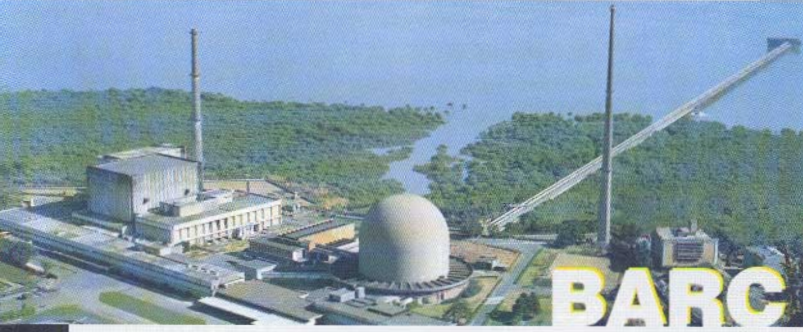

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DEVELOPMENT OF NEW INTERVENTIONAL STRATEGIES FOR POSSIBLE REPLACEMENT OF PRUSSIAN BLUE IN CURTAILING THE WHOLE BODY RETENTION OF RADIO-CESIUM IN THE EVENT OF ITS RELEASE*

D.N.Pahuja, V.S. Jagtap, V.R.Sonawane and A.M.Samuel
Radiation Medicine Centre (BARC)
Atomic Energy Regulatory Board
Tata Memorial Centre Annexe
Parel, Mumbai 400 012

Beginning of the new millennium is an appropriate time to pause and reflect on what we have achieved and where we are headed for. Even more timely is the opportunity for us to cut the shackles of the past and create a bold new vision in this aspect for the India of 21st century. Accidents can happen anywhere, whether in the nuclear power sector or by genetically modified organisms. Any technology has both risks and opportunities. It is up to us to maximize opportunities and minimize risks. How safe is safe, is some thing we have to sort out for our selves.

Nuclear accidents like Chernobyl or Goiania [1– 3] should not lead us to altogether dismissing the potential of tapping atomic energy. Preventing a natural or manmade disaster may not be in our hands but limiting its impact may well be within our reach. It is not only our achievements in generating more electric power from nuclear reactors that hold hope for accelerating our economic growth and prosperity, but our constant efforts in mitigating the damaging effects of the radiations that must be given rightful importance.

*This is the summary of three papers presented at the International Conference on Radiation Protection, Measurements and Dosimetry: Current Practices and Future Trends (IARP – IC 2K1), February 20 – 23, 2001.

Contents

Atomic Energy, Genetic Engineering or any other Cutting Edge Technology has both Risks and Opportunities;
But by adopting appropriate safety strategies with a strong sense of Responsibility,
we can reach the Goal with proper Accountability.
Safety is to be considered the Right,
And not just a Privilege.

Hence, coping with the future is nothing but coming to grips with the current challenges. And one of the greatest challenges we are facing today in this regard is the search for better interventional counter measures which could help us in minimizing the radiation induced damage in the face of ever increasing levels of environmental radioactivity. Of the various isotopes of Cesium (Cs), ^{137}Cs is the most important and a common fission by-product material, besides being a frequent active component of sealed sources used for industrial / medical purposes. It is an important radionuclide, particularly in radiation oncology, found in hospitals performing either gynaecological brachytherapy or intestinal therapy for solid tumours. All this has resulted in a steady increase in the use of radio-cesium (*Cs) for various experimental, diagnostic and therapeutic purposes. The presence of a large number of nuclear reactors world-wide has further increased the chances of its accidental release, posing a greater radiation hazard, not only to the workers at the reactor site and the public at close range, but also to the population at a distance, if they are exposed to the air–borne radionuclide or contaminated food/water. These risks have been clearly exemplified by the Chernobyl and Goinia accidents.

Radio-cesium (*Cs), particularly ^{137}Cs, has a high impact on human health for following five reasons:

1. It is easily absorbed by the body through different routes (ingestion, inhalation and/or skin penetration).
2. It has a relatively long biological half-life in humans of about 100 – 110 days.
3. Its physical half-life is about 30 years.
4. It emits beta & penetrating gamma radiations.
5. It is distributed more or less uniformly throughout the body due to its proximity to Potassium (K).

Hence, presence of the excess levels in the environment of radioactive ^{137}Cs, a long-lived radio-

nuclide released by the Chernobyl / Goiania accidents, has been the major cause of concern. Agenda – 2001, must therefore, be designed as a springboard for new ideas and new approaches to resolve these old problems. Our earlier as well as recent work in successfully dealing with the emergency preparedness in the event of any accidental release of radio-iodine and radio-strontium in the environment, has been quite encouraging [5–7]. The present study is our modest attempt in this direction to develop some new indigenous interventional strategies, which could help us in curtailing the whole body retention (WBR) of *Cs in the event of its accidental release in place of Prussian Blue (PB), normally used in this regard, so that our dependence on the import of PB, which is not available in India, could be considerably reduced / avoided. Even stable Cs, normally used in many industrial and biomedical applications, is also toxic and needs to be decorporated, in case it enters in our *in vivo* system.

The rationale behind this study and the principles behind the basic approaches adopted in dealing with the present problem are briefly outlined as under:

RATIONALE

- Only one stable isotope out of total of ~36 isotopes of Cs (*Cs: $T_{1/2}$ ranging from 0.38s to 2.95×10^6 years).
- 8 of the *Cs isotopes are fission products.
- ^{137}Cs ($T_{1/2}$ – 30years) is one of the high yield fission products (6 atoms / 100 fissions)
- *Cs fallout reaching humans through plant – animal food chain.
- *Cs, with its proximity to 'K', gets avidly concentrated by soft tissues, maximum by skeletal muscle.
- Stable Cs is also toxic to our *in vivo* milieu.

