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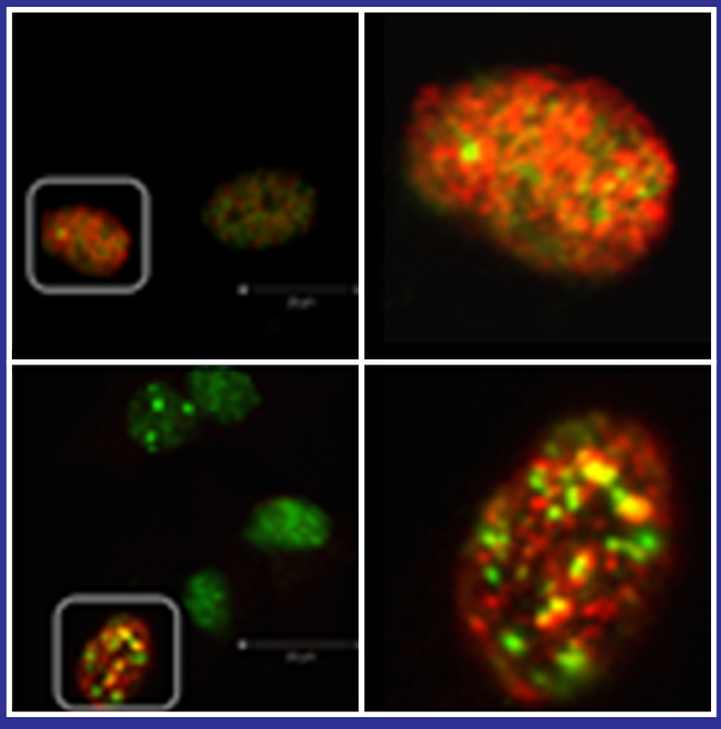
BARC NEWSLETTER

भाभा परमाणु अनुसंधान केंद्र
BHABHA ATOMIC RESEARCH CENTRE



IN THIS ISSUE

CONTENTS

From the Editor's Desk

Welcome to the last issue of the BARC Newsletter for the year 2014. This issue features four articles and two Brief Communications. It also features the various events of the Founder's Day programme at BARC, held on 30th October this year.

On a personal note, this will be my last issue as Editor, BARC Newsletter. During the past five years, we have tried to introduce several new features in the BARC Newsletter, such as the publication of different types of articles, quality enhancement of the published articles through a peer review process, coverage of interviews of Senior Scientists of BARC and showcasing the latest R&D accomplishments of BARC through "Brief Communications". These changes have increased our readership. We brought the BARC Newsletter on par with international serial publications, when it was assigned the International Standard Serials Number (ISSN) in August 2010.

Through this five-year journey as Editor, I had the support and cooperation of several colleagues from BARC and I would like to thank them all: first the BARC Newsletter Editorial Committee members who in spite of their busy schedules, took out time to contribute to the smooth publication of the BARC Newsletter; second, I would like to thank all the authors who contributed various articles, Brief Communications, reports of various news and events at BARC, third the reviewers who had the patience to go though the articles and make suggestions for further improving the quality of the articles.

As I lay down office on 31st Dec. 2014, I wish you all a fruitful and scientifically rewarding 2015 ahead and I hope that you continue your association with the BARC Newsletter.

Dr. K. Bhanumurthy
On behalf of the Editorial Committee

संस्थापक दिवस 2014

डॉ. रतन कुमार सिन्हा,
अध्यक्ष, परमाणु ऊर्जा आयोग एवं
सचिव, परमाणु ऊर्जा विभाग का संबोधन

"विशिष्ट आमंत्रितमहानुभाव, आदरणीय वरिष्ठजन, प्रिय साथियों, मीडिया से आए प्रतिनिधिगण, देवियों और सज्जनों, आज हम इस सुबह यहां पर डॉ.होमी जहांगीर भाभा के 105 वें जन्म दिवसके अवसर पर एक दिवसीय समारोह मनाने हेतु एकत्र हुए हैं । हम इस दिन को स्थापना दिवस के रूप में मनाते हैं तथा इस अवसर पर हम अपने हाल ही के कार्य निष्पादन तथा उपलब्धियों का जायजा लेते हैं तथा हमारे संस्थापक के स्वप्न को साकार करने हेतु आवश्यक गति को बनाए रखते हुए उनके दिखाए पथ पर निरंतर प्रगति करने के लिए अपने आप को पुनःसमर्पित करते हैं ।

वर्ष 2014 के दौरान हमारे देश के परमाणु ऊर्जा कार्यक्रम ने नई उपलब्धियाँ हासिल की है।

3 अगस्त 1954 को गठित परमाणु ऊर्जा विभाग (पऊवि)ने इस वर्ष 60 वर्षों की सेवाएं पूर्ण कर ली हैं तथा हम इस वर्ष को पऊवि के हीरक जयंती वर्ष के रूप में मना रहे हैं।

भारत के पहले पुनर्प्रसंस्करण संयंत्र, प्लूटोनियम संयंत्र (पीपी) ने वर्ष 2014 में अपने स्वर्ण जयंती वर्ष में प्रवेश किया । द्रुत प्रजनन रिएक्टरों में उपयोग में लाए जानेवाले प्लूटोनियम आधारित ईंधन से युक्त प्लूटोनियम संयंत्र की स्थापना भारतीय नाभिकीय ऊर्जा कार्यक्रम के द्वितीय चरण की पहली प्रमुख उपलब्धि है ।

पोखरन में दिनांक 18 मई, 1974 को किए गए शांतिपूर्ण नाभिकीय परीक्षण की 40वीं वर्षगांठ भी वर्ष 2014 में है ।

चिकित्सा उत्पादनों के निजर्मीकरण हेतु भारत का पहला गामा विकिरण संसाधन संयंत्र आईसोमेड के कमीशनन के 40वें वर्षगांठ में इस साल प्रवेश कर चुका है ।

गत वर्ष दो माननीय विशिष्ट व्यक्तियों ने भापअके, ट्राम्बे का दौरा किया । भारत के माननीय राष्ट्रपति ने भापअके प्रशिक्षण विद्यालय के 56वें बैच के स्नातक समारोह के दौरान भापअके का दौरा किया । राष्ट्रपति महोदय ने रिमोट द्वारा पांच सुविधाओं का उद्घाटन किया,साथ ही भापाअके द्वारा विकसित देश के अति प्रसिद्ध फसल उत्परिवर्ती मूँगफली बीज टीएजी-24 देश को समर्पित किया।

माननीय प्रधानमंत्री जी ने हमारे कार्यक्रमों के विभिन्न पहलुओं से स्वयं परिचित होने के लिए दिनांक 21/7/2014 को भापअके का दौरा किया था। माननीय प्रधानमंत्री ने परमाणु ऊर्जा विभाग की प्रमुख उपलब्धियों के बारे में जनसामान्य के बीच जागरूकता बढ़ाने संबंधी विशिष्ट निदेश दिए हैं।

अब मैं पिछले वर्ष के दौरान हमारी कुछ प्रमुख उपलब्धियों का उल्लेख करना चाहूंगा :

न्यूक्लियर पावर कॉरपोरेशन ऑफ इंडिया लिमिटेड (एनपीसीआईएल) ने वर्ष 21013-14 के दौरान कुल 83% क्षमता गुणक तथा 88% उपलब्धता गुणक सहित आज तक का सर्वोत्तम 3533 करोड़ यूनिट (35,333 मिलियन यूनिट) का उत्पादन हासिल किया है। एनपीसीआईएल ने सुरक्षित प्रचालन के 405 रिएक्टर वर्ष पूरे कर लिये हैं और यह अन्य कई प्रचालन उपलब्धियों में प्रतिबिंबित होता है।

रापबिघ-5 के प्रचालन से पर्यावरण में 4.25 मिलियन टन के कार्बन-डाई-आक्साइड के उत्सर्जन होने से बचाया गया है। उल्लेखनीय है कि इस संयंत्र के साढे चार वर्ष के वाणिज्यिक प्रचालन से उत्पादित बिजली की बिक्री से इसके निर्माण के लागत मूल्य से भी अधिक लाभ प्राप्त हो चुका है। मपबिघ इकाई-2 योजनाबद्ध अनुरक्षण हेतु दिनांक 4.10.2014 को शट-डाऊन किए जाने से पहले तक 370 दिनों के लगातार प्रचालन हासिल कर चुका था। यह ऐसा 15वाँ अवसर है जब हमारे बिजली रिएक्टर ने एक साल से अधिक अवधि का लगातार प्रचालन प्राप्त किया हो।

अक्तूबर, 2013 को कुडनकुलम परमाणु बिजलीघर की पहली इकाई को ग्रिड से जोडा गया। 7 जून, 2014 को वह अपनी निर्धारित क्षमता 1000Mwe हासिल कर चुकी है। इस इकाई ने संचित रूप से 282.5 करोड यूनिट की बिजली का उत्पादन किया है। इस इकाई को वाष्प टरबाइन के निरीक्षण एवं अनुवर्ती अनुरक्षण कार्यों के लिए दिनांक 26.09.2014 को शटडाऊन किया गया था। आशा है कि नवंबर, 2014 के अंत तक इसे पुनः प्रचालित किया जाएगा।

भारतीय नाभिकीय विद्युत संयंत्रों में संरक्षा के उच्चतम मानकों को लागू करने के प्रति परमाणु ऊर्जा विभाग की प्रतिबद्धता के एक अंश के रूप में, हमने राजस्थान परमाणु बिजलीघर (आरएपीएस) यूनिट-3 एवं 4 के पीयर रिव्यू करने हेतु आईएईए की ऑपरेशनल सेफ्टी रिव्यू टीम यानि प्रचालनीय संरक्षा पुनरीक्षा टीम (ओसार्ट) को आमंत्रित किया था। हमने ओसार्ट का आरएपीएस यूनिट-3 एवं 4 का एक 'फॉलो अप मिशन' फरवरी 3 से 7, 2014 के दौरान आयोजित किया था। ओसार्ट टीम ने यह मूल्यांकन किया कि कई मामलों में ओसार्ट की टिप्पणियों(प्रेक्षणों) में अपेक्षित संरक्षा व्यवस्थाओं से कहीं अधिक संरक्षा व्यवस्थाएं हमारे बिजलीघर द्वारा की गई हैं।

नवंबर, 2013 में आयोजित कॉनवेक्स-3 नामक आईएईए के सबसे बड़े नाभिकीय एवं विकिरणीय आपातकालीन तैयारी अभ्यास में भारत ने पहली बार भाग लिया। इस अभ्यास में भाग लेने के लिए 57 सदस्य राष्ट्र एवं 20 अंतर्राष्ट्रीय संगठनों ने पंजीकृत किया था। इस अनुकरित अभ्यास के दौरान, आईएईए के किसी सदस्य-राष्ट्र में नाभिकीय संरक्षा घटना के द्वारा विकिरणीय आपातकालीन प्रवर्तित किया गया था। भाग ले रहे राष्ट्रों का कार्यनिष्पादन की समीक्षा चेतावनी मिलते ही उनकी अनुक्रिया, सूचना का आदान-प्रदान एवं अंतर्राष्ट्रीय सहायता प्रदान करने में उनकी क्षमता आदि विषयों के आधार पर किया

गया था । 25 घंटों के इस अभ्यास के अंत में, आईएईए की अंतिम निष्पादन मूल्यांकन शीट में मूल्यांकन के सभी 6 वर्गों के अंतर्गत भारतीय निष्पादन जिसमें पऊवि सचिवालय के आपातकालीन प्रबंधन वर्ग का संयोजन था, को सर्वश्रेष्ठ ठहराया गया था ।

हमारी परमाणु नियामक पद्धति आईएईए के एकीकृत नियामक पुनरीक्षण सेवाओं (आईआरआरएस) के अधीन प्रस्तावित पुनरीक्षण हेतु इस महीने के पहले सप्ताह में, पऊनिप एवं पऊवि ने आईएईए के विशेषज्ञों के साथ एक प्रारंभिक बैठक आयोजित की थी । आईएईए आईआरआरएस मिशन वर्ष 2015 के प्रथम तिमाही में निर्धारित है ।

कल्पाक्कम में 500 Mwe का प्रोटोटाइप द्रुत प्रजनक रिएक्टर के निर्माण की पूर्ति के तहत सभी क्रांतिक, स्थायी इन-कोर घटक की स्थापना का कार्य पूरा हो चुका है । अनुमान है कि यह रिएक्टर मार्च, 2015 तक अपनी पहली क्रांतिकता प्राप्त करेगा । इस रिएक्टर के लिए भापअके द्वारा तारापुर में विनिर्मित प्लूटोनियम एवं यूरेनियम युक्त मिश्रित आक्साइड ईंधन पिन पहुँचा दिए गए हैं ।

काकरापार एवं रावतभाटा में स्वदेशी रूप से विकसित 700MWe के चार दाबित भारी पानी रिएक्टरों का निर्माण कार्य प्रगति पर है । हरियाणा में दिनांक 13.01.2014 को गोरखपुर हरियाणा अणु विद्युत परियोजना का शिलान्यास किया गया । इस ग्रीनफील्ड परियोजना के प्रथम चरण में 2x700 MW संस्थापित क्षमता वाले दाबित भारी पानी रिएक्टर (रु.20,594 करोड़ के अनुमानित लागत में) होंगे और वर्ष 2020-21 तक इनका कमीशनन किया जायेगा।

थोरियम आधारित रिएक्टर प्रौद्योगिकियों तथा संबद्ध ईंधन चक्र गतिविधियों के सभी पहलुओं में अनुसंधान एवं विकास प्रयासों को जारी रखा गया है। थोरियम के उपयोग के लिए एक प्रौद्योगिकी प्रदर्शक के रूप में 300 मेगावाट एएचडब्ल्यूआर के निर्माण हेतु एक स्थल के चयन की प्रक्रिया प्रगत चरण में है। इस संदर्भ में, मैं यह भी बताना चाहूँगा कि मूलभूत नाभिकीय भौतिकी सिद्धान्त के अनुसार अतिरिक्त विखंड्य पदार्थ जैसे समृद्ध युरेनियम-235 या प्लूटोनियम या युरेनियम-233 (थोरियम के किरणन से प्राप्त) के साथ ही थोरियम का उपयोग किया जा सकता है । हमारे देश में यूरेनियम संसाधनों की न्यून उपलब्धता को ध्यान में रखते हुए, आवश्यक बडे पैमाने में थोरियम को उपयोग में लाने के कार्य को शुरू करने से पहले हमारे द्रुत प्रजनक रिएक्टर कार्यक्रम में आवश्यक विखंड्य पदार्थ यथा प्लूटोनियम या युरेनियम-235 का स्वदेशी रूप से उत्पादन कर संधारणीय ऊर्जा आत्मनिर्भरता प्राप्त करना ही हमारे त्रिचरणीय नाभिकीय विद्युत कार्यक्रम का लक्ष्य है ।

परमाणु खनिज अन्वेषण एवं अनुसंधान निदेशालय ने भारत में 2,11,473 टन यूरेनियम आक्साइड संसाधनों को पहचाना है । एएमडी ने हमारे देश में मोनाजाइट (थोरियम का स्रोत) के लगभग 11.93 मिलियन टन एवं जिरकॉन (जिरकोनियम का स्रोत) के लगभग 33.71 मिलियन टन के संसाधनों को पहचान कर ली है।

यूसीआईएल लगातार अपनी उत्पादन क्षमता को बढ़ा रहा है ।

यूसीआईएल-जादुगुड़ा ने अपने प्रचालनीय क्षेत्रों के आस-पास के समुदाय हेतु अनुकूल सीएसआर परियोजनाएं प्रदान किये जाने हेतु अपने निगमीय सामाजिक उत्तरदायित्व (सीएसआर) के लिए प्रतिष्ठित गोल्डन पीकॉक अवार्ड जीता है।निदेशक संस्थान द्वारा संस्थापित और विभिन्न क्षेत्रों में प्रतिष्ठित निगमित मान्यता प्राप्त यह

पुरस्कार दिनांक 17.01.2014 को बेंगलूरु में प्रदान किया गया था।

यूसीआईएल ने दो श्रेणियों (सात संभव श्रेणियों में से) : (i) सर्वाधिक पर्यावरण हितैषी सार्वजनिक क्षेत्र का उपक्रम; (ii) निगमीय सामाजिक दायित्व एवं संधारणीयता में सर्वोत्कृष्ट, में अपने कार्य-प्रदर्शन की मान्यता स्वरूप इंडिया टुडे पीएसयू अवार्ड, शुरूआती वर्ष में ही प्राप्त किये हैं। इस "अन्यपीएसयूटाइप"(अन्य टाइप हैं: महारत्न, नवरत्न, मिनीरत्न) में से दो श्रेणियों में अवार्ड जीतने वाला यूसीआईएल अकेला पीएसयू है। पहले, वर्ष 2013 में यूसीआईएल के तुरमडीह खदान को पर्यावरण प्रबंधन में उत्कृष्ट उपलब्धि हेतु नई दिल्ली के ग्रीनटेक फाउंडेशन द्वारा रजत पुरस्कार प्राप्त हुआ था। यूसीआईएल की नरवापहाड़ कॉलोनी को 14001:2004 पर्यावरण प्रबंधन पद्धति प्रमाणन से पुरस्कृत किया गया है जो कि सिर्फ इने-गिने खदान टाऊनशिपों को ही प्राप्त है। राष्ट्रीय अखिल भारतीय खदान बचाव प्रतियोगिता में समग्र चैम्पियनशिप पुरस्कार वर्ष 2010 से लेकर हर साल यूसीआईएल को प्राप्त हुआ है।

हमारी ईंधन चक्र सुविधाओं का कार्य-प्रदर्शन पिछले वर्ष अपने उच्चतम स्तर पर पहुंच गया। नाभिकीय ईंधन सम्मिश्र ने पीएचडब्ल्यूआर ईंधन उत्पादन में पिछले वर्ष की तुलना में 18% की वृद्धि प्राप्त की। नाभिकीय ईंधन सम्मिश्र अपने हैदराबाद संयंत्र में उत्पादन सुविधाओं को नवीनीकृत कर अपनी उत्पादन क्षमता को बढ़ा रहा है और परमाणु ऊर्जा कार्यक्रम के विस्तरण आवश्यकताओं को पूरा करने के लिए कोटा में नयी ईंधन उत्पादन सुविधा स्थापित करने का कार्य प्रारंभ किया गया है।

इसके अतिरिक्त, नाईस ने आकाश मिसाइल में अंत्य उपयोग हेतु, लाइट कंबैट एयरक्राफ्ट एवं अन्य रक्षा उपयोगों के साथ साथ प्रगत अल्ट्रा सुपर क्रांतिक थर्मल बिजलीघरों में उन्नयित तापमान बाइलरों में उपयोग हेतु इगापअकें को विशिष्ट सामग्रियों का उत्पादन एवं आपूर्ति की है।

भारी पानी संयंत्र लगातार उत्कृष्टतापूर्वक काम कर रहे हैं और उन्होंने न्यूनतम विशिष्ट ऊर्जा खपत के साथ उच्चतम उत्पादन प्राप्त किया है। भारी पानी बोर्ड ने संयुक्त राज्य अमेरिका और फ्रांस जैसे विकसित देशों सहित अन्य देशों को भी भारी पानी का निर्यात किया है।भारी पानी बोर्ड ने भी अपने उत्पादनों और प्रक्रियाओं की रेंज को विस्तृत किया है, उदाहरण के रूप में उन्होंने नाभिकीय ईंधन चक्रण हेतु विलायकों के प्रचुर मात्रा में उत्पादन में आत्मनिर्भरता प्राप्त की है, बोरॉन समस्थानिक बोरॉन-10 एवं बोरॉन-11 के उत्पादन में व्यापक सामर्थ्य का विकास किया है, और वडोदरा में नाभिकीय स्तर के सोडियम धातु के उत्पादन हेतु प्रोटोटाइप संवृत्त इलेक्ट्रोलिटिक सेल का सफलतापूर्वक परीक्षण प्रचालन किया है।

ट्रांबे, कल्पाक्कम और तारापुर स्थित रि-प्रोसेसिंग संयंत्रों और अपशिष्ट प्रबंधन सुविधाओं का नेम-प्लेट क्षमता या उससे उच्चतर स्तर पर भरोसेमंद प्रचालन, नाभिकीय ईंधन चक्र कार्यक्रम, प्लूटोनियम और अवक्षयित यूरेनियम के निष्कर्षण और उच्च स्तरीय विकिरण अपशिष्ट को विट्रिफाइड कांच में बदलने में बीएआरसी का महत्वपूर्ण सहयोग रहा है। निदेशक, भापअके पहले ही लंबे आयुयुक्त ऐक्टिनाइड के सफल पृथक्करण और सीजियम-137 की पुनःप्राप्ति जैसे नाभिकीय अपशिष्ट प्रबंधन क्षेत्र के अतिमुख्य विकास पर प्रकाश डालचुके हैं।

कंटेनरों तथा बंदरगाह में आने व जाने वाले अन्य वाहनों की निगरानी हेतु ईसीआईएल द्वारा

सप्लाई किये गये विकिरण संसूचक उपस्कर बारह बड़े बंदरगाहों पर लगाये गये हैं।

स्वास्थ्य देखभाल, जल, उद्योग और पर्यावरण संरक्षण के क्षेत्र में परमाणु एवं विकिरण प्रौद्योगिकियों के अनुप्रयोगों का विस्तार जारी है और समाज के व्यापक क्षेत्रों को लाभान्वित कर रहा है।

इस वर्ष के दौरान, ब्रिट के साथ समझौता ज्ञापन के अधीन उन्नाव, उप्र एवं बावला, गुजरात में निर्मित दो और विकिरण संसाधन संयंत्रों का कमीशनन किया गया। इनको जोड़ कर कुल बारह विकिरण संसाधन संयंत्र प्रचालन में हैं, जो पूर्ण रूप से निजी उद्यमियों के स्वामित्व और प्रचालन में हैं। ऐसे कई और संयंत्रयोजना और निर्माण के विभिन्न स्तरों पर हैं।

ब्रिट द्वारा चिकित्सा, उद्योग, कृषि और अनुसंधान में अनुप्रयोग हेतु विभिन्न रेडियोन्यूक्लाइड की आपूर्ति की जा रही है। विभिन्न स्वास्थ्यरक्षण संस्थानों को ब्रिट द्वारा की जानेवाली आपूर्ति के आकलन का परिणाम है कि 2.5 लाख से अधिक नैदानिक प्रतिबिंबन परीक्षण, पोजीट्रान उत्सर्जन टोमोग्राफी का उपयोग कर लगभग 15000 परीक्षण, लगभग 20000 नैदानिक उपचार, लगभग 10 लाख इन-विट्रो नैदानिक परीक्षण किए जा चुके हैं। ब्रिट ने अपने संयंत्र में 4000 टन से भी अधिक मसाले और अन्य खाद्य उत्पादों का विकिरण हाइजिनाइसेशन किया है। इस वर्ष के दौरान रेडियोसक्रियता उपलब्धता प्रमाणन हेतु लगभग 9000 खाद्य पदार्थ नमूनों का विश्लेषण किया गया।

टाटा मेमोरियल सेंटर जो परमाणु ऊर्जा विभाग के अंतर्गत एक स्वायत्त संस्थान है, को मानव अनुसंधान बचाव कार्यक्रमों के प्रत्यायन संध (एएएचआरपीपी)द्वारा अनुसंधान प्रतिभागियों के संरक्षण के लिए मान्यता प्रदान की गई है। इस मान्यता से टीएमसी विश्व के सबसे मर्यादित, विश्वसनीय अनुसंधान संगठनों में गिना जाएगा, क्योंकि यह प्रत्यायन यह सुनिश्चित करता है कि यह संगठन नीति, गुणवत्ता और मानव अनुंसधान में संरक्षण हेतु सख्त मानकों का अनुपालन करता है।

टाटा मेमोरियल सेंटर जो परमाणु ऊर्जा विभाग के अंतर्गत एक स्वायत्त संस्थान है, ने बीएआरसी के साथ मिलकर ट्यूमरों की इमेजिंग और उपचार हेतु खास स्थानों पर रेडियोआइसोटोपों को पहुंचाने के लिए वाणिज्यिक रूप से उपलब्ध मोनोक्लोनल एंटीबॉडीज का उपयोग कर, उपयोगी तकनीकें स्थापित की हैं। यह तकनीक नॉन-हॉकिन्स लिम्फोमा के मामलों में बहुत प्रभावी पायी गयी है, क्योंकि इससे उपचार की अवधि 9 महीने से एक माह तक घट गयी है।

टीएमसी महिलाओं एवं बच्चों के लिए कैंसर केन्द्र और राष्ट्रीय हैड्रान बीम सुविधा की स्थापना करेगा। इस सुविधा का शिलान्यास दिनांक 10.01.2014 को मुंबई में किया गया। जापान के बाद, पूरे एशिया में यह दूसरी सुविधा होगी। टीएमसी दिनांक 30.12.2013 को आरंभ की गई नई परियोजना के अंतर्गत पंजाब में होमी भाभा कैंसर अस्पताल एवं अनुसंधान केन्द्र भी शुरू करेगा।

पऊवि यूनिटों में उच्च गुणवत्ता की वैज्ञानिक अनुसंधान गतिविधियां जारी रहीं और उनमें से अधिकांश ने प्रकाशन, साइटेशन और पुरस्कारों के रूप में स्वाभाविक रूप से व्यापक मान्यता प्राप्त की है।

आरआरकेट में सिंक्रोट्रॉन विकिरण स्रोत इंडस-1 और इंडस-2 24 घंटों काम कर रहे हैं तथा अधिकाधिक अनुसंधानकर्ताओं द्वारा उपयोग किये जा रहे हैं। इन्डस-2 के प्रचालन में और एक विशेषपड़ाव है कि 2.5GeVऊर्जा में 200 mA से

अधिक बीम करेंट में प्रचालन । मुझे यह नोट करते हुए प्रसन्नता होती है कि कई महीनों के लिए बीम-लाइन की उपलब्धता अनुसूची इन्टरनेट में उपलब्ध है और उपयोगकर्ता बीम टाइम के लिए अग्रिम आनलाइन बुकिंग कर सकते हैं । पीएचडी और एम.टेक के छात्रों की बड़ी संख्या इस सुविधा का उपयोग कर रही है ।

विज्ञान एवं प्रौद्योगिकी विभाग द्वारा प्रायोजित परियोजना के अंतर्गत, जापान में फोटोन फैक्टरी सिंक्रॉटॉन सुविधा में एक बहुउद्देशीय बीम लाइन स्थापित कर दी गयी है, जिसके क्रियान्वयन की नोडल केन्द्र की जिम्मेदारी साहा इंस्टिट्यूट ऑफ न्यूक्लियर फिजिक्स (एसआईएनपी) की है। लगभग 25 भारतीय संस्थान और विश्वविद्यालयों के अनुसंधानकर्ता इस सुविधा में परीक्षण कर चुके हैं ।

आयनन विकिरण के अधि-घातक डोज से चूहों को बचाने के लिए एक नये लेक्टिन क्लास रेडियोप्रोटेक्टर का आविष्कार किया गया । प्लांट लैक्टिन के एक इंजेक्शन द्वारा चूहों को (12Gyका) पूर्ण शरीर किरणन,जिससे मृत्यु हो सकती है, से 100% सुरक्षा मिलती है ।

भापअके के सहयोग से इंडियन रेअर अर्थ लि. (आईआरईएल, पऊवि के अधीन लोक उद्यम) ने प्रेरण भट्टी के प्रयोग से नियोडिमियम धातु के लिए और अपचयन विस्तरण भट्टी के प्रयोग से समारियम धातु के लिए विरल पदार्थ धातु बनाने की प्रक्रिया का विकास किया है ।

मुझे यह कहते हुए बड़ी प्रसन्नता है कि बीएआरसी के तीन युवा वैज्ञानिकों को इस साल के इनसा (INSA) युवा वैज्ञानिक पुरस्कारों के लिए चुना गया है। यह पहला रिकार्ड अवसर है, जब पऊवि के एक केन्द्र के तीन वैज्ञानिक इनसा (INSA) सम्मान प्राप्त कर रहे हैं।

पऊवि की यूनिटोंने नाभिकीय संलयन एवं त्वरक संबंधी प्रौद्योगिकियों सहित कई महत्वपूर्ण क्षेत्रों में उच्च प्रौद्योगिकी को विकसित करने की दिशा में प्रगति जारी रखा है ।

त्वरक चालित सिस्टम और समुत्खंडन न्यूट्रॉन स्रोत पर हमारी भावी प्रमुख परियोजनाओं के लिए अधिक मात्रा में उच्च तीव्रता प्रोट्रान त्वरक हेतु अतिचालक रेडियो आवृति गुहिकाओं की आवश्यकता होगी । ऐसी गुहिकाओं के संविरचन और निष्पादन मूल्यांकन के लिए आरआरसीएटी ने एक विस्तृत अवसंरचना का निर्माण किया है । गत वर्ष के दौरान, यहाँ विकसित एक-कोशीय 650MHz गुहिका और लेसर वेल्डित 1.3GHz गुहिका ने उत्कृष्ट कार्यनिष्पादन प्रदर्शित किया है । आगे, ऐसी गुहिकाओं के कार्यनिष्पादन वर्गीकरण हेतु वर्टिकल परीक्षण स्टैंड के कमीशनन ने हमें और अधिक स्वावलंबी बना दिया है ।

संलयन प्रौद्योगिकी के अनुसंधान में एक प्रमुख सुविधा एसएसटी-1 टोकामैक का, प्लाज्मा अनुसंधान संस्थान में कमीशनन किया गया है और प्लाज़्मा परिचालन प्रारंभ हो गया है । 42GHz की आरएफ बिजली निवेश के साथ 1.5 टेस्ला के टोराइडल चुंबकीय क्षेत्र में प्रचालन से 75 किलोएम्पीयर की प्लाज़्मा धारा का उत्पादन हुआ है । टीए क्वाइल 2 टेस्ला में बिना अवरोध के लंबे समय तक (~20000 s) नियमित रूप से प्रचालित किए जा रहे हैं ।

आईपीआर द्वारा समाज के हित में बडे पैमाने पर औद्योगिक अनुप्रयोग हेतु पर्यावरण हितैषी प्लाज़्मा प्रौद्योगिकी का विकास किया जा रहा है । जैवचिकित्सकीय अपशिष्ट के निपटान हेतु वायुमंडलीय दाब प्लाज़्मा प्रौद्योगिकी का प्रयोग किया जा रहा है । स्टील के पृष्ठ गुणधर्म को बढाने के लिए उसमें नाइट्रोजन को सम्मिलित

