

बी ए आर सी
न्यूज़लैटर

BARC
NEWSLETTER

IN THIS ISSUE

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TECHNOLOGY AND
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**SINGLE CRYSTAL X-RAY
DIFFRACTOMETER**

ATTACHED REAL
TIME MANIPULATOR
DESIGNED BY
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X-MOTION

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भाभा परमाणु अनुसंधान केंद्र Bhabha Atomic Research Centre



पंडित जवाहरलाल नेहरू द्वारा परमाणु ऊर्जा संस्थान, ट्रॉम्बे (जिसका बाद में श्रीमती इंदिरा गांधी द्वारा दिनांक 12 जनवरी 1967 को भाभा परमाणु अनुसंधान केंद्र के रूप में पुनर्नामन किया गया) का दिनांक 20 जनवरी 1957 को औपचारिक उद्घाटन किया गया था।

Atomic Energy Establishment Trombay (later renamed as Bhabha Atomic Research Centre on 12 January 1967 by Smt. Indira Gandhi) was formally inaugurated by Pandit Jawaharlal Nehru on 20 January 1957.

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MASTER-SLAVE MANIPULATORS: TECHNOLOGY AND RECENT DEVELOPMENTS

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Introduction

Remote handling is the operation, in which manual tasks are performed without human intervention at the work site. The use of remote handling equipment enables people, to maintain a safe distance in hazardous work environments. The remote handling strategy adopted, depends on the risks and the complexities associated with the task.

The simplest forms of remote handling devices are long reach tools, which extend the length of standard tools, providing a safe distance between the hazard and the operator. A remote handling tong consists of a gripper, a

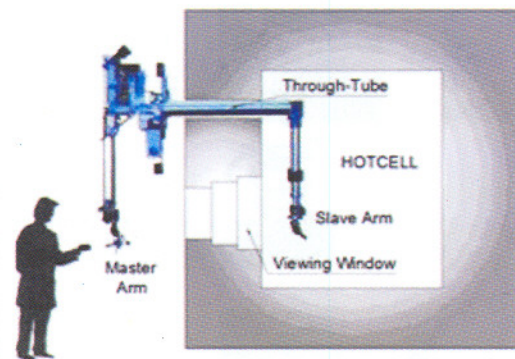


Remote handling tong

handle and a connecting rod. It can be installed in a shielding wall, hung on a carrying system (for use in a water pool), or carried by the operator.

If the task needs additional shielding and it can be brought to a work cell, handling can be done using in-cell crane, a power manipulator or master-slave manipulators. The in-cell crane and power manipulator are used for handling heavy objects, where orientation of objects and precision in handling are not very important. They are usually controlled by push button switches.

Layout of MSM in Hotcell



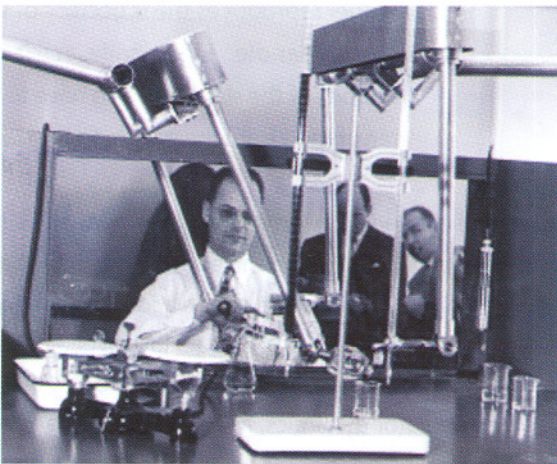
Radioactive materials are handled in a heavily shielded room, called a hotcell using remote manipulators. The cells are shielded with normal or high-density concrete walls of thickness ranging upto 2m. Hotcells are generally viewed through shielded glass windows.



Master-slave manipulators (MSMs) are the most widely used general purpose remote handling tools used in nuclear industry. In master-slave manipulation, human being is within the process, and his abilities are extended to the remote place.

An MSM has two arms: the slave arm, which is usually located in the hotcell and the master arm in the control station. When the operator grasps and manipulates the master arm, the motion of his hand is reproduced at the slave arm, performing the necessary task. In most of the cases, the master arm and the slave arm are made geometrically similar to each other. MSMs are usually employed in pairs and the operator manipulates the master arms using both his hands.

First Master-Slave manipulator



The first master-slave manipulator was developed in 1948 at the Argonne National Laboratory by Ray Goertz. It was designed to be used in cells, where the slave arm can penetrate through its ceiling. The first electrical manipulator also was developed by Goertz.

Mechanical Master-Slave Manipulators

Most of the mechanical manipulators are of through-the-wall type, where the slave arm remains in the hotcell, the master arm in the control station and the through-tube connecting these arms, passes through the shielded wall. The manipulator provides a mechanical linkage between the operator at the control station and the hazardous task inside the hotcell. The gripper of the slave arms are powered and controlled by the operator's hand through the master arm. From the task area, the operator gets visual feedback through a shielding window and force feedback through the manipulator. Mechanical MSMs are suitable, where the work area is constant and not too large, the force requirement is within the capacity of the operator and the task is not repetitive. DRHR has developed various types of mechanical manipulators with payloads ranging from 4.5 kg to 45 kg and volume coverage from 1 m³ to 20 m³. Several such manipulators are installed in various DAE units.

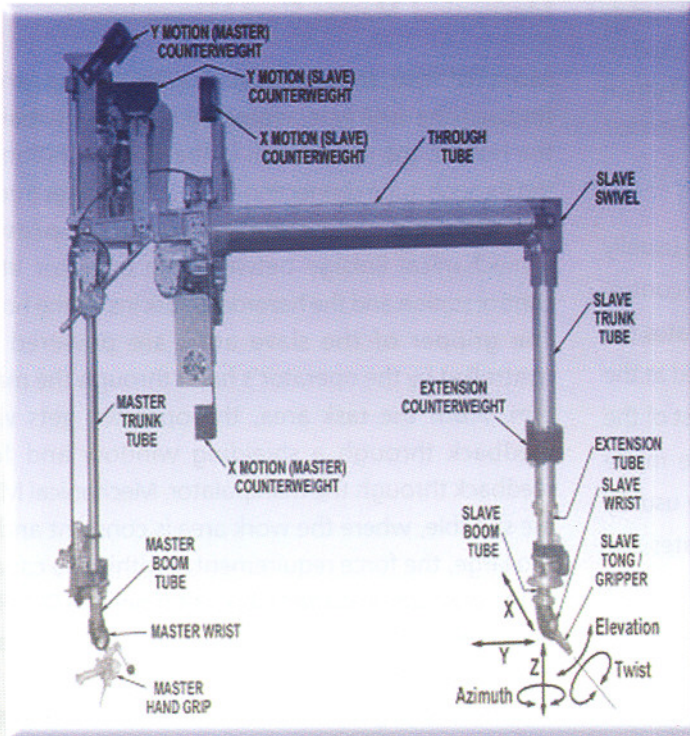
Degrees of Freedom

For the slave gripper to attain arbitrary position and orientation, the manipulators should have at least six independent motions. The gripper should also have a squeeze (open and close) motion to grip and release objects. In addition to this, the slave arms are usually provided with two or three supplementary electrical motions to increase their work volume.

Types of Mechanical MSMs

There are mainly two types of mechanical manipulator designs: articulated and telescopic.

All joints of the articulated arm are of revolute (articulated) type. Articulated manipulators allow transmission of forces up to a medium level. They have a small working volume and are suitable for hotcells with small wall thickness, typically made of lead.

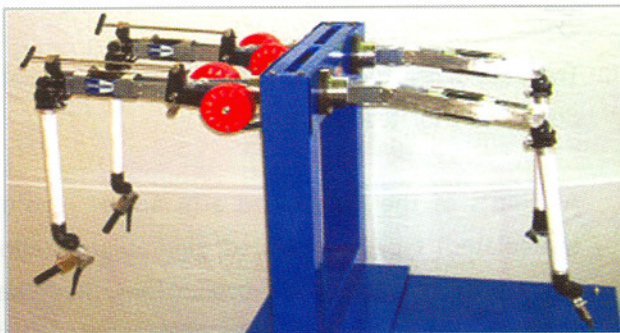


Parts and motions of a telescopic manipulator

Power Transmission

Power Transmission between the master arm and the slave arm is the most challenging task in manipulator design. When a master hand grip is moved, the corresponding slave gripper should also move by the same amount in the same direction. Moreover, any application of force/ torque on the master arm should reflect on the slave arm and vice versa. Seven motions (or force) of the master gripper have to be converted into corresponding master joint motions (forces), transmitted across the cell-wall to the slave in the hotcell and converted into motion (force) of the slave gripper. All transmission mechanisms should operate in parallel, so that, the slave gripper reproduces the trajectory of the master handle. Electrically actuated motions of the slave arm also have to be transmitted from the master to the slave.

Manipulators with telescopic arms have at least one linear (telescopic) joint. They can transmit larger forces and are suitable in larger hotcells with thick concrete wall shielding.



