CATEGORIES OF POSSIBLE PROJECTS WITH I.I.Sc., Bangalore UNDER BRNS SCHEME

Sr No.	Category	Number of proposals
1	Sensor development	12
2	FM & Heat Transfer	10
3	CFD / Codes development	4
4	Seismic and Civil Structures	12
5	Structural/Fracture/Fatigue studies	7
6	Reliability	1
7	Environment	3
8	Extractive metallurgy – electrorefining	2
9	Materials/alloys	6
10	NPP accident	2
11	Corrosion	2
12	Cn I D	10
13	Computer / Database	6
14	Chemical Engineering	8
	TOTAL	**85**

BRNS –possible projects:Consolidated: Domain-wise

1 Sensor development

Sr. No	Project title	Scope of work
1 HSK	Development of wireless sensors	Development of wireless sensors for temperature, pressure, humidity, strain/stress force, displacement, fluid velocity and void fraction in single and two phase flows
2 HSK	Under water acoustic sensors for low frequency measurement and their field evaluation	Development of under water acoustic sensors and evaluation of signal processing techniques
3 HSK	Design and fabrication of multi leaf collimators for high energy X rays	Radiotherapy treatment of cancer patients requires highly irregular shaped fields to avoid unnecessary irradiation of normal tissues. Multi leaf collimator (MLC) fitted under Cobalt or accelerator heads helps in shaping such treatment fields. There is a need to design and fabricate such indigenous MLCs for use in radiotherapy. In these collimators, two stacks more than 50 tungsten leaves of 5 mm thickness and 50 mm width are positioned using individual micro motors under computer control to form any irregular opening.
4 HSK	Development of a liquid ionization chamber based high energy dosimetry and imaging device	Imaging devices are required for verification of target coverage by planned radiation beam delivered in radiotherapy treatment. A liquid ionization chamber array consisting of sixty four 10 mm x 10 mm liquid ion chambers arranged in an 8 mm x 8 mm matrix is used for imaging. The work involves development of ion chamber array and micro-controller based front-end electronics to multiplex and measure currents from the individual chambers. A PC based software for data acquisition and image construction is also to be developed.
5 HSK	Design, development and testing of measuring electronics for insulated capacitance level for water level measurement	Reactor Control Division has developed a flexible type insulted capacitance level sensor. The probe has to measure level of D.M. water with salt content of 0.5mg/lit to 15 mg/lit, with varying process water temperature. The measuring electronics is required to be mounted 30m away from the sensor. Thus the measuring electronics measures the compound capacitance of dry probe, actual capacitance due to water and the cable.

		The project aims at design, development and testing of measuring electronics to measure the change in capacitance of level sensor. The electronics has to condition the signal and compensate for cable capacitance, nonlinearity and effects due to change in water temperature and salt content. The measuring electronics and cable and should function in the specified EMI field. The measuring electronics should have remote health check facility by which one can check the healthiness of the electronics remotely. The electronics shall be designed for 220V, 400 Hz power supply and should have 3-port isolation. The electronics should offer non-interactive span and zero adjustments. The measuring electronics should be designed to give standard analog output of 4-20mA with digital output based on MODBUS protocol to communicate to communicate to compatible host device.
6 RKP	Characterization of electro-ceramic material for development of electro-ceramic based sensors	Computation of material properties sensor elements and their shapes and sizes suitable for Engineering application (Development of sensors). Impedance spectroscopy of the materials for deciding frequency of operation for sensors to be developed. Resonant frequency calculations from impedance spectroscopy data. Similar characterization will be done during various staves of comple4tion of sensor assembly. Similar computation of material properties sensor elements will be carried out for Polarized PVDF (Polyvinylidence fluoride) films. Backing material and face plate matching material will also be characterized both separately and in conjunction after attachment to sensor housing.
7 RKP	Design, development and characterization of a high repetition rate spark gap switch based on triggering by ferroelectric electron emission	Ferroelectric Electron Emission is a phenomenon by which free electrons are emitted from the surface of a ferroelectric material such as barium titanate. This phenomenon has been utilized by some groups to make high voltage spark gap switches. There also exists quite a detailed description of a high repetition rate spark gap. Reported parameters are 500 ps rise time and 70 ps jitter at a rep rate of 1Hz. This project will involve re-engineering of a similar spark gap tailored to a specific application involving a repetitive pulse power system.
8 RKP	Design, development and testing of measuring electronics for high temperature water flow measurement using ultrasonic principle	The project aims at design, development and testing of measuring electronics for clamp-on type high temperature ultrasonic flow meter for water flow measurement. The flow velocity ranges from 0.1 to 5 m/sec. The flow meter has to be mounted for different pipe of different sizes. Measuring electronics shall measure the average water velocity by using time of flight method. The method should be able to compensate the change of sound velocity in the water due to water temperature. The developed electronics shall excite the transmitter crystal, detect output voltage at receiver crystal, eliminate noise, identify the correct signal and measure the time between transmitted