BASIC APPROACHES BEHIND OUR INTERVENTIONAL STRATEGIES

- ✓ Diluting the radioisotope with its stable isotope, viz. stable iodide in case of radio iodine [5,6].
- ✓ Trial of simple congeners / their salts, which have similar properties as radio-nuclide [7].
- ✓ Use of some common dietary / health promoting substances with some mild excretory properties [8].
- ✓ Use of metal chelators / complexing agents.

Protocol

- Radio-cesium (*Cs - 1.3μCi / ml) was administered orally to all the different groups (6 each) of rats (270 – 300g).
- They were put on the following treatment – regimens: 1 hr post *Cs – administration, 5 d / week for – 4 – 8 weeks.
  a) Control – placebo (1 ml water, orally).
  b) Prussian Blue (PB) : 5mg suspension / ml / day / 100g BW, orally.
  c) KBC – Potassium (K) based compound, prepared in our lab: 5mg suspension / ml / day per 100g BW, orally.
  d) KDS – K based dietary substance: 1 ml initially and later given, instead of drinking water.
  e) Congeners & metal chelators:
     i. Glucose saline (GS): 1 ml initially and later given instead of drinking water.
     ii. Cyclodextrin (CD): 1 ml (1.5%) initially and later given as 1.5% solution, instead of drinking water.
     iii. Crown ether (15 CE): 25 mg / ml / rat / day.
     iv. Potassium Gluconate (KG): 15 mg / ml / d, orally and 5% in the diet, 2 weeks later to CD – treated rats.
     v. CBC – Calcium (C) based compound, prepared in our lab : 5 mg suspension / ml / day per 100g BW, orally, 2 weeks later to GS – treated animals.
  f) CBC: 5mg suspension / ml / day per 100g BW, orally, was later repeated in the fresh group of rats 1 hr after the administration of *Cs .
- Whole Body Retention (WBR) of *Cs was measured every day for ~ 4 – 8 weeks, in specially designed gamma counter (Fig. 1), routinely used for bio-distribution studies of the radiopharmaceuticals [9,10].

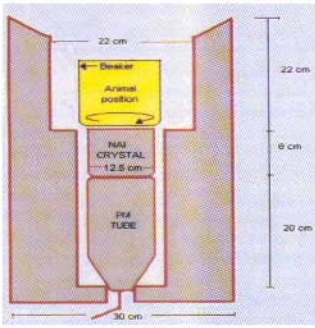

Fig. 1 Gamma-Counter

Results

WBR of *Cs, given as percent of the administered dose, in control and experimental group of rats, treated with PB and KBC is shown in Figs. 2. Initially both these compounds (PB & KBC) seem to be equally effective in enhancing the clearance of *Cs, compared to that in untreated control animals, during 1st week of their administration (Cont. ~ 36%, PB ~ 10%, KBC ~ 6%). Thereafter, rats from KBC – treated group started showing significant reduction in their WBR of *Cs, bringing it appreciably lower to ~ 0.7% by the end of the fourth week compared to ~ 3% in the animals treated with PB ($p < 0.001$), while WBR of *Cs in control animals still remained

significantly higher at ~ 13% of the administered dose.

It is further observed that the rats supplemented with KDS as drinking water were certainly drinking more fluid than other two groups of animals, probably because of its sweet taste, and also passing more urine as their cage–beddings were found to be more wet compared to that from other two groups. WBR of ^{137}Cs in these rats was also significantly reduced (~8%), compared to that in control group of animals (~13%) after 4 weeks with concomitant increase in the clearance of ^{137}Cs from their *in vivo* system but significantly lesser than PB – treated rats (Fig.3)