Articulated manipulator

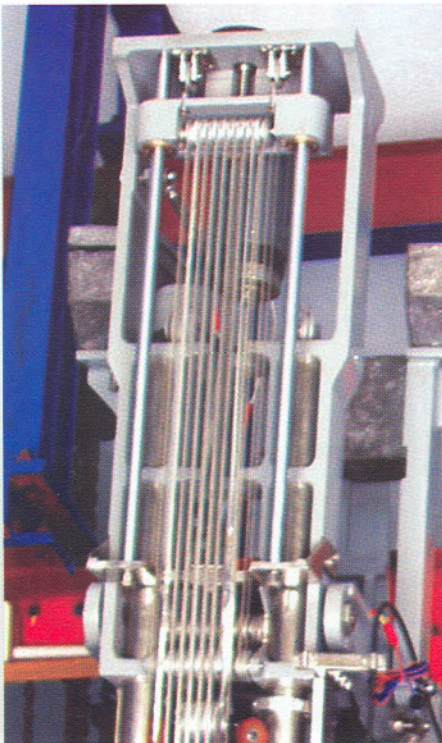
Rotation of every joint, will result in movement of a large number of parts, relative to one another. For faster and accurate gripper positioning, the motion transmission should be rigid, positive and backlash-free. During handling, the operator will feel the forces due to manipulator dynamics, in addition to the external load, acting on the slave. Therefore, friction, gravity load and inertia of the manipulator are to be minimised, to reduce operator fatigue. The design should be highly optimised to meet contradictory requirements: low friction with low backlash and high rigidity with low inertia members.

Mechanical power transmission across the cell wall, is done using wire ropes, metal tapes, 4-bar mechanisms or shafts. Wire ropes and metal tapes

are lightweight, compact and flexible, compared to other transmission mechanisms. Within the master and the slave arms, spur gears, bevel gears, rack and pinion etc. are also used, for power transmission and motion conversion.

Bilateral Control

The coupling between the master arm and the slave arm must be bilateral such that, the forces acting on the slave arm must be reflected at the master arm and displacements produced at the slave arm must be able to produce a displacement at the master arm. The force reflection helps the operator to feel and control the applied force and helps him, to perform the task faster and more accurately. In addition to this, the back-drivability due to the bilateral coupling, makes the slave arm compliant with respect to the task and enables the slave arm to align itself, in response to the constraints imposed by the task.



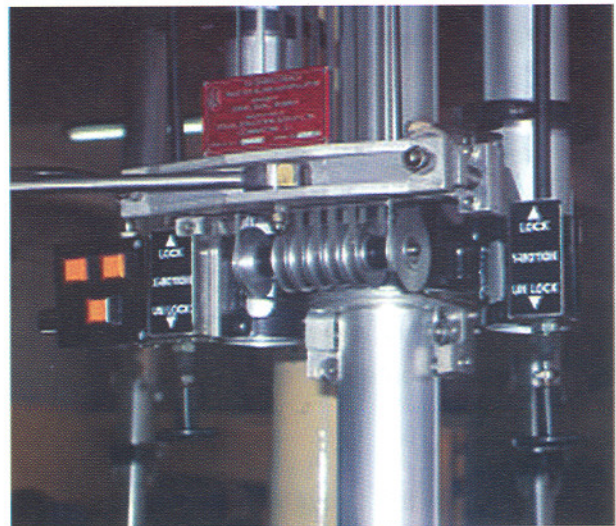
Metal tapes for power transmission

Balancing

The manipulator joints are mechanically balanced, so that, the operator does not feel the weight of the manipulator during handling. It is generally achieved with adjustable counter weights installed on the master arm and in some cases, on the slave arm.

Motion Locks

Motion locks are used, to lock the manipulator joints rigidly in any position. They also facilitate installation and removal of the manipulator. In general, motion locks are made in three distinct units that can be operated independently: X-motion, Y-motion and combined Z-motion/ azimuth/ elevation/ twist rotations. The manipulator handle assembly also has its own tong/grip lock.



Motion locks in an MSM

Remotely Replaceable Jaws/Tong

The only parts of the manipulator that come in contact with the objects in the hotcell are the jaw friction-pads of the slave tong. Friction pads need periodic replacement. By remote replacement, the jaws can quickly adapt to gripping surfaces of different sizes and shapes.

Materials

Material selection is of utmost importance in any manipulator design. To reduce the size and weight of parts, the material should have high strength-to-weight ratio. The material used in the slave arm should also have high radiation tolerance. The bearings should be of stainless steel, filled with radiation-resistant grease.

Electrical Indexing Motions

Indexing motions provide offset, between corresponding joint angles of the slave arm and the master arm. They are used to enlarge working volume and to reduce operator fatigue. Y-motion indexing allows the slave arm to be oriented in horizontal direction for installation and removal of the manipulator through the wall-sleeve. In addition to this, indexing allows the operator to remain in front of the window for viewing, thus reducing the required size of an expensive shielding window. Indexing motors are usually mounted on the master arm.

Extended Reach

Extended reach motion is the motorised telescopic extension of the slave arm, usually provided in manipulators used for larger hot cells. It is provided with a double telescope: the inner telescope for manual Z-motion and the outer one for motorised Z-motion.

Shielding

Shielding within the through-tube is provided as an optional feature in MSMs. It reduces the amount of radiation penetrating from the hotcell, at the through-tube level. Shielding is better achieved in manipulators of three-piece construction.

Sealing

Sealing isolates the hotcell atmosphere, from the outside. The through-tube of the manipulator may be unsealed for beta-gamma cells or sealed for alpha-gamma cells.

Seals are also useful in inert gas cells containing toxic gases or airborne contamination. In the absence of sealed type construction, manipulators depend on booting, to prevent gas flow out of the cell.

Extended Reach Master-Slave Manipulator (ERM)

The first two indigenous pairs of ERMs are installed at Augmentation of Cobalt Handling Facility, RAPP COF, Kota. The 9 kg capacity manipulator has a reach of 3.4 m from its shoulder joints. ERM has low friction compared to other manipulators



Indigenous ERM

Rugged Duty

High strength in rugged duty construction is achieved, by careful proportioning of parts and proper selection of materials. Mechanical transmission line incorporates step-up/ step-down gearing, to improve its rigidity and to reduce loads in tapes and ropes. Such force/ torque

multipliers are used in azimuth, wrist and gripper tape/ rope circuits. Handles of rugged duty manipulators incorporate a force-multiplying system, called pumping mechanism, for holding heavy weights, which are beyond the holding capacity of a human operator. Higher load-carrying capacity in rugged duty design is achieved, with a modest sacrifice in inertia and friction characteristics.

Manipulator Booting

The slave arms can be equipped with a flexible sleeve, called booting or gaiter, to protect them from contamination and to provide leak tightness to the hotcell. Indigenous booting is made up of polyurethane, which has excellent resistance to radiation, resistance to punctures, tears and abrasion and resistance to minerals oils, gasoline, animal oils, alkalis and ozone.

Indigenous Rugged Duty Master Slave Manipulator

The indigenous rugged duty manipulator (RDM) is designed to withstand the force that a human operator can exert, in normal operating position. It has a load-carrying capacity of 45 kg. Recently, 20 pairs of RDMs were manufactured by M/s HMT Machine Tools Ltd., based on the design and drawings supplied by DRHR. They are installed in the newly constructed PIED hotcells.



Indigenous booting developed for rugged duty Master-Slave manipulator



RDMs installed at PIED hotcell

Three-Piece Design

A three-piece master-slave manipulator (TPM) consists of three distinct and easily separable assemblies: the master arm, the through-tube and the slave arm. The unique feature of 3-piece construction is that, its slave arm can be remotely replaced in the hotcell,

using in-cell crane or power manipulator. This modularity reduces installation and maintenance time. Unlike other MSMs, TPM uses parallel rotating shafts for power transmission, along the through-tube. This feature is effectively used in indigenous TPM to provide sealing and shielding across the cell wall.

Sealed Type 3-Piece Manipulator

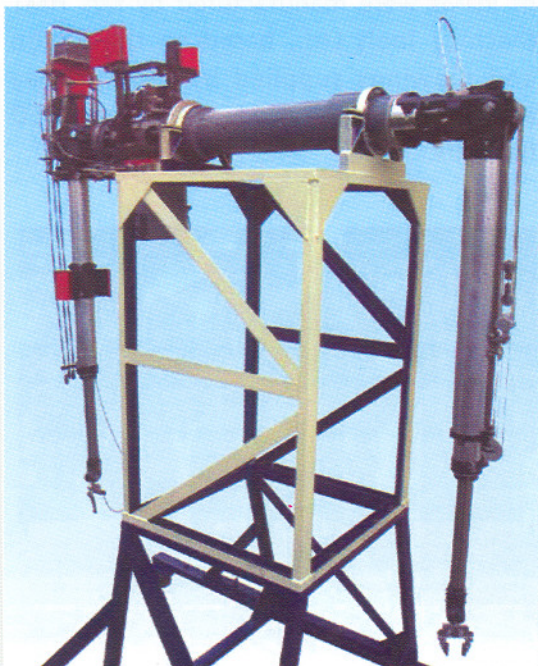
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Mobile Manipulators

In a mobile manipulator system, the slave arm of the manipulator is usually mounted on a transporter to increase its effective range. Unlike the mechanical manipulator, the slave arm of a mobile manipulator

Remote Missile Fuelling for the Indian Navy

Liquid fuels used in missiles are highly toxic. Missile fuelling had been done by operators wearing plastic suits covering their entire body. Fuelling involves aligning the ports of fuelling gun with that of missile, locking the gun to the missile body, opening the gun valve etc. A master-slave manipulator pair and other accessories were supplied to INS Tunir, Uran for remote missile fuelling.



The first indigenous sealed-type 3-Piece Manipulator



Missile fuelling system at INS Tunir

should have its own mechanical power source, such as electrical motors or hydraulic actuators. The communication between the master and the slave should be either wireless or through electrical cables.