करने में न्यून दाबित प्लाज़्मा का प्रयोग किया जा रहा है । आई पी आर ने इन प्रौद्योगिकियों का निरूपण कर लिया है और इनके आधार पर औद्योगिक स्तर के रिएक्टरों का निर्माण कर लिया है ।

भारत के प्रथम मंगलग्रह मिशन मंगलयान में, पऊवि की इकाइयों यथा ईसीआईएल, भापअके और आरआरसीएटी का विशिष्ट योगदान रहा । मंगलग्रह के आर्बिटर मिशन पर खोज-खबर रखनेवाले 32 मीटर इंडियन डीप स्पेस नेटवर्क एन्टेना ईसीआईएल और भापअके द्वारा उपलब्ध कराया गया था । मंगलग्रह आर्बिटर से फोटो और डाटा प्राप्त करने में इस एन्टेना का महत्वपूर्ण योगदान जारी रहेगा । मंगलयान में लगाये गये लाइमैन अल्फा फोटोमीटर (ड्यूटेरियम से हाइड्रोजन प्रचुरता अनुपात के मापन हेतु) के अंशांकन हेतु आरआरसीएटी, इन्दौर स्थित इन्डस-1 सिन्क्रोट्रान विकिरण स्रोत में भापअके द्वारा लगाये गये उच्च विभेदन निर्वात पराबैंगनी बीमलाइन का उपयोग किया गया था ।

मई, 2015 के लोकसभा चुनाव हेतु चुनाव आयोग को इसीआईएल द्वारा 8.5 लाख इलेक्ट्रानिक वोटिंग मशीनों की आपूर्ति की गई थी । चुनाव में उपयोग किए गये कुल ईवीएम में यह लगभग 50% है ।

जन जागरूकता के क्षेत्र में हमने कई कदम उठाए हैं । इस वर्ष एनपीसीआईएल ने "सर्वोत्तमसंचार अभियान (बाहरी जनता), एनिमेटेड फिल्मों और "बुधिया" परकॉमिक-श्रृंखलाकेलिएराष्ट्रीय पुरस्कार तथा न्यू पावर "नाभिकीय बिजली पर एक अंतरराष्ट्रीय जर्नल" केलिए "सर्वोत्तमगृहपत्रिका" पुरस्कार (अंग्रेजी) जीता है।

पऊवि की इकाइयों में बडी संख्या में आगंतुक पधारे और ये इकाइयाँ अपने संयंत्र के निकट और अन्य स्थलों में कई व्याख्यान और प्रदर्शन भी करवा रही हैं ।

उदाहरण स्वरूप, एनपीसीआईएल के संयंत्रों में 53600 आगंतुक आये, जिनमें से लगभग 50% तो केवल कुडनकुलम परमाणु बिजली संयंत्र (केकेएनपीपी) में ही आये। इसके अलावा प्रिंटेड सामग्री-सूचना पत्र एवं पुस्तिकाओं की बड़ी मात्रा,यानि कुल 7.13 प्रिंटेड सामग्री बांटी गयी, जिसमें से 5.16 लाख केवल केकेएनपीपी साइट में या उसके इर्द-गिर्द बांटी गयी। इसके साथ ही 330 पत्रकारों को भी जानकारी दी गयी ।

भापअके ने भारत के विभिन्न प्रदेशों के 30 कॉलेजों से 2100 छात्रों और संकायों का आतिथ्य किया । भापअके ने 35 स्थलों में लगभग 1.5 लाख आगंतुकों एवं प्रतिभागियों के लिए कई कार्यक्रम और प्रदर्शन भी करवाये ।

प्रिय सहकर्मियों, हमारे छह दशक के इतिहास में हमारे कार्यक्रम के मार्ग में आने वाली असंख्य चुनौतियों पर हमने विजय पायी है । ऐसी प्रत्येक चुनौती ने हमें बाधाओं को पार करने हेतु गुरुतर संकल्प तथा और कड़ा श्रम करने का दृढ़ निश्चय दिया है । मुझे विश्वास है कि पऊवि परिवार के प्रत्येक सदस्य एवं सहकारकर्ताओं के सहयोग से हम आने वाले वर्षों में अपने कार्यक्रम को सतत उत्साह एवं जोश से आगे बढ़ाते रहेंगे । हम याद रखें कि आगामी प्रगति की ओर हमारे कूच के रास्ते में पड़ने वाला हरेक पड़ाव, वास्तव में हमारे संस्थापक डॉ.होमी जहांगीर भाभा एवं विभाग के अन्य अग्रदूतों को हमारी श्रद्धांजलि है ।

धन्यवाद,जय हिन्द ।"

Founder's Day 2014

Address by

Dr. Ratan Kumar Sinha
Chairman, Atomic Energy Commission &
Secretary to Government of India, Department of Atomic Energy

"Distinguished Invitees, Respected Seniors, Dear Colleagues, Representatives from the Media, Ladies and Gentlemen,

We have assembled here this morning to commence the day-long celebrations on the occasion of the 105th birth anniversary of Dr. Homi Jehangir Bhabha. We celebrate this day as our Founder's day. On this occasion, we take stock of our recent performance and achievements, and rededicate ourselves to realise the vision of our Founder by sustaining the required momentum and continuing the progress along the road map drawn by our Founder.

The year 2014 marked several landmarks for the Atomic Energy programme in our country.

The Department of Atomic Energy (DAE), established on August 3, 1954, has completed sixty years of service this year and we are into the Diamond Jubilee Year of our Department.

India's first reprocessing plant, 'Plutonium Plant' (PP), entered its Golden Jubilee year in 2014. The establishment of the Plutonium Plant was the first major step for the second stage of Indian nuclear power programme, involving plutoniumbased fuel use in Fast Breeder Reactors.

The year 2014 also marks the 40th anniversary of the Peaceful Nuclear Experiment conducted at Pokharan on May 18, 1974.

At the beginning of this year, we also reached the milestone of the fortieth anniversary of the commissioning of the ISOMED plant, India's first gamma radiation processing plant for sterilisation of medical products. ISOMED handled in the last year over 60,000 cubic meters of medical products sterilisation.

During the last year two very high dignitaries visited BARC, Trombay.

On 15th November 2013, Honourable President of India visited BARe for the Graduation Function of the 56th Batch of BARC Training School. The President remotely inaugurated five facilities and also dedicated to the nation the most popular crop mutant variety of Groundnut seed, called TAG-24, developed by BARC.

On 21 st July 2014, Hon'ble Prime Minister of India visited BARC for obtaining a first-hand familiarisation with several aspects of our programmes. Hon'ble PM has given specific directions for enhancing public awareness of the important contributions of the DAE.

Let me, now cite some of our major achievements during the last year.

Nuclear Power Corporation of India Ltd. (NPCIL) achieved the highest generation ever 3533 crore units (35,333 Million Units) in 2013-14, with overall capacity factor of 83% and availability factor of 88%. Till date, NPCIL has logged over 405 reactor years of safe operation and this is reflected in several other operating achievements.

The Unit-5 of Rajasthan Atomic Power Station completed 765 days of continuous operation on

September 6, 2014. This is the highest in the world in the last two decades, and the second highest in the entire 60-year history of nuclear power. Such performance is a singular testimony for the strength and maturity of the Indian Nuclear Power Programme.

The operation of RAPS-5 has also helped in avoiding 4.25 million tonnes of carbon-dioxide emission to the environment. Moreover, the sale of electricity produced by this plant over nearly four and half years of commercial operation has already met the cost of its construction. Madras Atomic Power Station Unit-2 (MAPS-2) achieved 370 days of continuous run on October 4, 2014, prior to being shut-down for planned maintenance. This is the 15th time one of our power reactors has recorded over one year of continuous operation.

The first unit of the Kudankulam Nuclear Power Plant was synchronised to the grid in October 2013. It reached its rated capacity of 1000 MWe on ih June this year. The Unit has cumulatively generated 282.5 crore units (2825 MUs) of electricity. It was shutdown on September 26, 2014, to attend to inspection and subsequent maintenance activities on its steam turbine, and expected to be brought on line by the end of November 2014.

As a part of DAE's commitment towards implementing the highest standards of safety in the Indian nuclear power plants, DAE had invited the IAEA Operational Safety Review Team (OSART) for peer review of Rajasthan Atomic Power Station (RAPS) units - 3&4. A 'follow up mission' of OSART was conducted in this Plant during February 3 to 7, 2014. The OSART team assessed that in many cases the station has done much more than what was intended in the OSART observations.

In November 2013, India participated for the first time in the IAEA's largest nuclear and radiological emergency preparedness exercise called ConvEx-3. In this exercise 57 Member States and 10 international organisations had registered for participation. During the simulated exercise, a radiological emergency was triggered by a nuclear security event in an IAEA Member State. Following the alert, performance of the participating countries was assessed on the basis of their response, exchange of information, and capability to provide international assistance. At the end of the 25-hour exercise, the Indian performance, coordinated by the Crisis Management Group (CMG) Secretariat at DAE, was adjudged "Excellent" under all the six categories of evaluation in the IAEA's final performance evaluation sheet.

In the first week of this month, AERB and DAE held a preparatory meeting with the IAEA experts for the proposed review of our nuclear regulatory system under the IAEA's Integrated Regulatory Review Services (IRRS). The IAEA IRRS mission is scheduled in the first quarter of 2015.

Towards the completion of the construction of the 500 MWe Prototype Fast Breeder Reactor (PFBR) at Kalpakkam, erection of all critical, permanent in-core components has been completed. The reactor is now expected to achieve its first criticality by March 2015. The required fuel pins using mixed oxide of plutonium and uranium, manufactured at Tarapur by BARC, have been delivered.

Construction work on four 700 MWe indigenously developed PHWRs at Kakrapar (KAPP-3&4) and Rawathbhata (RAPP-7&8) has been progressing well. On January 13, 2014, the foundation stone was laid for the Gorakhpur Haryana Anu Vidyut Pariyojana in Haryana. The first phase of this Greenfield project will have an installed capacity of 2x700 MW PHWRs, (at an estimated cost of about Rs. 20,594 crore) and would be commissioned by the year 2020-21.

R&D endeavours on all aspects of Thorium-related reactor technologies and allied fuel cycle are continuing. The process of selection of a site for the construction of 300 MWe AHWR, as a technology demonstrator of Thorium utilisation, is in an advanced stage. In this context, I will like to add that the basic

nuclear physics principles warrant that Thorium can be used only with added fissile material, such as, enriched Uranium-235, or Plutonium, or Uranium-233 (obtained by irradiation of Thorium). Considering the modest uranium resources in our country, our three stage nuclear power programme, therefore, provides for achieving sustainable energy independence by producing the required fissile material, plutonium or uranium-233 in our fast breeder reactor programme, prior to introducing Thorium on the required large scale.

Atomic Minerals Directorate for Exploration and Research (AMD) has established 2,11,473 tonnes of Uranium Oxide (U30 a) resources in India. AMD has also progressively established resources of about 11.93 million tonnes of Monazite (source of Thorium), and about 33.71 million tonnes of Zircon (source of Zirconium) in our country.

UCIL has been continuously improving its production capacity.

The Jaduguda facility of UCIL bagged the prestigious Golden Peacock Global Award for Corporate Social Responsibility (CSR) for delivering tailored CSR projects for communities around its operational areas. This Award, founded by the Institute of Directors and one of the prestigious corporate recognitions in various fields, was given on January 17, 2014 in Bangalore.

Very recently, UCIL also bagged the maiden 'India Today PSUs Awards 2014' in recognition of its performance in two categories (out of seven possible): (i) Most Eco-Friendly PSU; (ii) Best in Corporate Social Responsibility and Sustainability. UCIL is the only PSU in this 'Other PSUs' type (other types are:

Maharatna; Navratna; Miniratna) to bag awards in two categories. Earlier in 2013 UCIL's Turamdih mine had won the Silver Award of Greentech Foundation, New Delhi for 'Outstanding Achievement in Environment management'. The ISO 14001 :2004 Environment Management System (EMS) certification of UCIL's Narwapahar Colony makes it one of the very few mining townships to have received such recognition. UCIL has also been getting the 'Overall Championship' award in the National All India Mines Rescue Competitions every year since 2010.

The performance of our fuel cycle facilities reached their highest levels last year. Nuclear Fuel Complex (NFC) achieved an increase of 18% of PHWR fuel production compared to the previous year. NFC has been increasing its production capacity by modernising its manufacturing facilities at its Hyderabad site, and to meet the expanding nuclear power programme needs, work has commenced for setting up a new fuel manufacturing facility at Kota.

NFC has, in addition, manufactured and supplied special materials for end use in Akash missile, Light Combat Aircraft and other Defence use, as well as materials to IGCAR for use in elevated temperature boilers of Advanced Ultra Super Critical Thermal Power Plants.

The heavy water plants continued to perform excellently and achieved the highest production with the lowest specific energy consumption. Heavy Water Board has also exported heavy water, including to developed countries like USA and France. Heavy Water Board has also expanded the range of their products and processes, as for example, they have made the Department self-sufficient in bulk solvents for Nuclear Fuel Cycle; developed comprehensive capability in production of Boron isotopes Boron-10 and Boron-11; and successfully test operated prototype closed electrolytic cell at Vadodara for production of nuclear grade Sodium metal.

BARC's crucial support to the nuclear fuel cycle programme continued with the reliable operation of reprocessing plants and waste management facilities at Trombay, Kalpakkam and Tarapur, at or above the name plate capacity, in the extraction of plutonium and depleted uranium, as well as in the conversion of the high level radioactive waste to

vitrified glass. Director, BARC has already covered some very important developments in the nuclear waste management area, particularly, the successful separation of long life actinides, and recovery of cesium- 137.

Radiation detection equipment supplied by ECIL has been installed at twelve major seaports for monitoring vehicles entering or leaving the port.

Applications of nuclear and radiation technologies in the area of food and agriculture, health-care, water, industry and environmental protection continue to expand, delivering wide-ranging benefits to the society.

During this year, two more Radiation Processing Plants - one at Unnao, UP, and the other at Bavla, Gujarat, built under MoU with BRIT, have been commissioned. With this, twelve radiation processing plants are under operation, which are totally owned and operated by private entrepreneurs. More such plants are in different stages of planning and construction.

BRIT has been supplying various radionuclides for applications in medicine, industries, agriculture and research. The impact of BRIT supplies to various healthcare institutions is estimated to result in over 2.5 lakhs diagnostic imaging investigations, about 15,000 investigations using Positron Emission Tomography (PET), about 20000 therapeutic treatments, about 10 lakhs in-vitro diagnostic investigations. In its plant, BRIT has also carried out radiation hygienisation of over 4000 tonnes of spices and other food products. Analysis of nearly 9000 food product samples, for their radioactivity content certifcation, has also been done during the year.

The Tata Memorial Centre (TMC), an autonomous institution under the Department of Atomic Energy, has been awarded the Accreditation for Protecting Research Participants, by the Association for the Accreditation of Human Research Protection Programmes (AAHRPP). The AAHRPP's endorsement places TMC among the world's most respected, trustworthy research organisations, since this accreditation confirms that the organisation follows rigorous standards for ethics, quality, and protections for human research.

TMC, in collaboration with BARC, has established techniques, using commercially available monoclonal antibodies, to deliver radioisotopes to specific sites for imaging and treatment of tumours. This approach has been found very effective in cases of Non-Hodgkin's Lymphoma by reducing the treatment period from 9 months to 1 month.

TMC will be establishing a National Hadron Beam Facility and Cancer Centre for Women and Children. The foundation stone for this Facility was laid in Mumbai on January 10, 2014. This facility will be the second such facility in Asia, after Japan. TMC will also set up the Homi Bhabha Cancer Hospital and Research Centre in Punjab under a new project launched on December 30,2013.

High quality scientific research activities continue to be carried out in DAE Units and most of them invariably receive wide recognition in terms of publications, their citations, as well as awards.

The synchrotron radiation sources Indus-1 and Indus-2 at RRCAT have been operating in round the clock mode and are being used by an increasing number of researchers. Indus-2 reached yet another major milestone of operation at beam current exceeding 200 mA at 2.5 GeV energy. I am happy to note that the beam-line availability schedule for several months is displayed on the internet and users can make advance online bookings for beam time. A growing number of students, both Ph.D. and M.Tech., are also using these facilities.

A multi-purpose beam-line has been successfully set up at the Photon Factory Synchrotron Radiation Facility in Japan, under a DST-sponsored project with

Saha Institute of Nuclear Physics (SINP) as the nodal centre for its implementation. Researchers from about 25 Indian institutes and universities have performed experiments in this facility.

A new lectin class of radioprotector was found to protect mice against supra-lethal doses of ionising radiation. A single injection of the plant lectin offered 100% protection to mice against whole body irradiation (12 Gy) induced death.

BARC's collaborative support to Indian Rare Earths Limited (IREL, Public Sector Company under DAE), has led to IREL developing Rare Earth metal making processes for Neodymium metal, using induction furnace, and a process for making Samarium metal, using reduction diffusion furnace.

I am pleased to note that three young scientists of BARC have been selected for the INSA Young Scientist Award this year, a first time record of three scientists from one Centre of DAE selected for the INSA honour.

DAE Units continued to register progress in developing high technology in many important areas, including nuclear fusion and accelerator related technologies.

Our future major projects on Accelerator Driven System and Spallation Neutron Source would require a large number of superconducting Radio Frequency (RF) cavities for the high intensity proton accelerators. RRCAT has set up an extensive infrastructure for fabrication and performance evaluation of such cavities. During the last year, in-house developed single-cell 650 MHz cavity, and a laser welded 1.3 GHz cavity, have shown excellent performance. Further, commissioning of a Vertical Test Stand for the performance characterisation of such cavities has made us more self-reliant.

The SST-1 tokamak of Institute of Plasma Research, an important facility for research in fusion technology, has been commissioned and plasma operations have started. Operations at a Toroidal magnetic Field (TF) of 1.5 Tesla assisted by RF power input at 42 GHz have produced plasma currents of 75 kiloAmperes. The TF coils have been operated routinely for long durations (-20000 s) without interruption also at 2 Tesla.

Environment-friendly plasma technologies are developed at IPR for industrial applications, benefiting the society at large. Atmospheric pressure plasma technology is used for biomedical waste disposal. Low pressure plasma is used for incorporation of nitrogen in steels for enhancing surface properties. IPR has demonstrated these technologies and have put up industrial scale reactors.

In India's maiden Mars mission, Mangalyaan, DAE Units ECIL, BARC and RRCAT have made specific contributions. ECIL and BARC provided the 32 meter Indian Deep Space Network (IDSN) antenna that is tracking the Mars Orbiter Mission. The antenna will continue to play an important role in receiving data and photographs from the Mars Orbiter. The high resolution vacuum ultra violet beamline, set up by BARC at Indus-1 synchrotron radiation source at RRCAT, Indore, was used for calibrating the Lyman Alpha Photometer (meant for measurement of Deuterium to Hydrogen abundance ratio) placed on-board the Mangalyaan.

For the May 2014 Lok Sabha elections about 8.5 lakhs Electronic Voting Machines (EVMs) have been supplied by ECIL to Election Commission. This constitutes about 50% of all the EVMs used in the elections.

In the area of Public Outreach, we have taken several steps. This year, NPCIL received National Awards for 'Best Communication Campaign (External Public) Animated Films and Comic Series' on "Budhiya" and for 'Best House Journal (English)' "NuPower, an International Journal on Nuclear Power".

DAE Units have been hosting a large number of visitors and also holding lectures and exhibitions in the vicinity of their sites and other places.

For example, NPCIL hosted over 53600 visitors to its plants, with nearly 50% of them received at Kudankulam Nuclear Power Plant (KKNPP) alone. In addition, about 7.13 lakhs printed materials containing information for public awareness were distributed. NPCIL had also briefed 330 Journalists. BARC hosted 2100 students and Faculty from 30 Colleges from different parts of India. BARC also organised events and exhibitions in 35 sites involving nearly 1.5 lakhs visitors and participants.

Dear colleagues, in our history of six decades we have overcome numerous challenges coming in the path of growth of our programme. Each such challenge has given us a greater resolve and determination to work even harder to overcome the hurdles. I am sure that with the contributions from every member of the DAE family and our collaborators, we will carry forward our programme with sustained enthusiasm and vigour in the years to come. Let us remember that each milestone reached in our march to further progress is, in fact, our tribute to our founder Dr. Homi Jehangir Bhabha and the other pioneers of our Department.

Thank you,
Jai Hind."

संस्थापक दिवस 2014

डॉ. शेखर बसु,
भापअ केन्द्र के निदेशक का संबोधन

"परमाणु ऊर्जा आयोग के अध्यक्ष डॉ. आर.के. सिन्हा, परमाणु ऊर्जा विभाग परिवार के वरिष्ठ सदस्यगण, विशिष्ट आमंत्रित अतिथिगण, मीडिया के प्रतिनिधिगण, मेरे प्रिय साथियों और दोस्तों, मैं, संस्थापक दिवस समारोह में आप सभी का हार्दिक स्वागत करता हूं। आज के दिन हम सब मिलकर अपने स्वप्नद्रष्टा संस्थापक, डॉ. होमी जहांगीर भाभा के 105 वें जन्मदिवस के अवसर पर उन्हें भावभीनी श्रद्धांजलि अर्पित करेंगे। इस वर्ष हमारे लिए संस्थापक दिवस का विशेष महत्व भी है क्योंकि हमारा परमाणु ऊर्जा विभाग 03 अगस्त से हीरक जयंती वर्ष में प्रवेश कर चुका है जिसकी स्थापना 03 अगस्त 1954 को हुई थी।

हम यहां इसलिए एकत्रित हुए हैं कि हम पिछले वर्ष के अपने कार्य निष्पादन और उपलब्धियों पर चिंतन-मनन कर सकें और लगातार सर्वोत्तम प्रयास करते रहने हेतु अपने आपको पुनःसमर्पित कर सकें ताकि नाभिकीय विज्ञान और प्रौद्योगिकी एवं इनके विविध अनुप्रयोगों से अपने राष्ट्र को अधिकतम लाभ पहुंचाना सुनिश्चित कर सकें।

पहले, मैं आपको पिछले एक वर्ष के दौरान, भापअ केंद्र के कार्य निष्पादन की झलकियों और कुछ विशिष्ट उपलब्धियों के बारे में बताना चाहूंगा।

A.1 इस अवधि के दौरान, बीएआरसी में दो अति महत्वपूर्ण व्यक्तियों का आगमन हुआ। 15 नवंबर 2013 को भारत के माननीय राष्ट्रपति ने बीएआरसी प्रशिक्षण विद्यालय के 56 वें बैच के अधिकारियों के दीक्षांत समारोह में पधारकर समारोह की शोभा बढ़ाई और बाद में 21 जुलाई, 2014 को भारत के माननीय प्रधानमंत्री ने पऊवि तथा बीएआरसी के कार्यक्रमों और परियोजनाओं की प्रत्यक्ष रूप से जानकारी लेने के लिए दौरा किया।

A.2 सन 2014 का वर्ष, बीएआरसी के लिए महत्वपूर्ण उपलब्धियों से भरा हुआ वर्ष रहा। प्लुटोनियम प्लांट (पीपी) के कमीशनन की स्मृति में 18 अगस्त, 2014 को स्वर्ण जयंती समारोह मनाया गया और हमने 18 मई 1974 को पोखरण

में किए गए प्रथम शांतिपूर्ण परमाणु परीक्षण के 40 वर्ष पूरे किए।

प्रिय साथियों,

भापअ केंद्र, एनपीसीआईएल के रिएक्टरों के सतत प्रचालन के लिए सहयोग करता रहा।

B.1 TAPS 1 और 2 की रिएक्टर दाब वाहिकाओं के ऊपरी क्षेत्र में वेल्डों का निरीक्षण करने के बाद, क्रोड बेल्ट निरीक्षण के लिए एक मैनिपुलेटर का विकास किया गया।

B.2 KAPS-2 रिएक्टर के Q-10 शीतलक चैनल की दाब नलिका और गार्टर स्प्रिंगों का पश्च-किरणन परीक्षण (PIE) पूरा किया गया।

आज हम, अपने उच्च प्रौद्योगिकी गतिविधियों में हमारे अनुसंधान और विकास के प्रयासों के परिणाम निष्कर्ष (आउटपुट) को परिनियोजित करने की हमारी गतिविधियों की ओर ध्यान केंद्रीय कर रहे हैं। मैं आपको रिएक्टरों से संबंधित कुछ ऐसी ही गतिविधियों के बारे में बताऊंगा।

C.1 AHWR ऊष्मा वहन प्रणाली, स्टीम एंड फीड वाटर प्रणाली, आपातकालीन क्रोड शीतलक प्रणाली तथा संबंधित नियंत्रणों का अनुकार करते हुए एनपीसीआईएल के साथ संयुक्त रूप से स्थापित PARTH नामक एक समग्र परीक्षण सुविधा का कमीशनन, निम्न ऊर्जा पर प्रचालित करने हेतु किया गया।

C.2 सर्वोच्च स्ट्रेस्ड वेल्डों में से एक स्ट्रेस्ड वेल्ड पर मशीनित नॉच-युक्त एक पाइपिंग लूप का शेक-टेबल परीक्षण, त्वरण का स्तर बढ़ाते हुए किया गया। यह पाइपिंग, 40 सुरक्षित शटडाउन भूकंप लेवेल को सह पाया। मुझे यह घोषणा करते हुए प्रसन्नता हो रही है कि इस परीक्षण को OECD/NEA द्वारा उच्च भूकंपी भार (MECOS) परियोजना के अंतर्गत धात्विक संघटक मार्जिनों के फ्रेमवर्क में एक बेंचमार्क प्रयोग के रूप में चुना गया।

C.3 मोल्टेन फ्यूल-कूलैन्ट इंटरएक्शन कोड, PINAK प्रथम आकृति/ढ़ांचे का विकास, भापअ केंद्र और जादवपुर विश्वविद्यालय की नेप्चुन प्रयोगशाला द्वारा संयुक्त रूप से किया गया। यह कोड, PHWR में दुर्घटना होने की स्थिति में किसी एक चैनल के असफल हो जाने के कारण अन्य चैनलों पर उसके प्रभाव से संबंधित मुद्दों के बारे में बताता है।

C.4 रिएक्टर में गंभीर दुर्घटना होने की स्थिति में, हाइड्रोजन अल्पीकरण के लिए विकसित पैलेडियम-प्लैटिनम उत्प्रेरक पैनलों का परीक्षण, एनपीसीआईएल की हाइड्रोजन पुनर्योगज परीक्षण सुविधा में किया गया। H_2 हटाने की दर, यूरोप के वाणिज्यिक उत्प्रेरक की दर के समान है।

C.5 सुनामी का रूप ले सकने वाले भूकंपों का शीघ्र संसूचन और पहचान करने के लिए, एक साफ्टवेयर का विकास किया गया है और इस प्रणाली को डाटा सेंटरों में स्थापित किया गया है ताकि अंडमान, निकोबार, हिन्द महासागर/बंगाल

की खाड़ी के सुमात्रा क्षेत्रों के भूकंपों को मॉनीटर किया जा सके।

C.6 जैतापुर, गोरखपुर, चुटका और मिठी विरडी में एनपीसीआईएल की प्रस्तावित परियोजनाओं से जनता के डोज का मूल्यांकन किया गया। वैज़ाग स्थित रिएक्टरों और अन्य सुविधाओं के लिए भी जनता के डोज का मूल्यांकन किया गया।

C.7 बैंगलोर स्थित जैन-विश्वविद्यालय में विशाल पूल अग्नि परीक्षण सुविधा (4 मी. x 4 मी.) का कमीशनन पूरा किया गया। इस सुविधा का प्रयोग करके हमारे देश में प्रयुक्त अधिकांश पैकेजों को प्रमाणित किया जा सकता है।

प्यारे साथियों,

हमारी पश्चांत सुविधाएं अच्छा कार्यनिष्पादन करती रहीं ।

D.1 तारापुर की प्रगत कांचीकरण प्रणाली (AVS) ने दो वर्षों की प्रचालन अवधि के भीतर ही 150 VWP कनस्तर (16Te) का उत्पादन करने की महत्वपूर्ण उपलब्धि प्राप्त की।

D.2 तारापुर के एक्टिनाइड पृथक्करण निदर्शन सुविधा (ASDF) के तप्त/रेडियोसक्रिय कमीशनन होने के बाद से इसे प्रयोक्ताओं की अपेक्षा के अनुसार कैम्पेन मोड में लगातार चलाया जा रहा है।

D.3 पीपी में ICWसे भरे हुए एक टैंक का उपचार वर्ष के दौरान किया गया।

निम्नलिखित क्षेत्रों में प्रौद्योगिकी विकास होने से पश्चांत गतिविधियों को और बढ़ावा मिलेगा:-

E.1 भुक्तशेष ईंधन के बंडलों को पानी के अंदर प्रयोग करने का परीक्षण करने के लिए तारापुर और कलपाक्कम के पुनर्संसाधन संयंत्रों को 9 कि.ग्रा. और 25 कि.ग्रा. पेलोड क्षमताओं वाले दो प्रकार के जलगत मैनिपुलेटरों की आपूर्ति की गई।

E.2 30 kW पॉवर पर एक लंबे जेट, उच्च ताप (~80000C) प्लाज्मा का उत्पादन करने वाले एक सक्षम एयर-प्लाज्मा-टॉर्च का विकास पहली बार किया गया। यह टार्च, प्लाज्मा गैस, हैफनियम इलेक्ट्रोड के रूप में एम्बिएंट वायु का प्रयोग करता है। इसे नाभिकीय पुन:चक्रण वर्ग के रेडियोसक्रिय अपशिष्ट दाहक में प्रस्थापित किया जा रहा है।

E.3 वेस्ट ड्रम और हल में विखंडनीय पदार्थ का पता लगाने के लिए विभेदी डाई अवे तकनीक नामक एक उच्च संवेदी विधि का विकास किया गया। एक स्पंदित न्यूट्रॉन स्रोत का प्रयोग करके, सक्रिय गामा और न्यूट्रॉन बैकग्राउंड की उपस्थिति में 150 कि.ग्रा. जिरकोलॉय हल में 500 मि.ग्रा. Pu का पता लगाया जा सका।

हमने उच्च ऊर्जा भौतिकी के क्षेत्र में कुछ महत्वपूर्ण प्रगति देखी है।

F.1 गामा किरण खगोल-विज्ञान के लिए भारत की सबसे बड़ी दूरबीन (21 मीटर व्यास), MACE का परीक्षण, ईसीआईएल, हैदराबाद में पूरा किया गया। इसे प्रस्थापित करने के लिए अब लदाख के हानले में ले जाया जा रहा है।

F.2 इंडस-2 सिंक्रोट्रॉन के/में प्रतिबिंबन कणपुंज रेखा नामक पदार्थ और जैव-चिकित्सा अनुसंधान हेतु सूक्ष्म-प्रतिबिंबन सुविधा का कमीशनन किया गया।