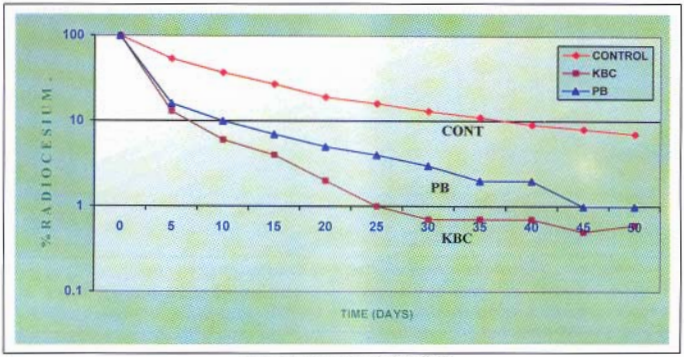

Fig. 2 : Comparison between PB and KBC

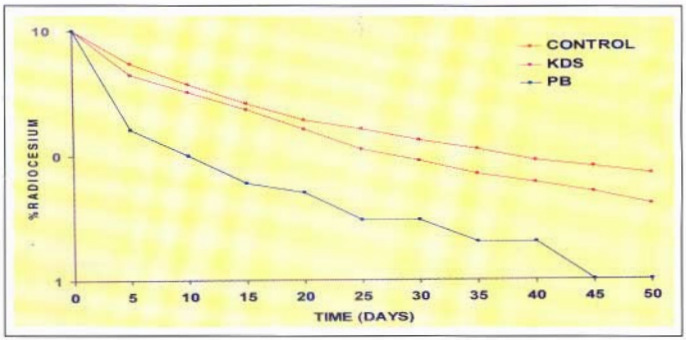

Fig. 3 : Comparison between PB and KDS

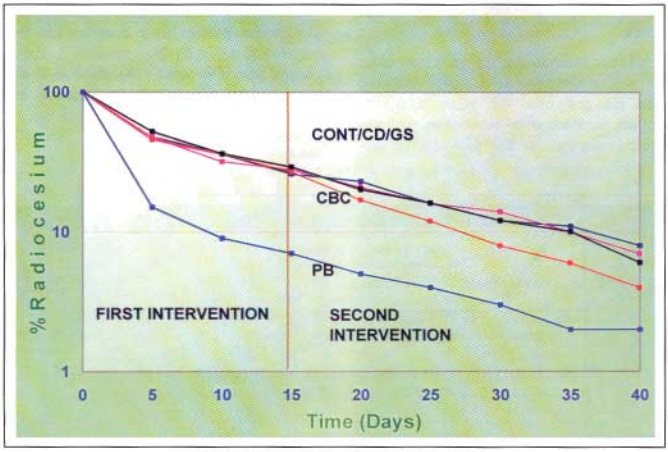

Fig. 4: Comparison of Control, GS, CD and CBC with PB

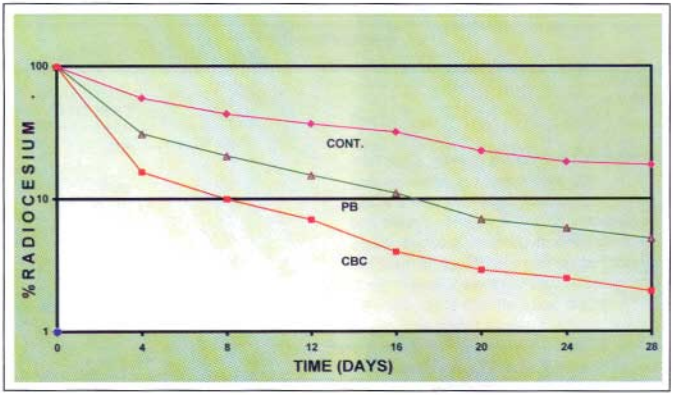

Fig. 5: Comparison between PB and CBC

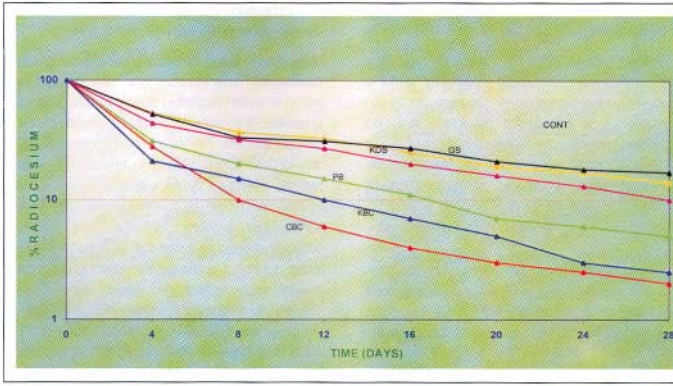

Fig. 6: Comparison of Control, GS, KDS, CBC and KBC with PB

Only PB–supplemented rats showed significant reduction (~7.0%) in their WBR of ^{134}Cs, compared to the other set of animals, treated with one of the Cs – congeners (sodium as glucose saline – GS) and metal chelators (cyclodextrin & crown ether), as WBR of ^{134}Cs in these groups of rats remained at control level (~27%) for the first two weeks (Fig. 4). WBR of ^{134}Cs was again measured after every 24h for further two weeks, after the change in the treatment regimen of the rats from GS–group to another new calcium based compound – CBC, prepared in our laboratory and those from cyclodextrin (CD)–treated group to another congener – potassium, as potassium gluconate (KG), after first two weeks on the treatment of GS and CD, respectively.

As is seen from Fig. 4, all the rats from PB and CBC – treated groups showed significant reduction in WBR of ^{134}Cs (2% & 5% respectively), but not in other groups of animals, which remained at control level (~10%). CBC, when supplemented initially, also showed enhanced clearance of ^{134}Cs from the *in vivo* system of the animals, compared to that of PB–treated rats (Figs. 5 & 6).

Discussion

The search for the effective counter measures for internal as well as external radioactive contamination in the event of any sudden release of radioactivity in the environment has been going on since the Hiroshima and Nagasaki atomic bombings, over a half century ago. But it has picked up its pace mainly after the Chernobyl accident in April, 1986 and radiological accident in Goinia in Brazil in September, 1987, resulting in the ^{134}Cs – contamination of a large number of people, spread over a wide area.

The presence of ^{134}Cs in the human body was identified through spectrometry for the first time in 1956, almost a century after Cs–metal was discovered from the mineral waters of Durkheim, Germany, in 1860 by Bunsen & Kirchhof. Cs–compounds are readily absorbed into the gut and follow the movement of Potassium (K) in our body, competing with it for transport across cell membranes. The main pathway for Cs – excretion is through glomerular filtration in kidneys. Because of its reabsorption in the intestine, Cs also gets cleared, partly through faecal excretion, more often

after its chelation by any complexing agent like Prussian Blue.

Prussian Blue (PB), a practically nontoxic compound, has been found to be very useful in enhancing the clearance of ^{137}Cs from the *in vivo* system [3], in the affected population, in Goinia accident, reducing the biological half life of ^{137}Cs to 1/2 to 1/3 of its original. But, the radiation dose, however small, is capable of inducing cellular malfunction, and the probability of its occurrence, but not its severity, depends on the radiation dose.