Electrical Manipulators

A simple electrical manipulator system consists of two kinematically similar arms: the master and the slave. The mechanical power sources of the slave arm are electric motors, which are mounted on the slave joints and gripper. The controller continuously monitors the joint angles of the master and the slave, using the joint angle sensors like synchro and potentiometer. It drives the slave motors to correct any deviation in angles between corresponding joints of the master and the slave.

The presence of external power source in an electrical manipulator, reduces the operator's handling effort and fatigue. In addition, the force available at the slave arm is not limited by the strength of the human operator. The presence of the transporter allows the slave arm to

approach the hotcell equipment from different positions and directions, providing flexibility in equipment layout in the cell. The effective range of the slave arm is limited only by the range of the transporter and a single pair of slave arms can serve a large cell.

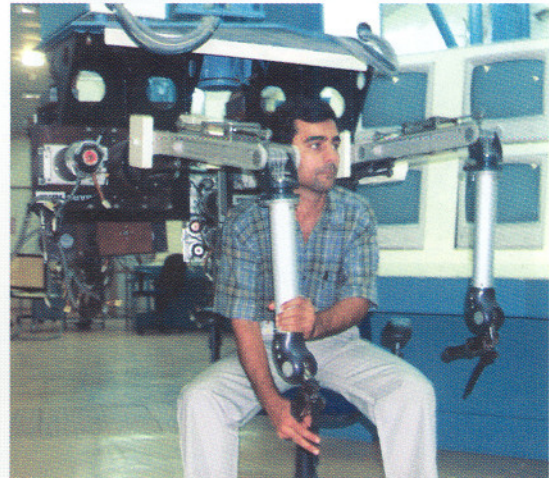
In hotcells using electrical manipulator, the task area is viewed using CCTV cameras mounted on the manipulator and at different locations in the hotcell. Use of CCTV cameras in place of expensive viewing windows, reduces the cost of viewing system.

Hydraulic Manipulator

Hydraulic actuators have high power-to-weight ratio compared to their electrical counterparts. Hydraulically powered manipulators can be used for handling heavy loads.



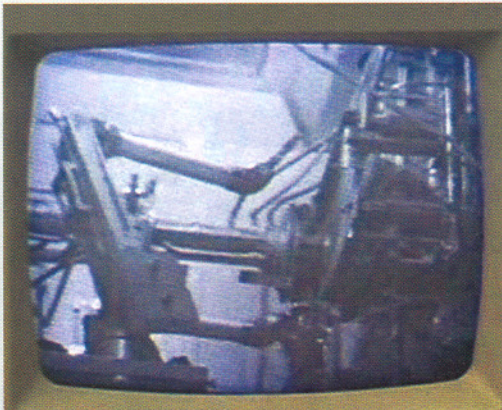
Indigenous servo manipulator:
The slave arm is mounted on tracked vehicle



**Control Station and Master Arm of the
Indigenous Servo Manipulator at WIP**

Servo Manipulator Installation

Two pairs of servo manipulators are installed at the Waste Immobilisation Plant, Trombay. Their master arms and slave arms are kinematically similar to each other and each of them has six joints and a gripper. The joints are powered by 2-phase AC servo motors. One of the challenges in design is to exclude electronic components from the slave arm. The only electrical components used on the slave arm are motors, potentiometers and cables, which have good radiation tolerance. All other components needed for control are kept near the control station, which is about 100m away (cable length) from the slave arm. The slave arms are mounted on a telescopic mast, providing a large effective range, to the manipulator.



Slave arm in the hotcell, as seen by the operator on the CCTV monitor

Wireless Controlled Manipulators

If the hazardous area is large and cannot be confined to a work cell (like outdoor environment), it may not be possible to use wire or fibre for power and signal

transmission (tethered), between the control station and the manipulator. Similar situation may arise in areas, which were accessible once, but later become inaccessible or unsafe later due to the presence of explosives, radiation, toxic chemicals etc. In such cases, the manipulator needs to be transportable to the work area and be wireless controllable.

Indigenous Hydraulic Manipulator

The 6-DOF articulated manipulator is powered by hydraulic motors and hydraulic cylinders. The slave arm is controlled by a kinematically similar, but smaller master arm. It can handle a weight of 50 kg at a distance of 3m from its base. The manipulator was developed by Refuelling Technology Division based on the mechanical design and drawing by DRHR



The first indigenous Hydraulic Manipulator

Advanced Manipulator Systems

Compared to mechanical master-slave manipulators, servo manipulators have a high potential in remote handling, due to their advantages described earlier. The major research in this area would be to make them

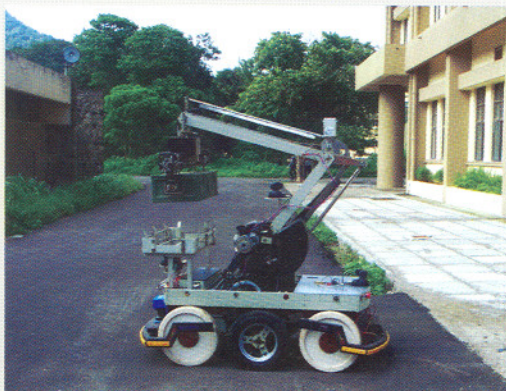
more operator-friendly and more autonomous.

Telepresence Systems

Human-Machine Interface is a crucial element in the success of any remote operation. In ideal

Explosive Ordnance Disposal System for Ordnance Factory Khamaria (OFK), Jabalpur

The system was developed for handling ammunition boxes containing rejected fuzes of antitank mines. The boxes are to be picked up from a row of stacks in the ammunition storage rooms, brought to the disposal site, opened and tilted for transferring the fuzes into a pit for disposal. The system consists of a manipulator, a Remotely Operated Vehicle (ROV) and a device for remote removal of fuzes from ammunition boxes. The ROV houses a battery, communication devices, computer, CCTV cameras, laser range finder, sonars, bumper switch etc. Its four-axis manipulator can carry a weight of 30 kg at a distance of 2.5 m.



Wireless controlled manipulator and vehicle

Stereo Vision System for Enhanced Teleoperation

A stereo vision system is being developed in collaboration with IIT Kanpur for enhanced visual feedback. Binocular images synthesised from multiple cameras will be presented to the operator, in a head mounted display. A head-tracking system will monitor the motion of the operator's head to control the orientation of remote pan-tilt cameras.



Head Mounted Display (HMD) for the stereo vision system (under development)

telemanipulation, the operator should be able to move the manipulator as if it was his own arm and he should feel as if he is physically present at the remote site (telepresence). To achieve this, the operator should be presented the stimuli of the remote site (video, audio, force, touch etc.) and he should have the ability to control the remote site (master arm with instrumented gloves, head tracking devices etc.). Typical equipment needed at the remote site would include slave arm with anthropomorphic grippers, pan-tilt cameras, microphones and sensors for touch and force.

Advanced Servo Manipulator

A 25 kg capacity servo manipulator with supervisory control capabilities is being developed. Its master arm will have force reflection, so that the operator can feel the external force/ torque acting on the slave. The manipulator will be computer controlled and it will have features like, motion scaling, force scaling, dynamics compensation for force reflection, indexing in world coordinates and teach & playback. The structure of the manipulator can be mechanically reconfigured to suit application.

Telerobots

A robot is a reprogrammable manipulator, capable of performing repeated sequences of operations, without human intervention. It can relieve qualified operators from dull jobs and make remote operation faster, accurate and consistent. However, as robots need a good knowledge base about the environment, the task and themselves, they are more suitable for repetitive jobs in well-structured environments.

Telerobots are master-slave manipulators with some level of autonomy. Supervisory control combines autonomous control performed under human supervision with manual control. In systems with large time delays and lower communication bandwidths, supervisory control with computer at remote site, is essential, to perform any handling task.

As the majority of remote handling tasks need the sensory, manipulative and decision-making capabilities of a human being, MSMs will continue to dominate remote handling, until artificial intelligence and robot technology, make the robot self-sufficient to take decisions and act on them, based on intuitive information.

REHABILITATION OF HELIUM LIQUEFIER OF THE LIQUID HELIUM PLANT

Mechanical Design & Prototype Development Section and
Technical Physics & Prototype Engineering Division

The Mechanical Design & Prototype Development Section (MDPDS), Physics Group, was instrumental in the re-engineering and renovation of a Helium liquefier system at the liquid helium plant. This system has a capacity of 30 litres/hr with pre-cooling and 15 litres/hr without pre-cooling and was installed in the year 1990. The plant is being operated by ASCS, TPPED and caters to the requirements of Liquid Helium cryogen, from all the low temperature experimental facilities in BARC. It produces approximately 9000 liters of Liquid Helium per annum.