F.3 इंडस-1 सिंक्रोट्रॉन के/में अवरक्त कणपुंज रेखा का भी कमीशनन पदार्थ विज्ञान के अध्ययन के लिए किया गया।

F.4 भापअ केंद्र में बनाए गए 50 RPC और 200 कूलिंग पैनलों की स्थापना और कमीशनन, मई, 2014 में लार्ज हैड्रॉन कोलाइडर (LHC), सर्न के कम्पैक्ट म्युऑन सॉलिनॉइड (CMS) में की गई जो वर्ष 2015 से 14 TeV पर संघात प्रक्रिया (collision) के लिए तैयार हो रहा है।

डाटा प्रासेसिंग और नेटवर्किंग फील्ड में साफ्टवेयर और हार्डवेयर दोनों में भी महत्वपूर्ण प्रगति की गई।

G.1 150 टेराफ्लॉप्स के शीर्ष कार्यनिष्पादन और 109 टेराफ्लॉप्स के सतत कार्यनिष्पादन के साथ एक नवीन समांतर प्रोसेसिंग सुपरकंप्यूटर, अनुपम-अग्र का कमीशनन किया गया।

G.2 भापअ केंद्र के इंट्रानेट प्रयोक्ताओं को कंप्यूटिंग इंफ्रास्ट्रक्चर उपलब्ध कराने हेतु "मेघ" नामक एक क्लाउड कम्प्यूटिंग सेवा विकसित की गई। इसमें 1024 कम्प्यूटिंग कोर, 4 टेराबाइट रैम और 128 टेराबाइट डिस्क स्पेस है। इस सेवा का प्रयोग करके, प्रयोक्ता अपनी आवश्यकतानुसार सर्वर ऑन डिमांड बना सकते हैं।

G.3 ग्राफिक्स डाटा विजुअलाइजेशन के लिए, एक नवीन प्रोजेक्टर आधारित सीमरहित टाइल्ड डिस्प्ले का विकास किया गया। इस सिस्टम में 3x3 टाइल्ड फैशन में व्यवस्थित किए गए 9 एलसीडी प्रोजेक्टर हैं जो स्क्रीन पर उनके प्रतिबिंब प्रक्षेपित करते हैं। अलग-अलग स्क्रीनों के बीच सीम नहीं होने से चिकना दोषमुक्त प्रतिबिंब मिलता है। नए डिस्प्ले सिस्टम में एक्टिव स्टीरियोस्कोपिक ग्लासों का प्रयोग करके 3-D में ग्राफिक्स कन्टेन्टों को डिस्प्ले करने की भी क्षमता है।

G.4 "मार्ग दर्शक" नामक साफ्टवेयर विकसित किया गया है जो बिल्डिंगों के 3-D वाकथ्रू मॉडल देता है। यह महत्वपूर्ण संस्थापनाओं की रक्षा करने हेतु सुरक्षा कार्मिकों और अनुक्रिया बलों के प्रशिक्षण में उपयोगी है।

G.5 सुरक्षित, स्वदेशी नेटवर्क कम्पोनेन्टों का विकास और परिनियोजन करने हेतु ईसीआईएल के मौजूदा सहयोग के एक भाग के रूप में, NKN नेटवर्क और MTNL के वाणिज्यिक नेटवर्क में ECR सिरीज राउटरों का सफलतापूर्वक एकीकरण किया गया। इन राइटरों पर आधारित एक पाइलट

वीडियो निगरानी प्रणाली का भी एकीकरण किया गया।

प्यारे साथियों,

हम रक्षा अनुप्रयोगों के विभिन्न क्षेत्रों में अपना योगदान देते रहे।

H.1 संहत LWR नोदन संयंत्र द्वारा अपेक्षित नौ प्रकार के प्रक्रम संवेदकों का सफलतापूर्वक देशीकरण किया गया और प्रौद्योगिकी, ईसीआईएल को हस्तांतरित की गई।

H.2 P4 में शीत और तप्त क्रांतिकता प्रयोगों के लिए नाभिकीय यंत्रीकरण और विकिरण मॉनिटरिंग प्रणालियों का अभिकल्पन, विकास और कमीशनन किया गया। भापअ केंद्र में विकसित गामा स्कैनिंग मशीन का प्रयोग, ईंधन वंडलों को स्कैन करने, पश्च किरणन बर्न-अप अध्ययनों, आइसोटोपिक विश्लेषण तथा परिमाणात्मक मापन के लिए किया गया।

H.3 P4 रेडियोसक्रिय सुविधा में रिएक्टर कोर न्यूट्रॉन फ्लक्स को मानीटर करने के लिए स्व-गृहे विकसित उच्च न्यूट्रॉन सुग्राहिता हीलियम-3 संसूचकों का प्रयोग किया गया।

H.4 रक्षा हेतु सामरिक इलेक्ट्रॉनिक प्रौद्योगिकी के विकास के लिए ईसीआईएल के साथ सहयोगात्मक कार्यक्रमों के अधीन, अगले एकीकरण के लिए ईसीआईएल को तीन स्टैबिलाइजेशन और ट्रैकिंग सर्वो प्रणालियां सौंपी गईं। इसमें निम्नलिखित शामिल हैं :

- DRDO के इंडियन एयरबोर्न अर्ली वार्निंग सिस्टम (AEWS) में ऑनबोर्ड परिनियोजन के लिए 0.45 मीटर व्यास का SATCOM टर्मिनल।
- ब्रह्मोस मिसाइल के लिए दो एक्सिस जिम्बल्ड X - बैंड सीकर
- DRDO के लिए रुस्तम अनमैन्ड एरियल वाहन (UAV) हेतु ऑन-बोर्ड परिनियोजन के लिए 0.73 मीटर SATCOM टर्मिनल।

H.5 प्रचालनरत नाभिकीय नोमोग्राम का अभिकल्पन और विकास किया गया और रगेड टेबलेट पीसी पर कार्यान्वित किया गया, ताकि नाभिकीय आक्रमण के प्रभाव का मूल्यांकन करने के लिए रक्षा बलों के द्वारा प्रशिक्षण प्राप्त करते समय उपस्कर हाथ में पकड़ा जाए और इसका प्रयोग किया जाए।

ईंधन संविरचन के क्षेत्र में, निम्नलिखित क्षेत्रों में विकास हुआ :

J.1 FBTR में किरणन के परीक्षण लिए यांत्रिक रूप से जुड़े हुए धात्विक ईंधन पिन के संविरचन हेतु एक ग्लोब बॉक्स सेट अप तैयार किया गया है।

J.2 ईंधन संविरचन के दौरान उत्पन्न यूरेनियम स्क्रैप का उपयोग करने के लिए नाभिकीय ग्रेड अमोनियम डाइयूरेनेट (ADU) के उत्पादन हेतु धातु न्यूनीकरण प्रौद्योगिकी का उन्नयन एवं बहि:स्राव हस्तन सुविधा का कमीशनन किया गया।

J.3 ध्रुवा रिएक्टर में उपलब्ध अभिक्रियता को बढ़ाने के लिए दो भिन्न –भिन्न यूरेनियम लोडिंग सहित रूपांतरित ईंधन क्लस्टर संविरचित किए गए और किरणित किए जा रहे हैं ।

J.4 थोरियम आधारित ईंधन के लिए प्रौद्योगिकी विकास के भाग के रूप में (Th-P_u) MOX ईंधन संयोजन के किरणन को 20 GWD/Te के बर्न अप तक ध्रुवा में सफलतापूर्वक पूरा कर लिया गया और एक नया (Th-LEU) MOX संयोजन, पाइल में संस्थापित किया गया।

अब मैं, आपको कुछ और क्षेत्रों के बारे में बताना चाहूंगा जहां हमारे प्रौद्योगिकी विकास के प्रयास सफल हुए ।

K.1 रेडान और हानिकारक गैसों के रीयल टाइम लेवेल के फीडबैक द्वारा प्रचालित स्वदेश में विकसित खदान संवातन नियंत्रण प्रणाली, तुरमडीह के भूमिगत यूरेनियम के खान में संस्थापित कर ली गई है।

K.2 हमारे प्रयास से, जर्मेनियम की शुद्धिकरण, 8N की शुद्धता स्तर तक पहुंच गई है और संसूचक के विकास के लिए 2 कि.ग्रा. सामग्री सौंपी गई ।

K.3 1.7 टेसला विद्युतचुंबक का अभिकल्पन और विकास तथा ITER-TBM के लिए संक्षारण लूप प्रयोगों हेतु इसकी विद्युत आपूर्ति पूरी कर ली गई और आईपीआर, गांधीनगर को चुंबक सौंप दिया गया ।

K.4 भापअ केंद्र ने ऑनलाइन स्टीम टरबाइन ब्लेड कंपन मानीटरन प्रणाली का विकास किया है । एनटीपीसी द्वारा अप्रैल 2014 में इस पोर्टेबल प्रणाली का प्रयोग करते हुए, यूपी में तांदा विद्युत संयंत्र में ब्लेड की असफलता के बारे में भविष्यवाणी की जा सकी।

K.5 एक परमाण्वीय चुंबकमापी सह परमाणु घड़ी के रुप में इस प्रकार की पहली घड़ी विकसित की गई है । लगभग ~10^{-9} के स्थायित्व सहित परमाण्वीय आवृत्ति मानक प्रदान करते हुए, यह साथ में पिकोटेसला संवेदिता सहित परानिम्न चुंबकीय क्षेत्रों को भी माप सकता है।

K.6 ईसीआईएल को हस्तांतरित की गई प्रौद्योगिकी के अधीन, 40kJ क्षमता वाली विद्युत चुंबकीय विनिर्माण मशीन की दो इकाइयों का निर्माण किया गया। ये मशीनें अधिकांश औद्योगिक कार्य करने के लिए पर्याप्त हैं।

K.7 ग्लोव बॉक्स अनुप्रयोग के लिए उपयुक्त, कॉम्पैक्ट इलेक्ट्रॉन वेल्डिंग मशीन का विकास करके उसका परिनियोजन किया गया है ।

प्रिय साथियों ,

हम अंतरिक्ष कार्यक्रम को अनेक क्षेत्रों में निरंतर सहयोग देते रहे हैं :

L.1 संवेदकों और संबद्ध घटकों का एक सेट, एसआरई-II स्पेसक्राफ्ट में लैंगमुईर प्रोब पेलोड में लांच करने के लिए इसरो को सौंप दिया गया। इन संवेदकों का प्रयोग प्लाज्मा के निदान के लिए किया जाएगा जो पुनः प्रविष्टि के दौरान उत्पन्न होती हैं और आरएफ ब्लैक आउट से जुड़े मुद्दों को सुलझाती हैं।

L.2 भापअ केंद्र ने 32m एन्टेना में परिशुद्ध सर्वो प्रणाली सहित मार्स ऑर्बिटर के लिए ट्रैकिंग प्रणाली को फाइन ट्यून करके मंगलयान कार्यक्रम में सहयोग दिया जिसे पूर्व में चंद्रयान मिशन के लिए विकसित किया गया था।

इस अवधि के दौरान, सामाजिक अनुप्रयोग के लिए चार नई प्रौद्योगिकियों का हस्तान्तरण संभव हो पाया।

M.1 भापअ केंद्र में विकसित, लीची संरक्षण संसाधन प्रौद्योगिकी, मडगासकर के अंतर्राष्ट्रीय ट्रेडिंग कंपनी को अंतरित की गई। फलों और सब्जियों के संसाधन के लिए भापअ केंद्र में एक स्वचालित फूट डिप उपचार मशीन (10 कि.ग्रा./घंटे की क्षमता) का अभिकल्पन और विकास किया गया।

M.2 NOx आधारित घाव की, ड्रेसिंग करने संबंधी प्रौद्योगिकी को सफलतापूर्वक उष्मायित करके तमिलनाडु में निजी पार्टी को अंतरित कर दिया गया । मनुष्य के मधुमेह संबंधी और दीर्घकालिक घावों का इलाज करते समय इस ड्रेसिंग को बहुत प्रभावी पाया गया।

M.3 वर्ष के दौरान चार पेटेन्टों के लिए अनुमोदन प्राप्त किए गए। "एक लचीली धात्विक झिल्ली आधारित एक्चुएशन प्रणालीयुक्त डिवाइसेज" के लिए एक यूरोपीय पेटेंट प्रदान किया गया है।

भापअ केंद्र के वैज्ञानिकों ने विभिन्न क्षेत्रों में लगातार अवार्ड प्राप्त किए। हम उनमें से कुछ का जिक्र यहां कर रहे हैं :

N.1 पहली बार ऐसा हुआ कि हमारे तीन युवा वैज्ञानिकों को 2014 INSA युवा वैज्ञानिक पुरस्कार के लिए चुना गया। पुरस्कार प्राप्त करने वालों के नाम इस प्रकार हैं; पदार्थ विज्ञान हेतु श्री मणि कृष्ण वेंकट कर्री (एमएसडी-एमजी), भौतिक विज्ञान के लिए श्री प्रकाश चंद्र राउत (एनपीडी-पीजी), जैविक विज्ञान के लिए डॉ आशीष कुमार श्रीवास्तव (एनएबीटीडी - बीएसजी)।

N.2 भापअ केंद्र पादप उत्परिवर्तन दल ने पादप उत्परिवर्तन प्रजनन में अपनी उपलब्धियों के लिए आईएईए-एफएओ पुरस्कार प्राप्त किया। वियेना में आईएईए के 2014 महासभा सप्ताह के दौरान इस पुरस्कार की घोषणा की गई और वहीं पर पुरस्कार दिया गया।

भापअ केंद्र के भिन्न भिन्न परिसरों में विभिन्न अवसंरचनात्मक सुविधाओं में सुधार के लिए लगातार प्रयास किए जा रहे हैं :

P.1 ट्रांबे हिल में स्थित 11KV सब-स्टेशनों की दो इकाइयों का नवीकरण, अत्याधुनिक उपस्कर जैसे SF_6 गैस से भरे हुए स्विच गियरों और ड्राइ टाइप ट्रांसफार्मरों, से कर दिया गया है ताकि ट्रांबे हिल में स्थित सुविधाओं में विद्युत आपूर्ति की जाए।

P.2 वाशी परिसर में स्थित बेरिलियम धातु संयंत्र में पीएलसी आधारित नियंत्रण सहित एक वीएफडी आधारित वातानुकूलित प्रणाली का कमीशनन किया गया।

P. 3 खारघर औषधालय को प्रचालनरत किया गया जिसमें अभी स्टाफ की संख्या सीमित है। मानवशक्ति की संस्वीकृति के बाद यह सुविधा पूर्ण रूप से क्रियात्मक हो जाएगी। अभी लगभग 6000 लाभार्थी इस सुविधा का लाभ उठा रहे हैं।

प्रिय साथियों,

विविध क्षेत्रों में प्राप्त उपलब्धियों पर हमें गर्व होना चाहिए। अब मैं बीएआरसी की कुछ प्रमुख उपलब्धियों का उल्लेख करूंगा जो विशाल समूहों के संगठित प्रयासों के कारण ही संभव हो पाया।

SP-1 अरिहंत के प्रोपेलर शाफ्ट को पहली बार 11 दिसंबर, 2013 को नाभिकीय वाष्प से घुमाया गया। बाद में, बंदरगाह पर किए जाने वाले ज्यादातर परीक्षण पूरे किए गए और अब यह पनडुब्बी समुद्री यात्रा के लिए तैयार हो रही है।

SP-2 पी-4 सुविधा में, अरिहंत के पुनर्भरण क्रोड पर शीत क्रांतिकता प्रयोग/कोल्ड क्रिटिकैलिटी एक्सपेरिमेन्ट पूरा किया गया और बाद में तप्त क्रांतिकता/हॉट क्रिटिकैलिटी और इससे संबंधित भौतिकी के प्रयोग भी किए गए। रंध्र बनाने की गतिविधियां पूरी करने के बाद, क्रोड अब शिपिंग के लिए तैयार है।

SP-3 पुनर्संसाधन सुविधाएं बहुत अच्छा कार्य निष्पादन करती रहीं तथा प्रीफ्रि- II ने, प्रचालन प्रारंभ होने से लेकर अब तक लगातार तीसरे वर्ष भी निर्धारित क्षमता से अधिक क्षमता पर कार्य किया। कार्प भी अच्छा काम कर रहा है तथा निर्धारित प्रचालन क्षमता के काफी नजदीक क्षमता पर प्रचालित हो रहा है।

SP-4 इस सफलता के परिणामस्वरूप मुझे यह घोषणा करते हुए गर्व हो रहा है कि हमने PFBR की क्रांतिकता के लिए आवश्यक सभी पिनों का उत्पादन कर लिया है। बेरिलियम ब्लाकों और डिलेड न्यूट्रॉन डिटेक्टर पिनों की भी आपूर्ति कर दी गई है। विकास-गतिविधियां पूरी करने के बाद, एक्टर नियंत्रण और मॉनिटरिंग के लिए न्यूट्रॉन संसूचकों/डिटेक्टरों का उत्पादन भी पूरा होने वाला है।

SP-5 WIP कलपाक्कम में, मध्यम स्तरीय अपशिष्ट पुनर्संसाधन सुविधा का प्रचालन जारी है और कार्प का एक टैंक खाली कर दिया गया है। कलपाक्कम में, कार्बनिक अपशिष्ट और रेजिन सीमेन्टेशन सुविधाओं का भी कमीशनन किया गया है। यूरेनियम पृथक्करण संयंत्र के साथ उच्च

स्तरीय अपशिष्ट संसाधन सुविधा (कांचीकरण को छोड़कर) का कमीशनन इसी सप्ताह किया गया। कांचीकरण सुविधा के अक्रिय/निष्क्रिय कमीशनन का कार्य कुछ समय पहले पूरा किया गया था।

SP-6 RLG में रेडियोसक्रिय प्रकोष्ठ सुविधा का तप्त कमीशनन कार्य पूरा किया गया। यह सुविधा, उच्चतर बर्न-अप की स्थिति में और बड़े आकार के ईंधन असेम्ब्लियों के किरणन पश्च परीक्षण करना संभव करेगा।

SP-7 मुझे यह घोषणा करते हुए प्रसन्नता हो रही है, कि कलपाक्कम में प्रगत उन्नयन सुविधा का नियमित रूप से प्रचालन किया जा रहा है, और सामग्री को परिवहन के लिए डिब्बे में बंद कर दिया गया है । संयंत्र ने अपने प्रचालन और फीड की उपलब्धता से MAPS रिएक्टर के प्रचालन की बराबरी कर ली है ।

SP-8 भारत ने अंतर्राष्ट्रीय परमाणु ऊर्जा एजेंसी केंद्र, वियना की महासभा में नाभिकीय अपशिष्ट प्रबंधन विषय पर वैज्ञानिक मंच में भाग लिया । हमने अपशिष्ट प्रबंधन के सभी मुद्दों का संपूर्ण समाधान प्रस्तुत करते हुए वहां एक स्टॉल लगाया था, जिसमें भुक्तशेष ईंधन भंडारण से लेकर, पुनर्संसाधन, ऐक्टिनाइड पृथक्करण, कांचीकरण, अंतरिम भंडारण और बाद में उसके निपटान तक की सुविधाओं का प्रदर्शन किया गया था । यह प्रदर्शनी देखने के लिए महासभा के दौरान लगभग 400 आगंतुक आए । इस क्षेत्र के अनेक विद्वान/जानकार, व्यवसायियों ने भारत के सर्वांगीण विकास की सराहना की ।

SP-9 हमारे प्रशिक्षण विद्यालय में प्रवेश हेतु प्रतिभाओं को आकर्षित करने के लिए किए गए विशेष प्रयासों के परिणामस्वरुप, एक लाख बीस हजार आवेदन पत्र प्राप्त हुए और बाद में BARC प्रशिक्षण विद्यालय के विभिन्न कैंपसों में, 258 प्रशिक्षुओं को भर्ती किया गया।

SP-10 ध्रुवा का प्रचालन 80MW की उच्चतम शक्ति पर लगातार होता रहा । इसे संभव बनाने के लिए, ध्रुवा रिएक्टर प्रचालकों (operators) तथा ईंधन संविरचन करने वालों (fuel fabricators) द्वारा किए गए प्रयास सराहनीय हैं।

SP-11 संवर्धित लिथियम धातु संयंत्र के तप्त कमीशनन का कार्य कल शुरू किया गया।

SP-12 इस सप्ताह, पीपी से अल्फा वाहक इंटरमीडिएट अपशिष्ट का अंतरण करके अतिरिक्त अपशिष्ट टैंक फार्म का भी तप्त कमीशनन शुरू किया गया।

SP-13 विकिरण औषध केंद्र, परेल में रोगियों की प्रतीक्षा अवधि 6 माह थी । इसे कम करने के लिए कार्यविधि में कुछ परिवर्तन करने के साथ-साथ, स्टाफ सदस्यों ने विशेष प्रयास किए । परिणामस्वरुप 6 महीनों की प्रतीक्षा अवधि, अब शून्य हो गई है। मैं मानता हूँ कि स्वास्थ्य देखभाल

क्षेत्र में उठाए गए हमारे कदमों में, यह एक बड़ी सफलता है।

हम देखते हैं कि हमारे देश में न केवल फल और सब्जियां मौसमी हैं बल्कि वैज्ञानिक और प्रौद्योगिकीय उपलब्धियां भी मौसमी हैं । प्रत्येक वर्ष, संस्थापक दिवस से चार महीने पूर्व, भापअ केंद्र में अधिकांश महत्वपूर्ण उपलब्धियां प्राप्त की जाती हैं।

प्रिय साथियों,

अंत में, मैं, प्रशासन, लेखा, स्वास्थ्य देखभाल, अग्निशमन सेवाओं, इंजीनियरी सेवाओं, सुरक्षा, एसोसिएशनों के मामलों और अन्य विभिन्न क्षेत्रों में हमारे साथियों द्वारा दिए गए उत्तम सहयोग की सराहना करता हूँ जिससे हमारी सारी प्रगति और उपलब्धियां संभव हुई हैं ।

अपनी बात समाप्त करने के पहले, मैं यह सूचित करना चाहता हूं, कि बीएआरसी परिवार राहत योजना के माध्यम से शोक संतप्त परिवार को दी जाने वाली सहयोग राशि एक लाख रूपए से बढ़ाकर एक लाख तीस हजार रूपए कर दी गयी है ।

अब तक हमने काफी उपलब्धियां हासिल की हैं, परन्तु हमारे अंदर, इससे और भी बेहतर कर सकने की संभावना है। हमें इस बात पर ध्यान देना है, कि हम अपने अनुसंधान एवं विकास के प्रयासों को, कैसे एक नई दिशा देकर, देश और समाज के लिए और उपयोगी बनाएं, ताकि हमारे प्रयासों का प्रत्यक्ष लाभ देश को मिल सके ।

धन्यवाद!"

Founder's Day 2014

Address by

Dr. Sekhar Basu
Director, BARC

"Dr. R.K. Sinha, Chairman, AEC, Senior Members of the DAE Family, Distinguished Invitees, Representatives from Media, my dear Colleagues and Friends, I extend warm welcome to all of you to this Founder's Day functions. Today, we will collectively pay respectful homage to our visionary Founder, Dr Homi Jehangir Bhabha, on his 105th birth anniversary. This year's Founder's Day is also very special for us, since our Department of Atomic Energy, founded on August 3rd, 1954 entered in to its Diamond Jubilee year. We have assembled here to reflect upon our performance and achievements in the past year, and rededicate ourselves to continue to make the best efforts in ensuring maximum benefit to the nation from nuclear science and technology and their multi-fold applications. To begin with, let me tell you, about the performance highlights, and some specific achievements of BARC during the last one year.

A.1 Two VVIPs visited BARC during this period. On November 15th, 2013 the Hon'ble President of India graced the Graduation Function of the 56th Batch of BARC Training School and later the Hon'ble Prime Minister of India visited BARC on July 21st, 2014 for first-hand familiarisation with DAE - BARC programmes and projects.

A.2 The year 2014 is a year of milestones for BARC. On August 18, 2014, the Golden Jubilee Celebration was held to commemorate the commissioning of Plutonium Plant (PP) and we completed 40 years since the first peaceful nuclear explosion on May 18, 1974 at Pokran. Dear Colleagues, BARC continued its support to NPCIL for continued operation of their reactors.

B.1 After performing inspection of welds in the upper region of Reactor Pressure Vessels of TAPS 1&2 a manipulator has been developed for core belt inspection.

B.2 Post Irradiation Examination (PIE) of pressure tube from Q-10 coolant channel of KAPS-2 reactor and garter springs were completed.

Today we are focusing our activities towards deploying the outputs of our R&D efforts in our high technology activities. I would tell you about some of them related to reactors.

C.1 PARTH, an integral test facility, set up jointly with NPCIL, simulating AHWR Heat Transport System, Steam and feed water system, Emergency core cooling system and associated controls has been commissioned for operation at low power.

C.2 A piping loop, with a notch machined on one of the highest stressed welds, was subjected to a shake-table test with increasing levels of acceleration. The piping could withstand 40 events of Safe Shutdown Earthquake level. I am glad to announce that this test has been chosen by OECD/NEA as a benchmark exercise in the framework of the Metallic Component Margins under High Seismic loads (MECOS) project.

C.3 The first version of the molten fuel - coolant interaction code, PINAK, has been jointly developed by BARC and Neptune Laboratory, Jadavpur University. The code addresses issues related to the effect of single channel failure on the other channels under accident conditions for PHWRs.

C.4 Palladium-platinum catalyst panels, developed for hydrogen mitigation under severe reactor accidents, were tested at Hydrogen Recombiner Test Facility of NPCIL. The H2 removal rate is on par with that of the commercial catalyst from Europe.

C.5 For prompt detection and identification of earthquakes that could be tsunamigenic, a software has been developed and system has been installed at the data centers to monitor earthquakes in Andaman, Nicobar and Sumatra Regions of Indian Ocean / Bay of Bengal.

C.6 Public dose assessment from the proposed projects of NPCIL at Jaitapur, Gorakhpur, Chutka and Mithi Virdi, have been carried out. Public dose assessment for reactors and other facilities at Vizag was also completed.

C.7 Commissioning of Large Pool Fire Test Facility (4m x 4m) at Jain-University, Bangalore was completed. Most of the transportation packages used in our country can be certified by using this facility. Dear Colleagues, Our back end facilities continued to perform well.

D.1 Advanced Vitrification System (AVS) at Tarapur achieved the milestone of producing 150 VWP canisters (16 Te) within two years of operation.

D.2 Since its hot commissioning, Actinide Separation Demonstration Facility (ASDF) at Tarapur is being run regularly in campaign mode as per the requirement of the users.

D.3 One full tank containing ILW at PP was treated during this year. Technology development in the following areas will boost the back end activities:-

E.1 Two types of under-water manipulators of 9 kg and 25 kg payload capacities have been supplied to the reprocessing plants at Tarapur and Kalpakkam for under water handling trials of spent fuel bundles.

E.2 An efficient air-plasma-torch, using ambient air as plasma gas, hafnium electrodes, producing a long jet, high temperature (~80000C) plasma at 30 kW power has been developed for the first time. This is being installed at the radioactive waste incinerator of Nuclear Recycle Group.

E.3 A highly sensitive method, called Differential Die Away technique, of detecting fissile material in waste drum and hull has been developed. Using a pulsed neutron source, 500mg of Pu could be detected in 150 kg of Zircaloy hull in the presence of active gamma and neutron background.

We have seen some important developments in the field of High Energy Physics.

F.1 MACE, India's largest telescope (21 M dia) for Gamma Ray astronomy, completed trials at ECIL Hyderabad. It is now being shifted to Hanle in Ladakh for installation.

F.2 The Imaging beamline at Indus-2 synchrotron, which is a micro-imaging facility for material and bio-medical research, has been commissioned.

F.3 The Infra-red beamline at Indus-1 synchrotron has also been commissioned for materials science studies.

F.4 50 RPCs and 200 Cooling panels made at BARC were installed and commissioned in May 2014 at Large Hadron Collider (LHC), CERN in Compact Muon Solenoid (CMS) experiment which is getting ready for the collisions at 14 TeV from 2015. Significant progress was also made in the data processing and networking field both in software and hardware.

G.1 A new parallel processing supercomputer, ANUPAM-Aggra with peak performance of 150 Teraflops and sustained performance of 109 Teraflops has been commissioned.

G.2 A cloud computing service named "Megh" has been developed to provide computing infrastructure to BARC Intranet users. It has 1024 computing cores, 4 Terabytes of RAM and 128 terabytes of disk space. Using this service, users can create servers on demand according to their requirements.

G.3 A new projector based seamless tiled display has been developed for graphics data visualization. This

system consists of 9 LCD projectors arranged in a 3x3 tiled fashion, projecting their images on a screen. Absence of seams between individual screens gives smooth break-free images. The new display system also has the ability to display graphics content in 3-D using Active Stereoscopic glasses.

G.4 Software named "MARG DARSHAK" has been developed which provides a 3-D walkthrough model of buildings. It is useful for training of security personnel and response forces for protecting vital installations.

G.5 As part of ongoing collaboration with ECIL to develop & deploy, secure, indigenous network components, ECR series routers have been successfully integrated in NKN network and in MTNL's commercial network. A pilot video surveillance system based on these routers was also integrated. Dear Colleagues, We continued to contribute in multiple areas of defence applications.

H.1 Nine types of process sensors required by the compact LWR propulsion plant have been successfully indigenized and technology transferred to ECIL.

H.2 Nuclear Instrumentation and radiation monitoring systems were designed, developed and commissioned at P4 for Cold and Hot criticality experiments. Gamma scanning machine developed in BARC was used for scanning fuel bundles, for post irradiation burn-up studies, isotopic analysis and quantitative measurements.

H.3 In-house developed high neutron sensitivity Helium-3 detectors have been used to monitor the reactor core neutron flux in P4 hot facility.

H.4 Under the collaborative programmes with ECIL for development of strategic electronics technologies for defence, three stabilization and tracking servo systems were delivered to ECIL for further integration. These include:

- - 0.45 metre dia SATCOM terminal for onboard deployment in Indian Airborne Early Warning System (AEWS) of DRDO
- - Two axis gimbaled X-band Seeker for Brahmos missile
- - 0.73 metre SATCOM terminal for on-board deployment in Rustum Unmanned Aerial Vehicle (UAV) for DRDO.

H.5 Operational Nuclear Nomograms have been designed, developed and implemented on a Rugged Tablet PC, as a hand-held tool for training and use by the Defence Forces to assess the impact of a nuclear strike. In the field of fuel fabrication, development took place in the following areas:

J.1 A Glove Box set-up has been made ready for fabrication of Mechanically Bonded Metallic fuel pin for irradiation testing at FBTR.