There is no other known compound which has been as effective and useful as PB in the decorporation of ^{137}Cs from our *in vivo* system. But it is not available in India and there has been quite some difficulty in the recent past in obtaining it from outside. Considering the severity of the radiation damage [1–4] in the event of any sudden release of ^{137}Cs, Atomic Energy Regulatory Board has asked RMC to shoulder the responsibility of developing some new interventional strategies which could possibly be more or as potent as PB in enhancing the clearance of ^{137}Cs from our *in vivo* system. Our exhaustive efforts put in this search are not because of any academic interest but because of a dire necessity in the prevailing circumstances. In continuation of our search for alternate strategies, we have prepared some new compounds in our laboratory. The efficacy of such two new compounds prepared in our laboratory with potassium and calcium base (KBC and CBC) has been examined, in curtailing the WBR of ingested ^{137}Cs, in comparison to PB, in rats. PB, KBC and CBC were administered in equivalent dosage (5mg/100g BW) as suspension in water, because of their insolubility. Both KBC and CBC were found to be more effective than PB, in enhancing the clearance of ^{137}Cs from the *in vivo* system of the animals (Figs. 2,3, 4 & 6).

The efficacy of one of the natural, routinely used dietary substances (KDS) with mild diuretic and laxative properties and containing some congeners (viz. Na & K, being in the same group as Cs and sharing some of its common properties) and known metal chelators, was also examined for increasing the clearance of ^{137}Cs from the interior milieu.

Many micro / macro–nutrients present in our dietary substances have found wide spread use as important health promoting agents by their inherent protective properties against the onset of the disease process. The latter could be due to their anti–oxidant nature, helping to scavenge the free radicals generated by the oxidative stress due to ionizing radiations, or these nutrients may have some other property by which the harmful substances could be cleared at the faster rate. The increased intake of this dietary mixture, used in the present study, with a mild diuretic and laxative property, besides having sodium and potassium – the congeners of Cs, in some natural complex form, could have helped in the removal of ^{137}Cs at a little faster rate than that in the control rats. Though this clearance of ^{137}Cs from *in vivo* system of the rats, was quite smaller compared to that observed in PB – supplemented animals (~ 8% vs 3%), it does provide us a useful alternative natural dietary substance which, besides its health improving properties, could also help in curtailing the WBR of ingested ^{137}Cs and could be given along with any suitable compound for enhancing the rate of clearance of ^{137}Cs. However, two salts of Cs – congeners (Na & K) and metal chelators/ complexing agents did not help in reducing the WBR of ^{137}Cs.

The results of this exhaustive study are quite encouraging and warrant a detailed in depth examination of the composition, besides its toxicity, if any, of the new compounds (KBC and CBC), which show better decorporation of ^{137}Cs than PB, from the *in vivo* system. The conclusions and comments in brief along with the message this study conveys are given below.

Conclusion and Comments

- The new prepared compounds in our laboratory - KFB, CaFB & CaMgFB – show better decorporation of ^{137}Cs than PB–the Gold

MESSAGE = MESS + AGE

- *Clear the* **mess** *out of your* **age** *about the scare of radiation – hazards and be ever ready with necessary emergency preparedness.*
- *Preventing natural disaster or man made accidents may not be in our hands, but limiting its impact may well be within our reach.*

standard, normally used, resulting in more reduced body burden, compared to that by PB.

- KDS, though less effective, is a natural dietary substance with health–promoting effect and can be a useful alternative in enhancing *Cs – clearance, along with any suitable *Cs decorporating agent.
- Many of the salts with Cs-congeners as well as known metal chelating agents are not capable of reducing / decorporating *Cs from *in vivo* system.

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DESIGN AND DEVELOPMENT OF DRIVE MECHANISMS FOR ADJUSTER RODS, CONTROL RODS AND SHUT-OFF RODS OF TARAPUR ATOMIC POWER PROJECTS - 3 & 4

D.N.Badodkar, N.K. Singh, N.S.Dalal, M.K.Mishra and Manjit Singh
Division of Remote Handling & Robotics

Introduction

BARC and NPCIL have entered into MoU for design and development of drive mechanisms for adjuster rods, control rods and shut-off rods of Tarapur Atomic Power Projects (TAPP) - 3 & 4.

Signing of MoU between BARC & NPCIL

Under the MoU, Division of Remote Handling & Robotics (DRHR), BARC, shall carry out the design and development of prototype drive mechanisms and issue detailed drawings and specifications to NPCIL so as to meet the TAPP-3&4 project schedule requirements. The BARC drawings and specifications shall be directly used by NPCIL for production of drive mechanisms for TAPP - 3 & 4.

DRHR, BARC, has designed cable winch drive mechanisms for adjuster rods, control rods and shut-off rods of TAPP - 3 & 4 incorporating a number of advanced features. These mechanisms are significantly different from the mechanisms used in Dhruva, Kamini and 220 MWe PHWRs. The prototype drive mechanisms are being tested on full scale test station at BARC for design validation. The tender drawings (total 240 nos.) and specifications for production of drive mechanisms have been issued to NPCIL. Under the MoU , NPCIL shall maintain the authenticity of drive mechanism drawings made by BARC. The clearance for production shall be given on completion of testing of prototype mechanisms at BARC.