It consists of the following subsystems :

- 1) Helium Compressors ~ 17 bar g
- 2) Chilled de-ionized water to cool the compressors
- 3) Buffer Gas tank and Bank of Helium Cylinders
- 4) Cold-box where compressed Helium is liquefied
- 5) Gas Bag and recovery compressor (~ 200 bar g)
- 6) Gas purifier
- 7) Liquid Nitrogen tanks

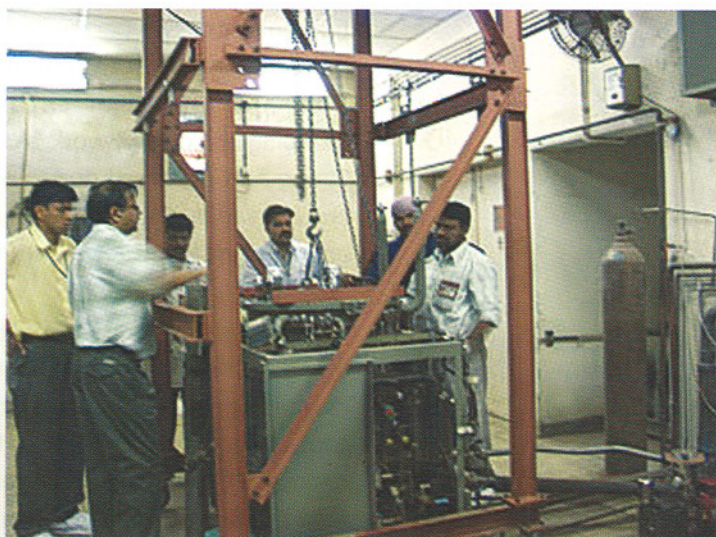


Fig. 1 : Cold box of He plant

After more than thirteen years of successful operation, the Liquid Helium Plant developed a major problem of Sweating of cold box, which disrupted the functioning of the plant, leading to the shutdown of the system. Investigation into the course of this malfunction revealed, that a vacuum leak had developed at a location, between the top cover plate and collar of the cold box, due to the failure of a bolt head. The cold box consists mainly of a main cylindrical chamber i.e Vacuum Chamber or Jacket, top cover plate or flange and a C-shaped collar. The vacuum chamber encloses heat exchangers, filters, cold valves and cold piping of the liquefier. The collar is at the top of this chamber, through which the gas piping penetrates. The top cover plate, which is

attached at the top of the collar, provides a base for the engines, flywheel, control valves and the delivery tube glands. The collar is fastened to the top cover plate, with the help of ten cap screws entering from below, through the clear hole in the collar flange (top), into the blind threading in the top cover plate; whereas the vacuum chamber is fastened to the collar flange (bottom) with the help of nuts and bolts as shown in Fig. 2. O-rings, seal the interfaces between the collar, the top cover plate and the vacuum chamber. All the tubes entering from the top cover plate are connected through internal components, to the tubes entering from the collar, thereby making the collar and the top cover a single identity.

Initial efforts to seek the help of the original manufacturer to provide a strategy for rectification, proved futile.

A few similar units had to be abandoned from operation, due to similar failure in the past, for lack of indigenous rectification technology. Hence, it was a highly rewarding challenge, to develop the technology for this rectification.

Some rectification strategies, which were explored to plug the vacuum leak, were :

1. Tightening the top cover plate and the collar together, so that the O-ring would get compressed making the sealing effective.
2. Replacement of the O-ring.
3. Welding the top cover plate with the collar and plugging all the ten bolt holes.

Efforts to seal the leak by tightening the two parts with the help of custom built external C-clamps and semi circular clamping ring did not work, as the O-ring had hardened due to age and cracked due to prolonged use and exposure to low temperatures.

Replacement of O-ring requires the lifting of the top cover plate and creating sufficient gap between the top cover plate and the collar for removal and insertion of O-ring and then refastening them together. It requires loosening and removal of all the screws along with the extraction of the broken screw and cleaning the tapped holes of the

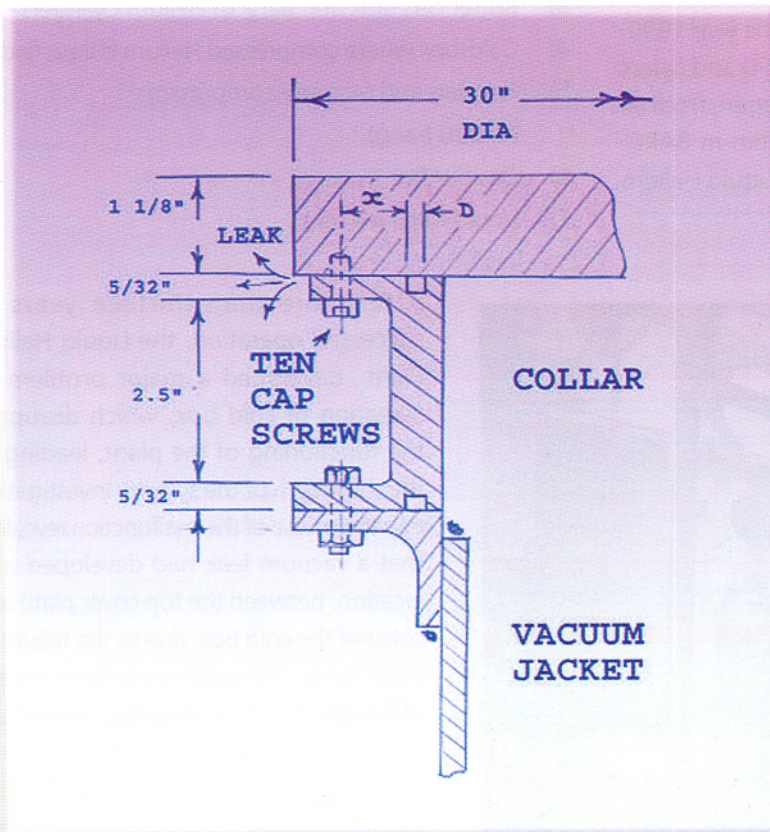


Fig. 2 : Sectional sketch of 1410 jacket (vacuum leak problem)

top cover plate and refastening them together with new screws after the replacement of the O-ring. In case one or more of the tapped holes are damaged, it may be retapped to a larger size or a through-hole may be made, for fastening with nuts and bolts. As mentioned earlier, since all the tubes entering from the top cover plate are also connected to the collar, it is impossible to create the required gap, without cutting the tubes or removing the weld joint between the top cover plate and different connectors. The manufacturer had followed certain protocols in welding different pieces, which were unknown. If these joints were cut, it would require two welded joints, for each joint opening and so there would be ~50 such welds. It was a tough task to make such joints in the limited space, available between the tubes, with ZERO failure.

The simulation for removing the lip-joints between casings and the top flange was tried, which showed that, lips on the casing body would be of no further use. Moreover, the broken bolt could not be extracted, as the access was minimal due to multiple gas tubes entering the cold box at this location (Fig. 3). Removal

of the rest of the highly rusted bolts was also not easy, due to limited space. With all these limitations, even if the O-ring was replaced successfully, there was a probability of crack or deformation developing on the tube joints or the tube. And then, it would be difficult to detect and rectify it, because of the complexity and delicacy of the tube meshing.

Other possibility of creating a gap for replacement of the O-ring was, to cut the weld from all the connectors, to detach the top cover plate from the collar. But this option was also rejected because it was difficult to cut the weld from all the connectors and after putting the O-ring, re-welding the connectors and leak testing would be even more difficult. Exercising this option could lead to various other technical problems/challenges. Hence the second option of replacement of the O-ring was rejected.

On thorough analysis of the problem, it was decided that, the best course of action would be the full welding of the top cover plate with the C-shaped spacer and plugging all the ten bolt holes, after removing the existing bolts.

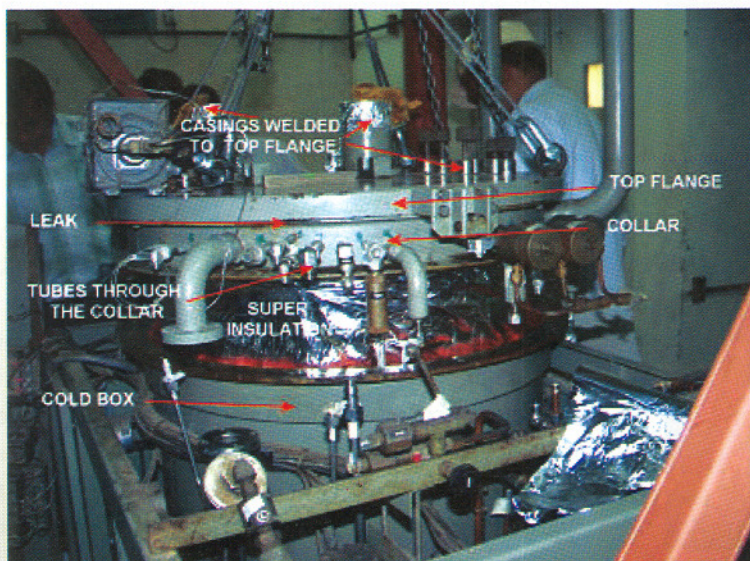


Fig. 3 : Top flange (plate), collar and internal structure being removed

The main advantages of this option were :

- Internal structure would not get much affected .
- Testing of the welded joint after welding can be done with comparatively less difficulty.

The main difficulties associated with the option were:

- Welding joint was of the nature of almost over head, so rotation of the collar and the top cover unit, along with the internal structure was absolutely necessary.

- Protection of cantilever internal structure along with thin delicate tubes, which was suspended from the top flange.
- Space and access to welding torch was limited due to the presence of tubes coming out through the collar.

As the plant was not in operation for several months, leading to non-availability of scarce resources of liquid Helium, the job was taken up on a priority basis.

The job mainly involved the opening of the cold box by removing the badly rusted nuts and bolts between the vacuum chamber and the collar; lifting and moving the

top cover plate and the collar along with integral internal structure to temporary workstation; tilting it by 180 degrees for welding the top cover plate to the collar and reassembling it by reversing the order of all the previous operational steps.

Here the first challenge was to open the badly rusted bolts, which were not touched in twelve to thirteen years. There was no handling facility in the plant room and the ceiling height of the room was also insufficient. Therefore, a movable workstation was designed and fabricated with inbuilt handling facility, which could be accommodated within the limited headroom available.