		wave and received wave. The electronics shall be designed to distinguish the signals traveling through stainless and water. The measuring electronics should have remote health check facility by which one can check the healthiness of the electronics remotely. The electronics shall consist of microcontroller based flow computer. The flow computer shall accept pipe size input from user, compute the water flow for the different pipe sizes, indicate on the LCD in different engineering unit selected by user. The measuring electronics shall be validated on the actual setup. The velocity of water shall be measured with different pipe sizes in the test setup. The electronics shall be designed for 220V, 400 Hz power supply and should have 3-port isolation. The electronics should offer non-interactive span and zero adjustments. The measuring electronics should be designed to give standard analog output of 4-20mA with digital output based on MODBUS protocol to communicate to communicate to compatible host device.
9 KVK	Development of specialized optical sensor fibres for high temperature applications (700 C)	Development of procedures for optical fibres for FBR to be operated at 700 C: - stripping of acryl amide coating from commercial optical multitude fibre - preparation of fibre surface for proper metal adhesion - coating the fibre with gold or any other suitable metal - testing of coated fibre for integrity at rated specification
10 KVK	Sensitivity analysis for permanent magnet flow meter	To do numerical simulation based on electromagnetic modeling to estimate sensitivity. The code developed should be suitable for estimating the sensitivity of all the 14 sizes of flow meters which are used in PFBR. Measured parameters of flowmeter and the process parameters will be given as input to the code. The code should be able to estimate the sensitivity at different flow rates and at different temperatures. The code will be validated based on data provided by IGCAR.
11 HSK	Optical cone beam CT scanner for 3D gel dosimetery system	3D dosimetery system is a promosing technique for verification of complex 3D dose distribution. 3D Gel dosimetry system is made up of tissue equivalent organic compound whose opacity changes with exposure to radiation beam. In optical cone beam CT scanners an optical light beam and a light detector are arranged across a gel dosimeter block opposite each other. The transmitted light intensity is continuously sampled and stored as the light detector assembly rotates to cover the entire dosimeter block. A suitable software is to be developed to reconstruct the dose distribution in the dosimeter block from the optical density data.
12 HSK	Development of image reader system for photo stimulated luminescence (PSL) phosphor plates	Photo Stimulated Luminescence phosphors are being developed in RP&AD, BARC from which image plates will be fabricated. There is a need to develop a LASER based image scanning system for scanning the exposed image plate. The system involves design of a LASER scanner and a

		luminescence measurement unit to generate the pixel data of the image. The necessary software for image reconstruction from the pixel data is to be developed. The system should have the facility to change the LASER source so that the reader system can be used for different phosphors.

2 FM & Heat Transfer

Sr. No	Project title	Scope of work
1 HSK	Condensation heat transfer study	Evaluation of condensation heat transfer coefficient for concrete, steel, concrete with epoxy coatings etc in presence of air steam ratio, saturated steam, superheated steam
2 HSK	Heat transfer studies for nano fluids	Experimental studies on basic heat transfer, properties generation, heat transfer coefficient and pressure drop measurements for nano fluids. Few nano fluids will be synthesized and characterized in various divisions of BARC and other nano fluids will be taken from commercial sources. Thermal conductivity measurement will be done at BARC and /or collaborative institutes. Small heat exchanger loops will be established at collaborative institutes for a range of nano fluids for basic fundamental heat transfer studies.
3 HSK	Debri bed heat transfer during severe accident for PHWR	To study the heat transfer aspects of the debri bed along with stagnant water available on the outer surface of the Calandria vessel. This work aims to assess the debri bed temperatures for a prolonged time to evaluate the Calandria vessel integrity.
4 KBD	The effect of fuel element spacing devices on flow mixing across the bundle	The fuel elements are welded with a wire wrap or split spacers to provide gap between fuel elements to avoid hot spot. These spacers also provide mixing in the different sub-channels of the bundle by way of disturbance and by flow direction. The influence of these devices in promoting cross flow across the elements in the sub channels of the bundle is to be estimated. This job is important for the aging reactors from the point of channel radial creep and consequent hot spots expected across fuel elements. The job is of selecting different spacing devices and quantifying their effect in enhancing the cross flow. It involves literature survey, experimentation and theoretical thermal – hydraulic analysis. Period will be 2 – 3 years.
5 KBD	Estimation of gap heat transfer coefficients across fuel sheath gap	The heat transfer across fuel element involves thermal resistance across sheath gap which constitutes UO2, graphite and Zircaloy. The material surface roughness and the interfacial pressure across them also play a role in the heat transfer conductance. It involves literature survey, experimentation and theoretical thermal analysis. About 2 years.