Functional Requirements

The drive mechanisms are designed to meet the following functional requirements:

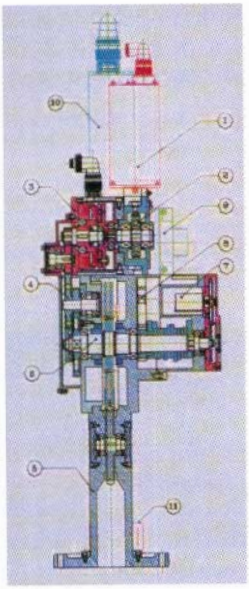
- Raising, lowering & holding of rods
- Position indication & limit position indication
- Scram characteristics
- Size constraints
- Environmental conditions
- Remote engagement/ disengagement
- Limited reactivity addition capability
- Fail-safe, non-reverse scram characteristics
- Service life requirements
- Trips, alarms & indications to check safe operation & healthiness
- Reliable, non-dependent on external power source for safety action
- Minimum periodic maintenance

Basic Design Specifications: The basic design specifications for the drive mechanisms are as follows :

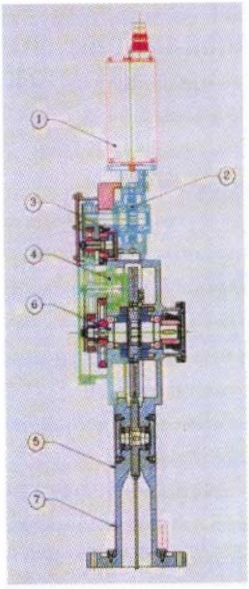
Number of shut-off rods	: 28
Number of control rods	: 4
Number of adjuster rods	: 17
Reactivity worth of shut-off rods	: 72 mk
Total travel of shut-off rod / control rod	: 6600 mm
Weight of shut-off rod / control rod	: 50 kg
Time to raise shut-off rod / control rod (at max speed)	: 150 ± 10 s
Total length of shut-off rod / control rod	: 5500 mm
Reactivity addition rate during withdrawal of rods	: ≤ 0.33 mk/s
Max linear speed during withdrawal of shut-off rod / control rod	: 56.5 mm/s
Drop time for 5940 mm (90% travel) of shut-off rod, excluding signal	: 1.8 ± 0.1s
processing and actuation delay	: Upto 1:10
Speed variation of adjuster rods / control rods	: 15 kg
Weight of adjuster rod	: 70 ± 10 sec
Time to raise adjuster rod at max speed	: 4 sec approx.
Drop time for 5940 mm (90% travel) of control rod	: Anywhere upto 100% drop
Partial drop distance for stepback function of control rod	: 65°C
Max ambient temperature for machanisms	: 10 R/hr
Max radiation field for mechanisms	: ASME Boiler andPressure Section
Applicable code	III, NB and for OBE & SSE

Shut-off Rod/ Control Rod Drive Mechanism: During normal reactor operation, shut-off rods/ control rods are held through electromagnetic clutches for fail-safe operation. On de-energisation of clutches, the rods fall freely under gravity. The drive mechanisms for shut-off rods and control rods are identical. The shut-off rod element contains an orifice at its top end which comes into action at 80% downward travel of the rod and limits its free fall speed. The control rod element contains an orifice at its bottom end to limit its free fall speed. The hydraulic dashpot is designed to gradually reduce the speed of shut-off rod/control rod during 90% to 100% downward travel.

Adjuster Rod Drive Mechanism: The adjuster rod drive mechanism is designed for raising and lowering of adjuster rods at controlled speeds and does not contain electromagnetic clutch or hydraulic dashpot.



Shut-off rod/control rod drive mechanism



Adjuster rod drive mechanism

Sub-assemblies:

1. Motor sub-assembly
2. Worm gear sub-assembly
3. Electromagnetic clutch sub-assembly
4. Reduction Unit-I sub-assembly
5. Mechanism housing sub-assembly
6. Sheave shaft sub-assembly
7. Potentiometer sub-assembly
8. Reduction unit-II sub-assembly
9. Hydraulic dashpot sub-assembly
10. Limit switch sub-assembly
11. Reed switch sub-assembly

Sub-assemblies:

1. Motor sub-assembly
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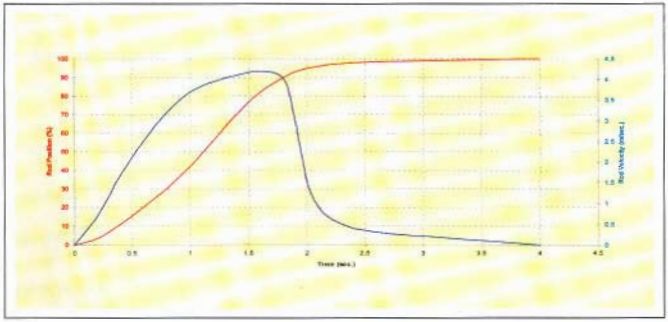


Drop characteristic of shut-off rod for TAPP-3&4

Salient Design Features: The salient design features of drive mechanisms are as follows:

- 28 shut-off rods constitute the Primary Shutdown System. 4 control rods and 17 adjuster rods constitute Reactor Regulation System. The unavailability of the Primary Shutdown System shall not exceed 10^{-3} year/year.
- Heavy water moderator is used for cooling of shut-off rods, control rods and adjuster rods. A perforated guide tube surrounds each shut-off rod, control rod and adjuster rod. The guide tubes for shut-off rods and control rods are identical.
- The drive mechanism is flange mounted on top of guide tube extension and it forms part of pressure boundary for heavy water moderator system.
- The drive motors in the drive mechanisms operate on 3 phase 220V, 50 Hz. The drive motors for control rods and adjuster rods are designed for variable speed (10% to 100%).
- Simplified absorber element design to facilitate easy inspection and replacement of wire rope used for attaching the absorber element to the drive mechanism.
- The electromagnetic clutch operates on 90V dc. Clutch design and torque capacity are suitable to permit partial release of shut-off rod from parking position for checking healthiness of drive mechanisms. Clutch design and torque capacity are also suitable to permit re-arresting control rod after release for reactor stepback function.
- 90% free fall of shut-off rod/control rod (without dashpot) for highest reliability and consistent performance. Maximum free fall speed of shut-off rod element is limited through the use of an orifice at its top end (orifice is effective during 80% to 90% downward travel of shut-off rod). Maximum free fall speed of control rod element is limited through the use of an orifice at its bottom end.
- Hydraulic dashpot incorporates an oil window connected to low pressure side. Above the oil level, the window has adequate space for expansion of oil at high ambient temperature.
- The conventional single vane replaced by double vane to balance forces on dashpot shaft

arising from high oil pressure during damping action.