The delicate internal structure has chambers containing charcoal absorbers at many places for trapping of impurities. Detailed internal information was not available. During handling and inverting, there was a fear of transportation of these absorbers to adjacent components or tubes, which could lead to non-reversible damage / problem to the system. Hence, radiography of the tubes at required places was done, with the help of HPPD and AFD and it was confirmed that, the absorbers were mechanically confined to their positions, by metal-wire mesh at inlets/outlets.

Since the internal structure was suspended from the top flange, its tilting would result in the situation of cantilever loading and there was a fair possibility of misalignment of the thin delicate tubes. Therefore, a support frame was designed, fabricated and suitably fastened with the top flange and internal structure to support and protect it from any probable damage during handling. For tilting this integral structure of the top flange, collar, internal structure and the support frame, suitable shaft was welded at appropriate position on the support frame itself. A base structure with pivot was designed and fabricated, to support and tilt the whole integral assembly.

Special gadgets and tooling were designed and fabricated for working in the limited space.

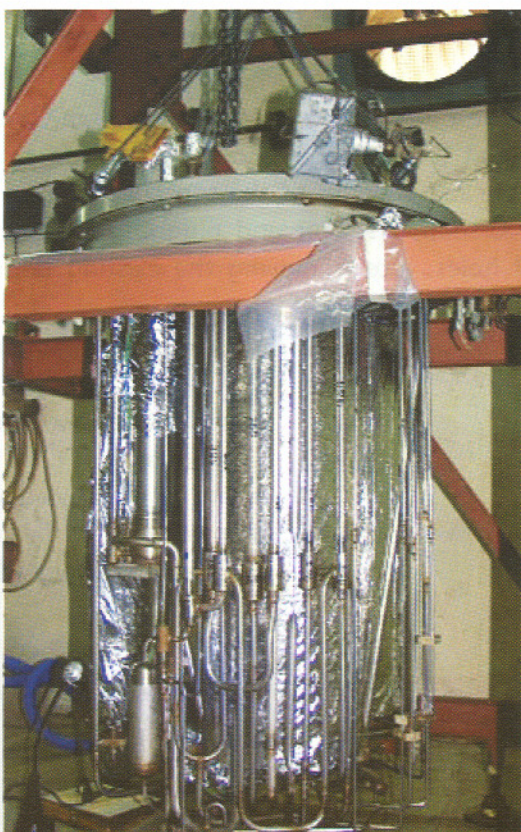


Fig. 4 : Internal structures before fastening the support frame

As the authentic data / specification of the material of collar and top cover plate was not available, the chemical composition test of the materials of these components, which were to be welded together, was done and accordingly filler material was chosen. There is a large difference in the thickness of the top flange (~32 mm) and the collar flange (~6 mm), therefore for proper leak-tight welding and to minimize the heating of adjacent components as well as to avoid appreciable deformation of flanges etc., welding parameters were optimized, by simulation and various trials on dummy pieces, of the same material and thickness.

After detaching all the components and tubes, the bolts holding the vacuum jacket and the bottom of the collar were removed. Then the movable platform was aligned and the integral structure of top cover plate, collar and internal structure was lifted out of the cold-box, with the help of temporary hoist mounted on the workstation. The support frame was properly fastened to this structure. Then the integral structure was kept on the platform and moved to a new location nearby, for further operation. The base structure with pivot was installed on the ground and the integral structure was supported on it, by keeping shaft at pivot. Now the whole structure was ready for



Fig. 5 : Internal structures with support frame being tilted with the help of base structure and pivot

supported on upper platform, to provide sufficient clearance between internal structure and ground, but for welding, the structure is kept at lower tier for easy and comfortable welding access.

Precautions taken for actual welding were :

- Pre weld – Removing paint and rust followed by cleaning with chemical agent.
- During welding – Staggered welding with particular sequence to minimize welding deformation. All the eleven intact bolts were replaced by mild steel bolts with appropriate bolt heads. The material of the bolts was compatible with the flange material. After every stage there was a dye-penetrant test, to ensure sound welding joint. Minor cracks developed during welding were immediately rectified after the test.

- Post weld – Dye-penetrant for whole welding joint was done, delayed cracks were rectified, overall deformation checked.
- Welding operation was performed with a very high level of skill due to limited space and obstacles imposed by the various inlet and outlet tubes.

As the job was very delicate, each and every step as well as their sequences were planned and performed with extreme care.

After weld test and cleaning, the system was reassembled and tested for actual operation. Thereafter, the performance of the liquefier was found to be as good as prior to the initiation of the leak.

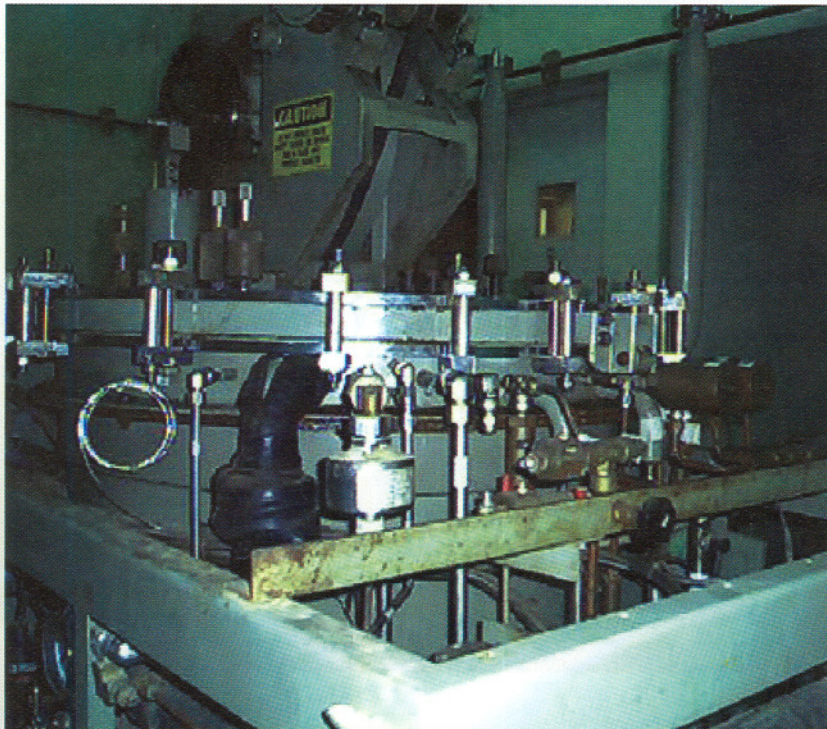


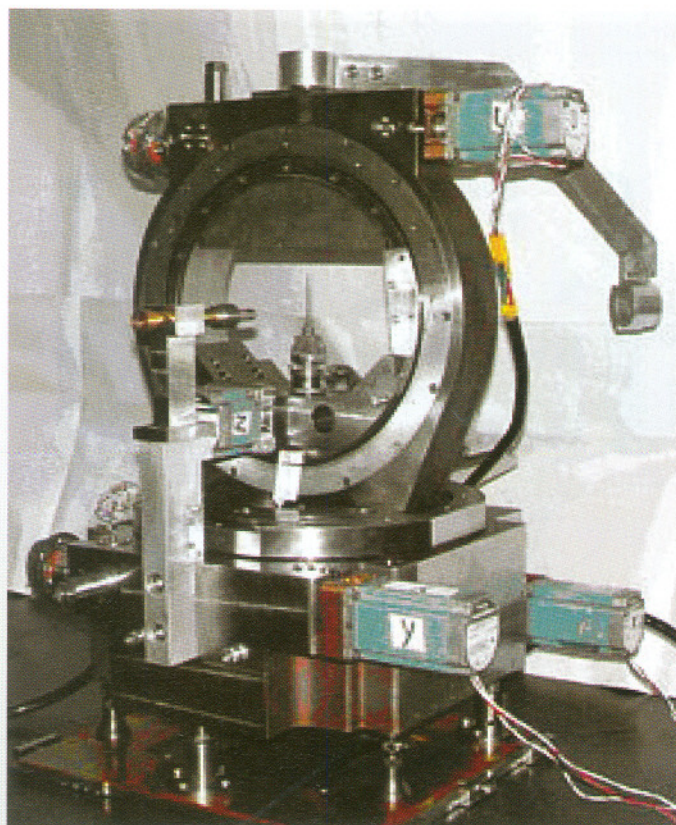
Fig. 6 : Reassembly after welding top flange with C- shaped collar

DESIGN AND DEVELOPMENT OF A SINGLE CRYSTAL X-RAY DIFFRACTOMETER

Centre for Design & Manufacture

Single Crystal X-Ray Diffractometer is used, for crystallographic studies, to investigate lattice parameters of single crystal, using Bragg's theory. Centre for Design & Manufacture, has designed and manufactured one such system and it is ready for laboratory experiments. The heart of the mechanical system, is a four-circle Goniometer of Eulerian geometry, having three axes namely Phi, Chi and Omega, for orientation of crystal and a 2-Theta axis, to scan the diffracted beam. The sphere of confusion of Phi, Chi and Omega axes is 25 microns i.e. Phi, Chi axes intersect orthogonally on a point, on Omega axis within a sphere of 25 microns.

All the axes are driven by precision backlash-free worm gear drives driven by stepper motors. The worm wheels are made of Phosphor Bronze and worm shafts are made of hardened and ground stainless steel. To remove backlash, the worm shaft is housed in a tube, which is made to float by hinging it at one end with two pins (with the worm wheel housing) and supporting the other end by two rollers and spring, loaded radially, towards the axis of worm wheel. Chi and 2-Theta axes are supported by precision 4-point contact (thin section) special ball bearings. Precision cross-roller bearing supports Omega axis. Phi axis is supported by precision matched-pair angular contact ball bearings.