J.2 Up-gradation of Metal Reduction Technology & Effluent Handling Facility has been commissioned for production of nuclear grade Ammonium Diuranate (ADU) for utilization of the U-scrap generated during fuel fabrication.

J.3 To increase the available reactivity in Dhruva reactor modified fuel clusters with two different Uranium loadings were fabricated and are being irradiated.

J.4 As a part of our technology development for thorium based fuels, irradiation of (Th-Pu) MOX fuel assembly to a burn-up of 20 GWD/Te was completed successfully at DHRUVA and a new (Th-LEU) MOX assembly was installed in pile. Now, I would like to tell you about some more areas, where our technology development efforts were successful.

K.1 An indigenously developed mine Ventilation Control System operating through feedback of real time levels of radon and noxious gases, has been installed at Underground Uranium Mine, Turamdih.

K.2 Our efforts towards the purification of germanium have reached 8N level of purity and 2 kg material was delivered for detector development.

K.3 Design and development of a 1.7 Tesla Electromagnet and its power supply for corrosion loop experiments for ITER-TBM was completed and magnet was delivered to IPR, Gandhinagar.

K.4 BARC has developed an online steam turbine blade vibration monitoring system. In April 2014, NTPC was able to predict blade failure in Tanda power plant in UP using this portable system.

K.5 An atomic magnetometer cum atomic clock, a first-of-its-kind, has been developed. While providing an atomic frequency standard with stability of about ~10-9, it can simultaneously measure ultra-low magnetic fields with pico-tesla sensitivity.

K.6 Two units of electromagnetic manufacturing machine of 40 kJ capacities, which is sufficient for most of the industrial jobs, have been built under a technology transfer to ECIL.

K.7 A compact electron welding machine suitable for glove box application has been developed and deployed. Dear Colleagues, We continued to support the space programme in many areas:

L.1 A set of sensors and associated components have been delivered to ISRO for launching in the Langmuir probe payload, in SRE-II spacecraft. These sensors will be used for diagnostics of the plasma that is generated during re-entry and resolve the issues related to RF blackout.

L.2 BARC supported the Mangalyaan programme by fine tuning the tracking system for the Mars Orbiter with precision servo system in 32m antenna developed earlier for Chandrayaan mission. During this period it was possible to transfer four new technologies for societal application:-

M.1 Litchi preservation processing technology developed at BARC was transferred to an international trading company in Madagascar. An automatic fruit dip treatment machine (10 kg/h capacity) was designed and developed at BARC for processing fruits and vegetables.

M.2 The technology of NOx based wound dressing was successfully incubated and transferred to a private party in Tamilnadu. The dressing was found to be very effective in managing diabetic and chronic wounds in human trials.

M.3 Four patent approvals were received during the year. An European patent has been granted for "A Flexible Magnetic Membrane based Actuation System and Devices involving the same".

BARC scientists continue to get award in diverse fields. We may note a few of them:-

N.1 Three of our young scientists have been selected for the 2014 INSA Young Scientist Award, a first-time event. The awardees are; Shri Mani Krishna Venkata Karri (MSD-MG) for material science; Shri Prakash Chandra Rout (NPD-PG) for Physical Science; Dr Ashish Kumar Srivastava (NABTD-BSG) for Biological Science.

N.2 BARC plant breeding team bagged the IAEA-FAO Award for their achievements in plant mutation breeding; this award was announced and given during the 2014 General Conference week of the IAEA in Vienna. Continuous efforts are being made to improve various infrastructural facilities in various BARC campuses:-

P.1 Two units of 11 KV Sub-Stations at Trombay Hill have been renovated with the state-of-the-art equipment like, SF6 gas filled Switch Gears and dry type Transformers, to feed power supply to facilities located at Trombay Hill.

P.2 A VFD-based ventilation system, including PLC based control, was commissioned in Beryllium Metal Plant at Vashi Complex.

P.3 Kharghar dispensary was made operational with limited staff. The facility will be fully functional after manpower is sanctioned. About 6000 beneficiaries are making use of the facility. Dear Colleagues, This list of achievements mentioned so far in diverse fields, is something we should be proud of. Now I would like to mention some major achievements of BARC which were possible only because of concentrated efforts by large groups.

SP-1 Propeller shaft of Arihant was rotated for the first time with nuclear steam on 11.12.13 i.e. December 11, 2013. Subsequently most harbour trials have been completed and the vessel is getting ready for sea voyage.

SP-2 Cold criticality experiment on reload core of Arihant was completed at P4 facility, and later, hot criticality and associated physics experiments, were also carried out. After completion of orificing activities, the core is now ready for shipping.

SP-3 Reprocessing facilities continued to perform very well and PREFRE-II exceeded the rated capacity in the third consecutive year since the beginning of operations. KARP also is working well and operating near rated capacity.

SP-4 As a result of this success I am proud to announce that we have been able to produce all the pins necessary for criticality of PFBR. Beryllium blocks and delayed neutron detector pins have also been supplied. After completion of development activity, production of neutron detectors for reactor control and monitoring, is nearing completion.

SP-5 Intermediate level waste processing facility operation continues at WIP Kalpakkam and one tank of KARP has been emptied. Organic waste and resin cementation facilities have also been commissioned at Kalpakkam. I am happy to announce that high level waste processing facility (excluding vitrification) along with uranium separation plant was hot commissioned this week. Inactive commissioning of vitrification facility was completed sometime back.

SP-6 Hot commissioning of new hot cell facility at RLG has been completed. This facility, will make it possible to do the Post Irradiation Examination of larger size fuel assemblies subjected to higher burn-up.

SP-7 I am glad to announce that advanced heavy water up-gradation facility at Kalpakkam, is being operated regularly and the plant has matched its operation with MAPS reactor operation and availability of feed.

SP-8 During the General Conference at IAEA, Vienna; India participated in scientific forum on nuclear waste management. We had put up a stall exhibiting the facilities, for total solution to waste management issues, starting with spent fuel storage, reprocessing, actinide separation, vitrification, interim storage and subsequent disposal. The exhibition attracted over 400 visitors during the General Conference. The all round development in India in this field, drew appreciation, from many knowledgeable professionals.

SP-9 Extra efforts for induction of talents in our Training School resulted in 1.2 lakh applications and subsequent recruitment of 258 Trainees in various campuses of BARC Training School.

SP-10 Starting from the beginning of this year, Dhruva continued to operate at peak power of 80 MW. The effort made by the Dhruva operators and the fuel fabricators for making this happen is commendable.

SP-11 Hot commissioning of augmented Lithium Metal Plant was started yesterday.

SP-12 This week, the hot commissioning of Additional Waste Tank Farm was also started with the transfer of Alfa bearing intermediate waste from PP.

SP-13 The waiting period for patients at Radiation Medicine Centre, Parel was brought down from 6 months to zero, by some procedural changes and extra efforts on the part of their staff members. I consider this as a major success in our initiatives in healthcare sector. We observe that not only fruits and vegetables are seasonal but scientific and technological achievements are also seasonal in our country. Every year in four months preceding the Founder's Day most major milestones are achieved in BARC. Dear Colleagues, In the end I must appreciate the excellent support from our colleagues in administration, accounts, health care, fire services, engineering services, security, association matters, and several other areas, that made all our progress and achievements possible.

Before concluding I wish to inform that the BARC Family Relief Scheme support to the bereaved family is being increased from Rs.1 lakh to Rs.1.3 lakh. So far we have achieved a lot, but we have the potential for much more. We have to re-orient ourselves and concentrate on converting our R&D efforts towards the deliverables for the benefit of our nation.

Thank you."

26th All India Essay Writing Contest

The 26th All India Essay Contest on Nuclear Science and Technology was held in October 2014. The three topics for the essay were:

Topic 1 - The Future of Nuclear Power – An Approach to Sustainable Development

Topic 2 - Emerging Trends and Applications of Radioisotopes and Radiation Techniques for Societal Benefits

Topic 3 - Accelerators in Nuclear Programme: Energy Security and Societal Applications

In all 270 essays were received in five languages i.e Hindi, English, Marathi, Bengali and Tamil. Authors of 29 essays were invited to Mumbai (October 21 – 31) to make the oral presentation before the respective panel of judges and only 24 of them came to Mumbai for the oral presentation. During their stay at Mumbai, the students were shown various facilities like BARC, BRIT, Vashi, ACTREC,Kharghar, Electron Beam Centre, Kharghar and TAPS 3&4, Tarapur.

The oral presentations were made on October 29 at DAE, OYC. The first three prize winners in each topic are as follows:

Topic [1] - The Future of Nuclear Power – An Approach to Sustainable Development

I Prize winner:

Name of Student	Student of	Place	Language
Mr. Prashant S. Bhide	B.E (Mech.) 2nd year	Pune	Marathi

II Prize winner:

Name of Student	Student of	Place	Language
Ms.. Jerusha S.	B.Sc. 3rd year	Toothukudi TN	English

III Prize winner:

Name of Student	Student of	Place	Language
Mr. Azad Hind Gulshan Nanda	B.Sc. 3rd year	Patna	English

Topic [2] - Emerging Trends and Applications of Radioisotopes and Radiation Techniques for Societal Benefits

I Prize winner:

Name of Student	Student of	Place	Language
Ms. Riviresa Mahata	B.E (Mech.) 3rd year	Navi Mumbai	English

II Prize winner:

Name of Student	Student of	Place	Language
Mr. Rajesh Debnath	B.Sc. (Agri) 2nd year	Tiruchirapalli	English

III Prize winner:

Name of Student	Student of	Place	Language
Mr. K.K. Someshwar	Pharma D. 5th year	Chitradurga, Karnataka	English

Topic [3] - Accelerators in Nuclear Programme: Energy Security and Societal ApplicationsI Prize winner:

Name of Student	Student of	Place	Language
Ms. Krishnaveni	B.Sc. (Chem.) 2nd year	Kovilpatti, TN	English

II Prize winner:

Name of Student	Student of	Place	Language
Mr. Tushar Tayade	B.E. (Mech.) 2nd year	Pune	English

III Prize winner:

Name of Student	Student of	Place	Language
Ms. R. Gayathri	B.Sc. (Phy.) 2nd year	Chennai	English
Ms. P. Shiva	BTDC 3rd year	Khammam, AP	English

The rest of the students were awarded Consolation Prizes. The prizes were distributed by Dr R K Sinha, Chairman, AEC on Founder's Day, at BARC.

Industrial Safety Awards 2013

As part of safety promotional activities, Industrial Hygiene and Safety Section of HS&EG, BARC has introduced an Industrial Safety Award Scheme in the form of Director's Safety Shield on rotation, for BARC units.

The entries from the various Divisions/Sections/ Units of BARC for the year 2013 were invited from three different categories of units/facilities, namely,

A: Operating Plants
B: R&D Labs and Industrial Units
C: Engineering, Projects and Support Units

A thorough scrutiny of the entries were made and a comparative study of all the entries in each category was carried out based on the different parameters in respect of Safety Statistics and Safety Management Indicators including that of training and motivational efforts.

During the Founder's Day Programme held at the Central Complex Auditorium, BARC on 30.10.2014, Shri S.G. Markandeya, Chairman, CFSRC and Chairman, Industrial Safety Award Scheme Committee announced the winning units for the year 2013. The winning units are:

A: Operating Plants [Joint-winners]	(i) Kalpakkam Reprocessing Plant
	(ii) Tarapur Reprocessing Plant (PREFRE-I, PREFRE-II, AWTF, SFSF), NRB
C: Engineering, Projects and Support Units	Integrated Nuclear Recycle Project Construction (INRPC), NRB, Tarapur

Representatives from the respective units received the shield at the hands of Shri Sekhar Basu, Director, BARC. The award comprised one Rotating Shield and a small replica for retention by the respective winning unit.

Shri S. Pradhan, Chief Superintendent, TNRPO, and Shri Hemant Kumar, Safety Coordinator, TRP and Shri B. Shreekumar, Plant Superintendent, and Shri N.S. Vivekanandan, Safety Coordinator, KARP jointly received the award in Category A - Operating Plants.

On behalf of Integrated Nuclear Recycle Project Construction (INRPC), NRB, Tarapur Shri D.A.S. Rao, Project Director, INRPC and Shri M. Domesa, Safety Coordinator, INRPC, Tarapur received the award in Category – C Engineering, Projects and Support Units.

Category A: Operating Plants [Joint winners]:
(i) Kalpakkam Reprocessing Plant &
(ii) Tarapur Reprocessing Plant

Shri Sekhar Basu, Director, BARC giving away the Safety Shield to Shri B. Shreekumar, Plant Superintendent, KARP and Shri S. Pradhan, Chief Superintendent, TNRPO accompanied by Shri Hemant Kumar, Safety Coordinator, TRP and Shri N.S. Vivekanandan, Safety Coordinator, KARP

Category C: Engineering, Projects and Support Units:
Integrated Nuclear Recycle Project Construction (INRPC), NRB, Tarapur

Shri Sekhar Basu, Director, BARC giving away the Safety Shield to Shri D.A.S. Rao, Project Director, INRPC, NRB, Tarapur, and Shri M. Domesa, Safety Coordinator, INRPC, Tarapur.

Release of the Founder's Day Special Issue of the BARC Newsletter

The CD of the Founder's Day Special Issue of the BARC Newsletter was released by Director, BARC on 30th October, 2014. This year, the Special issue carried 60 Award winning Papers; 40 papers on the DAE Excellence in Science, Engineering & Technology Awards for the year 2012 and 20 papers on Merit Awards received by BARC Scientists & Engineers in 2013. Out of the 40 DAE Award Papers, 8 papers were from Homi Bhabha Science & Technology Award winners, 14 from Scientific & Technical Excellence Award winners, 3 from Young Applied Scientist/Technologist Award winners, 7 from Young Engineer Award winners, 3 from Young Scientist Award winners and 6 from Group Achievement Award winners. The 20 Merit Awardees received Awards and Honours at various national and international seminars, symposia and conferences held in 2013. As with the regular issues of the BARC Newsletter, the Founder's Day Special Issue can be accessed through BTS and Lakshya portals and through the BARC website.

Dr. Sekhar Basu, (Second from left) Director, BARC releasing the Founder's Day Special Issue of the BARC Newsletter. (from left to right: Shri H. Mishra, Controller, BARC, Dr. Sekhar Basu, Director BARC, Dr. R.K. Sinha, Chairman, AEC, Shri S.G. Markendeya, OSD, BRNS and Shri R.C. Sharma, Director, RG.)

DAE (Excellence in Science, Engineering & Technology) Awards 2013

The DAE awards scheme was instituted in the year 2006 to recognize outstanding accomplishments and exceptional achievements of the DAE staff, who are engaged in scientific research, technology development, engineering /project implementation, teaching, healthcare and support services.

These awards are given annually.

The awards for the year 2013 were given on the eve of Founder's Day on October 30, 2014 in BARC. These were presented to the winners by the Chief Guest, Prof. V.S. Ramamurthy, Director, National Institute of Advanced Studies, Bengaluru & Chairman, Recruitment & Assessment Board, Council of Scientific and Industrial Research.

The Awards were in the following categories:

A. Homi Bhabha Science & Technology Awards
B. Exceptional Service Awards
C. Scientific & Technical Excellence Awards
D. Young Applied Scientist / Technologist Awards
E. Young Scientist Awards
F. Young Engineer Awards
G. Special Contributions Awards
H. Meritorious Technical Service Awards
I. Group Achievement Awards
J. Special Contributions Awards
K. Meritorious Service Awards

A. Homi Bhabha Science & Technology Award carries a Cash award of Rs 5 Lakhs, a Citation and a Medal.

There were Eight award winners: Five from BARC and one each from AMD, IGCAR and NFC. Following were he award winners from BARC:

1. Dr. T.K. Ghanty , SO/H, TCS, CG, BARC

Dr Ghanty has been awarded for his outstanding research contributions in the field of "Computational & Theoretical Chemistry". His main contributions include:

Prediction of novel rare gas containing ions involving partially covalent bond between a rare gas and other atom which was later experimentally observed by researchers abroad in the year 2011.; Introduction of a new concept, "Intra-ligand Synergism" and demonstration of the concept for designing actinide selective novel ligands and Demonstration of a novel scheme, through which smaller size fullerenes can be stabilized by encapsulation of an actinide or lanthanide metal atom/ion and these metallofullerenes have potential applications in nuclear medicine and waste management.

Dr. T.K. Ghanty receiving the Homi Bhabha Science & Technology Award from Prof.V.S.Ramamurthy, Director, National Institute of Advanced Studies, Bangalore & Chairman, Recruitment & Assessment Board, Council of Scientific and Industrial Research.

2. Dr. T.C. Kaushik, SO/H+APD, MRG, BARC

Dr. Kaushik has been awarded for his outstanding contributions in the "Development of Pulsed Power based systems for applications to material

investigations under high pressures". His developments include: Electrically exploded foil based electric guns, Rail guns and Ultra high magnetic field coils. In addition he has also developed Inductive energy based systems to amplify input current by a factor of more than 50 for applications to deliver high current pulses. Pulsed Fusion based devices have also been demonstrated by him for use in assay of fissile materials.

Dr. T.C. Kaushik receiving the Homi BhabhaScience & Technology Award from Prof.V.S.Ramamurthy, Director, National Institute of Advanced Studies, Bangalore & Chairman, Recruitment & Assessment Board, Council of Scientific and Industrial Research.

3. Dr. Hari Sharan Misra, SO/G MBD, BSG, BARC

Dr Misra has been awarded for his outstanding research contributions in understanding the molecular mechanism underlying biological responses to gamma radiation effects on life. He identified a novel antioxidant and radioprotector pyrroloquinoline-quinone (PQQ) from the radioresistant bacterium, Deinococcus radiodurans and demonstrated that it induces differential cytotoxicity between cancerous and normal cells.

He is peer recognized as the invited speaker/Chair during various meetings held in India and abroad and recipient of several national awards and a recipient of International fellowship "Fulbright-Nehru Senior Scholarship".

Dr. Hari Sharan Misra receiving the Homi BhabhaScience & Technology Award from Prof.V.S.Ramamurthy, Director, National Institute of Advanced Studies, Bangalore & Chairman, Recruitment & Assessment Board, Council of Scientific and Industrial Research.

4. Dr. (Smt.) S.B. Roy, OS UED, MG, BARC

Dr. Roy has been awarded for her excellent and comprehensive contributions in "Setting up the required facilities for production of U metal to meet the requirement of Indian research rectors and various strategic programmes".

Her work on process development for production of specific grade uranium metal powder and specific grade metal ingot including facility development for production of specific grade uranium metal powder is commendable.

Dr.(Smt.) S.B. Roy receiving the Homi Bhabha Science & Technology Award from Prof.V.S.Ramamurthy, Director, National Institute of Advanced Studies, Bangalore & Chairman, Recruitment & Assessment Board, Council of Scientific and Industrial Research.

5. Shri Joti Nath Sharma, SO/G, PsDD, NRG, BARC

Shri Sharma has been awarded for his excellent research contributions in the area of "Synthesis and Development of Organic Solvents for separation processes of nuclear metals".

He has synthesized cesium specific solvent Calix-Crown-6 (CC6) indigenously at large scale.

Based on his work, an engineering scale facility was set up for treating HLW where cesium using calix-crown-6 solvent and americium and strontium using TEHDGA solvent will be separated. Separation of these elements from HLW, results in about 30 fold reduction in the vitrified glass volume.

Shri Joti Nath Sharma receiving the Homi Bhabha Science & Technology Award from Prof.V.S.Ramamurthy, Director, National Institute of Advanced Studies, Bangalore & Chairman, Recruitment & Assessment Board, Council of Scientific and Industrial Research.

B. Exceptional Service Award carries a Cash award of Rs 5 Lakhs, a Citation & a Medal.

Shri K.N. Mahule, Head, ED&DD, MRG, BARC was the only recipient of this Award. Shri Mahule has been awarded for his excellent contributions in the areas of "Nuclear fuels fabrication, transportation of nuclear materials, and strategic programmes of the department".

His contributions include design and commissioning of FBTR fuel fabrication facility and production campaign, design and development of equipment and facilities for plate type fuel, metallic fuels for fast reactors, sol-gel based fuel and development of fully automated fuel fabrication facility.He also actively contributed in setting up pilot scale alpha solid waste treatment facility, and design and fabrication of transport packages for nuclear materials.

C. Scientific & Technical Excellence Award carries a Cash award of Rs 1 Lakh, a Citation and a Medal.

There were Twenty seven award winners: Twenty two from BARC, two each from IGCAR and RRCAT and one from VECC. Following were the award winners from BARC:

1. Dr. Prashant Shukla, SO/G, NPD, PG, BARC
2. Shri Sudhir Mishra, SO/G, RMD, NFG, BARC
3. Shri Vivek Bhardwaj, SO/E, A&CED, ESG, BARC
4. Shri M. Thakuria, SO/F, LWRD, RPG, BARC
5. Shri Raman Kumar, SO/F, NRPSED, NRB, BARC
6. Dr. (Smt.) Dipanwita Dutta, SO/F, NPD, PG, BARC
7. Shri S.K. Sinha, SO/H, RED, RD&DG, BARC
8. Dr. Sudipta Chakraborti, SO/F, IA&RD, RC&IG, BARC
9. Dr. Chiranjib Majumder, SO/G, ChD, CG, BARC
10. Dr. G. Kedarnath, SO/F, ChD, CG, BARC
11. Shri A.K. Haruray, SO/H, DRHR, DM&AG
12. Dr. (Smt.) P.M. Dighe, SO/F, ED, E&IG, BARC
13. Shri Clement C. Verghese, SO/H, RCnD, E&IG, BARC
14. Dr. Sunil Dutt Sharma, SO/F, RP&AD, HS&EG, BARC
15. Dr. Abhijit Ghosh, SO/G, G&AMD, MG, BARC
16. Dr. K.D. Joshi, SO/G, APD, MRG, BARC
17. Dr. Manoj Kumar Warrier, SO/F, CAD, MRG, BARC
18. Dr. Aniruddha Kumar, SO/G, AFFF, Tarapur, NFG, BARC
19. Dr. Kathi Sudarshan, SO/F, RCD, RC&IG, BARC
20. Shri Vishnu Verma, SO/G, RSD, RD&DG, BARC
21. Dr. Usha Pal, SO/G, RPDD, RD&DG, BARC
22. Shri B.S. Manjunath, SO/G, RTD, RD&DG, BARC

D. Young Applied Scientist / Technologist Award carries a Cash award of Rs 50,000/-, a Citation and a Medal.

There were Eleven award winners: Eight from BARC and three from IGCAR. Following were the award winners from BARC:

1. Shri R.D. Phulsundar, SO/E, ChTG, RMP/BARC
2. Shri Tushar Roy, SO/E, NXPD, PG, BARC
3. Shri Abhijit R. Tillu, SO/E, APPD, BTDG, BARC
4. Shri Jyoti Prakash SO/D, PMD, MG, BARC
5. Shri Shivam Mishra, SO/E, PED, ChTG, BARC
6. Smt. Chandrani Bhattacharya, SO/E, ThPD, MRG, BARC
7. Shri Amit Verma, SO/E, MMD, MG, BARC
8. Shri Kodeboina Rajendra Babu, SO/E, TPD, PG, BARC

E. Young Scientist Award carries a Cash award of Rs 50,000/-, a Citation and a Medal.

There were seven award winners: six from BARC and 1 from VECC. Following were the award winners from BARC:

1. Dr. Prabhat Kumar Singh, SO/E, RPCD, CG, BARC
2. Dr. Ashish Kumar Srivastava, SO/E, NABTD, BMG, BARC
3. Dr. Manoj Mohapatra, SO/E, RCD, RC&IG, BARC
4. Dr. Rahul Checker, SO/E, RB&HSD, BSG, BARC
5. Dr. Veerendra Kumar Sharma, SO/D, SSPD, PG, BARC
6. Dr. Jitendra Bahadur, SO/E, SSPD, PG, BARC

F. Young Engineer Award carries a Cash award of Rs 50,000/-, Citation and a Medal.

There were seventeen award winners: nine from BARC, four from IGCAR, three from RRCAT and one from NFC. Following were the award winners from BARC:

1. Shri Dev Ranjan Das, SO/E, L&PTD, BTDG, BARC
2. Shri Surendra Singh Saini, SO/D, DRHR, DM&AG, BARC
3. Shri Nagaraj Alangi, SO/E, L&PTD, BTDG, BARC
4. Shri Ankur Patel, SO/E, APPD, BTDG, BARC
5. Shri Ravindra K Sharma, SO/E, ATSS, E&IG, BARC
6. Shri Piyush Jain, SO/E, IADD, PG, BARC
7. Shri Ashish A. Dike, SO/E, LWRD, RPG, BARC
8. Shri Sanjay Kumar, SO/E, RPD, RPG, BARC
9. Shri M.T. Kamble, SO/F, RED, RD&DG, BARC

G. Special Contributions Award carries a Cash award of Rs 50,000/-, Citation and a Medal.

There were 68 Award winners in this category.

1. Dr. V. Natarajan,SO/H+, RCD,RC&IG,BARC
2. Shri Anand Mohan, SO/H, AFD, NFG, BARC
3. Dr. S.K. Thulasidas, SO/G, RCD, RC&IG, BARC
4. Shri V.M. Chavan, SO/G, RTD, RD&DG, BARC
5. Shri S.D. Bharambe, SO/G, IHSS, HS&EG, BARC
6. Shri A.P. Rao, SO/G, LWRD, RPG, BARC
7. Shri K.C. Krishnamurthy, SO/G, PRPD, RPG, BARC
8. Shri K. Premsai, SO/G, PRPD, RPG, BARC
9. Shri P.S. Kutty, SO/G, RMD, NFG, BARC
10. Shri D.K. Das, SO/G, AFFF, NFG, BARC
11. Dr. P.B. Wagh, SO/F, APD, MRG, BARC
12. Shri K.K. Srivastava, SO/F, TRP, NRB, BARC
13. Shri Sunil Gulati, SO/F, TRP, NRB, BARC
14. Dr. (Smt.) Sumita Saha, SO/F, RPD, RPG, BARC
15. Shri R. Ramakrishnan, SO/F, PRPD, RPG, BARC
16. Dr. R.M. Altekar, SO/F, MFD, NFG, BARC
17. Shri Gorakh Nath, SO/F, AFFF, NFG, BARC
18. Dr. A. Chandrashekara, SO/E, RMP, ChTG, BARC
19. Dr. S.K. Rakshit, SO/E, PDD, RC&IG, BARC
20. Shri A.P. Sahu, SO/E, TRP, NRB, BARC
21. Shri T.V. Vittalrao, SO/E, FCD, RC&IG, BARC
22. Shri Y.R. Bamankar, SO/E, FCD, RC&IG, BARC
23. Shri Ramesh R. Khuspe, SO/E, RSSD, HS&EG, BARC
24. Shri M.B. Pote, SO/E, RSSD, HS&EG, BARC
25. Shri S. Chinnaesakki, SO/E, HPD, HS&EG, BARC
26. Shri I.A. Sarjekhan, SO/E, RMD, NFG, BARC
27. Shri C.N.S.R. Prasad, SO/D, RMP, ChTG, BARC
28. Shri L.C. Sagayaraj, SO/D, PRPDR, PG, BARC
29. Shri Abhishek K. Singh, SO/D, RP&AD, HS&EG, BARC

30. Shri D.B. Kulkarni, SO/D, RP&AD, HS&EG, BARC
31. Shri Sanjay Singh, SO/D, RSSD, HS&EG, BARC
32. Shri P. Mathew, SO/D, HPD, HS&EG, BARC
33. Smt S.K. Raut, SO/C, PDD, RC&IG, BARC
34. Smt N.V. Jisha, SO/C, ED&DD, MRG, BARC
35. Shri Surendra Kumar, SO/C, MFD, NFG, BARC
36. Shri T. Mukundan, TO/C, RSSD, HS&EG, BARC
37. Shri P.T. Ghare, TO/C, RSSD, HS&EG, BARC
38. Shri Sanjeev Singh, TO/C, WMD, NRG, BARC
39. Shri Vinod Kumar Verma, TO/C, MFD, NFG, BARC
40. Shri E. Ravindran, Sr.PS, Director's Office, BARC
41. Shri S.V. Mane, Sr.T/H, CDM, DM&AG, BARC
42. Shri V.N. Mane, Sr.T/H, CDM, DM&AG, BARC
43. Shri R.J. Vankudre, Sr.T/H, CDM, DM&AG, BARC
44. Shri P.M. Koli, Sr.Tech, PDD, RC&IG, BARC
45. Shri B.N. Raut, Sr. Tech, PDD, RC&IG, BARC
46. Shri I.B. Patrick, SA/E, FRD, NRG, BARC
47. Shri Sanjay V. Vanave, SA/E, HPD, HS&EG, BARC
48. Shri Kiran Govind Kate, SA/E, PDD, RC&IG, BARC
49. Shri Vikram M. Joshi, SA/E, HPD, HS&EG, BARC
50. Shri Anjan Kumar Singh, SA/E, RSSD, HS&EG, BARC
51. Shri S.B. Dogra, SA/E, RSSD, HS&EG, BARC
52. Shri Nitin V. Choughule, SA/E, IHSS, BARC
53. Shri J.L. Sharma, SA/D, PDD, RC&IG, BARC
54. Shri Mukesh M. Uke, SA/D, RP&AD, HS&EG, BARC
55. Shri Vinod Kumar Joshi, SA/D, RP&AD, HS&EG, BARC
56. Shri Vinay S. More, SA/D, RP&AD, HS&EG, BARC
57. Shri N. Sebastian, SA/D, PDD, RC&IG, BARC
58. Shri N. Selvamani, SA/D, RSSD, HS&EG, BARC
59. Shri M.G. Reddy, SA/C, PDD, RC&IG, BARC
60. Smt. H.V. Khadilkar, SA/C, PDD, RC&IG, BARC
61. Shri A.G. Desai, SA/C, ED&DD, MRG, BARC
62. Shri C.B. Dusane, SA/C, EMAS, BARC
63. Shri K.R. Rathish, SA/C, RSSD, HS&EG, BARC
64. Shri G. Yesu Rathnam, Steno, Director's Office, BARC
65. Shri A.P. Sawant, Tech/F, PDD, RC&IG, BARC
66. Shri S.S. Gijare, Tech/D, PDD, RC&IG, BARC
67. Shri U.N. Dhuri, Tech/C, ED&DD, MRG, BARC
68. Shri D.K. Dalvi, Driver, Director's Office, BARC

H. Meritorious Technical Service Award carries a Cash award of Rs 20,000/-, Citation and a Medal.

There were twenty five award winners; 16 from BARC, 4 from IGCAR and 3 from RRCAT and one each from HWP (Kota) and GSO, Kalpakkam.