6 KVK	Pool thermal hydraulics of innovative fast breeder reactor	To develop a complete Computational Fluid Dynamics (CFD) model of the primary system of the planned innovative design with adequate internal details, incorporating conjugate heat transfer option and carryout thermal hydraulic investigation for various steady and transient conditions of the reactor.
7 KVK	Simulation of gas entrainment in sodium pools of FBR	To develop mathematical models that predict the various aspects of gas entrainment and validate the mathematical models based on the suitable experiments. The investigation would be on (i) sodium free surface velocity conditions that can avoid gas entrainment, (ii) locations of the grid plate where entrained gas bubbles could segregate and (iii) positions of purger sub-assemblies in grid plate and holes in purger subassemblies that are conducive for de-gassing of the grid plate, without allowing the gas to pass through fuel subassemblies.
8 KVK	Thermal hydraulic investigation of thermal stripping in T – joints of FBR	To develop a 3-D computational fluid dynamics (CFD) model of the T-joint and simulate flow and temperature distributions in sodium and in metal walls. The transient study should adopt a suitable turbulence model such as Large Eddy Simulation which is suitable for this type of applications. The predictions of the CFD studies can be validated by suitable experiments in water.
9 KVK	Thermal hydraulic analysis of integrated safety grade decay heat removal system	Estimation of multi-dimentional flow and temperature distribution under steady state condition for various shapes of IHX. To establish variation of flow and temperature distribution with respect to geometric parameters like ratio of distance in the minor to major axis in case of ellipse. The primary flow and inlet temperature, secondary flow and inlet temperature and power transferred remain constant.
10 KVK	Thermal hydraulic analysis of horse shoe shape IHX	Estimation of multi-dimensional flow and temperature distribution under steady state condition for various shapes of IHX. To establish variation of flow and temperature distribution with respect to geometric parameters like ratio of distance in the minor to major axis in case of ellipse. The primary flow and inlet temperature, secondary flow and inlet temperature and power transferred remains constant.

3 CFD / Codes development

Sr. No	Project title	Scope of work
1 HSK	Free surface tracking experiments	Experiments on basic 3D dam break; similar experiments with the presence of single and array of structures for basic understanding of the phenomenon and data generation for CFD code validation. The experiment will be carried out at prospective collaborative institutes and numerical modeling will be done at RSD, BARC
2 HSK	Evaluation of flow assisted corrosion problems in tubes, pipes and pipe bends	Experimental evaluation and characterization of FAC problems with CFD.
3 HSK	MPI based specific CFD code development for light scalar dispersion in multi-compartment enclosures	MPI based unstructured CFD code development for buoyant gas dispersion in turbulent situation for multi compartment enclosures
4 HSK	Development of parallel numerical methodologies to predict properties of nuclear materials	Development of molecular dynamic .Monte Carlo codes for atomistic calculations, coupled atomistic and finite element models for dealing large systems, meso scale materials models such as 2D and 3 D dislocation dynamics simulations and parallelization of these codes.