All the mating components and bearing housings and shafts are made of hardened stainless steel and are machined to tolerance grade IT6 or better. The adjustments at assembly and inspection of the mechanical system are also very critical, in achieving the specifications. Proper balancing is also done for all rotating bodies about the Chi axis, using counterweights. The other critical components integrated with this system are the collimator, the half-shutter assembly and a variable slit.

The precision of the instrument was inspected using a theodolite and the following values were obtained. Trueness of Phi axis = 5 microns, Offset of Phi axis with Chi axis = 5 microns, Orthogonality error of axes = 1 arc minute, Phi axis co-linearity with Omega axis = 5 microns, total sphere of confusion = 25 microns.

MOU BETWEEN BARC AND THE ELECTRONICS CORPORATION OF INDIA LIMITED FOR THE PRODUCTION OF ANTENNA PLATFORM FOR THE LCA-MMR AND DEVELOPMENT OF 32M DEEP-SPACE NETWORK ANTENNA SYSTEMS FOR THE CHANDRAYAAN MISSION

BARC and ECIL signed two Memoranda of Understanding on February 16, 2006 at BARC, Mumbai. The first MoU was for the production of Antenna Platform Unit (APL) for LCA Multi-mode Radar developed jointly by CnID, BARC and ECIL. The second MoU was for the development of 32M Deep-space antenna systems for Chandrayaan-I mission.

ECIL had sought BARC's participation, in the design and development of APL control electronics, for which a development order was received by ECIL, from the Aeronautical Development Agency, Bangalore. The steering mechanism and mechanical assembly were built by ECIL, whereas the hardware and software for the control electronics of APL were designed and



Mr G. Govindarajan, Director, Electronics & Instrumentation Group, BARC and Mr G. P. Srivastava, Chairman & Managing Director, ECIL, exchanging the MoU documents

developed at CnID, BARC. APL employs complex technologies in the areas of controls, mechanical, electronics, drives and real-time software and is qualified to stringent air-worthiness standards. APL is required to accurately position the 650 mm X-band antenna, while scanning at high speeds - in the presence of disturbing air-craft body rates and 'g' accelerations.

This MoU was signed in the background of successful completion of safety-of-flight tests at Hyderabad recently. The MoU will facilitate ECIL to plan and execute production orders.

ECIL has been selected by ISRO, as the prime contractor, for the supply of 32 Metre Deep-Space Network (DSN) antenna for the Chandrayaan project, to be completed by 2007-2008. This will be used for telemetry, tracking and control of the space-craft orbiting the moon, at a distance of 400,000 Kms from the earth. The antenna consists of a main reflector made-up of 32m diameter parabolic dish, hyperboloid sub-reflector supported by quadripods, beam-wave guide, mirror and feed assembly. It is fully steerable and is mounted on Elevation-over-Azimuth mount with track and wheel drive for Azimuth. The DSN32 station is designed to transmit and receive radio signals in S and X bands. In order to focus the radio energy into a narrow beam, the antenna dish has to be designed and manufactured to surface accuracy to better than a fraction of a milli-meter. The total rotating mass in Elevation and Azimuth are 130 tons and 250 tons respectively. This massive structure is steered to track the space-craft to an accuracy of few milli-degrees, even in the presence of disturbing wind - requiring a high performance servo control system. The station will be unmanned and remotely operated.

As per the MoU, CnID, BARC, will be responsible for the design of hardware and software for Antenna Control Servo System while CDM, BARC will design and manufacture sub-reflector positioning mechanism.

RSD, BARC will provide support for structural analysis and design.

ANNOUNCEMENT

FORTHCOMING CONFERENCE

(DM-BNFL-2006)

Discussion Meet on Role of Electrochemistry in Biosensors, Nanomaterials, Fuel Cells and Ionic Liquids

The Indian Society for Electro Analytical Chemistry (ISEAC) has organised a meeting on the 24th and 25th September 2006, at Multipurpose Hall, BARC, Training School Hostel & Guest House, Anushaktinagar, Mumbai. The aim is to provide a forum to scientists and engineers, to discuss the role of electrochemistry in Biosensors, Nanomaterials, Fuel Cells and Ionic Liquids. The program includes both invited talks and contributory papers.

Important Dates :

Manuscript submission : July 15, 2006
Payment of registration fee : August 15, 2006

For further enquires, please contact :

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SIXTH DAE-VISION OF INFORMATION EXCHANGE (DAE-VIE) THEME MEETING

The Sixth DAE-Vision of Information Exchange (DAE-VIE) meet, was held on February 23 and 24, 2006, at the Central Complex auditorium, BARC. It was organised by the Computer Division and sponsored by BRNS. DAE Vision of Information Exchange (DAE-VIE) meetings are held regularly, to provide a forum for exchange of information, between Computer and IT professionals of DAE, in relevant advanced fields such as Grid Computing, Visual Computing, High Performance Computing, High Speed Communication and Networking, Information Security etc. The first such meeting was held in BARC, Mumbai in 1997 and subsequent meets were held at ECIL Hyderabad, IGCAR

Kalpakkam, CAT Indore and VECC Kolkata. During the previous meets, detailed deliberations and technical discussions were also held on subjects related to on-going plan projects, undertaken by DAE, related to computer and information technologies.

About 150 computer and IT professionals from various DAE units and from DAE-aided institutions, attended the sixth DAE-VIE meet and actively participated in the discussions. Prof. V.S. Ramamurthy, Secretary, Department of Science and Technology inaugurated the Sixth DAE-VIE meet. Prof. S.V. Raghavan of I.I.T., Madras, delivered the keynote address.



Prof. V.S. Ramamurthy, Secretary, Department of Science and Technology, delivering the inaugural address at the Sixth DAE-VIE meet



Dignitaries on the dais from left to right are : Prof. S.V. Raghavan, I.I.T., Madras, Prof. V.S. Ramamurthy, Secretary, Department of Science and Technology, Mr R.K. Patil, Associate Director, E&I Group, BARC, Mr A.G. Apte, Computer Division, BARC and at the podium Mr P.S. Dhekne, Head, Computer Division, BARC.

A demonstration of the DAE Grid Computing with live connections to RRCAT, Indore and VECC, Kolkata was given by actual submission of computing jobs from RRCAT and VECC to grid-enabled supercomputing clusters, at BARC.

The technical sessions of the meet were held on the subjects of Visual Computing, Grid Computing, Information Security, Information Management Systems and Autonomic Computing.

Special invited lectures of the meet included an evening lecture on 'Future of Electronics and

Information Technology' in India by Dr R. Chidambaram, Principal Scientific Advisor to the Government of India and a lecture on 'Security Systems for Nuclear Installations' by Mr G.P. Srivastava, CMD, Electronics Corporation of India Ltd.

A poster session depicting development work carried out at different units, was organised during the meet. A CD containing technology related articles, written by experts from DAE institutions, was also released.

THEME MEETING ON SELF-ASSEMBLY ROUTES FOR NANOTECH MATERIALS : SARNaM-06

A Theme Meeting on Self-assembly Routes for Nanotech Materials, was sponsored by the Board of Research in Nuclear Sciences (BRNS) and was organized at the Central Complex auditorium, BARC, Mumbai, during April 26-28, 2006. The aim of the meeting was to encourage scientists in universities, to submit projects in the emerging area of self assembly, for funding by BRNS. The meeting was inaugurated by Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy, Government of India, who in his inaugural address, discussed the significance,

of the practical applications of nanotechnology. The welcome address was delivered by Dr S. Banerjee, Director, BARC, in which he elaborated that, self-assembly is an inherent part of nature, in various living organisms and suggested that, scientists follow similar routes for development of future technologies, for nanotech materials. Dr J.V. Yakhmi, Convener, SARNaM-06 and Associate Director(S), Physics Group, BARC, gave introductory remarks covering the broad aspects of the meeting and pointing out the multidisciplinary nature of research in this field.



Dr S. Banerjee, Director, BARC, delivering the welcome address at the theme meeting



On the dais seen from left to right are : Dr D.K. Aswal, Secretary, SARNaM-06, Dr S. Banerjee, Director, BARC, Dr J.V. Yakhmi, Convener, SARNaM-06 and Associate Director (S), Physics Group, BARC and on the podium is Dr Anil Kakodkar, Chairman, AEC delivering the inaugural address

The inaugural session concluded with a vote of thanks by Dr D.K. Aswal, Secretary, SARNaM-06.

About 250 delegates from various disciplines of physics, chemistry, biology and materials science participated in the meeting. There were about 9 sessions of invited talks, covering various aspects of Nano-technology including self-assembly of Nano-Materials, Self-assembly for devices, Biosystems, Mono- and Multi-layers via self-assembly Electrochemistry etc. Seventeen invited talks were delivered by senior scientists from within the country and from abroad. In these talks, different issues of research on nanotechnology were addressed. The scientific and technical issues involved in control of the size and shape of nano-particles during synthesis. Functional nanostructures of practical interest,

generated using thin film growth methods were introduced. Applications of conjugated polymers-based Langmuir-Blodgett films in bio-molecular electronics were addressed. The electronic and physical properties of molecular devices based on self-assembled monolayers on silicon were discussed. Apart from the invited talks, 68 contributed papers were presented as posters and these included various topics such as self-assembly, mono and multi-layers, LB films, nano-particles etc. The discussion meeting included a presentation by Dr P.P. Chandrachoodan (BRNS), in its last session. He described the methodology for submitting projects to BRNS. This was followed by presentations on summary project proposals, from many scientists across the country, which would be considered by the BRNS for funding.