1. Shri M.S. Farash, Sr.T/H, RED, RD&DG, BARC
2. Shri Ramesh G. Barge, F/B, G&ACD, MG, BARC
3. Shri Dipak Kumar Ghosh, F/B, ACL, RMP, BARC
4. Shri Narayan C. Bhowmick, SA/F, DF, RMP, BARC
5. Shri A.B. Sonawane, Sr.T/H, CDM, DM&AG, BARC
6. Shri N.V. Surendran, T/H, PED, ChTG, BARC
7. Shri K.D. Waghmare, T/F, IADD, PG, BARC
8. Shri Gian Chand Chouhan, Sr.T/H, CDM, DM&AG, BARC
9. Shri Narayan Laxman More, T/F, WMD, NRG, BARC
10. Shri M. Padhy, T/J, DRHR, DM&AG, BARC
11. Shri Shyam Lal Sharma, F/C, TSD, ESG, BARC
12. Shri G.K. Patel, F/B, PMD, MG, BARC
13. Shri G.W. Diwan, F/C, AFD, NFG, BARC
14. Shri M.M. Nicholas, F/C, PRPD, RPG, BARC
15. Shri S.T. Panchal, SA/G, RPD, RPG, BARC
16. Shri D.S. Khobragade, F/C, AFFF/Tarapur, NFG, BARC

I. Group Achievement Award winners received a medal, a Citation and suitable cash awards for each group commensurate with the group size and its overall achievement.

A total number of forty four Groups received these awards. Out of these, 24 were from BARC, 4 each from NFC, IGCAR and RRCAT, 2 each from HWB, VECC and BRIT, 1 from BARC, IGCAR and HWB (Combined) and 1 from AMD. Following were the Group Leaders from BARC, who received the awards for their groups:

1. Dr. S. Kailas, former Director, PG, BARC.
2. Dr. P. Singh, OS & Head, IADD, PG, BARC.
3. Shri Kunal Chakraborty, SO/H, ROD, RG, BARC.

4. Shri R.R.S. Yadav, Director, RPG, BARC.
5. Shri Sadanand S. Malar, PRO, BARC & Shri G.S. Kurhade, Asstt. PRO, BARC.
6. Dr. K.C. Mittal, Former Head, APPD, BARC & Shri R.K. Rajawat, SO/H+, APPD, BTDG, BARC.
7. Dr. K.C. Mittal, Former Head, APPD, BTDG, BARC
8. Dr. (Smt) Sadhana Mohan, Head, HWD, ChEG, BARC and Shri M.M. Rajput, PS, NDDP/AUGF, ChEG, BARC.
9. Shri A.K. Verma, SO/H, Head, CDS, MDD, ChTG,BARC
10. Shri K.C. Guha, OS, RMP/ChTG, BARC/Mysore.
11. Shri S.P. Srivastava, SO/H+, CDM, DM&AG, BARC.
12. Shri Uday W. Vaidya, SO/H+, Head, Computer Control Design Section, RCnD, E&IG, BARC.
13. Dr. M.S. Kulkarni, SO/H, Radiological Physics and Advisory Division, HS&EG, BARC.
14. Dr. D.M. Gaitonde, SO(G), HRDD, KMG, BARC and Dr. (Smt) Sangeeta, SO/H+, Prog. Officer, BRNS, P&CD, KMG, BARC.
15. Dr. S.C. Gupta, Project Manager, EHPPL, Head, APD, MRG, BARC.
16. Shri T. Sreenivas, SO(H) and Head, MinD, MG, BARC.
17. Dr. (Smt) S.B. Roy, OS & Head, UED, MG, BARC.
18. Smt. Smitha Manohar, SO/H, PDD, NRG, BARC.
19. Shri Biplob Paul, SO/H, Plant Supdt., SWMF, NRB, BARC.
20. Shri F.T. Qureshi, SO/F, Supdt(M), TRP, NRB, BARC.
21. Shri Y. Kulkarni, SO/H+, CS, TNRPO (presently GM, INRP, WMD, NRB)
22. Dr. Sanjay C. Gadkari, OS, TPD, PG, BARC.
23. Dr. N.K. Sahoo, OS & Head, AMPD, PG, BARC and Dr. Amar Sinha, OS & Head, N&XPD, PG, BARC.
24. Shri R.R.S. Yadav, Director, RPG, BARC.

K. Meritorious Service Award carries a cash prize of Rs. 20,000/-, a citation and a medal.

There were 23 Award winners. Seventeen were from BARC, 1 each from RRCAT and VECC and two each from DAE and IGCAR. Following were the award winners from BARC:

1. Shri P.S. Tawde, Sr.Clerk, MD, BSG, BARC
2. Shri G. Johnkutty, UDC, RC&IG, BARC
3. Shri Nagesh V. Pawar, Asstt., PD, Adm., BARC
4. Shri Sheshrao G. Angrakh, Dr.Gr.I, Traffic/PD, Adm., BARC
5. Shri Dashrath S. Dogra, Asstt., PRO, PD, Adm., BARC
6. Shri R.R. Mayekar, Asstt., PD, Adm., BARC
7. Smt. Shailaja Prakasam, DEO, PD, Adm., BARC
8. Smt. S. Komalavalli, APO, PD, Adm., BARC
9. Shri C.V.S. Sastry, APO, PD, Adm., BARC
10. Shri Pradeep T. Shyal, Asstt., PD, Adm., BARC
11. Smt. Jayalakshmi B. Menon, Asstt., PD, Adm., BARC
12. Shri H.K. Pal, Sr.AO, AD, Adm, .BARC
13. Shri R. Easwaran, UDC, AD, Adm, .BARC
14. Shri Namdeo S. Babar, Sr. Security Guard, Security Section, Adm, .BARC
15. Shri P.P. Solanki, Asstt., CDM, DM&AG, BARC
16. Smt. Lata B., AO-III, HRDD, KMG, BARC
17. Kum. Rekha B. Narang, Sr.PS, PG, BARC.

Dr. J.P. Mittal (Former Director, Chemistry and Isotope Group, BARC) in conversation with the BARC Newsletter Editorial Committee

Dr. J.P. Mittal is presently M.N. Saha Distinguished Professor (NASI) at BARC. He joined Chemistry Division, BARC in 1960 through the third batch of BARC Training School. He became Head, Chemistry Division in 1986, Director, Chemistry Group in 1993 and Director, Chemistry and Isotope Group in 1999. He did seminal work in the area of radiation and photochemistry, and was responsible for initiating ultra-fast chemistry labs at Chemistry Group. He superannuated in 2003. He has published more than 350 papers in international journals and guided about 35 younger colleagues for their PhDs. In recognition of his significant contributions, he has been conferred with a number of national and international awards such as Humboldt Senior Research Award, Senior JSPS Fellowship, Fulbright Fellowship-USA, Distinguished Photo-chemist Award from Japanese Society of Photochemistry, Goyal Prize in Chemical Sciences, Life Time Achievement awards from the Chemical Research Society of India and the Indian Chemical Society, Padma Shri (2003) from Government of India, just to name a few. He is a Fellow of all the three Science academies in India, namely the National Academy of Sciences, India (FNASc); the Indian Academy of Sciences (FASc) and the Indian National Science Academy (FNA). He is also a Fellow of World Academy of Sciences (TWAS).

How did the Chemistry programme originate in BARC? Our young colleagues would be interested in knowing some of the historical aspects of this programme.

I would rather rephrase your question as "How did the Chemistry Programme originate in DAE" You will be surprised to know that the Chemistry Programme and the Chemistry Division were one of the very first programmes and Divisions under DAE. The Atomic Energy Act was passed in 1948 and the Atomic Energy Commission was constituted in the same year with Dr. Homi Jehangir Bhabha as the Chairman and Dr. K.S. Krishnan and Dr. S.S. Bhatnagar as members. Dr. S.S. Bhatnagar was known to have started the CSIR establishment and he was an internationally renowned Chemist. On his suggestion, Dr. Jagdish Shankar was appointed as the First Chemist in DAE. Dr. Shankar was instrumental in initiating major programmes in Chemistry right from ore extraction, ore dressing and purification and fuel reprocessing. The major challenge in those days was the extraction of small amount of uranium from the available low-grade ores. Then the next question was how to go about purifying it. In very early stages Dr. Shankar and his peers realized its importance and that was how the Analytical Chemistry Division was established under the leadership of Dr. V.T. Athawale. It was he who established the basic laboratory for chemical analysis of the ores. This whole activity started in the basement of Kennilworth, Dr. Bhabha's bungalow. The period 1950-54 was the time when research on basic chemistry was being carried out. Three more chemists joined the existing team: Dr. M.D. Karkhanawala, Dr. A.K Sundaram and Dr. T.K.S. Murthy. So this was how the chemistry programme began in DAE along with the generation of basic expertise in several areas such as Radiation Chemistry, Gas Chromatography, Solid State Chemistry, X-ray diffraction, Development of high purity materials and Zone refining. The first published paper in Chemistry from the DAE was in 1955 at the Geneva conference where Dr. Bhabha presented a paper on separation of zirconium and hafnium by solvent extraction.

What are the significant early contributions of chemists to the DAE programme?

The CIRUS reactor was built with the Canadians collaboration who detected fungus inside the coolant channels. They suggested the use of potassium dichromate. However, due to radiation, chromium was deposited on the walls resulting in the choking of the coolant tubes. This problem was tackled by injecting large amounts of complexing agents inside the coolant channels to remove the chromium deposits. This was how CIRUS was cleaned up. This was one of the early important inputs from chemistry.

In many aqueous coolant systems suspended sub-micron size particles in a low or medium concentration are referred to as the turbidity of the coolant. At low concentrations parts per billion(ppb) level of turbidity, solution may apparently look clear, but at parts per million level (ppm) the coolant can appear very turbid. Turbidity itself or its deposition on surface can cause heat transfer problems in the nuclear reactor. Such a problem was encountered in the form of aluminum hydroxide turbidity in Dhruva reactor in 1985. Efficient inorganic ionic exchanger / adsorbent was developed by Chemistry Group, which was successfully deployed for the removal $Al(OH)_3$ turbidity.

You are an internationally acclaimed Radiation and Photochemist. How this specific chemistry programme started at BARC?

In early 1960's there was a move internationally to use organic coolants in nuclear reactors as they were envisaged to be advantageous in terms of corrosion and high specific heat. However, under operating reactor conditions, one needed to look into their radiation stability. In view of this, a comprehensive radiation chemistry programme was initiated at Chemistry Division. Subsequently, the idea of organic coolants was abandoned, but it led to the foundation of this important programme, which is vigorously pursued at Chemistry Group even now. The first 7 MeV LINAC in India was installed at Chemistry Group, BARC in 1986. This programme expanded to the study of ultra-fast chemical dynamics of Chemical reactions. Now we can boast of the very first established state-of-the-art level femto-seconds chemistry facilities at BARC wherein many fundamental chemical questions have being addressed. This facilities can easily be compare to the top Three/four laboratories in the world. The radiation chemistry research had several societal off-shoots also such as hydrogels for wound dressing. Recently Chemistry Group has developed a nitric oxide releasing hydrogel, which is effective even for diabetic foot ulcars.

You have also been associated with practicing analytical chemistry related to materials and have contributed immensely in this area. The present trend is to do research in frontier areas as a consequence of which focus on this field has been diminishing slowly. What steps need to be taken quickly so that we revive this important area and create a pool of experts?

Analytical chemistry itself has changed texture now and today it is mostly instrumentation-based analysis. But one should remember that any instrumentation analysis technique requires sample making and unless the sample is correctly prepared, the results may not be replicable. It requires knowledge of basic process chemistry. To get analytical capability of a very high sensitivity one may require more and more sophisticated instruments but the sample you feed-in has to be very pure, genuine sample and it is for this reason that the National Centre for Compositional Characterization of Materials (NCCCM) was set up in Hyderabad in early 1990s. There is no denying the fact that a chemist whether one is a physical chemist, organic chemist, or Laser chemist, he/she has to be first basically a good analytical chemist. Knowledge about process chemistry and analytical chemistry is a must. It is experimental science. You need to conduct experiments with your own hands in the laboratory. One cannot differentiate between basic research and applied research. Whatever you think today is basic research tomorrow it will be applied research and in my opinion it is not an encouraging situation to tell younger colleagues that they should do only applied research. Basic research is the one which gives us the pool of knowledge.Youngsters should be equipped

to solve challenging problems in such a manner that they can rub their shoulders with professionals at an international level and it can only be achieved when you encourage them in whatever basic research they do. They should be encouraged to publish their work in peer reviewed international journals.

Nano science and Nano technology have been projected as very promising areas of contemporary R&D, with tremendous potential for applications for societal benefits. What are your thoughts on this? What are the areas within this field of relevance to DAE programs, where should BARC concentrate and focus its efforts in the near future?

Nano Science and Nano Technology have been projected as new things but at BARC we have been doing nano science and nano technology since long, because what you mean by Nano Science and Nano Technology is that you are conducting and observing reactions at a nano scale in time as well as in size and space. So whenever you do any precipitation reaction basically the first particle that is produced is a nano particle. This is nothing new. We have now acquired the technology to see that particle, we can look directly at the nano time scale but chemistry-wise it goes through the Nano science particle and then gradually it becomes nano to micro, micro to milli, milli to even to still larger etc. but chemistry-wise Nano Science has always existed and only now we have learned the technology to see it at nano time scales. Of course there are many applications and our scientists are quiet good in BARC and they are in the frontline of Nano Science area and again I see many places where there is direct application of Nano Science and Technology in the Atomic Energy Programme. So basically if we have trained people in the area of Nano science technology, they will be able to use it and apply either insitu in the reactor or in any place where Nano science is required. Nanomaterials have tremendous potential for separation of radio-nuclides from nuclear waste for health and other applications. Likewise catalysis is another area where nanomaterials are going to play a significant role.

What will be the role of chemistry in some of the futuristic mega-projects in DAE, such as non-water cooled reactors like HTRs, MSBRs, etc.?

The whole radiation chemistry programme was initiated in the DAE because water was supposed to be both coolant and moderator in most of our reactors. For this purpose very high purity water is required which is completely stable.If the water is impure, due to some basic reactions free radicals are produced.Now new kinds of reactors are coming up, like the High Temperature Reactors and Molten Salt Breeder Reactors.Chemists have a very important role to play in these reactor technologies.Here we face whole new challenges in materials chemistry, surface chemistry, design of carbon composites, silicon carbide coatingsetc. Other challenges would be development of materials which can withstand high temperatures and corrosion. MSBR is a fantastic idea for a reactor concept. In fact, often it is referred to as a Chemists' reactor. Chemists will play a major role particularly in the chemistry of molten fluorides.

Chemistry is considered to be a central science with strong linkages to other branches. How these linkages with other disciplines such as physics, biology, material science and other engineering disciplines can be further enhanced in BARC?

Chemistry is the basic central science. Knowledge of Chemistry is applicable to whatever branch of Science one takes up. Even Engineers need to know basic chemistry to excel in their fields. In IITs and in ICT there are important courses of chemistry for the engineers. The emergence of new subjects like Chemical-Biology, Chemical-Physics and Chemistry of Materials, all are examples of linkages of Chemistry with other disciplines.

You have had a long association with the Materials chemistry programme of DAE.In this regard would you like to share some memorable successes which you have cherished?

Well as I said earlier,theChemistry Division has been making high purity materials for various requirements

of the Department. So, wherever materials were required, chemistry people have delivered the goods and at present they are the pioneers in handling and purifying materials at the 6-7N level of purity including many of the 3rd generation Electronic grade materials. I am very proud of our colleagues who achieved this feat as a challenge posed to them by the nation.Chemists at BARC continue toface newer and newer challenges; for example in the fuel cell materials and the catalyst that would be used.Chemistry is going to be an integral part of research on multi-functional materials.

Is there something that you wanted to recall i.e.recall that you wanted to do something and thesystem did not allow and which subsequently got resolved?

Many a times we proposed to do certain things and the department thought it was too ambitious. But I also know that if you are 100% convinced about your project, DAE still has that kind of culture that it will go through your project. But they will test your tenacity and the veracity of your ideas. To give you an example: We thought that the photons could be used to separate isotopes and as all of you know separation of isotopes is an expensive business. So we three or four young people in BARC proposed to the department that we should initiate a new area for isotope separation apart from the normal technology of gas and centrifuge which are very expensive. They asked how it was possible? But our chemical concepts were very clear. Committees were made to scrutinize the ideas of these "crazy" people (myself, Dr. Bhawalkar and Dr. P.R.K. Rao). It was one of the first experiments that have been done in BARC which was multidisciplinary. Later Dr. Ramanna made an announcement that BARC was working in the area of Laser Separation of Isotopes. So I am very convinced that if your chemistry is correct, DAE even today will accept your proposal but you have to defend your ideas and then DAE will support you.

Scientific research at BARC, while seeming to encompass diverse things, largely revolves around areas of relevance to DAE programs and is often considered as "not mainstream science" by outsiders. What, in your opinion is the best way to strike a balance between 'excellent mainstream science' and 'relevant DAE programs'?

DAE is a mandate-driven department. We are doing basic research which has direct relevance to DAE programmes. But I think simultaneously it is our responsibility to expose our scientists to R&D at national and international levels by asking them to present their data through general conferences so that we can emphasize and explain to our peers about the kind of challenging and novel chemistry being pursued at BARC laboratories. We should be able to compete and rub our shoulders with the best of the international scientists and I am convinced that not only scientists, chemists, physicists but also engineers in DAE are doing such a great amount of work which can be comparable with work done elsewhere in the world. But we don't get enough exposure. We must publicize and present our science at more and more National and International Conferences and Symposia etc.

Chemistry plays an important role in improving the quality of life of the country's population. How do you suggest enhancement of the linkages of Chemistry programme in DAE with societal benefits?

I have earlier answered a part of this question but to elaborate further, Chemistry plays a central role in society. Starting with your daily newspaper and your morning tea, everything is chemistry. We are all made of chemicals. Our whole body is made up of chemicals, water is a chemical, air is a mixture ofchemical. The entire medical industry depends on chemistry, similarly textile industry, material science all depend on chemistry. So chemistry is everywhere, in every human's life chemistry is involved and large number of Chemistry research at BARC is directly or indirectly connected towards solving some of these problems, take for example work done connected to material chemistry or radiation protection and antioxidants or radiation induced modification to polymers.

Today's researchers are more mobile. What differences can it make to our own domestic nuclear materials chemistry programme? How to attract better talent in chemistry to contribute to DAE programmes?

It is a very important question because unless you have good students coming into our department, there is going to be a bad situation. This can only be done by as much amount of advertisement of our work as possible, information by word of mouth, by publishing many papers. Good students should feel welcome at DAE. We must invite different colleges, different universities to come and see the kind of work we are doing. We must device new schemes so that students are welcome even from undergraduate levels. The teacher-student relationship should be maintained. The K.S. Krishnan Fellowship is also another good idea where postdoc people, after they have completed their PhDs at different universities can be absorbed. So I think more and more such schemes should be evolved. Where we can get fresh inputs from different areas, students at different levels; otherwise as you rightly pointed out this is a mobile system. Several opportunities are opening up for young students. But you need to attract them. This can be done by going to universities to give lectures, call them to our place,show them the laboratory where we are working and what we are doing. The only way to attract them is to make them excited about science. Students are valuable national assets.

What is the message you would like to give to the chemists belonging to the present generation? What are the challenges ahead?

Work hard as much as possible and always work at cutting edge of technology, don't try to repeat whatever somebody else has done. I say in every lecture to every scientist that they must dream and dream as much as possible and then work towards fulfilling that dream. There are many new challenges coming up. The basic challenges of energy, pollution, water still remain. Shortage of Water is going to be the biggest problem for the whole world. In India we are fortunate to have adequate rainfall every year. This is a big challenge of how you can purify water and provide clean potable water at reasonable cost. There are many technological ways of doing this. However, the biggest challenge is how to do in a sustainable way.

You have visited many labs and Institutes abroad, how does BARC compare with these institutes and in what way BARC can be further improved

I think there is no other research institute which is bigger than this unique institution BARC at one place on one campus and with so many trained scientists. I think we must encourage more and more students to join BARC. We must bring back science and its relevance to society. The challenge is to create more and more scientists in the country. Manpower resource in our country is very high and we have to tap it.

Would you like to share your impressions on BARC Newsletter and the BARC outreach programme. Please also suggest ways for further improvement

Newsletters should reflect and project the R&D achievements of the institution. I personally feel that there should be some more photographs of the people involved in the R&D, tools, instruments, equipment etc.

I think the outreach programme should not be left just only to the public relation professionals. It should also be seriously encouraged to be taken up by the working scientists and engineers of BARC. We should approach scientists who are very good speakers and ask them to give lectures, tell everyone what the department is doing. They will have conviction when they speak to the audience. For example the question of food irradiation: we must tell the truth about the whole thing that food irradiation is quite safe. Tell as much of scientific facts to the audience as possible.

Finally, I would like to thank the Editorial team for giving me this opportunity to express my views on a range of questions related to Chemical sciences and I do hope that the young chemists and engineers will get a better insight of the things that had happened and how it evolved in to the present system. I wish BARC Newsletter all success.

Ahmed's Integral: the Maiden Solution

Physics Group

In 2001-2002, I happened to have proposed a new definite integral in the American Mathematical Monthly (AMM), which later came to be known in my name (Ahmed). In the meantime, this integral has been mentioned in mathematical encyclopedias and dictionaries and further it has also been cited and discussed in several books and journals. In particular, a google search with the key word \Ahmed's Integral" throws up more than 60 listings. Here I present the maiden solution for this integral.

My proposal of evaluating the following integral

$$\int_0^1 \frac{\tan^{-1}\sqrt{2+x^2}}{(1+x^2)\sqrt{2+x^2}}dx \tag{1}$$

was published [1] in 2001, when it was thrown open to be solved within next 6 months. Subsequently, 20 authors and two problem solving groups proposed correct solutions. The solutions to (1) by two authors, Kunt Dale (Norway) and George L. Lamb Jr. (Arizona) have been published titled `Definitely an Integral' [2]. AMM usually prefers to publish the solutions of other solvers than that of the proposer.

This integral is now known as Ahmed's Integral. A Google search \Ahmed's Integral" brings more than 60 listings to view. It has been included in encyclopedias and dictionaries. Various solutions, extensions, properties and connections of this integral have been discussed in a variety of ways. This integral is very well discussed in two very interesting books on integrals [3,4] and mentioned in another [5]. This analytically solvable integral also serves as a test model for various new methods of high precision numerical (quadratures) integrations [6].

Since in recent times this integral has evoked a considerable attention, I propose to present the maiden solution that was sent along with the proposal [1].

Let us call the integral (1) as I and use $\tan^{-1} z = \frac{\pi}{2} - \tan^{-1}\frac{1}{z}$ to split I as $I = I_1$-I_2. Using the substitution $x = \tan\theta$, we can write

$$I_1 = \frac{\pi}{2}\int_0^{\pi/4} \frac{\cos\theta\, d\theta}{\sqrt{2-\sin^2\theta}}, \tag{2}$$

which can be evaluated as $I_1 = \frac{\pi^2}{12}$ by using the substitution $\theta = \sqrt{2}\sin\phi.$. Next we use the representation

$$\frac{1}{a}\tan^{-1}\frac{1}{a} = \int_0^1 \frac{dx}{x^2+a^2} \quad (a \neq 0) \tag{3}$$

to express

$$I_2 = \int_0^1\int_0^1 \frac{dx\, dy}{(1+x^2)(2+x^2+y^2)}. \tag{4}$$

Further I2 can be re-written as

$$I_2 = \int_0^1\int_0^1 \frac{1}{(1+y^2)}\left(\frac{1}{(1+x^2)} - \frac{1}{(2+x^2+y^2)}\right) dx\, dy \tag{5}$$

$$= \int_0^1\int_0^1 \frac{dx\, dy}{(1+y^2)(1+x^2)} - \int_0^1\int_0^1 \frac{dx\, dy}{(1+y^2)(2+x^2+y^2)}. \tag{6}$$

Utilizing the symmetry of the integrands and the domains for x and y, the second integral in (6) equals I2 itself. This leads to

$$2I_2 = \int_0^1\int_0^1 \frac{dx\, dy}{(1+y^2)(1+x^2)} = \left(\int_0^1 \frac{dx}{1+x^2}\right)^2 = \frac{\pi^2}{16}. \tag{7}$$

Eventually, we get $$I = \frac{\pi^2}{12} - \frac{\pi^2}{32} = \frac{5\pi^2}{96}. \tag{8}$$

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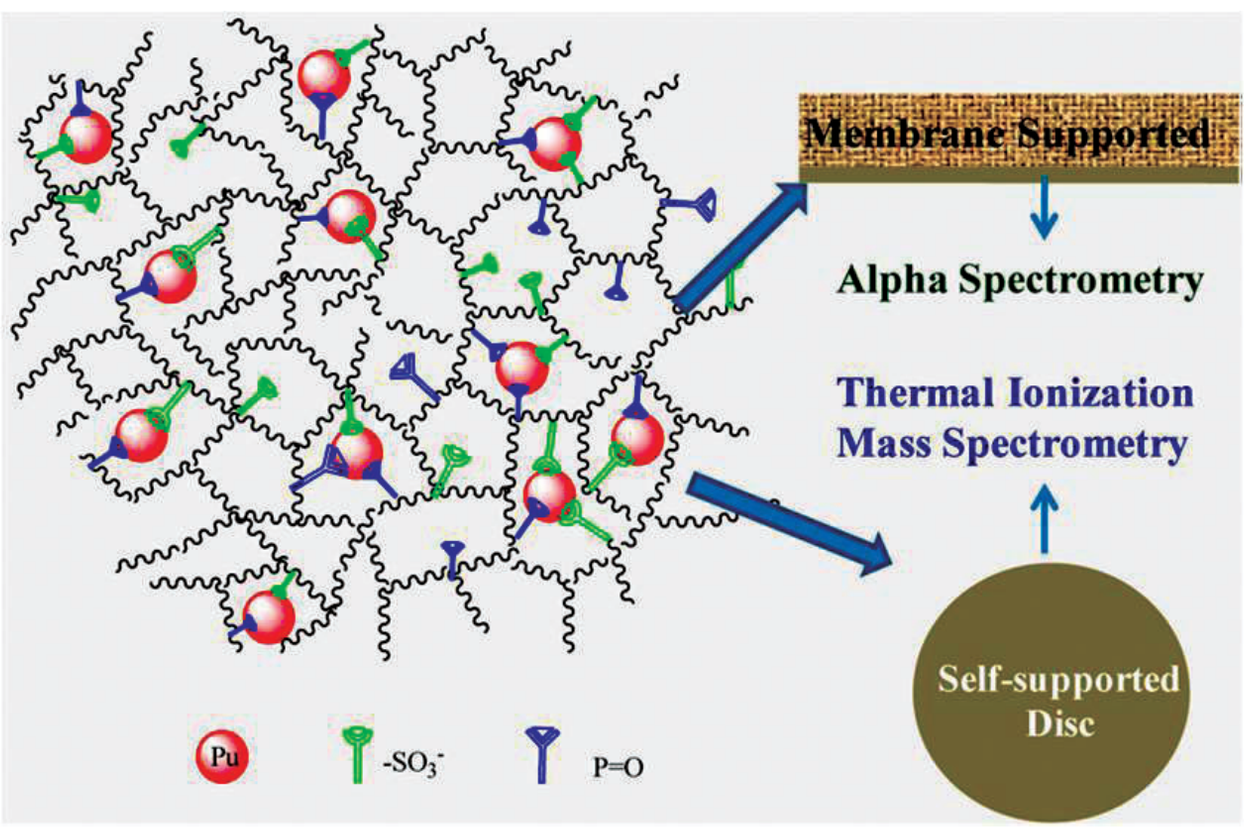
Tailored Bifunctional Polymer for Plutonium Monitoring

Radiochemistry & Isotope Group

Monitoring of actinides in various matrices with sophisticated conventional methods is affected by matrix interferences, spectral interferences, isobaric and polyatomic interferences. To circumvent these limitations, a bifunctional polymer, having both phosphonic acid and sulfonic acid functionalities, was developed in the present work for acidity-dependent selectivity towards Pu(IV)[1]. The bifunctional polymer was found to be better than the polymer containing either a phosphate group or a sulfonic acid group in terms of higher Pu(IV) sorption efficiency at 3–4 mol L^{-1} HNO_3, selective preconcentration of Pu(IV) in the presence of a trivalent actinide such as Am(III) and preferential sorption of Pu(IV) in the presence of a large excess of U(VI). The bifunctional polymer was tailored as a self-supported disk by bulk polymerization and also anchored as a 1–2 μm thin layer on a microporous poly(ether sulfone) (PES) membrane by surface grafting. Pu(IV) preconcentrated on a single bifunctional bead was used for determination of the Pu isotopic composition by thermal ionization mass spectrometry with minimal sample manipulation and reasonably good accuracy. Use of a single-bead loading also improved the ion collection efficiency of the TIMS instrument. The membrane-supported bifunctional polymer was used for preconcentration and subsequent quantification of Pu(IV) by □ spectrometry using the absolute efficiency at a fixed counting geometry. The analytical performance of the membrane-supported-bifunctional-polymer-based α spectrometry method was found to be highly reproducible for assay of Pu(IV) in a variety of complex samples.



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Multiple Diglycolamide Functionalized Ligands in Room Temperature Ionic Liquids: 'Green' Solvents for Actinide Partitioning

Arijit Sengupta and P.K. Mohapatra
Radiochemistry Division

Abstract:

Multiple-diglycolamide-functionalized ligands(MDGA) in room temperature ionic liquids (RTILs) were studied for extraction of actinides and lanthanides from aqueous acidic solutions. The extraction kinetics, separation behavior, associated thermodynamics of extraction, nature of the extracted species formed were studied. Luminescence spectroscopy was used to understand the nature of bonding between metal and ligands, formation of inner sphere/ outer sphere complex etc. The radiolytic stability of solvent systems was studied and attempt was made to understand the degradation products. Finally, all the systems were evaluated for 'actinide partitioning' from synthetic high level liquid waste solution (HLLW).

Introduction:

With the ever increasing demands for energy, nuclear power is slowly becoming one of the most viable sources along with the renewable. However, due to limited natural resources of the fissile material (^{235}U), the future nuclear energy program largely depends on the availability of man-made fissile materials such as ^{239}Pu and ^{233}U. To sustain nuclear power program beyond the availability of naturally occurring ^{235}U, it is imperative to follow the closed fuel cycle option. During the reprocessing of the ^{235}U based spent fuel, the fissile elements such as plutonium and uranium are recovered leaving behind a highly radioactive liquid waste solution referred to as High Level Liquid Waste (HLLW). This HLLW solution comprises long-lived alpha emitting actinides such as ^{241}Am, ^{243}Am, ^{245}Cm and ^{237}Np (referred as minor actinides) apart from the small amounts of un-recovered plutonium and uranium as well as beta / gamma emitting fission products (^{137}Cs, ^{90}Sr etc.) and significant concentrations of structural materials along with several process chemicals. Since the half lives of minor actinides and some of the fission products range from few hundreds to millions of years, HLLW poses long term radiological risk to the Environment [1]. Apart from the high radiological risk, some of the minor actinides and fission products, if recovered, may find various applications. The sustainability of the future nuclear energy program, therefore, depends on an efficient and effective radioactive waste management strategy which must be aimed at mitigating the long term hazards of the radioactive wastes.