4 Seismic and Civil Structures

Sr. No	Project title	Scope of work
1 HSK	Evaluation of concrete structures under fire, seismic and high strain rate impact loads	Fire rating of concrete structures and its evaluation for thermal and high strain rate mechanical loads. Characterization of near field and tele-seismic waves including effects in various soil strata.
2 HSK	Experimental and analytical studies on estimation of leakage rate for reinforced concrete and pre stressed concrete	Experimental estimation of - Leakage due to permeability of concrete - Leakage through the cracks which may get formed as a result of overpressure - Leakage through the penetrations in concrete
3 HSK	Seismic response of structures and equipments	Static and dynamic tests are required to be done on frames without and with URM infill panels having different aspect ratios to see the effects of panels on stiffness of the frames. A good analytical model is to be developed that can predict these effects accurately and shall have easy implementation in analysis of complete structure. An analytical model shall be developed to predict the strength of panels under out-of-plane loads and to retrofit them effectively.
4 HSK	Development of dampeners/isolators for reduction and control of seismic response	The performance of soil bed as an isolation media under earthquake varying soil strength parameters and water table will also be evaluated. The techno-economic feasibilities in adopting dampers to satisfy the serviceability conditions of the superstructure will also be studied.
5 HSK	Active and passive mechanism for vibration control	In this project, semi active devices and constitutive relations for analysis purpose will be developed.
6 HSK	Response of the coolant tube with Fuelling Machine latched on to the coolant tube	The coolant tube will be mounted on two supports representing the lattice tubes in the end shield. Mass of about 9 tons each representing the fueling machine will be attached on to the end fitting at two ends of the end fitting. The cylinder of the “Z” motion hydraulic cylinder will be connected to the end fitting whereas the piston of the “Z” motion hydraulic cylinder will be connected to the structure representing the fuelling machine and the Head. The input motion will be given at the base of the two structures representing the bridge and the head assembly and the motion coming from the end shield

		through the lattice tube to the coolant tube. The stresses and the forces coming on to the coolant tube will be measured during the shake table test.
7 KBD	Dynamic test to find out the damage to the flow tube of the reactivity mechanism and the calandria coolant tube assembly	The flow tube of the reactivity mechanism will be mounted in the pseuo dynamic test facility in vertical direction and will be given an input motion by two shakers representing the motion coming to the flow tube through the calandria shell top and bottom. The calandria coolant tube assembly will be given an input motion as per seismic movements coming to the coolant through the lattice tube in the end shield. The impact between the flow tube and the guide tube and the calandria tube will be measured in terms of displacement, stresses in the tubes and damage at the point of contact between the calandria tube and the flow tube.
8 KBD	Test on cable tray supports along with cable control and cables	The test will be conducted on three different sites of cable tray supports supporting the cable trays ranging from 5-20 nos. The aim of the test will be to find out the damping of the system with cables in the cable trays when the trays are filled partially, full and 50% more than the capacity and with application of the fire retardant paint at an interval of 6.0 m. During the test, the stress in the cable trays and cable supports and the acceleration in the cable trays and the cable tray support will be measured.
9 KBD	Test on pipe for getting the damping in the piping system and also the stress	The test will be conducted on various sizes of pipes from 15 mm, 25 mm, to 50 mm with usual dead weight supports and seismic supports to resist the earthquake resultant forces in the direction normal to the axis of the piping at an interval of 3-4 dead weight support spans. The test will be conducted as above to arrive at damping of the piping system, the stress (strain) in the pipe for the different levels of input motion from 0.2G to 1G.
10 KBD	Variable frequency equivalent damping in the piping system	In a piping, supported at number of points with sufficient gap between the piping and the support varying from 1 to 3 mm, the frequencies of the piping keep on changing whenver the piping makes a contact at the support point and then when it looses the contact with support. The continuously changing frequencies of the piping give rise to a reduced response in comparison to a fixed frequency system.
11 KVK	Seismic analysis of piping integrated with building	To get more realistic results for piping and embedment loads through integrated analysis of building (3D models) with piping (1D) To bring out the differences between the integrated approach based on multi-support excitation and quantify the conservatism in decoupling analysis for piping
12 KVK	Effects of hot clamps in sodium piping	Detailed anslysis of local stresses in sodium piping at the location of hot clamps seismic restraints under steady state as well as hot / cold thermal shocks and to recommend alternate designs, to comply RCC-MR piping rules.