SEMINAR ON "ADVANCES IN METALLOGRAPHY AND MICROSTRUCTURE : MICROSTRUCTURE-2005"

A two day seminar on "Advances in Metallography and Microstructure (Microstructure-2005)" was organised by the Indian Institute of Metals (IIM) Mumbai Chapter and BARC, Mumbai, during December 1-2, 2005 at the Multipurpose Hall, Training School Hostel, Anushaktinagar, Mumbai. The seminar was inaugurated by Dr T.K. Mukherjee, immediate past President of IIM and was presided over by Dr S. Banerjee, Director, BARC. Mr B.P. Sharma, Co-Chairman, National Organising Committee, highlighted the background and theme of the seminar. Dr D. Srivastava, Convener, Microstructure-2005, thanked all the delegates, volunteers, department and sponsoring agencies for their contribution towards making the conference successful.

Dr T.K. Mukherjee, in his inaugural address, explained the role of microstructure characterisation towards the development of new material. He also highlighted the role of IIM in providing a forum for interaction of persons from different fields, to exchange ideas and experience. Dr S. Banerjee, Director, BARC, explained the different aspects of microstructural studies. He gave an inaugural lecture on the topic "Learning Mechanisms of Phase Transformation Through Microstructure." He illustrated several examples of microstructure related investigations, carried out in the Materials Science Division, BARC.



On the dais from right to left are : Dr S. Banerjee, Director, BARC, Dr T. K. Mukherjee, Chief Guest, Dr G.K. Dey, Chairman, Organising Committee, Mr B.P. Sharma, Associate Director, Materials Group & Head, Materials Science Division, BARC



Dr T. K. Mukherjee, Chief Guest, inaugurating the technical exhibition, poster display and Metallography exhibition. Dr. S. Banerjee, Director, BARC and Dr D. Srivastava, Convener Microstructure -2005 are also seen in the picture

Dr T.K. Mukherjee, formally released the souvenir and abstract booklet during the inaugural function. For the first time, a technical exhibition was organised in such a seminar, which was also inaugurated by the Chief Guest.

A total of 230 delegates from academic institutes, laboratories and industries participated in the seminar. There were 31 invited talks including two theme lectures, which were given by eminent scientists. 71 scientific papers were exhibited in the poster

sessions. There were 32 entries in Optical, SEM, TEM and other microscopy technique categories of the Metallography exhibition.

The concluding session was presided over by Mr B.P. Sharma. It was suggested that a seminar on related topics should be organised at regular intervals. Senior delegates summarised the deliberations of the symposium. Both in the poster category and the Metallography exhibit category, prizes were awarded for the best paper and the best exhibit, respectively.

REPORT ON THE 10TH ISMAS TRIENNIAL INTERNATIONAL SYMPOSIUM ON MASS SPECTROMETRY

The 10th ISMAS Triennial International Symposium on Mass Spectrometry, was organised by the Indian Society for Mass Spectrometry (ISMAS, Mumbai) and co-sponsored by different scientific departments (BRNS, CSIR and DST) of the Government of India. It was held at Tea County, Munnar, Kerala, during January 28 to

February 01, 2006. Prior to the Symposium, two parallel short courses on "Mass Spectrometry in Proteomics" and "ICP-MS and its applications" were organised during January 26 and 27, 2006 at Tea County, Munnar. The course on Proteomics was conducted by Prof. Simon Gaskell and Dr. Robert



Dr T. Mukherjee, Director, Chemistry Group, BARC inaugurating the 10th ISMAS Triennial International Symposium on Mass Spectrometry .
On the dais from left to right are: Prof. Paul De Bievre, Belgium , Dr. S.K. Aggarwal, President, ISMAS and Head, Fuel Chemistry Division, BARC, Prof. W.Compston, Australia and Mr P.G. Jaison, Secretary, ISMAS.



Dr T. Mukherjee, Director, Chemistry Group, BARC releasing the special ISMAS souvenir-cum-bulletin containing abstracts of the invited talks and contributed papers

Beynon from UK. The course on ICP-MS and its applications was given by Dr I.B.Brenner from Israel, Dr. Ms. Sabine Becker from Germany and Dr Michael Ketterer from USA. The Symposium was preceded by a social get-together on the evening January 27, 2006, at Tea County, Munnar.

The Symposium was inaugurated by Dr T. Mukherjee, Director, Chemistry Group, BARC, on January 28, 2006. Dr. S.K. Aggarwal, President, ISMAS delivered the welcome address and detailed the scope of the symposium. Dr Mukherjee, in his inaugural address, highlighted the role of Mass Spectrometry in various branches of Science and Technology. During the

inauguration function, a special ISMAS souvenir-cum-bulletin containing abstracts of the invited talks and contributed papers, was released by Dr T. Mukherjee. Three ISMAS awards to eminent Mass Spectroscopists were conferred on (i) Mr V.K. Handu, BARC, Mumbai for his significant contributions in Mass Spectrometry Instrumentation (ii) Dr V. Balaram, NGRI, Hyderabad for his contributions in ICP-MS and (iii) Prof. S.V.S. Murty, PRL, Ahmedabad for his contributions in Noble Gas Mass Spectrometry. Mr P.G. Jaison, Secretary, ISMAS proposed a vote of thanks. The inauguration was followed by a formal opening of the exhibition stalls, arranged by different vendors.

About 200 participants including 30 overseas speakers attended the Symposium. There were 31 invited talks by distinguished mass spectroscopists, 104 technical posters; 3 thesis presentations and 8 oral presentations by instrument manufacturers spread over 19 technical sessions. The posters were grouped under 8 sub-topics: (i) Atomic and Molecular Physics (AMP), (ii) Biological and Environmental Sciences (BES), (iii) Earth and Planetary Sciences (EPS), (iv) Isotopic Composition and Concentration Measurement (ICC), (v) Inorganic Chemistry and Thermodynamics (ICT), (vi) Instrumentation (INS), (vii) Nuclear Technology (NT) and (viii) Organic Chemistry (OC). There was a special session for oral presentations by research scholars who had submitted their Ph.D. Theses, after the 9th ISMAS Symposium held during 2003. The oral presentations by research scholars as well as the posters, were evaluated by experts. Awards were given to the best oral presentation as well as to the best poster presentation under each subtopic mentioned above.

Invited speakers from overseas included : Prof. W.Compston from Australia; Prof. Paul De Bievre from Belgium; Prof. R.M.Srivastava from Brazil; Dr Mehran Alae from Canada; Prof. Ms J.Sabine

Becker, Dr Jurgen H. Gross and Dr. Markus Torsten from Germany; Dr I.B. Brenner from Israel; Dr. Maurizio Speranza from Italy; Dr. Ms. Shizuko Hirata and Dr Sergei Tolamchev from Japan; Dr Goran Aberg from Norway; Dr Ms. Maria Balcerzak from Poland; Dr Vikash Sewram from South Africa; Dr Detelf Guenther and Dr Ms. Ines Gunther Leopold from Switzerland; Prof. Simon Gaskell, Prof. R.P. Evershed, Prof. Ms. Carol V. Robinson, Dr Robert Beynon, Dr Tom Preston, Prof. A.I.Mallet and Dr Dominik Weiss from UK and Prof. F. Turecek and Dr Michael E. Ketterer from USA.

Two cultural programmes were arranged for the delegates : one on the traditional dance form of Kerala, the Kathakali on January 28 and the other, a DJ Sound and Light Show on January 30, 2006.

A valedictory function was held on Wednesday, February 1, 2006. During this function, prizes were awarded to the best poster presentation and the best oral paper presentation. Dr S.K.Aggarwal, President, ISMAS thanked all the delegates from India and abroad, as well as all the sponsors, for taking an active interest during the deliberations of the Symposium.

भा.प.अ. केंद्र के वैज्ञानिकों को सम्मान BARC SCIENTISTS HONOURED



Ms R.M. Rao



A.R. Parab



Dr S.K. Aggarwal



Ms D. Alamelu



P.S. Khodade



R. Govindan

जनवरी 28 से फरवरी 1, 2006 के दौरान मन्नार में आयोजित मॉस स्पेक्ट्रोमेट्री पर दसवीं आई एस एम ए एस की त्रिवर्षीय अन्तर्राष्ट्रीय परिचर्चा में ईंधन रसायन प्रभाग, भाभा परमाणु अनुसंधान केंद्र के दो शोध पत्रों को पुरस्कृत किया गया। आर.एम.राव, ए.आर.परब, एवं एस.के.अग्रवाल के ए स्टडी ऑन दि डिटरमिनेशन

ऑफ स्ट्रोन्शियम आइसोटोपिक रेशियोबाई थर्मल आयनाइजेशन मॉस स्पेक्ट्रोमेट्री यूजिंग सिंगल ऐज मल्टिपल फिलामेंट एसेम्बली शोध-पत्र को आइसोटोपिक कम्पोजिशन एन्ड कानसेंट्रेशन मेजरमेंट श्रेणी में द्वितीय पुरस्कार एवं डी. अलमेलू पी.एस. खोडाडे, आर.गोविंदन तथा एस.के.अग्रवाल के आइसोटोपिक डाइल्यूशन आयनाइजेशन थर्मल मॉस स्पेक्ट्रोमेट्री यूजिंग यू ओ + फॉर दि डिटरमिनेशन ऑफ ट्रेसेस ऑफ यू इन पी यू केमिकल एसे रेफरेन्स मेटेरियल शोध-पत्र को न्यूक्लियर टेक्नोलॉजी श्रेणी में प्रथम पुरस्कार प्रदान किया गया।