One of the major challenges in radioactive waste remediation is the selective separation of the long-lived minor actinides (Am, Cm) which have been proposed to be achieved by a strategy known as 'actinide partitioning' [2]. Extractants such as CMPO (carbamoyl methyl phosphine oxide), malonamide, TRPO (trialkyl phosphine oxide), DIDPA (diisodecyl phosphoric acid) and DGA (diglycolamide) are well known for the extraction of trivalent actinides from a moderately acidic medium [3-4]. The favourable extraction of these trivalent actinides by TODGA (N,N,N',N'-tetraoctyl diglycolamide) have been attributed to a reverse micellar aggregation where four extractant molecules are believed to be involved in the formation of an aggregate with a hydrophilic interior [5]. The aggregate formation is, however,

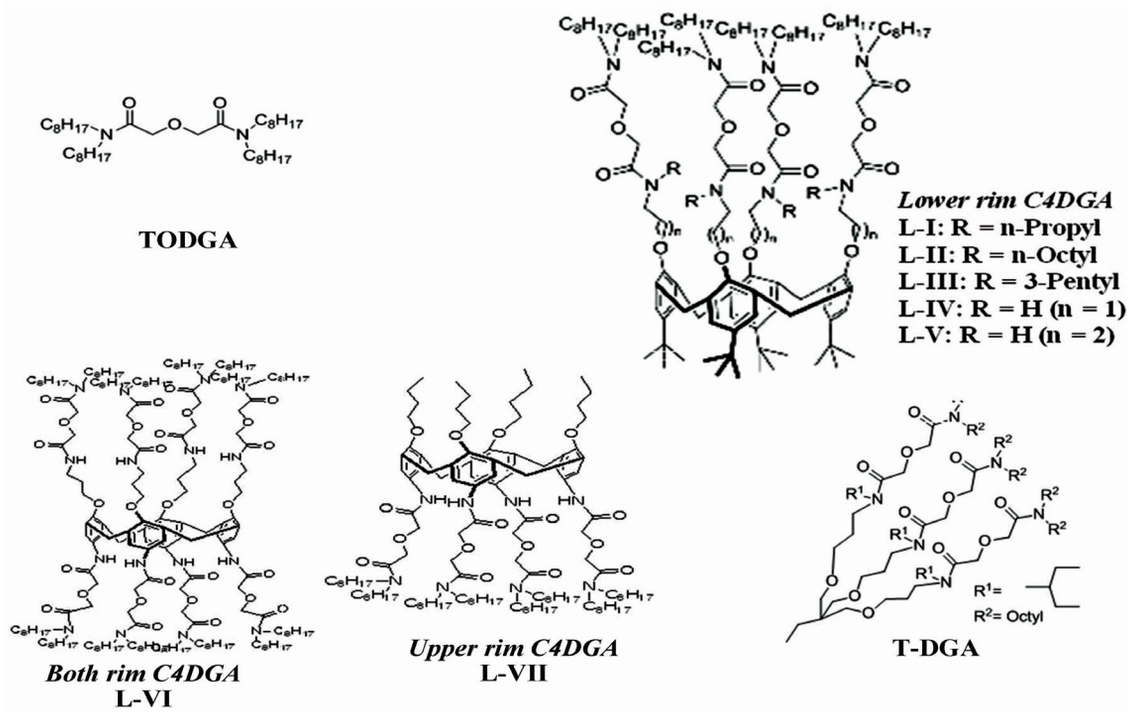

Fig. 1: Structures of diglycolamide functionalized ligands

dependent on the nature of the diluents [6]. This observation led to the idea of choosing multiple diglycolamide functionalized ligands [Fig. 1] to enhance extraction efficiency as well as selectivity.

Due to the growing awareness of the environmental impact associated with the use of volatile organic compounds (VOC), room temperature ionic liquids (RTIL) have been proposed as alternatives to the molecular diluents due to favourable properties like negligible vapour pressure, wide liquid range, good thermal stability, non flammability, good thermal conductivity, large potential window, good solvents for broad spectrum of inorganic, organic and polymeric compounds etc. The most attractive property of RTIL is its extraordinary degree of tunability, i.e. small structural modification either in cationic and anionic moieties of RTIL can lead to drastic change in physico-chemical properties as well as the extraction efficiency and selectivity of metal ions. The application of moisture stable RTILs in nuclear establishment have been reported only in late nineties. Several efforts have been reported worldwide, not only for demonstration of actinide partitioning in a 'greener way' using RTILs; but also to understand drastically different actinide chemistry in RTILs in comparison with the molecular diluents [7-8].

Extraction efficiency, selectivity, mechanism, nature of species

In the present investigation, the extraction of Am(III) was found to be considerably enhanced when diglycolamide (DGA) extractants such as TODGA or C4DGA are used in RTILs instead of the conventional *n*-dodecane as the diluent. A decrease in the distribution ratio of americium with increasing aqueous phase acidity was attributed to an ion exchange mechanism [Fig.2]. The presence of C_nmim^+ in aqueous phase was found to decrease the D_{Am} value revealed that cation exchange mechanism was operating (eq.1) which was further confirmed by no participation of either of NO_3^- or NTf_2^- anion for the extraction. In case of T-DGA the D_{Am} values were found to decrease with increasing the length of alkyl substituents in methylimidazolium ring i.e. $C_4mim^+ > C_6mim^+ > C_8mim^+$. The decrease in hydrophilicity with increasing alkyl chain length is responsible for the trends. For LVI D_{Am} value was found to be

independent of feed acidity which can be ascribed to the 'intra molecular buffering effect' of multiple DGA functionalities.

$$Am^{3+}_{aq} + nDGA_{IL} + 3C_8mim^{+}_{IL} = Am[DGA]_n^{3+}{}_{IL} + 3C_8mim^{+}aq \quad (1)$$

where, the species with the subscripts 'aq' and 'IL' refer to those in the aqueous phase and in the RTIL phases, respectively. A strong influence of H+ ion on the Am(III) extraction can be explained on the basis of a competing equilibrium reaction given as follows:

$$H^{+}_{aq} + DGA_{IL} + C_nmim^{+}_{IL} = H.DGA^{+}_{IL} + C_nmim^{+}_{aq} \quad (2)$$

C4DGA in RTIL was found to be more specific for An^{3+} over AnO_2^{2+} ans Sr^{2+} than the parent TODGA molecule either in molecular diluents or RTILs. The extraction efficiency was found to follow the trend $Eu^{3+} > Am^{3+} > Pu^{4+} > Np^{4+} >> UO_2^{2+} \sim PuO_2^{2+} > Sr^{2+} > Cs^{+}$ [Table 1]. The higher extraction efficiency of trivalent actinides over tetravalent actinides can be attributed to the pre-organized structure of the ligands. Eu^{3+} being more hard acid compared to Am^{3+}, interacts more efficiently with hard oxygen donor atoms of the ligands. The actinide contraction was found to be responsible for higher extraction efficiency of Pu^{4+} over Np^{4+}. The stoichiometry of the metal ligand complex was found to be 1:2 for TODGA while 1:1 for TDGA and C4DGA. Among different structurally modified C4DGA, the +I effect of 3-pentyl > *n-octyl* > *n-propyl* group, the electron density on the concerning amidic nitrogen atoms will follow the same order. As a consequence, the extraction efficiencies follow the same order, viz. L-III > L-II > L-I. This trend changes at comparatively higher feed acidities where the amidic nitrogen is protonated and

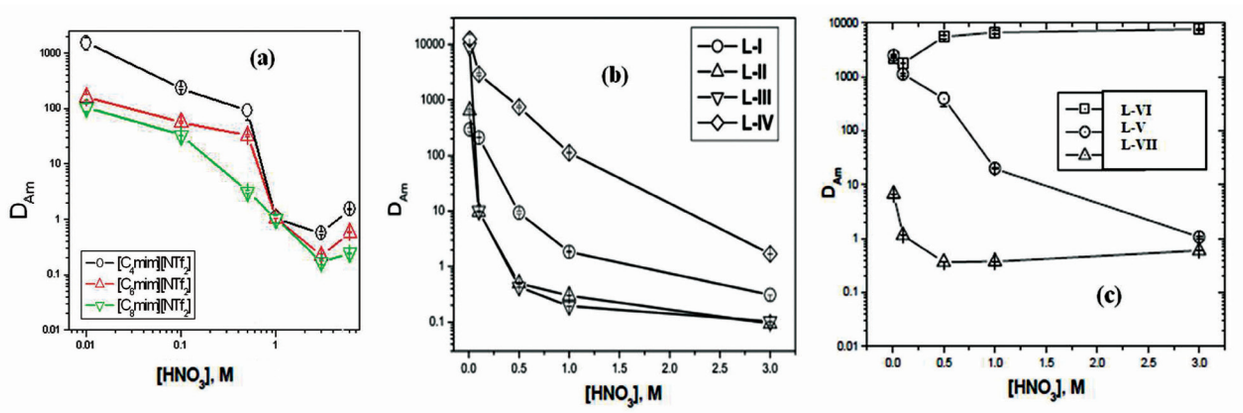

Fig. 2: Extraction profiles of Am^{3+} using (a) 0.001M T-DGA in RTILs; (b) structurally modified C4DGA ligands in $[C_8mim][NTf_2]$; (c) different rim functionalized C4DGA ligands in $[C_8mim][NTf_2]$ from various feed acidities

Table 1: Comparative extraction data of actinides and fission product elements using C4DGAs in $[C_8mim][NTf_2]$

Metal ion	L-I	L-IV	L-V	L-VI	SF_{L-I} #	SF_{L-IV} #	SF_{L-V} #	SF_{L-VI} #
DAm(III)	9.34	748	397	5500				
DU(VI)	0.07	0.16	0.41	0.19	1.3×10^2	4.6×10^3	9.6×10^2	2.9×10^4
DEu(III)	143	897	561	7000	0.065	0.85	0.71	0.79
DCs(I)	0.01	0.06	0.08	0.09	1038	1.3×10^4	4963	6.2×10^4
DSr(II)	0.02	0.15	0.15	0.18	467	4.9×10^3	2.6×10^3	3.1×10^4
DPu(IV)	2.88	5.62	6.17	62	3.24	133	64.3	89
DNp(IV)	1.22	3.54	2.22	10	7.6	211	179	550
DPu(VI)	0.1	0.18	0.6	0.26	93.4	$4.1\ 10^3$	6.6×10^2	2.1×10^4

Note: Ligand concentration: 5.0×10^{-4} M. Equilibration time: 3 h. feed acidity: 0.5 M HNO_3. Diluent: $[C_8mim][NTf_2]$. # SF means the separation factor values of Am(III) with respect to other metal ions, i.e., $SF = D_{Am}/D_M$.

becomes pyramidal and only steric factors become of interest. L-IV with a spacer chain length of two carbon atoms is a better extractant in comparison to its analog L-V with a longer spacer chain length (3 C atoms). It seems that the ligands with lower spacer length (for example, L-IV) can impart certain amount of rigidity to the pendent arms (due to lower flexibility) leading to a relatively more pre-organized structure. Therefore, L-V, with longer spacer length can have less probability of a pre-organized structure which explains its lower complexation tendency in ionic liquid medium.

Extraction kinetics and thermodynamics

The kinetics and thermodynamics are two important aspects to have proper understanding of the extraction systems. The kinetics of extraction was found to be slower compared to that in molecular diluents based systems. It was observed that the kinetics of extraction decreases with increasing chain length of the alkyl substituent in imidazolium ring. The overall kinetics of PF_6^- based ionic liquids were found to be slower than that of NTf_2^- based ionic liquids. The extraction kinetics remained unchanged by using different structurally modified C4DGA in RTILs. All these facts suggested that viscosity of the RTILs play detrimental role in kinetics of extraction.

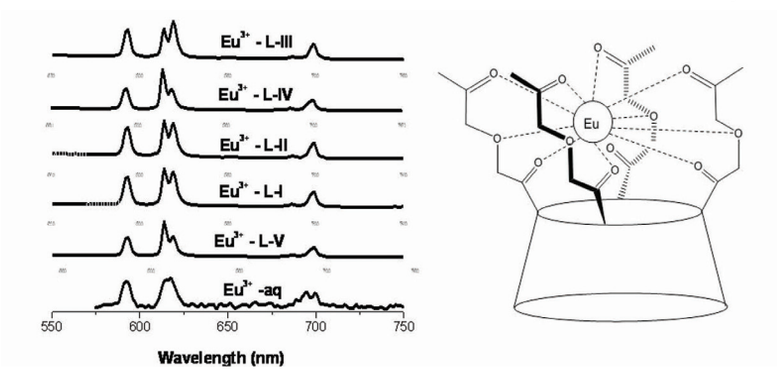

Fig.3: Fluorescence spectra of (a) Eu^{3+} complexes of different structurally modified C4DGAs in $[C_8mim][NTf_2]$ and most probable local symmetry of Eu^{3+} in complex.

The decreased D value with increase in temperature and the (-) ve ΔH values for the extraction revealed that all the extraction was exothermic in nature. The spontaneity of the reaction was reflected from the (-) ve ΔG values while during extraction the overall entropy was found to decrease which can be attributed to the decrease in rotational degrees of freedom of the supramolecular DGA ligands on complexation. The luminescence spectroscopic studies on the complex revealed the absence of water molecules in primary coordination sphere of metal ion. The high intensity of the $^5D_0 \rightarrow {}^7F_2$ transition revealed that the metal ion resided in highly asymmetric environment in the complex. From the splitting pattern of the emission spectra [Fig.3] the local site symmetry of the An^{3+} or Ln^{3+} with C4DGA was found to be C_{4v}.

Stripping and radiolytic stability

Stripping from RTIL phase is one of the major problems faced by the researchers. Out of several commonly employed strippants, 1 M Na_2CO_3 was found to be highly efficient for the quantitative recovery of hexavalent actinides (~95%) whereas 0.5 M oxalic acid is fairly good for the stripping of tetravalent actinides (~86%). 0.05 M EDTA or DTPA in 1 M guanidine carbonate was successful for quantitative stripping of trivalent actinides (~99.9% and 99.8%, respectively) from RTIL phase.

Though the C4DGA ligands are highly promising for actinide ion extraction, their actual use for actinide ion separation requires their prolonged reusability, which means their good radiolytic stability. This is because all actinide ions emit high LET (linear energy transfer) alpha particles, which can cause significant radiolytic damage. A systematic study, carried out to investigate the radiolytic stability of the C4DGAs in $C_8mimNTf_2$, indicated that after exposing the organic phase to 500 kGy of the absorbed gamma dose, the extraction efficiency becomes 72%, 49%, 69%, and 72% of the original D_{Am} values (with the unirradiated ligand solution)

with L-I, L-II, L-III, and L-IV, respectively, which after exposure to 1000 kGy decreased to 50%, 35%, 50%, and 46%, respectively of the original values. Scanning of the EPR signal from 2870 to 3870 G revealed no signal from any fluorinated paramagnetic species.

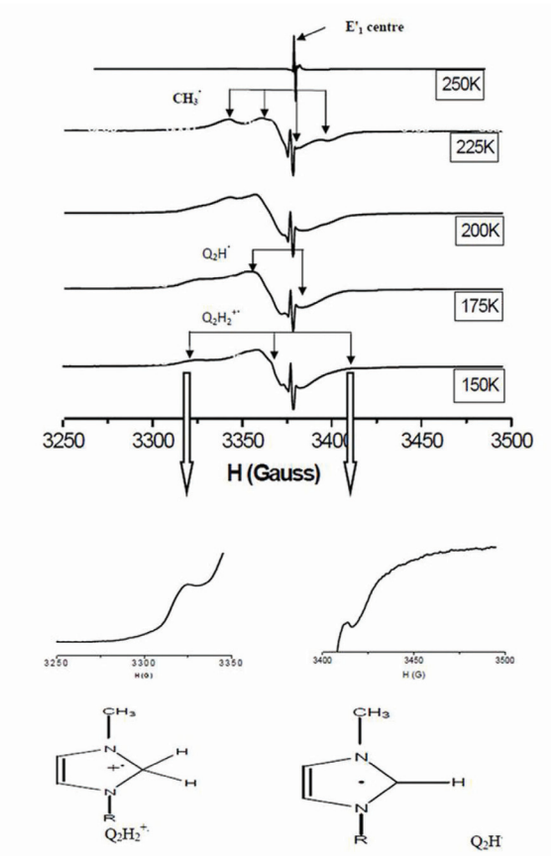

Fig.4: EPR spectra of irradiated C4DGA in [C_8mim][NTf_2]

Variation of the temperature from 150 to 200 K, clearly indicated a triplet with g ~2.0038 G, wide shoulders separated by a large isotropic hyperfine coupling constant of 98 G and a smaller doublet with g ~2.0042 and a hyperfine coupling constant of ~28 G. These signals can be tentatively assigned to $Q_2H_2^{+\cdot}$ and Q2H· [Fig.4], respectively. On increasing the temperature to ~225 K an unresolved quartet at g ~2.0019 was observed with A ~18 G.

This signal may be attributed to the methyl radical. Beyond 250 K, the only signal persists with g ~2.0001 is attributed to the stable E'[1] centered radical formed due to the irradiation of the quartz tube. The E'_1 centered radical, generated due to glass container irradiation, is sufficiently stable even at 250 K where other signals have washed out.

Finally the RTIL based solvent systems were employed for processing simulated HLLW solutions. It was also observed that Zr(IV), Pd(II), Y(III), La(III), Ce(IV), Pr(III), Nd(III), and Sm(III) were co-extracted along with minor actinides like americium.

Conclusion

Multiple diglycolamide functionalized ligands in RTILs are highly efficient systems for partitioning of minor actinides. Extraction kinetics was found to proceed via cation exchange mechanism with 1:1 metal – ligand stoichiometry for multiple dilglycolamide functionalized ligands. There was no inner sphere water molecule in the primary coordination sphere of metal ion with C4v local symmetry. The overall process was spontaneous, exothermic and entropically unfavorable. The RTIL based system was found to be radiolytically stable upto 500 kGy. Suitable aqueous phase complexing agent can be employed for quantitative stripping of actinides from the RTIL phase.

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Photosensitization of Cancer Cells, by Coralyne, is mediated through ATR-p38 MAPK-BAX and JAK2-STAT1-BAX Pathways

Rahul Bhattacharyya and Sandip Bandyopadhyay
KPC Medical College, Jadavpur, Kolkata
and
Pooja Gupta, Subrata Chattopadhyay and Birija Sankar Patro
Bio-Organic Division

Abstract: In photochemotherapy, ultraviolet radiation (UVR: 280–400 nm) or visible light is combined with a photosensitizing drug to produce a therapeutic effect. Importantly, the beneficial impact of photochemotherapyis not achieved by the drug or radiation alone. It is a proven therapeutic strategy for a number of non-malignant hyper proliferative skin conditions and various cancers. All existing photochemotherapies have drawbacks – for example the association of (psoralen plus UVA) PUVA with the development of skin cancer, and pain that is often associated with photodynamic therapy (PDT) treatment of skin lesions. In this study, we exploredan alternate possibility to address this need by exploiting coralyne-mediated DNA photo-sensitisation to low and non-toxic doses of UVA radiation. Current investigation also illustrates an overview of the mechanism of action underlying coralyne mediated photosensitization of cancer cells.

Introduction

Photochemotherapy uses a chemotherapeutic agent with photosensitizing property in combination with light to enhance the efficacy of the drug for cancer treatment with less side effects and without developing drug resistance (Postiglione et al., 2011). Many of the currently available targeted pharmacological therapies involving inhibitors of protein kinases, proteasome, histone deacetylase, telomerase and topoisomerase may be integrated with the photosensitization property of the drugs to provide better and more efficient anti-cancer photomedicines. Photomedicine has been successfully used in the diagnosis and treatment of superficial skin cancer, as well as lung and tracheobronchial, oesophageal, and bladder cancers, pituitary tumors and Barrett's esophagus. Combination of photodynamic therapy (PDT) and chemotherapy has been reported to provide synergistic effects for different diseases.The natural alkaloids (berberine, jatrorrhizine etc.) and a synthetic alkaloid(coralyne) protoberberine(Fig. 1) show impressive anticancer property invarious cancer cell lines due to their ability to bind to DNA and inhibit the topoisomerases. (Gatto et al., 1996 and Zhang et al., 2012)

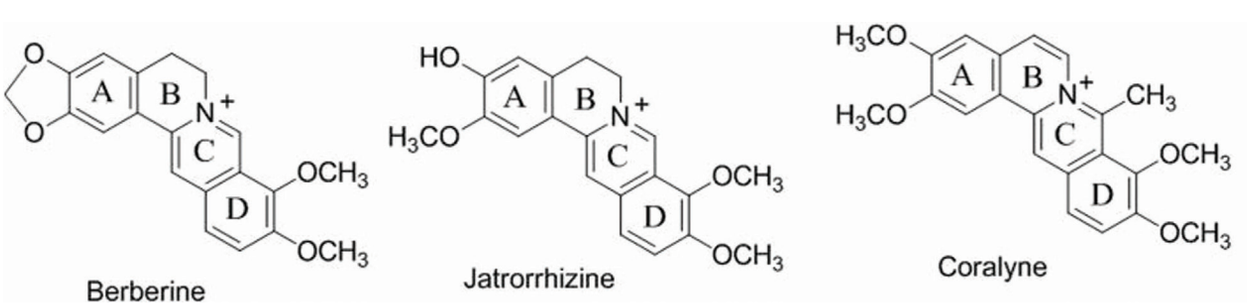

Fig.1:Chemical structures of berberine, jatrorhhizine and coralyne.

In PDT, the excited photosensitizer (PS) can directly react with a substrate (*e.g.*, DNA) in an oxygen-independent manner via transfer of an electron and/or a hydrogen atom to produce the substrate free radical (type I process). In an alternative indirect pathway (type II process), the PS transfers energy and/or electron to the O_2 molecules in the ground-state to generate reactive oxygen species (ROS) such as singlet oxygen ($^1O_2$) or superoxide anion ($^{\cdot-}O_2$), which subsequently reacts with the substrate. Although coralyne was reported to induce photo-nicking of plasmid DNA in a ROS-independent manner,the photochemical mechanism of the CUVA process remains unknown. Further, coralyne shows very interesting and complex behaviour in DNA binding. At high concentrations, it intercalates with DNA, but can also stack externally to stabilize DNA triple helices, and induce G-quadruplex structures.Studies performed with coralyne and several of its derivatives revealed the importance of the C-8 methyl substituent and the C-5,6 unsaturation in the protoberberinesfortheir antitumor activity against L1210 and P388 leukemias in mice. More recently, we reported significant enhancement of the anti-cancer property of coralyne in presence of UVA exposure, and the combination of coralyne and UVA(designated as CUVA) showed superior efficacy over the clinically-used psoralen and UVA (PUVA) combination in inducing apoptosis in several human carcinoma cell lines (Patro et al., 2010). Importantly, CUVA sensitized a wide range of human carcinoma cells regardless of their p53 status. Since approximately 50% tumors have defects in the p53 pathway, our results may be of clinical relevance. Here, we illustrate an overview of the mechanistic details of CUVA mediated photosensitization of cancer cells *in vitro*.

CUVA induces apoptosis in A431 skin carcinoma cells:

Previously we have shown that survival of A431 cancer cells reduced drastically in response to CUVA treatment. Here in the current investigation we sought to know whether CUVA treatment induced cancer cell death involves apoptosis. We looked for apoptosis-specific (i) sub G1 population and (ii) morphological changes. Initially CUVA treatment induced sub-G1 population in A431 cells was analysed, by flow cytometry, with different concentrations of coralyne (1-10 μM) and a fixed dose of UVA (20 J/m^2/s, 0.5 h). Our result showed that coralyne (1-10 μM) or UVA light (20 J/m^2/s, 30 min) treatment alone induced a marginal ~2% increase in sub-G1 population in A431 cells (Fig. 1). Interestingly, the combined CUVA treatment induced robust apoptosis at 48 h, as analysed in term of sub-G1 population, which was

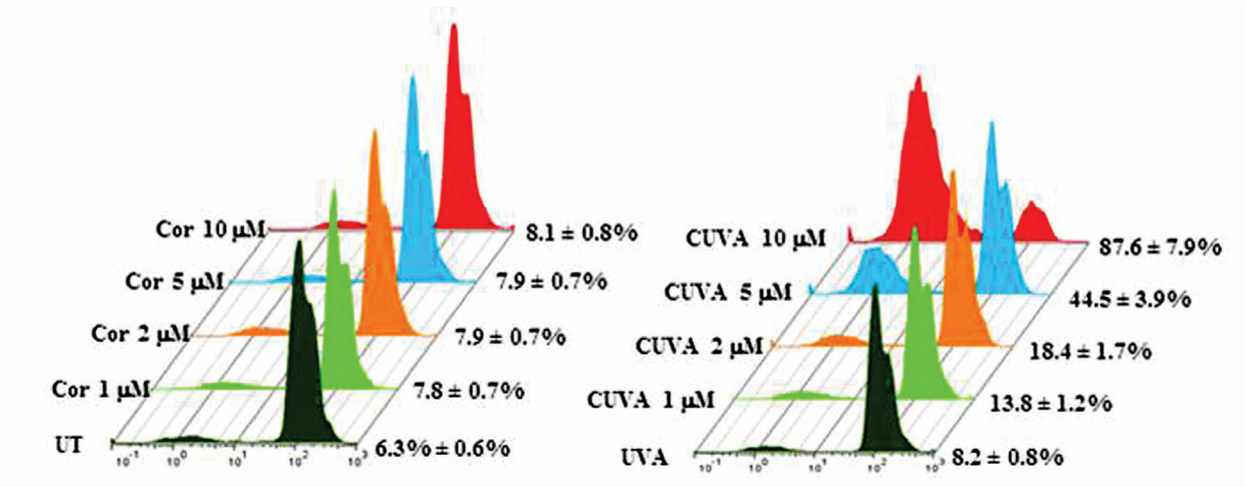

Fig.1: CUVA mediated photosensitization process kills cancer cells: Analyses of the sub-G1 population of the CUVA-cancer treated cells. TheA431skin carcinoma cells (1 × 10^5 cells /well) were treated with (i) coralyne (0-10 μM) alone (ii) UVA (30 min, dose rate: 20 J/m^2/s) or (iii) CUVA at the coralyne concentration of 0-10 μM. The sub-G1 cell populations were analyzed at 48 h by flow cytometry. Labels UT and cor represents untreated and coralyne treatment.

52 and 87% at 1, 2, 5 and 10 μM coralyne in CUVA treatment respectively (Fig. 1). Since, CUVA treatment at the coralyne concentration of 5 μM effectively induced ~50% cell death in A431 cells, rest of the studies were performed by using this concentration. Further, CUVA treatmentinduced alteration in cell morphology in a coralyne concentration dependent mannerwith increasing number of shrinking cells, blebbed membranes and condensed chromatin. These results establish the photosensitizing ability of CUVA treatment in A431 cells.

CUVA induced apoptosis in cancer cells is mediated through caspases and PARP

Next, we investigated whether caspase activation is required for the CUVA-induced apoptosis. Our results showed that caspase-8 and caspase-9 activation/cleavage in A431 cells ensued as early as at 8 h and remains steady thereafter in response to CUVA (coralyne 5 μM) treatment (Fig.2). However, caspase-3 activation was progressively increased from 8 h to 24 h after CUVA treatment. Further, the activation of caspase-9 and caspase-3 (cleaved caspases) correlated with disappearance of respective procaspases (Fig.2). Interestingly, we observed a dramatic increase in procaspase-8 expression up to 8 h, which remained steady thereafter in response to CUVA treatment (Fig.2). Besides, CUVA treatment led to dramatic disappearance of PARP protein, which indicates conventional role of PARP in the apoptosis process (Fig.2).

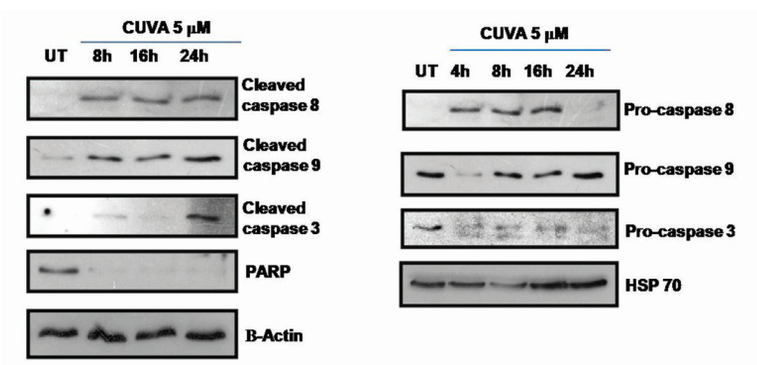

Fig. 2:Activation of apoptosis specific caspases and PARP in response to CUVA treatment.The A431 cells were untreated ortreated CUVA (coralyne, 5μM) for different time periods, and the activation of the caspases were assessed by the appearance of respective cleaved caspasesor cleavage of respective procaspases and PARP proteins in the whole cell extracts by immunoblotting. HSP70 and b-actin was probed for loading controls.