- A screw for controlling oil bypass from high pressure side to low pressure side for adjusting damping characteristics of dashpot.
- Modular design of drive mechanism layout to permit in-situ maintenance/replacement for individual sub-assemblies, e.g. motor and worm gear, clutch, dashpot, switchgear, potentiometer, etc without opening moderator pressure boundary.
- Better lubrication for gears, bearings, pick-up rings and spiral springs for long wear life.
- Rope sheave in place of rope-drum to eliminate chances of wire rope coming off the drum groove.
- Provision of single turn triplicate potentiometer on dashpot shaft to monitor retrieval of spiral spring while the rod is being raised. Raising of the rod will get inhibited incase of unsatisfactory retrieval of dashpot shaft. Rationality checks on potentiometer signal shall be done to detect potentiometer failure.
- Provision of multiturn dual potentiometer to monitor continuous position of rods. Rationality checks on potentiometer signals shall be done to detect potentiometer failure.
- Provision of rugged triplicated switchgear unit to monitor shut-off rod drop time for 90% fall.
- Gear reduction trains for potentiometer and limit switches are eliminated.
- Provision of one set of triplicated reed switches (directly actuated) to indicate shut-off rod fully out position for motor cut-off. Second set of reed switches shall be wired to the safety channels of protective system.

Design Testing of Prototype Units

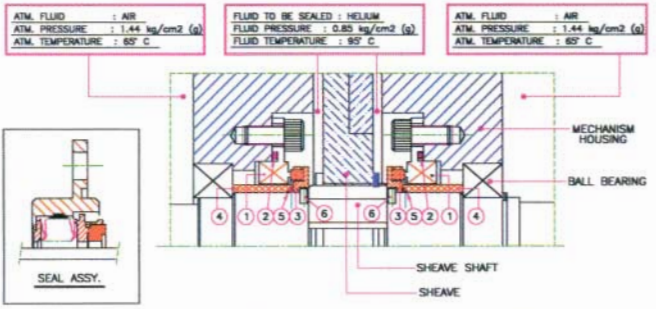
- Effect of initial accelerating spring on rod drop dynamics
- Optimisation of orifice in shut-off rod element for rod drop dynamics
- Optimisation of orifice in control rod element for rod drop dynamics and clutch resetting
- Effect of hole in guide tube stoppper plate on rod drop dynamic
- Effect of perforations in the guide tube on rod drop dynamics
- Effect of water level variation in calandria on rod drop dynamics
- Optimisation of partial release characteristics of shut-off rod for on-line testing
- Effect of moderator cross flow on rod drop dynamics
- Effect of dashpot by-pass screw adjustments on rod drop dynamics

Qualification of Special Hardware Items on Test Rigs

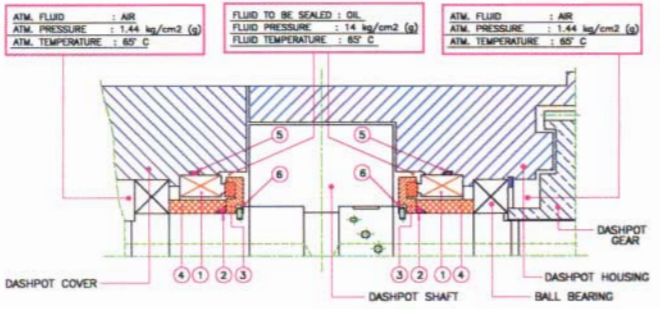
- Simulated testing and qualification of dynamic shaft seals used in sheave chamber and dashpot for 50,000 cycles.

Test rig for qualification of spiral spring, rotary switchgear and potentiometer

- Simulated testing and qualification of spiral spring, rotary switchgear and potentiometers for 10^4 cycles.
- Simulated testing and qualification of reed switch unit for 10^6 cycles.
- Qualification of drive motor and electro-magnetic clutch.
- Qualification of wire rope & its crimped terminals.

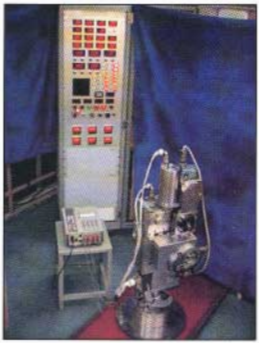


MECHANICAL SHAFT SEALS FOR SHEAVE SHAFT



MECHANICAL SHAFT SEALS FOR HYDRAULIC DASHPOT

S.No.	DESCRIPTION	MATERIAL
6	ANTI-ROTATION PIN	S.S.316
5	'O' RING	VITON
4	SLEEVE	S.S. 17-4 PH
3	MATING RING COMPOSITE (ROTATING)	T.C.+TITANIUM
2	'O' RING	VITON
1	SEAL ASSY. (STATIONARY)	CARBON FACE



Full scale test station

Seal test rig

Life Testing of Final Prototype Units

The final prototype mechanisms incorporating special hardware items shall be tested as follows:

- The shut-off rod drive mechanism shall be tested for at least 5000 full drops and 2500 partial release tests (on line test) with inspection and preventive maintenance after every 500 drops and servicing after every 1000 full drops.

The above mentioned drive mechanism shall also be tested for at least 2000 partial drops from various heights (for stepback) as control rod drive mechanism with inspection and preventive maintenance after every 500 drops.