श्रीमती आर.एम.राव अकार्बनिक मॉस स्पेक्ट्रोमेट्री एवं एचपीएलसी के क्षेत्र (नाभिकीय ईंधन पदार्थ हेतु विश्लेषणात्मक उपकरण) में कार्यरत हैं। इन्होंने बोरॉन के नमूनों में एसयूबीपीपीएम की मात्रा का निर्धारण करने के लिए एचपीएलसी की विधि का विकास किया है। इनकी रुचि के क्षेत्र में अल्फा स्पेक्ट्रोमेट्री एवं सूक्ष्म विद्युत तरंग के सहयोग से पाचन क्रिया आदि भी शामिल हैं।

श्री ए.आर.परब की वैज्ञानिक रुचि के क्षेत्र में घटकों का विशेष समस्थानिकीय विश्लेषण हेतु थर्मल मॉस स्पेक्ट्रोमेट्री आयनों का परिवर्तन, जो कि नाभिकीय प्रौद्योगिकी के लिए आवश्यक हैं। विभिन्न पत्रिकाओं तथा परिचर्चाओं में इनके 60 से अधिक शोध प्रकाशन हैं।

डॉ. एस.के.अग्रवाल परमाणु द्रव्यमान स्पेक्ट्रोमेट्री एवं अल्फा स्पेक्ट्रोमेट्री के क्षेत्र के विशेषज्ञ हैं तथा विभिन्न द्रव्य स्पेक्ट्रोमेट्री तकनीकों में रुचि रखते हैं। विद्युत-रसायन एवं विलायक निष्कर्षण भी इनकी रुचि के क्षेत्र में शामिल हैं। ये मुंबई विश्वविद्यालय के मान्यता प्राप्त शोध निर्देशक भी हैं।

श्रीमती डी.अलमेलू टाइम-आफ- फ्लाइट द्रव्यमान स्पेक्ट्रोमीटर की उड़ान समय के विकास में सक्रिय रूप से व्यस्त हैं। थर्मल आयनाइजेशन, द्रव्य स्पेक्ट्रोमेट्री, अल्फा स्पेक्ट्रोमेट्री, विकिरण मापी तकनीक तथा लेज़र प्रेरित भंजन स्पेक्ट्रोमेट्री भी इनकी रुचि के क्षेत्र में शामिल हैं। ये 50 से भी अधिक वैज्ञानिक पत्रिकाओं, राष्ट्रीय तथा अन्तर्राष्ट्रीय परिचर्चाओं के प्रकाशनोंकी सह लेखिका हैं।

श्री पी.एस.खोडाडे हाल में नाभिकीय प्रौद्योगिकी में आवश्यक अवयवों के सांद्रण का निर्धारण तथा विशेष आइसोटोपिक विश्लेषण हेतु द्रव्यमान स्पेक्ट्रोमेट्री तथा अल्फा स्पेक्ट्रोमेट्री के क्षेत्र में व्यस्त हैं। ये 60 से अधिक विभिन्न वैज्ञानिक पत्रिकाओं, राष्ट्रीय तथा अन्तर्राष्ट्रीय परिचर्चाओं के प्रकाशनों के सह लेखक भी हैं।

श्री आर.गोविंदन हाल में विभिन्न अवयवों के सांद्रण का निर्धारण तथा आइसोटोपिक विश्लेषण के लिए थर्मल आयनाइजेशन द्रव्यमान स्पेक्ट्रोमेट्री के क्षेत्र में कार्यरत हैं। ये बी डब्ल्यू आर, तारापुर के लिए मिश्रित आक्साइड ईंधनके अभिलक्षण में सक्रिय सहभागी हैं। इनकी रुचि के क्षेत्र में विभवमापी एवं वैद्युत वैश्लेषिक पद्धति रसायन आयनित इलेक्ट्रोड है।

Two papers from Fuel Chemistry Division, BARC, received awards at the Tenth ISMAS Triennial International Symposium on Mass Spectrometry held at Munnar during January 28-February 1, 2006. The paper "A Study on the Determination of Strontium Isotopic Ratio by Thermal Ionisation Mass Spectrometry using Single as well as Multiple Filament Assembly" by R.M. Rao, A.R. Parab and S.K. Aggarwal received the second prize in "Isotopic Composition and Concentration Measurement" category and the paper "Isotopic Dilution Thermal Ionisation Mass Spectrometry using UO^+ for the determination of Traces of U in Pu Chemical Assay Reference Material" authored by D. Alamelu, P.S. Khodade, R. Govindan and S.K. Aggarwal, was awarded the first prize in the "Nuclear Technology" category.

Ms R.M. Rao is working in the field of Inorganic Mass Spectrometry and HPLC, as analytical tools for nuclear fuel materials. She has developed an HPLC method, for determination of subppm amounts of boron in samples. Her other areas of interest are alpha spectrometry and Microwave assisted digestion.

Scientific interests of Mr A.R. Parab lie in the area of thermal ionization Mass Spectrometry, for precise isotopic analysis of elements, which are important in nuclear technology.

Dr S.K. Aggarwal is a specialist in the field of atomic mass spectrometry and alpha spectrometry and is interested in various mass spectrometric techniques. His other areas of interest include, electrochemistry and solvent extraction.

Ms D. Alamelu has been actively involved in the development of a Time of Flight Mass Spectrometer. Her other areas of interest include Thermal Ionization Mass Spectrometry, Alpha Spectrometry, Radiometric Techniques and Laser Induced Breakdown Spectrometry.

Mr P.S. Khodade has been working in the field of Inorganic Mass Spectrometry and Alpha Spectrometry for precise isotopic analysis and determination of concentration of various elements of importance, in Nuclear Technology.

Mr R. Govindan is currently working in the field of Thermal Ionisation Mass Spectrometry for isotopic analysis and concentration determination of various elements. He has actively participated in the chemical characterization of mixed oxide fuels for BWR, Tarapur. His other areas of interest include Potentiometry and Electroanalytical Chemistry involving ion selective electrodes.

नंद लाल मिश्रा, संगीता धरा एवं के.डी. सिंह मुधेर, ईंधन रसायनिकी प्रभाग, भापअ केंद्र द्वारा “ $K_2U_4O_{13}$ सॉलिड सोल्यूशन थर्मल एण्ड एक्सरे कैरेक्टराईजेशन” नामक लेख को राजस्थान



Dr N. L. Mishra



Ms S. Dhara



Dr K. D. Singh

विश्वविद्यालय, जयपुर में दिनांक फरवरी 6-8, 2006 के दौरान आयोजित तापीय विश्लेषण (THERMANS 2006) पंद्रहवीं राष्ट्रीय संगोष्ठी में प्रथम पुरस्कार पोस्टर प्रस्तुतीकरण) दिया गया। इस लेख में पोटेशियम एवं रूबिडियम यूरानेट्स, $(K_{1-x}Rb_x)U_4O_{13}$ (जहां $0 < x < 1$) के नये ठोस घोल के तैयार करने, अभिलक्षणन, एक्स-रे अध्ययन एवं तापीय आचरण के रिपोर्ट्स प्रस्तुत हैं। डॉ. नंद लाल मिश्रा एवं सुश्री संगीता धरा द्वारा पत्र को प्रस्तुत किया गया।

डॉ. नंद लाल मिश्रा विविध मैट्रीसेस एवं यूरानेट्स, मालिब्डेट्स की ठोस अवस्था रसायनिकी, उनके ठोस घोल एवं यूरेनिल मालिब्डेट्स में ट्रेस घटक निर्धारण हेतु कुल

उनके ठोस घोलों पर विविध मैट्रीसों में ठोस अवस्था रसायनिकी पर ट्रेस घटक निर्धारण हेतु TXRF अनुप्रयोगों के क्षेत्र में कार्य कर रही हैं। डॉ. के.डी. सिंह मुधेर ने नाभिकीय पदार्थों की ठोस अवस्था रसायनिकी के विविध क्षेत्रों में कार्य किया है एवं उन्हें एक्स-रे विवर्तन, एक्स-रे वर्णक्रममापी एवं ठोस पदार्थों के अभिलक्षणन की तापीय पद्धतियों पर निपुणता प्राप्त हैं।

A paper entitled “Thermal and X-ray Characterization of $K_2U_4O_{13}$ Solid Solutions” by Nand Lal Misra, Sangita Dhara and K.D. Singh Mudher, Fuel Chemistry Division, BARC, was awarded the first prize (poster presentation) at the Fifteenth National Symposium on Thermal Analysis (THERMANS 2006), held at the University of Rajasthan, Jaipur during February 6-8, 2006. In this paper the preparation, characterization, X-ray studies and thermal behavior of new solid solutions of Potassium and Rubidium uranates, $(K_{1-x}Rb_x)U_4O_{13}$ (where $0 < x < 1$) are reported. The paper was presented by Dr Nand Lal Misra and Ms Sangita Dhara.

Dr Nand Lal Misra has been working in the area of application of Total Reflection X-ray Fluorescence (TXRF) for trace element determinations in different matrices and solid state chemistry of uranates, molybdates, their solid solutions and uranyl molybdates. He has also worked at the Paul Scherrer Institute, Switzerland on applicability of TXRF for trace element determinations in Ice Core samples. Ms Sangita Dhara is currently working in the area of TXRF applications for trace element determination in different matrices and solid state chemistry of alkali metal uranates and their solid solutions. Dr K.D. Singh Mudher has worked in different areas of solid state chemistry of nuclear materials and has expertise in X-ray diffraction, X-ray spectrometry and Thermal methods of characterization of solid materials.



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