CUVA treatment elicitsa cascade of events leading to mitochondrial dysfunctions

Since CUVA treatment caused the activation of caspase -9 and caspase-3, which may be activated through mitochondria mediated intrinsic pathway in apoptosis. To unravel the role of mitochondria in CUVA mediated cell death process, we examined CUVA-induced were untreated ortreated with CUVA (coralyne, 5μM) for different time periods, and the activation of the caspases were assessed by the appearance of respective cleaved caspasesor cleavage of respective procaspases and PARP proteins in whole cell extracts by immunoblotting. HSP70 and β-actin was probed for loading controls.

changes in mitochondrial membrane potential ($\Delta\Psi_m$) and release of pro-apoptotic molecules from the mitochondria into cytosol. Our result showed that, although UVA and coralyne (5 μM) treatment alone induced only a marginal loss in $\Delta\Psi_m$ up to 3 h, the CUVA treatment induced a rapid loss of $\Delta\Psi_m$ to 60 % at 2 h which was progressively reduced further to 28 % at 3 h (Fig. 3A). However, the $\Delta\Psi_m$ was recovered to ~50 % at later time points (up to 12 h).Sinceapoptotic BCL-2 family members, especially BAX, BCL-2, BAD and BID play crucial role in mitochondrial mediated cell death process, we also analyzed the expressions of these proteins in the CUVA-treated cells. Our results showed that, BAX expression was increased while BCL2, BAD and BID were reduced significantly in a time dependent manner in response to CUVA treatment (Fig. 3B).These observations indicate that differential expression leading to imbalance in the ratio of BCL-2 proteins might cause

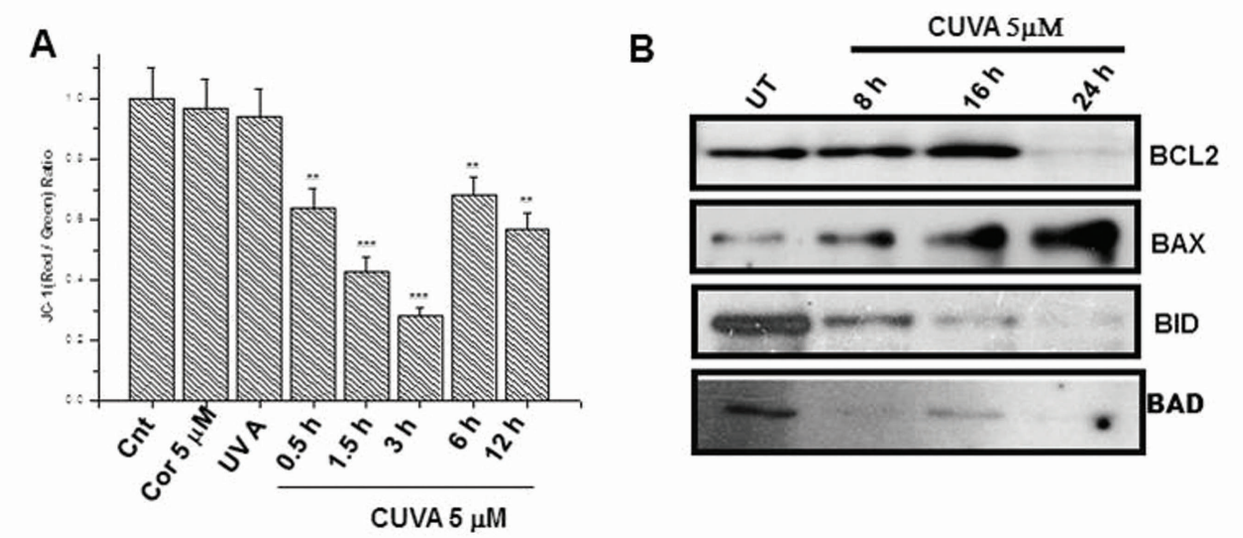

Fig. 3.CUVA-induced mitochondrial dysfunction is mediated through BAX/BCL-2 imbalance. (A) CUVA-induced $\Delta\Psi_m$ loss. A431 cells (1 × 10^5 cells /well) were untreated or treated with coralyne (5 μm), UVA (0.5h) or CUVA (coralyne, 5 μm) for different time periods. The cells were treated with JC-1 during last 30 min of the respective time points, and $\Delta\Psi_m$ were determined by flow cytometry from the retention of the red fluorescence due to JC-1 aggregates (upper panel). Simultaneously, the $\Delta\Psi_m$ loss was also determined by measuring the JC-1 monomer (green fluorescence). The ratio of red/green fluorescence was quantified and shown in the above panel. (B)Expression of BCL-2 family proteins. The cells were treated as above for different time periods. The expressions of the proteins in the whole cell extracts were assessed by immunoblotting.

mitochondrial dysfunction related cell death. To understand the role of these proteins, we depleted BAX and BID transiently in A431 cells by using specific siRNA targeted to BAX and BID mRNA respectively.Treatment of A431 cells with BID and BAX specific siRNA for 48 h led to depletion of BID and BAX proteins by ~84 and ~92 % respectively. Although, CUVA induced cell death remained unaffected in BID siRNA treated cells, the corresponding death process was reduced by ~80% in BAX siRNA treated cells. These results indicate that BAX plays a pivotal role in CUVA mediated photosensitization of cancer cells.

Replication is crucial for generating double strand breaks (DSBs) in CUVA mediated photosensitization process

Amongst the various types of DNA damages, the consequence of DSBs are considered most severe as they can initiate genomic instability, leading to cancer. DSB induction also forms the basis of the therapeutic roles of many anti-cancer agents(Helleday et al., 2008). One of the first cellular responses to DSB induction is the generation of the phosphorylated H2AX (γ-H2AX), which increases linearly with the severity of the damage (Rogakou et al., 1998).Earlier CUVA was found to induce single strand breaks (SSBs) in the A549 cell line (Patro et al., 2010). Given that CUVA is highly potent against a number of cancer cell lines, it was of importance to examine if the CUVA-induced SSBs get converted to DSBs, and if so, whether the process is mediated by replication or repair machinery. To this end, we assessed the time-dependent generation of γ-H2AX in the cancer cells by immunoblots after treatment with coralyne (5 μM), UVA (0.5 h exposure) and their combination (CUVA). Individually, coralyne or UVA did not produce significant γ-H2AX even up to 24 h. However, CUVA initiated the γ-H2AX formation at ~4 h whichincreased progressively (2.3-4.7 fold) compared to the control values at 4-24 h (Fig. 4A). Besides, we also confirmed the physical accumulation of DNA DSBs by the neutral comet assay. Coralyne (5 μM) and UVA treatment alone induced marginal changes in comet tail length up to 24 h. However, significantly lager comet tails were generated time dependently in response to CUVA treatment

(Fig. 4B). Together, our results confirmed the formation of CUVA-dependent, but apoptosis-independent DSBs in the cancer cells.

Previously we have shown that CUVA induced DNA damage elicits ATM-mediated S-phase arrest, which was abrogated in the presence of an ATM-specific inhibitor (Patro et al., 2010). This suggested that replication machinery in S-phase may play a pivotal role in interacting with the CUVA-induced SSBs. To test the putative role of replication machinery in

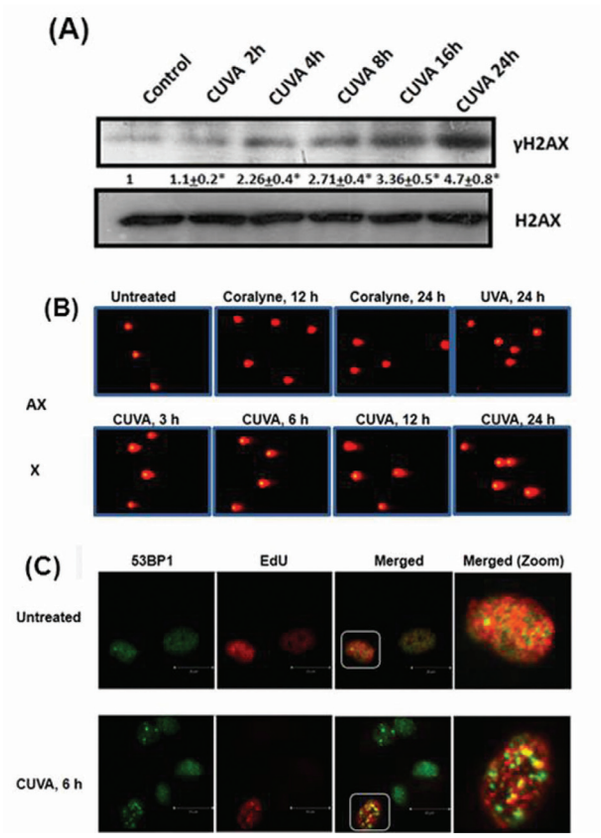

Fig. 4: The cancer cells were treated with coralyne (5 μM), UVA (30 min) or CUVA and subsequently allowed to recover for different time points. The γH2AX induction in **(A)** CUVA treated cells were assessed by western blotting. The total H2AX was also assessed for loading control. The results are expressed in fold increase in γ-H2AX level, considering that of the untreated control cells as 1.**(B)**For the neutral comet assay the electrophorased and dehydrated cells were visualized under a fluorescence microscope after staining with EtBr. Representative images, captured with a CCD camera are shown. The representative confocal images **(C)** of the indirect immunofluorescence of EdU (red) and 53BP1 (green) in untreated and CUVA-treated cells are shown. The yellow colorations in the merged images show co-localization of EdU and 53BP1 foci.

generating DSBs by CUVA, we examined whether the replication machinery, labeled with EdUcolocalizes with the p53 binding protein 1 (53BP1). The 53BP1 protein rapidly accumulates at DSBs in mammalian cells to form discrete foci and co-localize with several DSB repair proteins including γ-H2AX, providing the required scaffold structure for DSB repair. As shown in Fig. 4C, 53BP1 protein was preferentially located in diffused form in the untreated and CUVA-treated cells up to 1 h. However, at > 3 h, it got mobilized and distributed, preferentially co-localizing in replication foci (EdU) throughout the nucleus in the CUVA-treated cells. CUVA treatment led to a time-dependent increase in the number of 53BP1 foci, amounting to an average of 2.4 and 5.2 foci per cells at 3 h and 24 h respectively. This results indicated that CUVA induced SSBs are slowly converted into DSBs by active replication forks.

CUVA induces ATM/ATR-mediated DNA damage response and p38 MAPK activation

Based on the above results, we hypothesized that the CUVA-induced DSBs and putative DNA damage response could lead to the mitochondrial dysfunction through p38 MAPK activation. The ATM and ATR kinases play distinct, but overlapping roles in response to DNA DSBs. To substantiate the hypothesis, auto-phosphorylation at Ser-1981 ATM, and ATR-mediated Ser-345 phosphorylation in CHK1 protein and FANCD2 mono-ubiquitinationwere analyzed. As shown in Fig. 5A, CUVA treatment (coralyne, 5μM) induced a significant amount of phosphorylation on ATM-Ser1981 in a time dependent manner. Intriguingly, although ATR mediated CHK1-Ser345 phosphorylation was not elicited, ATR specific FANCD2 mono-ubiquitination was significantly increased in response to CUVA treatment (Fig. 5B). As a control for DDR response, cells were treated with CPT (1 μM, 3 h) and IR (8 Gy, 1 h), which induced modification in ATM, CHK1 and FANCD2 proteins. Above results show that CUVA treatment activates a canonical ATM- and non-canonical ATR

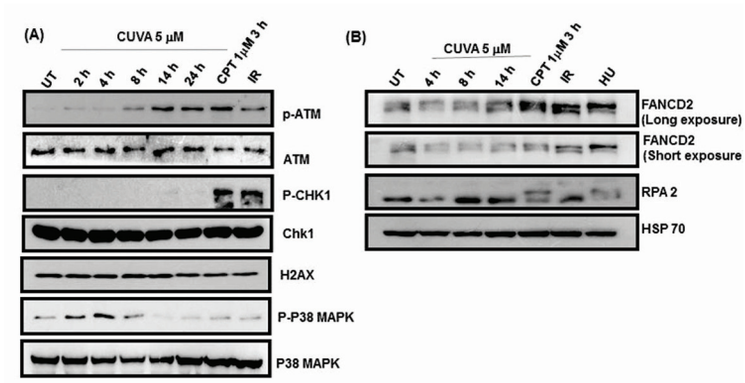

Fig. 5: CUVA-induced DNA damage response (DDR).A431 cells (1×10^6 cells) were untreated or treated with coralyne (5 μM), UVA (0.5h) or CUVA (coralyne, 5 μM) for different time periods. Expression and modifications in various DDR proteins were analysed by immunoblots.

pathway. Besides, we have also observed that p38 MAPK was rapidly phosphorylated within 2 h of CUVA treatment, which was further increased up to 4 h and reduced at later time point (8-24 h) (Fig. 5A)

CUVA treatment activates ATR-p38and JAK2-STAT1 pathways to induce BAX mediated apoptosis

Next, we determined whether down-regulation of ATM or ATR in the A431 cells impairs p38 MAPK response following CUVA treatment. For this, the ATM-depleted cells were generated using ATM mRNA specific shRNA. As ATR is an essential gene, and stable ATR-knockdown cells are not viable, we used siRNA to obtain the transiently ATR-depletedcells. Our result showed that, CUVA induced p38 MAPK remained unaltered in ATM-depleted cells, indicating no role of ATM in this process. Further, the activation of p38 MAPK pathways in ATR-siRNA treated cells was determined. ATR siRNA treatment caused significant decrease in ATR protein by 80 % vis-à-vis scrambled siRNA-treated cells as a control (Fig. 6A).Down-regulation of ATR led to abrogation of CUVA treatment induced p38 MAPK activation in ATR-siRNA treated cells as compared to scrambled siRNA treated cells (Fig. 6A). These results suggested a predominant role of ATR signalling pathways in p38 MAPK activation by CUVA treatment. Further to probe the role of ATR-p38 MAPK pathway in CUVA treatment induced apoptosis, we analysed CUVA-induced apoptosis in A431 cells pre-treated with p38 MAPK specific inhibitor. Inhibition of p38 MAPK supressed CUVA induced BAX expression by ~48% and apoptosis (sub-G1 population) by ~62%. This establishes a significant but partial role of ATR-p38 MAPK pathway in BAX expression and apoptosis. Since BAX down-regulation significantly suppressed apoptosis, we sought to unravel other putative mechanisms whichmight be responsible for transcriptional expression of BAX parallel to ATR-p38 MAK pathway. Apart from p38 MAPK, p53 and JAK2-STAT1 proteins are known to transcriptionally activate BAX expressions. From our previous report and current study, we observed no increase in the level of p53 expressions. Hence we overruled any role of p53 in CUVA induced BAX expressions and cell death process. However, JAK2 phosphorylation at 221 and STAT1 phosphorylation at 701 and 727

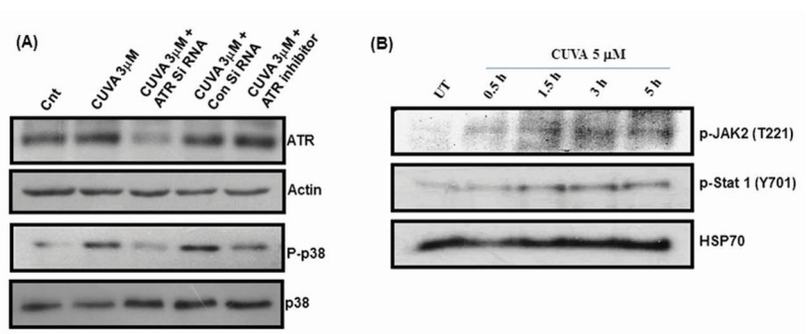

Fig. 6.CUVA-induce two parallel ATR-p38 and JAK2-STAT1 pathways. (A) Activation of ATR-p38 MAPK pathway. A431 cells were treated with respective siRNA for 48 h and subsequently untreated or treated with coralyne (5 μM), UVA (0.5h) or CUVA (coralyne, 5 μM) for different time periods. After 4h of CUVA treatment, p38 MAPK proteins were analyzed. (B) Activation of JAK2-STAT1 pathway.Cells were treated as above and phosphorylated forms of JAK2 and STAT1 were analysed by immunoblots.

amino acids rapidly occurred as soon as 0.5 h after CUVA treatment, which was increased further in a time dependent manner (Fig. 6B). Furthermore, the CUVA-induced BAX expressions and apoptosis were significantly reduced in cells treated with JAK2 specific inhibitor or siRNA. These results unravelled the hierarchy of molecular events in which ATR-p38 MAPK and JAK2-STAT1 pathway regulates BAX expressions leading to cell death in the CUVA-treated cancer cells.

Conclusions

Current investigation suggests that coralyne has potential as aphotochemotherapeutic drug. Its specific incorporation into the DNA of replicating cells suggests a highly targeted destruction of tumour cells, with minimal collateral damage to normal cells. Initially CUVA treatment induces DNA-DSBs in the cancer cells, which induces ATR-p38 MAPK-BAX activation and subsequent cell death. Our investigation also established that another pathway activates BAX expression in a DNA damage independent manner to induce mitochondrial dysfunction and cell death. Although the in vitro studies must be regarded as preliminary, they are encouraging enough to warrant confirmation withvarious cancer models in animals. Froma practical point of view, the development of CUVA photochemotherapy should include the development of custommadeUVA sources, taking into account possible changes in optical properties of coralyne when it gets incorporated into the DNA.

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Delayed Time Response Self-Powered Neutron Detectors for Reactor Control

A.K. Mishra and A.P. Tiwari
Reactor Control Division

Abstract

Large nuclear reactors like 540 MWe PHWR employ a large number of in-core detectors for flux monitoring and core control. For flux monitoring, the detectors with (n,β) characteristics like Rhodium and Vanadium Self Powered Neutron Detectors (SPND) are preferred due to their higher accuracy. However, these detectors respond slowly to changes in neutron flux. The slow response time characteristics of these detectors preclude their direct use for reactor protection and regulation applications. Whereas, by overcoming their inherent time delay, it is possible to use them in such applications. In this article, the use of dynamically compensated delayed time response detectors for controlling the reactor bulk power have been demonstrated using the plant data collected from the 540 MWe PHWR units. This puts the possibility of using delayed response time neutron detectors in lieu of prompt responding detectors like Cobalt, Inconel or Platinum SPNDs for reactor protection and regulation applications.

Introduction

Self Powered Neutron Detectors (SPNDs) are being widely used to monitor in-core neutron flux for control, safety, and mapping applications because of their small size, ruggedness and simplicity. These detectors use the basic radioactive decay process of its neutron activation material to produce an output signal. As the name implies, no external source of ionizing or collecting voltage is required to produce the signal current. Depending on the response time, these detectors are broadly classified as prompt and delayed response detectors. Prompt response detectors as Cobalt and Inconel are used in reactor protection and regulation applications, whereas the delayed response detectors like Vanadium and Rhodium are being widely used for Flux Mapping System (FMS) [1]-[2]. In 540 MWe PHWRs, 42 Cobalt / Inconel and 102 Vanadium SPNDs are used.

The slow response time characteristics of delayed neutron detectors preclude their direct use in reactor protection and regulation applications. However, merits offered by these detectors over prompt responding detectors in terms of higher sensitivity and signal strength make them desirable for use in such applications [1].

To deploy the delayed responding detectors for reactor regulation and protection applications, the approach is to first compensate for the delay by passing the signal through a dynamic compensator and then use this compensated signal for correction in Power Measurement and Correction Routine (PMCR) of the Reactor Regulating System (RRS). The approach provides the likelihood of deployment of Vanadium SPNDs (VSPND) for reactor protection and regulation applications as well as to fulfill core monitoring and surveillance requirements.

Various dynamic compensation algorithms for improving the response time characteristics of Vanadium SPNDs are discussed in [1]-[4]. In this article, a new algorithm for improving the response characteristic of Vanadium SPND is presented and the same is used for demonstrating their use for reactor bulk power regulation. Validation of proposed scheme for bulk power correction is carried out using plant data collected from the operational 540 MWe PHWR units 3 & 4 of Tarapur Atomic Power Station (TAPS).

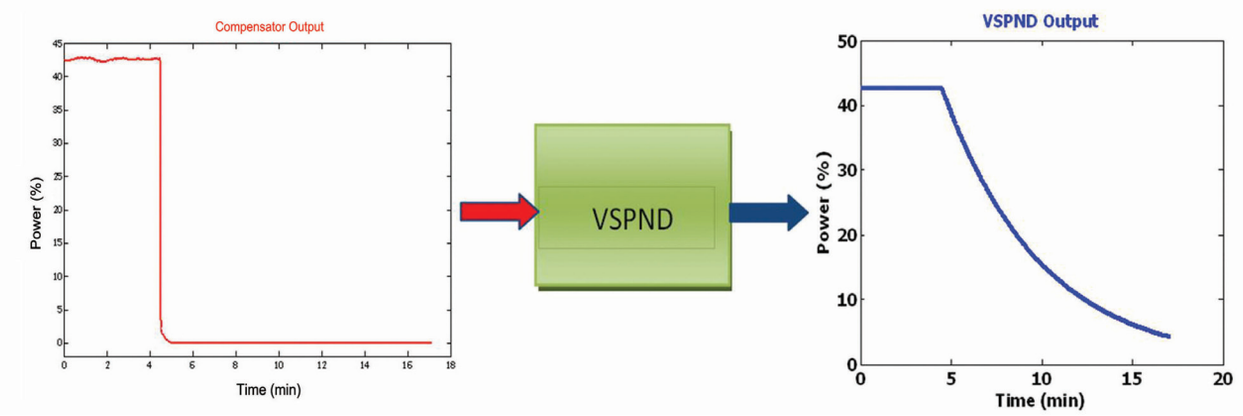

Fig. 1: Input Output Response of Vanadium SPND

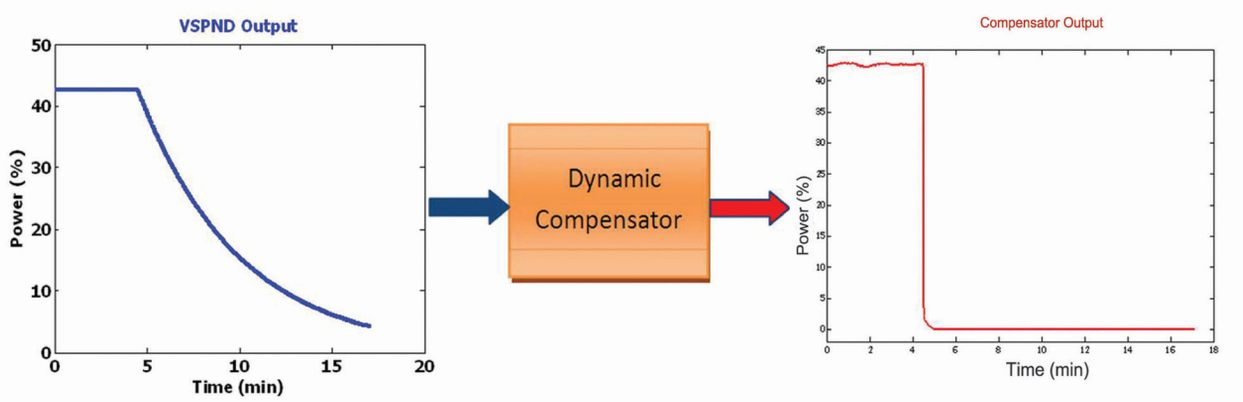

Fig. 2: Input Output Response of Vanadium SPND Compensator

Response of Vanadium SPND and its Dynamic Compensation

Fig. 1 shows the typical input – output response of VSPND, from which it is evident that output of vanadium SPND takes approximately 20 minutes to stabilize compared to its input. However, for controlling the rapid power transients, it is essential to have a faster time response. The dynamic compensator does this job and converts delayed responding detectors into prompt one, as depicted in Fig. 2.

Various model based dynamic compensators are proposed by the authors for improving the response time of Vanadium SPNDs [1]-[4]. Here, a different realization of dynamic compensator in discrete time is developed and given as:

$$P_{c,k}=x_{v,k}+\frac{1}{f_p}P_{v,k}, \quad (1)$$

$$x_{v,k}=\alpha f_p\, x_{v,k-1}-\frac{1}{f_p}(1-\alpha)(1-f_p)\,P_{v,k}, \quad (2)$$

where $\alpha=\frac{\tau_v}{T_{k,k-1}+f_p\tau_v}$, $T_{k,k-1}=T_k-T_{k-1}$.

In (1)-(2), the symbols f_p, τ_v, $T_{k,k-1}$, $P_{v,k}$, $P_{c,k}$ represent detector prompt fraction, detector time constant, sampling time, Vanadium output signal and Compensator output signal respectively. $x_{v,k}$ represents an internal variable or state for the VSPND. The Vanadium SPND senses the neutron flux inside the reactor core and produces the equivalent current signal as output, which is fed to the dynamic compensator as shown in Fig. 3.

Existing and Proposed Scheme for Bulk Power Correction in 540 MWe PHWR

Reactor Regulation System (RRS) of 540 MWe PHWR utilizes 42 number of fast responding Cobalt SPNDs (CoSPND). These detectors, three per zone, are located

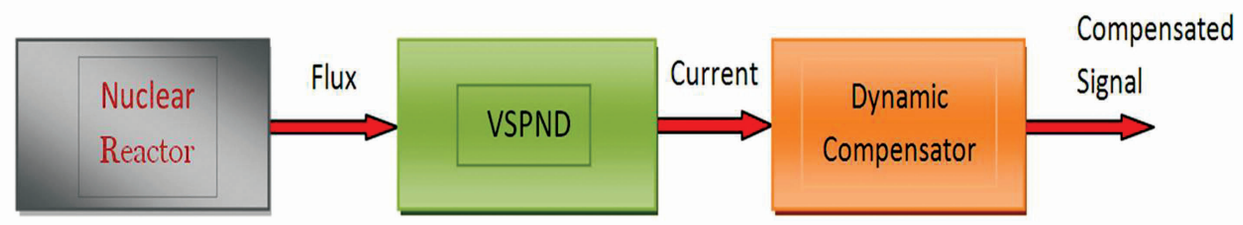

Fig. 3: Tandem Connection of Dynamic Compensator with Vanadium SPND

in Vertical Flux Units (VFU). Reactor Bulk power and 14 Zonal powers are computed from these 42 detector signals and utilized for computation of effective power error signal for reactor control after correction in Power Measurement and Correction Routine (PMCR) [1],[5]. The correction of bulk power and zonal power signals are essential since these detectors gives the point flux measurements and sometimes affected by background signals. Reactor bulk power is corrected using the reactor thermal power. The existing scheme of correcting the reactor bulk power is shown in Fig. 4. The uncorrected reactor bulk power (P_u) computed from Cobalt / Inconel SPNDs is passed through a first order lag filter (Thermal Lag Model) of 20 seconds time constant to bring the reactor thermal power $(P_{T/H})$ and uncorrected reactor bulk power on same time scale before comparison. The reactor bulk power correction factor (Δ_s) is the difference between the reactor thermal power and bulk power. This correction factor is passed through a smoothening filter before its application to correcting the bulk power. Smoothening of reactor bulk power correction factor is essential to avoid the effects of any transients from secondary side [5]. The corrected bulk power signal is obtained by adding the smoothened correction factor (Δ_{Sf}) to uncorrected reactor bulk power.

It is well established that the compensated bulk power signal based on Vanadium SPND signals is in very good agreement with the Cobalt SPND signals [1] – [4]. Therefore, compensated bulk power signal (P_u) can be considered in place of uncorrected bulk power signal obtained using Cobalt / Inconel

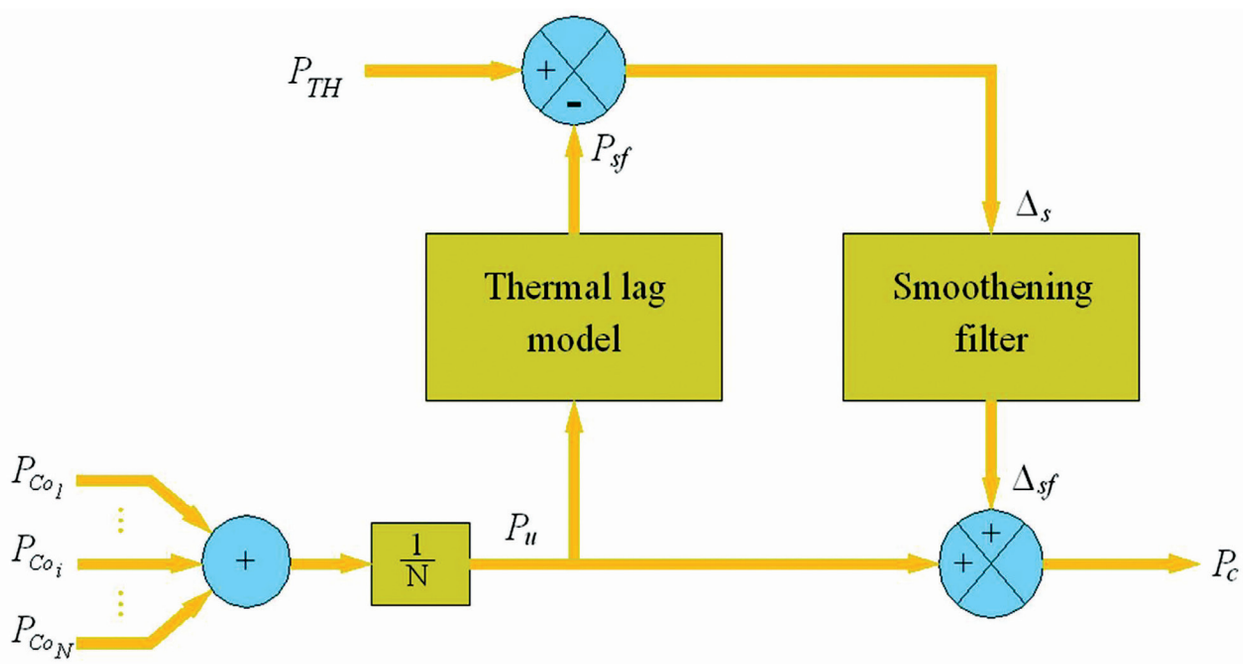

Fig. 4: Schematic of PMCR for correction of reactor bulk power using Cobalt / Inconel SPND signals (Existing Scheme).

SPNDs. The modified PMCR scheme is shown in Fig. 5. Comparison of the scheme shown in Fig.4 with that shown in Fig.5 reveals that an additional block of dynamic compensator is required when VSPND signals are used.

Advantage of using VSPND signals for reactor control will be in terms of cost (saving of the cost of detectors for control and associated electronics), less reactivity load (reduction of neutron poisons i.e. control detectors), and enhanced reactor safety (less penetrations in calandria).

