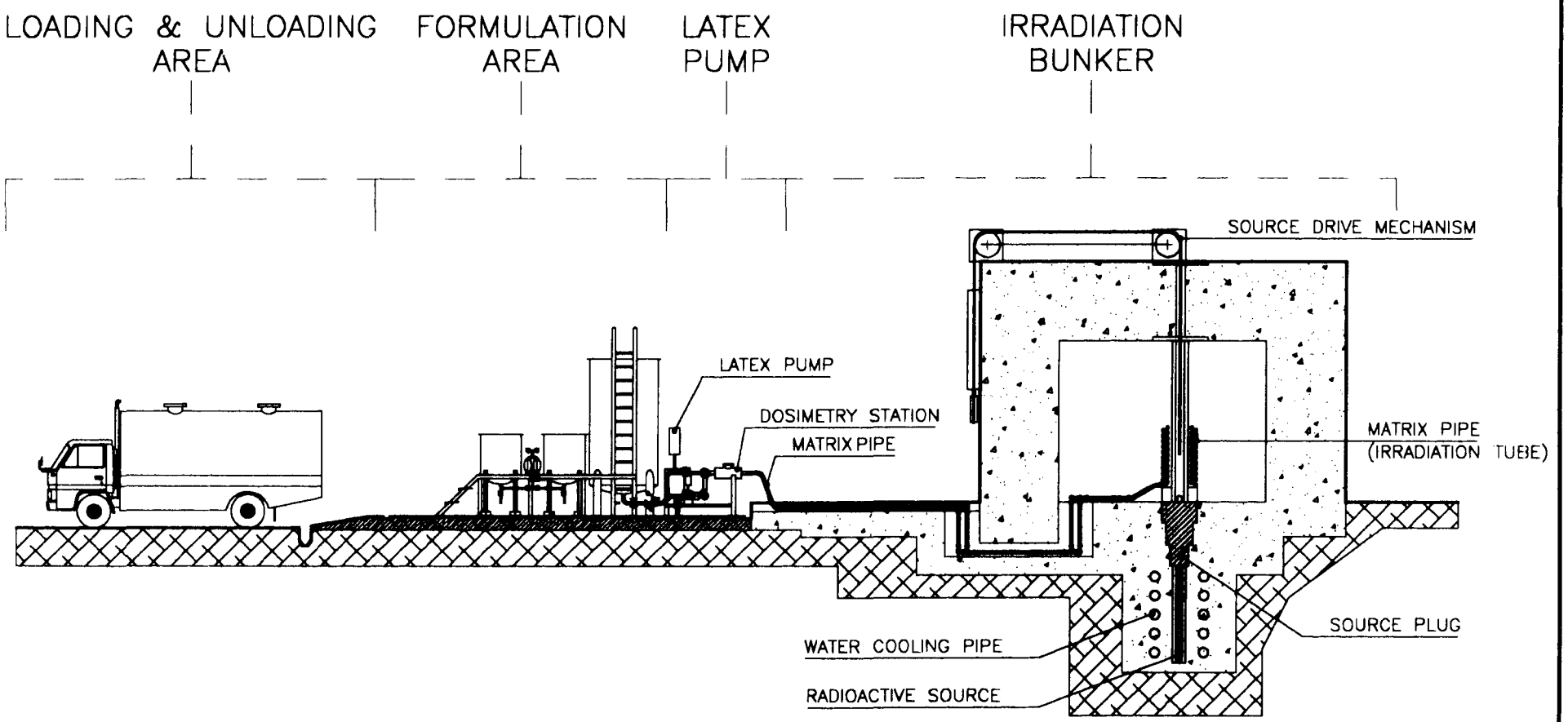

FINAL DESIGN

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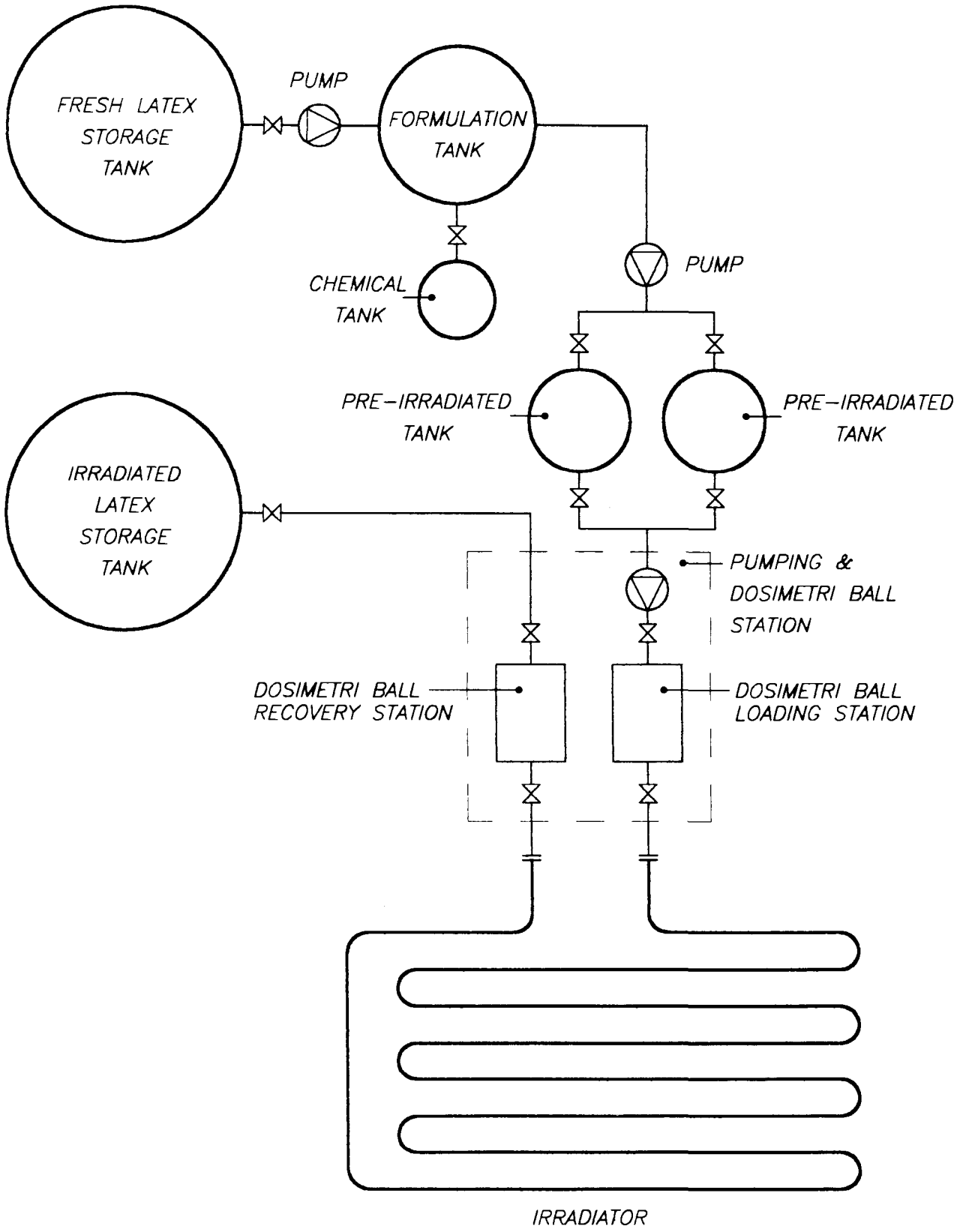
TYPICAL SECTION VIEW OF MINT RVNRL FACILITIES



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TYPICAL SCHEMATIC DIAGRAM OF RVNRL PLANT

(FINAL PLANT)

OPERATION TIME BY DOSE REQUIRED.

MANUAL DATE DETERMINATION

Date of loading	14-Feb-96	
No. of days after loading	147	Days
Daily decay rate	0.9996324	
Initial source strength	144200	Curies
Current source strength	136613.2704	Curies
Datum dose	10	kGy
Datum cycle time	513	sec.
Datum density	0.95	
Actual density	0.95	
Source correction	1.055534353	
Density correction	1	
Cycle time	541.4891231	sec.
Actual cycle time	649.7869477	sec.
Rounded Actual cycle time value	649	sec.
Operation time	**18.02777778**	hrs.
Rounded Operation time value	**18.03**	hrs.
Equivalent operation time	**64900**	sec.

AUTO DATE DETERMINATION

Today	13-Jul-96	
Date of loading	14-Feb-96	
No. of days after loading	150	Days
Daily decay rate	0.9996324	