- The adjuster rod drive mechanism shall be tested for atleast 4500 cycles with inspection and preventive maintenance after every 500 cycles.

Status of Development

- Mark-I shut-off rod drive mechanism has been tested for 1000 drops and & Mark-II has been tested for more than 5000 drops for design validation and optimisation of scram characteristics and further testing is in progress.
- The adjuster rod drive mechanism is being tested for design validation.
- Qualification of dynamic shaft seals, spiral spring, rotary switchgear, potentiometer and reed switches is in progress.
- Manufacturing of final prototype mechanisms incorporating qualified hardware items is in progress.

BARC SIGNS MoU WITH BEL

BARC and Bharat Electronics Limited (BEL), Bangalore, have signed MoU for joint development of Laser Communicator and its applications.

Laser Communication System consists of two sets of Optical Transceiver units. It offers a low cost and low power, short/long range (1.5 km/10 kms), compact and light weight, secure speech transmission of telephonic quality in full duplex mode using pulse frequency modulation at 10 kpps.

The main advantages of this atmospheric line-of-sight communication link, using a near infrared (invisible) light carrier beam, are :

- High security and privacy
- Low cost of installation

At MoU signing function, seated (from left to right) are: Mr S.L. Makker, Laser & Plasma Technology Division, Dr N. Venkatramani, Head, Laser & Plasma Technology Division, Mr Amar Sinha, High Pressure Physics Division, Dr B.N. Karkera, APPD, Dr R.B. Grover, Associate Director, TC & IRG, Mr S.C. Khanna, Director, Com. & Man. Services, BEL, Bangalore, Mr A.M. Pafankar, TT&CD, Mr T.R. Prasad, General Manager, TORQUE, BEL, Bangalore, Mr T.R.K. Janardan, General Manager, BEL, Pune

- Quick and easy installation and alignment
- Free from EM/RF interference
- No licence required

Prototype laboratory model has been developed at Laser and Plasma Technology Division of BARC. BARC will provide design expertise and BEL will carry out engineering and ruggedisation of lab model. Manufacturing and commercialisation will be done by BEL. Development of beam lock system will also be carried out to widen the scope of application of Laser Communicator.

WORKSHOP ON 'RADIOLOGICAL EMERGENCY PREPAREDNESS FOR MEDICAL OFFICERS'

The 11th Training Workshop on 'Planning, Preparedness and Response to Radiological Emergencies for Medical Officers' was held at AERB Auditorium, Niyamak Bhavan, Anushaktinagar, during March 12-15, 2001 and was attended by 26 medical doctors from Tarapur Atomic Power Station (TAPS), Rajasthan Atomic Power Station (RAPS), Madras Atomic Power Station (MAPS), Narora Atomic Power Station (NAPS), Kakrapar Atomic Power Station (KAPS), KGS, Nuclear Fuel Complex (NFC) (Hyderabad), Rare Materials Plant (RMP) (Mysore), Primary Health Centre (Tarapur), Medical Division, BARC (Mumbai), LTMG (Sion) Hospital, KEM Hospital and Seth G.S. Medical College, Parel, Mumbai.

Mr B.K. Bhasin, Executive Director (O), NPCIL, welcomed the Guest of Honour Padma Bhushan Dr. Anil Kakodkar, Chairman, AEC and Secretary, DAE, all the other distinguished invitees and the participants. In his introductory remarks, Mr G.S. Jauhri, Head, Health Physics Division, BARC, said that radioactivity was no stranger to a medical professional, but the aim of the workshop was to equip the participants with the state-of-the-art knowledge on medical management of radiation injuries. The Presidential address was delivered by Dr. V. Venkat Raj, Director, Health, Safety & Environment Group, BARC. He emphasised that a lot of knowledge would be gained by the participants by attending this workshop, but considering the defence-in-depth philosophy used in our plants and the practice of safety culture, it is highly improbable that the participants will ever have to use this knowledge in practice.

In his inaugural address, Dr. Anil Kakodkar stated that the fear for nuclear radiation in public psyche is

because of the terrible effects unleashed by the atomic bombs on Hiroshima and Nagasaki. He emphasised that nuclear power programmes should be carried forward while taking care of the public sensitivity. He said that medical doctors can play an integral role in (1) shaping public sensitivity, (2) providing medical management, and (3) handling an emergency situation, should it ever arise. Instead of having an exclusive emergency plan for nuclear plants, he advocated the formulation of an universal disaster management plan, the mechanisms of which could also be activated in case of other conventional emergencies like cyclones, earthquakes, industrial accidents, etc. He said that a large pool of medical professionals should be created to handle any sort of emergency and these medicos should function under the framework of a full fledged disaster management plan. He said that a database of this kind should be available so that it may be made use of in case of any requirement. He also said that this infra-structure should be kept in operational mode by conducting drills from time to time so that the system should not fail in case of an emergency.

Inauguration function of the BARC-NPCIL 11th training workshop on 'Planning, preparedness & response to radiological emergencies for medical officers' held at Niyamak Bhavan, Mumbai. Seated on the dais (from left) : Mr G.S. Jauhri, Mr B.K. Bhasin, Dr V. Venkatraj, Dr Anil Kakodkar (Guest of Honour) and Dr B.J. Shankar

Dr. Anil Kakodkar inaugurated the Workshop by lighting the traditional lamp.

The inaugural function concluded with the Vote of Thanks proposed by Dr. P.R. Bongirwar, Medical Division, BARC and Member, Organising Committee.