Simulation Results and Discussions

To compare the responses of existing and modified PMCR schemes, plant data corresponding to reactor thermal power, Vanadium SPND signals and CoSPND signals are collected from the COIS of 540 MWe PHWR. Bulk power is computed using CoSPND signals is prompt in nature basically due to promptness of detector while the computed bulk power using Vanadium SPND signals are delayed in nature. The delayed bulk power signal obtained using VSPND signals is compensated dynamically by processing it

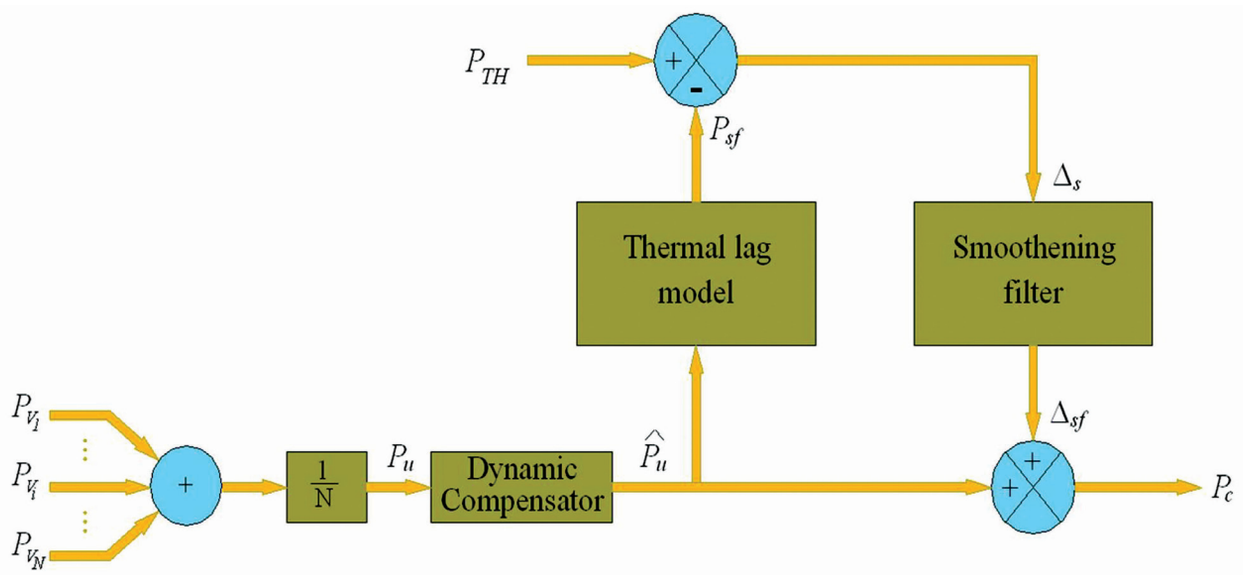

Fig. 5: Schematic of PMCR for correction of reactor bulk power using compensated Vanadium SPND signals (Proposed Scheme).

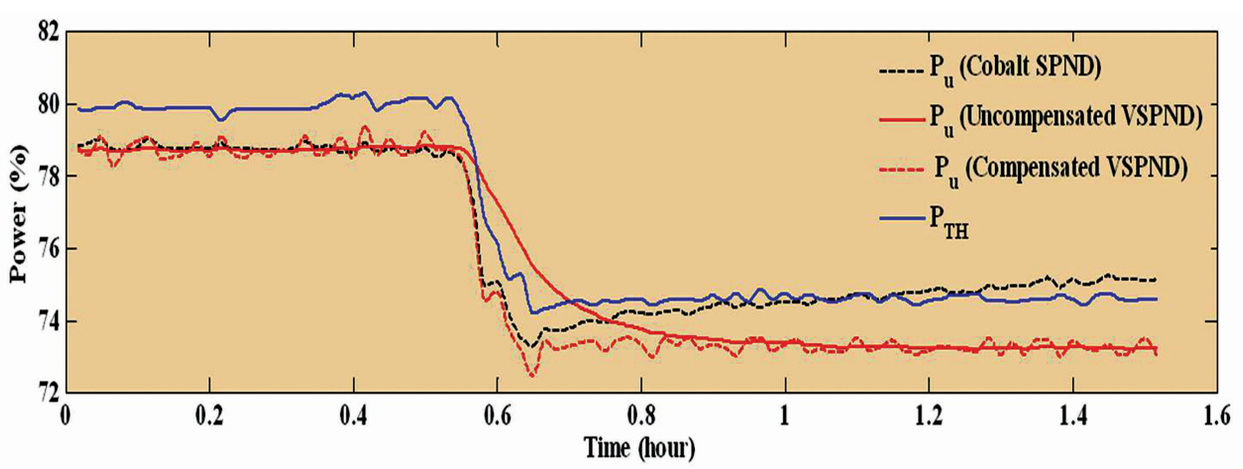

Fig. 6: Variation of Reactor thermal power signal (P_{TH}), Uncorrected reactor bulk power computed using Cobalt SPNDs (P_u), Uncorrected reactor bulk power signal computed using Vanadium SPNDs (P_u), and Compensated VSPND bulk power signal (P_u) during a power-lowering transient.

through the dynamic compensator described by (1), (2). The responses of all four signals during reference transient are shown in Fig. 6. It can be observed that the compensated bulk power signal based on VSPND signals is as prompt as that obtained using Cobalt SPND signals.

The bulk power signal obtained using Cobalt SPND signals is corrected with thermal power as shown in existing PMCR scheme while bulk power signal obtained using Vanadium SPND signals are corrected with thermal power as per the modified PMCR scheme. The three signals i.e. reactor thermal power, corrected bulk power signal from existing scheme and corrected bulk power from proposed scheme are shown in Fig. 7 (a) and their magnified view is shown in Fig. 7(b). From Fig. 7(a), it can be depicted that both corrected power signals acquire the steady state accuracy of reactor thermal power while during transients it maintains the promptness of the bulk power signal (P_u or P_u). From Fig. 7(b), it is clear that corrected power obtained from modified PMCR scheme closely follows the corrected power obtained from the existing scheme. For quantitatively analyzing the degree of match between the two corrected bulk power signals, the error is computed for each signal as

$$\% \text{ error} = \frac{(\text{Thermal Power} - \text{Corrected Power})}{(\text{Thermal Power})}$$, and compared.

It is observed that percentage error between thermal power and corrected bulk powers during steady state is in the range of ± 0.2% for Cobalt SPND and ± 0.3% for compensated VSPND while under transients it is in the range of ± 1.4% and ± 1.5% for Cobalt SPND and compensated VSPND respectively. The error during transients is slightly large due to delay in thermal power. Again, from the error magnitudes it is clear that result for corrected bulk power for VSPND signals, is in good agreement with that of corrected bulk power based on Cobalt SPND signals.

Conclusions

In this paper, it is established that corrected bulk power signals obtained from existing PMCR scheme (based on Cobalt SPND) and proposed PMCR scheme

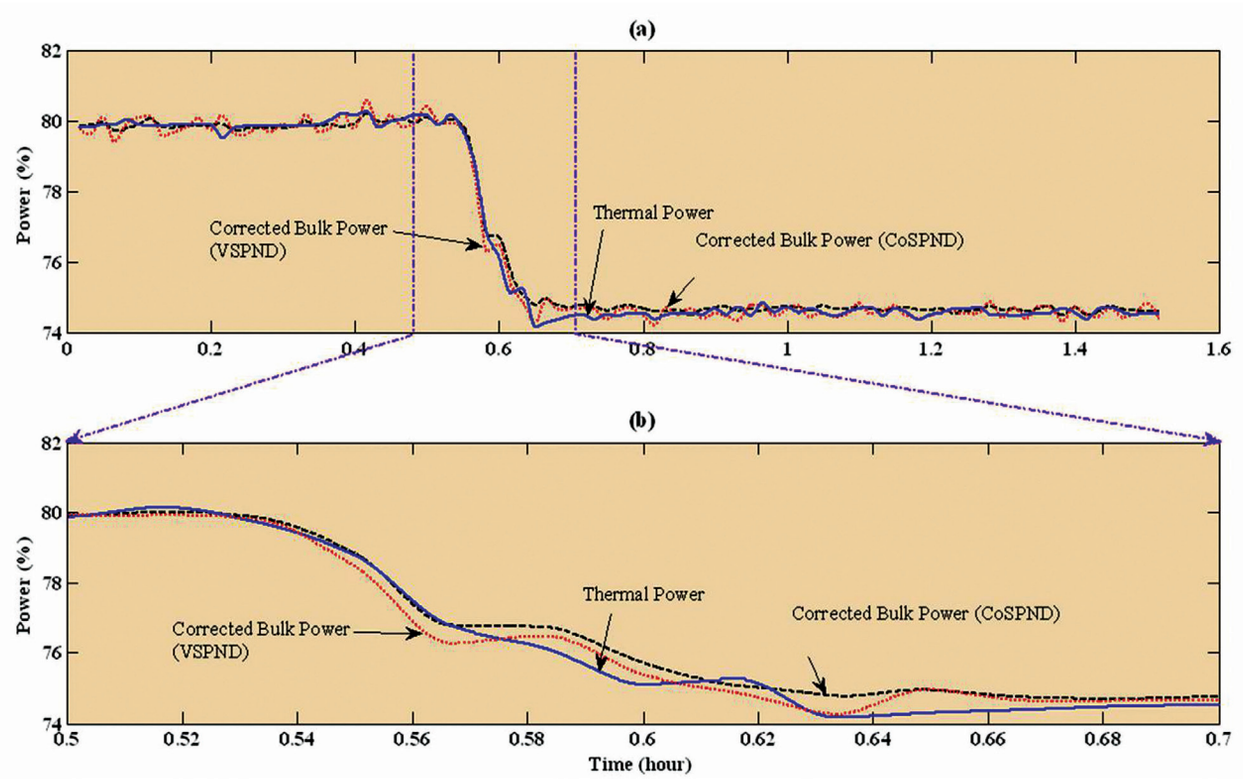

Fig. 7: (a) Comparison of responses of existing PMCR (Cobalt SPND) and Modified PMCR (Compensated VSPND), (b) Magnified view of (a).

(based on VSPND and its compensator) are in good agreement. This puts the possibility of using the same installed delayed neutron detectors in the reactor for core monitoring as well as for reactor regulation and protection applications. This eliminates the requirement of prompt responding detectors for reactor control and protection applications. This will lead to gain in terms of cost (saving of the cost of detectors for control and associated electronics), less reactivity load (reduction of neutron poisons i.e. control detectors), and enhanced reactor safety (less penetrations in calandria).

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Design, Development and Commercialization of ISOCAD (Integrated System Of Computer Aided Dosimetry) for Gamma Irradiators

Amit Shrivastava, Navneet Srivastava, A.K.Kohli
ISOMED, BRIT
and
Vinay Kumar Mishra, Ramnik Singh, A.K.Sinha
Centre for Design and Manufacture

Abstract

ISOMED facility is the indomitable architect of radiation sterilization era in the country providing the contract radiation processing services for the terminal sterilization of the healthcare products from the healthcare sector. ISOMED has acquired the international standards viz.ISO 9001, ISO 22000, ISO 13485, ISO 11137, OHSAS 18001, ISO 14001 that supplemented by European Union – GMP certification from MHRA – UK. One of the core focuses of these standards is the control of measuring and monitoring instruments with impeccable traceability features with respect to the quality critical processing data. The gamma radiation sterilisation process involves delivery of minimum 25 kGy of radiation dose to the healthcare products which is measured by internationally acclaimed *Cerric Cerric Potentiometric Dose Measurement Systems (CCPDMs)*. As the current variant of this system had extensive involvement of manual interventions, a novel, bar code based computerized application package called ISOCAD, incorporating portable risk free snapping tool for the dosimeter ampules has been synergistically developed by BRIT / BARC for the Cerric Cerrous Potentiometric Dose Measurement System for Gamma Irradiators. ISOCAD has been successfully operating in ISOMED and the techno commercial viability has been convincingly demonstrated to the operators of the gamma irradiators from the country as well as abroad. ISOCAD is now available as one of the commercial product packages from BRIT.

Introduction

The present generation of gamma irradiators operating worldwide and catering to the radiation processing requirements of medium and high dose products from the healthcare and food processing industry invariably resort to *Cerric Cerric Potentiometric Dose Measurement Systems (CCPDMs)*.

BRIT, being of the major suppliers of this dose measurement system in the country in particular and having expanded its clientele to the Asian continent as well in the recent past, had been endeavoring to provide its valued clients this internationally acclaimed dose measurement system at competitive pricing. The perpetually changing quality conscious business environment with demanding cGMP requirements particularly from the healthcare and the food sector propelled the development of the ISOCAD.

This system is essentially the ***computerized automated version of the present CCPDMs with impeccable operational features that substantially minimizes the potential occurrences of error events due to extensive manual data entry provisions available in the current variants.***

The ubiquitous cerric cerrus potentiometric dose measurement systems in the gamma irradiators operating in the country also deploy sealed 2 ml boro silicate glass ampoules. In order to facilitate electrochemical cell of the system to yield the radiation dose output, the glass ampoules require a circumferential cut across the neck. The current practices resort to an emery stone hammer

blow for snapping across the neck which bears the potential risk to the operator.

The internationally available portable tools with built-in improved safety features for this specific application are rather costlier and a monopolistic Minimum Order Quantity demand on the supplier's side deters this procurement mode.

It was therefore felt that an indigenous design and development of this tool would be beneficial to all the radiation processing facilities operational in the country. A portable, risk free snapping tool for the cerric cerrus dosimeter glass ampoule thus developed at CDM, facilitates a quicker and safe mode of the snapping of the glass ampoules and safe disposal of the snapped glass waste. This tool also can be conveniently deployed by the medical practitioners for break opening the injection ampoules.

ISOCAD - KEY FEATURES

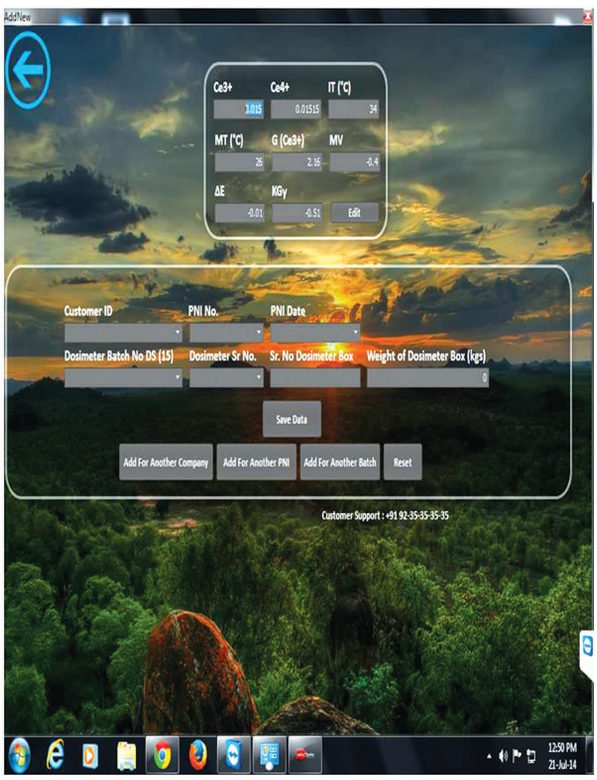
- An integrated Cerric Cerrus Potentiometric Dose Measurement System with automatic data entry for key quality parameters
- Unique DDD (Direct Dose Display) feature allows direct display of Gamma Radiation Dose on the Computer Screen
- No need to read voltage and then feed into computer
- Automatically Transfers the voltage generated in ECC to the Software
- Directly displays the dose in kGy once the ECC gives voltage output
- Dose is directly printed into Customer Order Processing Forms
- Bar code based read out for Dosimeter vials with improved traceability
- Dose Trending with multiple filter options
- With minimal manual data entry – System is counterfeit proof
- Complies in full to International cGMP requirements
- Minimal technical skills required to operate the system
- High reliability and precision of the dose read out
- Quick dosimetry read outs
- Low operating and maintenance cost
- Enhanced traceability in dosimetry
- Password protection for user authentication and data security
- Electronic form of data storage facilitates hassle free quality critical data archival
- Ease of data portability across various platforms
- The portable risk free snapping tool for the dosimeter glass ampule conforms to OHSAS 18001 requirements

System includes a state of the art, CE certified electronic data transfer device (between ECC and the computer), a back end custom made versatile proprietary software for providing a complete e dosimetry platform to the user containing features such as bar code generator, tool for generating graphs for dose trending with multiple filter options. System also includes the bar code scanner and the printer.

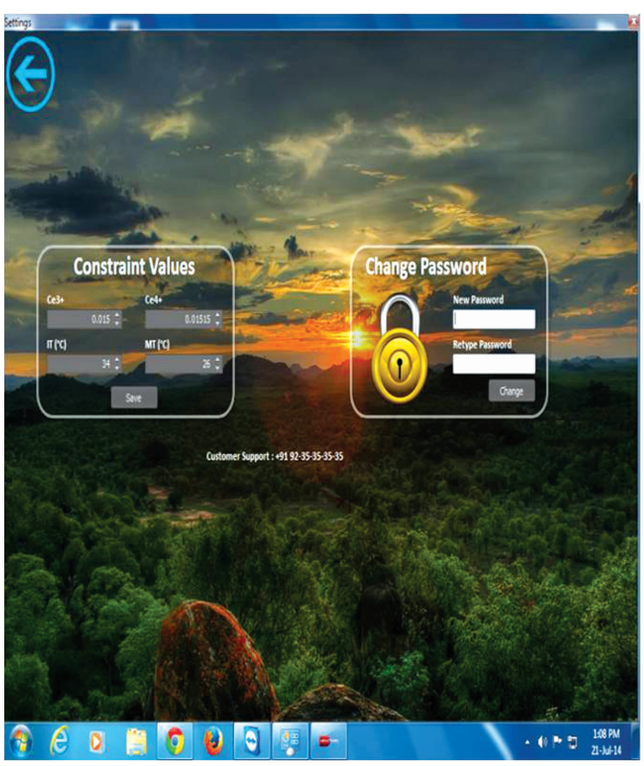
ISOCAD in operation

The following images display the screen shots of the operating environment of the ISOCAD.

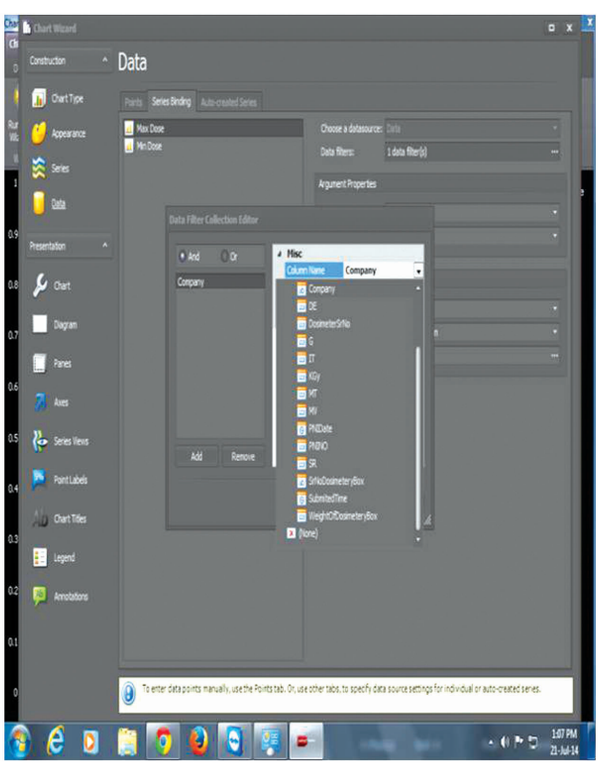
Main page of the software



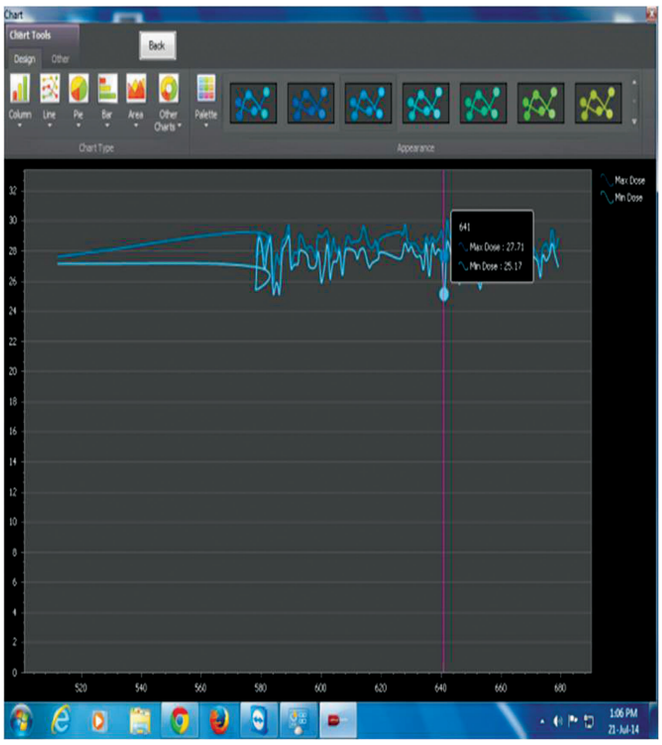
Direct Dose Display on screen



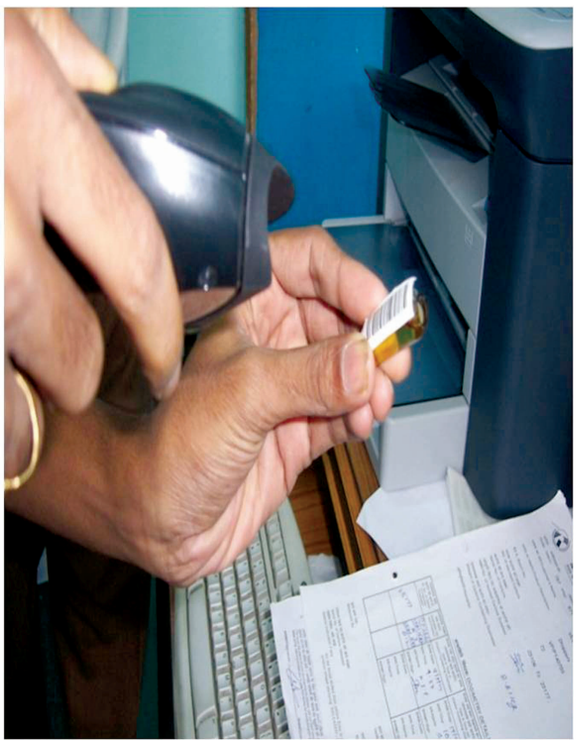
Filling dosimeter batch details under authorization



Multi filter options for Dose trending



Graph showing Maximum and Minimum dose variation For a particular customer over a period



Read out from bar coded dosimeter vial

ViewData

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PNINO	PNI Date	Dosimet...	Dosimet...	Sr No D...	Wight ...	Ce3	Ce4	IT	MT	MV	DE	G	KGy	Company	Submited Time
600	06-Jul-14	237	893	22149	8.98	0.015	0.01515	28	28	23.7	0.4	2.16	28.02	1238	08-Jul-14
600	06-Jul-14	237	894	22149	8.98	0.015	0.01515	28	28	23.9	0.4	2.16	28.23	1238	08-Jul-14
600	06-Jul-14	237	899	22149	8.98	0.015	0.01515	28	28	23.9	0.4	2.16	28.23	1238	08-Jul-14
600	06-Jul-14	237	900	22149	8.98	0.015	0.01515	28	28	23.9	0.4	2.16	28.23	1238	08-Jul-14
600	06-Jul-14	237	901	22249	8.99	0.015	0.01515	28	28	24.6	0.41	2.16	28.95	1238	09-Jul-14
600	06-Jul-14	237	902	22249	8.99	0.015	0.01515	28	28	24.6	0.41	2.16	28.95	1238	09-Jul-14
600	06-Jul-14	237	903	22249	8.99	0.015	0.01515	28	28	24.5	0.41	2.16	28.85	1238	09-Jul-14
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600	06-Jul-14	237	907	22308	8.54	0.015	0.01515	28	28	23.7	0.4	2.16	28.02	1238	09-Jul-14
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607	07-Jul-14	237	913	22799	13.5	0.015	0.01515	28	28	22.4	0.37	2.16	26.66	1238	09-Jul-14
607	07-Jul-14	237	914	22799	13.5	0.015	0.01515	28	28	22.4	0.37	2.16	26.66	1238	09-Jul-14
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605	07-Jul-14	237	917	22718	10.55	0.015	0.01515	28	28	23.4	0.39	2.16	27.71	799	09-Jul-14
605	07-Jul-14	237	918	22718	10.55	0.015	0.01515	28	28	23.6	0.39	2.16	27.92	799	09-Jul-14
605	07-Jul-14	237	919	22718	10.55	0.015	0.01515	28	28	23	0.38	2.16	27.3	799	09-Jul-14
605	07-Jul-14	237	920	22718	10.55	0.015	0.01515	28	28	23.4	0.39	2.16	27.71	799	09-Jul-14
595	04-Jul-14	237	921	21918	6.61	0.015	0.01515	28	28	23.7	0.4	2.16	28.02	07	09-Jul-14
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595	04-Jul-14	237	923	21918	6.61	0.015	0.01515	28	28	23.6	0.39	2.16	27.92	07	09-Jul-14

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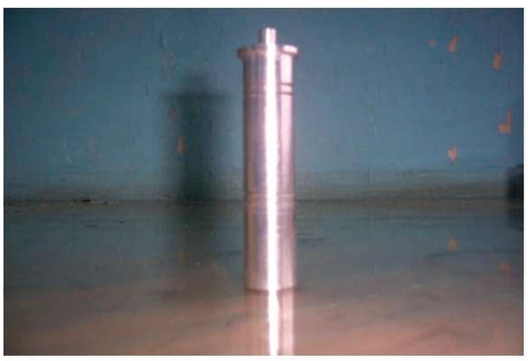
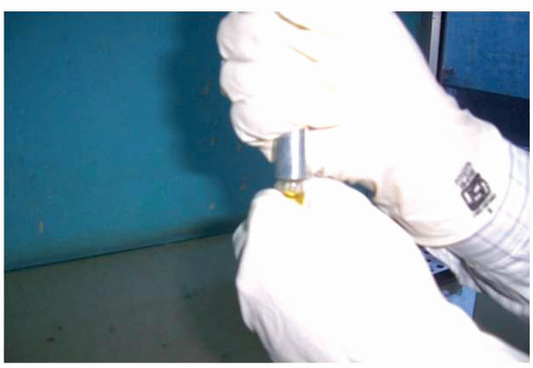
e data for dosimetry read outs

PORTABLE RISK FREE SNAPPING TOOL FOR DOSIMETER GLASS AMPOULE

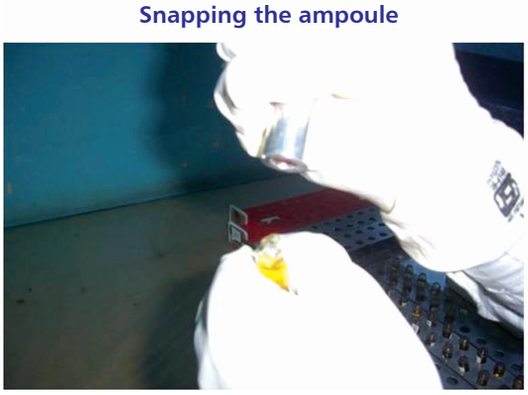
Actual Image



Tool-Ampoule alignment



Snapping the ampoule



Ejecting out the snapped glass

Conclusion

ISOCAD has been included in the product line of BRIT and is being made available commercially to the different irradiators operational in the country as well as those operating in the Asia Pacific region.

It is believed that deployment of the ISOCAD in the routine dosimetry applications in the commercial irradiators would bolster the quality and occupational safety infrastructure available with the facilities thus meeting the requirements of the internationally acclaimed cGMP requirements. The impeccable DDD feature of the system is expected to ensure quality critical dosimetry data security in a counterfeit proof manner. The irradiator operators would get extensively benefited resorting to this system as it would effectively address the quality concerns of their stake holders.

Acknowledgements

Authors are thankful to the staffs of ISOMED and CDM who have proactively contributed for the time bound development, testing and validation of ISOCAD for its commercial deployment in the gamma irradiators.

Director, BARC inaugurates Medical Examination Centre at BARC Facilities, Kalpakkam

Dr. Sekhar Basu, Director, BARC inaugurated the Medical Examination Centre of BARC Facilities (BARCF) at Kalpakkam on 16th October, 2014 in the presence of Shri Amitava Roy, Facility Director, Dr. Lilly Vijay, Medical Officer and Shri Biplab Das, Safety Officer. The medical examination centre is located at WIP and is equipped with the required infrastructure and various medical instruments including Audiometer, Electro Cardiogram and Body Mass Index (BMI) instruments. The necessity of this centre was felt due to the increasing number of employees as new plants are being constructed and commissioned by the Nuclear Recycle Board at Kalpakkam. The Integrated Nuclear Recycle Plant (INRP) of NRB at Kalpakkam has operating plants KARP-I (Kalpakkam Reprocessing Plant), CWMF (Centralized Waste Management Facility) and WIP (Waste Immobilization Plant), whereas the new Reprocessing plant KARP-II will be operational in 2015. In addition to NRB Facilities, the Nuclear Desalination Demonstration Plant (NDDP), the Water and Steam Chemistry Division (WSCD) and PRP are also part of BARCF. The total number of employees in BARCF is about 1100. This medical examination centre will be conducting periodic medical check up of the employees as per the provisions stipulated in the Radiation Protection Rules 2004 and the Atomic Energy (Factories) Rules 1996.

Dr. Sekhar Basu, Director, BARC inaugurates the Medical Examination Centre in the presence of Shri Amitava Roy, Facility Director, BARCF, Kalpakkam.

Director, BARC interacting with Dr. Lilly Vijay, Medical Officer. (From right to left: Dr. Sekhar Basu, Shri Amitava Roy, Shri Biplab Das, Safety Officer and Dr. Lilly Vijay)

BARC Scientists Honoured

Name of the Scientist/s	:	Munish Kumar, M.S. Kulkarni, Ratna P., Amit Bhatnagar, N. Gaikwad, K.P. Muthe, S.M. Tripathi, D.R. Mishra, S.D. Sharma, D.A.R. Babu and D.N. Sharma
Title of the Paper	:	Studies on α-Al_2O_3:C based OSL badge for eye lens monitoring in India
Name of the Award	:	Best poster paper award
Presented at	:	31st National Conference on Advances in Radiation Measurement Systems and Techniques, Organized by Indian Association for Radiation Protection (IARP) held at Bhabha Atomic Research Centre (BARC), Mumbai during March 19-21, 2014
Name of the Event	:	Academy conference on "Science and Technology for sustainable development" held at Indian Institute for Information Technology, Design and Manufacturing (IIITDM) Jabalpur, 20th March, 2014

Name of the Scientists	:	Rahul Singh, Ashwani Kumar, Biplab Ghosh, Sahayog Jamdar*, Ravindra Makde and S.M. Sharma
Affiliation	:	High Pressure & Synchrotron Radiation Physics Division, *Food Technology Division
Name of the Award	:	Best poster award
Title of the Paper	:	Crystal structure of mitochondrial intermediate peptidase (Icp55) from S. cerevisiae
Presented at	:	International Symposium-cum-Workshop on Frontiers of Structural Biology: New advances in X-ray diffraction and Cryo-electron Microscopy. Organized by Indian National Science Academy, New Delhi & Regional Centre for Biotechnolgy, UNESCO, New Delhi and held at Indian National Science Academy, New Delhi, 15-17 Dec. 2014.

Modular Lab at BARC

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