Initial source strength	144200	Curies
Current source strength	136462.6687	Curies
Datum dose	10	kGy
Datum cycle time	513	sec.
Datum density	0.95	
Actual density	0.95	
Source correction	1.056699253	
Density correction	1	
Cycle time	542.0867166	sec.
Actual cycle time	542.0867166	sec.
Rounded Actual cycle time value	542	sec.
Operation time	**15.05555556**	hrs.
Rounded Operation time value	**15.06**	hrs.
Equivalent operation time	**54200**	sec.

CONCLUSION:

* **DEDICATED PILOT LATEX IRRADIATOR WAS SUCESSFULLY COMMISSIONED ON 27th APRIL 1996. SINCE THEN IT HAS BEEN RUNNING SMOOTHLY WITH FEW PROBLEMS.**
  IT MEETS THE REQUIREMENT OF THE RVRNL USER.

* **THE PILOT PLANT IS TIMELY LAUNCHED TO TEST THE INDUSTRY AND BUILD THE MARKET DEMAND FOR THE RADIATION VULCANIZED NATURAL RUBBER LATEX**

* **PROBLEMS AND IMPROVEMENTS ON THE PLANT OPERATION WILL BE CONTINOUSLY MONITORED AND UPGRADED TO MAKE IT RELIABLE, SAFE AND EFFICIENT PLANT.**

* **PLANT DESIGN WILL BE FURTHER DEVELOPED TO REDUCE THE CAPITAL OUTLAY**