CANCER AWARENESS CAMP

The Women's Cell of BARC and the Cancer Patients Aid Association organised a cancer awareness programme for the employees of BARC and the residents of Anushaktinagar. The programme was inaugurated on June 20, 2001, with a lecture by Ms Alka Kapadia on cancers related to women. She emphasised on the prevention and early detection aspects of cancer. Dr A. Damodaran, Medical Officer-in-Charge, BARC Dispensaries, introduced the speaker. Dr A.M. Samuel, President, Women's Cell, presided over the function and Ms S.D. Joshi, Medical Social Work Officer, BARC Hospital & Secretary, Women's Cell, proposed the vote of thanks. The response was overwhelming and a series of 5 check up camps are being organised in Anushaktinagar for more than 300 women.

PATENT SEARCH ON THE INTERNET

Why

- *Know what's latest in your area of work at the start of an R&D program to avoid duplication*
- *Ascertain whether your creation, idea or process is novel or not before applying for patent*
- *Get ideas for solving your technological problems as browsing through patents provides invaluable source of up-to-date information*
- *Monitor worldwide technology trends by knowing number of patent application filings in any particular area*

How

There are a number of patent database sites. Almost every national patent office has its own site apart from international organisations and database vendors. Some provide **Bibliographic (with or without abstract)** details, **Full-text** or **both**. Some are paid and some are free. Some are for patent applications filed, some are for patents granted and some are for both. Normally, it is believed that a search in the following two sites, which cover major players including India, would reasonably ensure that the work has not been patented or applied for.

USPTO (US Patent & Trademark Office) http://www.uspto.gov
Gives bibliographic & full-text for both patents granted and patent applications filed in US. (Go to 'searchable databases'; 'patent and published application full-text databases' & 'quick search' in 'patent grants'/ 'patent applications'. 'Help' would guide you to proceed further).

EPO (European Patent Office) http://ep.espacenet.com
Worldwide database for patents granted and PCT applications filed. ('Help' would guide you through the 'quick search' in the home page).

Other useful sites:

➢ http://www.wipo.int
World Intellectual Property Organization initiated an international patent filing system under Patent Co-operation Treaty covering more than 110 countries. This site provides bibliographic information with abstracts for international patent applications filed through the PCT system.

➢ http://pk2id.delhi.nic.in
National Informatics Centre, New Delhi's site having databases of US, Europe and INPADOC.

➢ http://www.indianpatents.org
Hosted by TIFAC and gives Indian patent applications filed since January 1995.

➢ http://www.derwent.co.uk
Derwent Information's paid site covering information from over 40 patent issuing authorities and various scientific journals and conference proceedings worldwide.

➢ http://www.fiz-karlsruhe.de
STN International's paid site for value added services on literature and patents search.

WORLD NUCLEAR POWER STATUS 2000

Figures released by the International Atomic Energy Agency IAEA) show that there were 438 nuclear power units in operation world-wide as of 31st December 2000. Six new nuclear units were connected to the grid during the course of last year.

During 2000, six new nuclear power units with a total net capacity of 3056 MW were connected to the grid. Three of them were in India (Kaiga-1, Rajasthan-3 and Rajasthan-4); the other three were in Pakistan (Chashma), Brazil (Angra-2) and the Czech Republic (Temelin-1).

Nuclear power provides about 16% of total global electricity, with some 83% of nuclear capacity concentrated in industrialised countries. The 10 countries with the highest reliance on nuclear power in 2000 were: France(76.4%, Lithuania (73.7%), Belgium (56.8%), Slovak Republic (53.4%), Ukraine (47.3%), Bulgaria (45%), Hungary (42.2%), Republic of Korea (40.7%), Sweden (39%), Switzerland (38.2%). Overall, 17 countries relied on nuclear power plants to meet at least 25% of their total electricity needs.

The following table shows country-by-country figures for the number of nuclear power units in operation and under construction at the end of 2000, total nuclear output and nuclear share in electricity production, and total operating experience.

WORLD NUCLEAR STATUS 2000

Country	Reactors in operation		Reactors under construction		Nuclear electricity supplied in 2000	
	No of Units	Capacity MW(e)	No of Units	Capacity MW(e)	TWh(e)	Nuclear Share (%)
Argentina	2	935	1	692	5.73	7.26
Armenia	1	376			1.84	33
Belgium	7	5712			45.4	56.75
Brazil	2	1855			5.55	1.45
Bulgaria	6	3538			18.18	45
Canada	14	9998			68.68	11.8
China	3	2167	8	6420	16	1.19
Czech Republic	5	2569	1	912	13.59	18.5
Finland	4	2656			21.06	32.15
France	59	63073			395	76.4
Germany	19	21122			159.6	30.57
Hungary	4	1755			14.72	42.19
India	14	2503			14.21	3.14
Iran			2	2111		
Japan	53	43491	3	3190	304.87	33.82
Korea, Republic of	16	12990	4	3820	103.5	40.74
Lithuania	2	2370			8.4	73.68
Mexico	2	1360			7.92	3.86
Netherlands	1	449			3.7	4.0
Pakistan	2	425			1.08	1.65
Romania	1	650	1	650	5.05	10.86
Russia	29	19843	3	2825	119.65	14.95
South Africa	2	1800			12.99	6.58
Slovak Republic	6	2408	2	776	16.49	53.43
Slovenia	1	676			4.54	37.38
Spain	9	7512			59.3	27.63
Sweden	11	9432			54.8	39
Switzerland	5	3192			24.95	38.18
UK	35	12968			78.3	21.94
Ukraine	13	11207	4	3800	72.4	47.28
USA	104	97411			753.9*	19.83
Total*	**438**	**351327**	**31**	**27756**	**2447.53**	

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