5 Structural/Fracture/Fatigue studies

Sr. No	Project title	Scope of work
1 HSK	Pressurized thermal shock (PTS) test on small size pressure vessel	A small size vessel having an external flaw will be pressurized upto 10 MPa and will be heated to 300 C.
2 HSK	Thermal shock experiment on cruciform specimen	The test will consist of a small cruciform specimen having a part-through crack at around 300 C being subjected to bending load and then sudden spraying of cold water to study the crack surface to study the crack growth characterization.
3 HSK	Evaluation of damage mechanics parameters of bi-metallic weld joints	Studying of the evolution of void volume fraction in different materials with plastic strain and different triaxial stress fields to predict the crack initiation and propagation in the component with bi-metallic joints.
4 HSK	In-situ SEM studies of damage evolution in fatigue loading	Fatigue damage mechanics parameters for the materials will be evaluated.
5 HSK	Numerical and analytical studies on estimation of leakage rate for reinforced concrete and pressurized concrete	Development of J-integral for the nozzle and T-junction corner cracks.
6 KVK	Design confirmation of anchored safety vessel	- Conceptual design of embedded structure involving shell, sodium resistant concrete, load bearing concrete along with cooling coils and reinforcement bars - Thermal analysis of the structure to respect the temperature limits - Development of construction methodology - Validation of design by mock up tests - Assessment of aging effects
7 KVK	Stress indices for pipe bends with large diameter to thickness ratio	Development of modified correlations of stress indices applicable to pipe bends having large d/t ratios based on the understanding of structural behaviour of such bends and on the basis of shell theory. Robust guidelines to demonstrate the structural integrity of pipe bends with large d/t ratio including possible risk of additional failure modes such as buckling, which can be recommended to be included

		in future in the design codes.

6 Reliability

Sr. No	Project title	Scope of work
1 HSK	Development of methodology for quantifying the reliability of software in computer based systems	This project involves developing the reliability prediction models for the software systems. In addition to the existing software reliability growth models (SRGM) for the prediction of software reliability, as set of new prediction models will be derived based on the software failures. A methodology is developed to derive the reliability from the quality metrices that are generated by several testing tools for the given source code.

7 Environment

Sr. No	Project title	Scope of work
1 HSK	Monitoring and modeling of chemical pollutants from thermal power plants	Monitoring of toxic chemical pollutants in different environmental matrices around thermal power plants. Stack monitoring for emission inventory and collection of meterological data. Application of dispersion modeling and modeling the behaviour of these chemical pollutants in different environmental matrices.
2 HSK	Source apportionment of toxic pollutants using receptor modeling techniques	Ambient air samples will be collected and analysis will be carried out for various toxic constituents. Emission inventory for stationary (industries) and mobile (transportation) sources at the proposed site and collection of meterological data. The concentration data thus generated will be applied in the receptor modeling technique for the apportionment of different possible sources.
3 HSK	Dust dispersion in open cast mines – monitoring and modelling	Continuous monitoring of the dust load due to various mining activities. Continuous monitoring of size segregated particulates at open cast mining areas. Estimation of emission rates of each type of mining activity. Collection of simultaneous meterological data. Use of dispersion models to predict the dust concentration at various distances from the mine.

8 Extractive metallurgy – electrorefining

Sr. No	Project title	Scope of work
1 PRVR	High temperature counter current extraction of lanthanide metals from the molten LiCl-KCl containing rare earth chlorides by equilibration with LiCl-Cd alloys	Molten salt electrorefining is a pyrochemical reprocession method for processing irradiated U-Pu-Zr alloy fuels. In this process carried out at 773K, the actinides are selectively electrotransported from the spent fuel, which forms the anode of the electrorefining cell, through molten LiCl-KCl electrolyte to a solid or liquid cadmium cathode and deposted as metals. During this process, some amount of the actinides remain as chlorides in the salt phase which have to be extracted in to cadmium phase so that they can be recovered later. In the process flow sheet, this is proposed to be done by counter current extraction using pyrocontactors.
2 PRVR	Conceptual design of bulk electrorefining cells – optimization of configuration for enhancing throughput and enabling automation/remotization	The electrorefining process mentioned above has hitherto been carried out only in laboratory scale in India. It has to be scaled up to engineering scale so that plants based on the process can be designed in a few years. The design of the electrorefining cells which can have process tens of kilogram amounts of fuel materials has to be optimized for increasing the thoughput without affecting the purity of the product deposit. Further, the design aspects should enable remote operation since the irradiated fuels will be handled in hot cells. The optimization involves the evaluation of the impact of the geometry, size and the number of electrodes.

9 Materials/alloys

Sr. No	Project title	Scope of work
1 PRVR	Assessment of mechanical behavior of nitrogen alloyed stainless steels	IGCAR will supply four heats of 316LN for the evaluation of (i)tensile, (ii)creep, and (iii) low cycle fatigue properties as a part of a round robin programme. Tensile properties will be evaluated at various temperatures in the range 300-923K. Creep properties will be evaluated at 823, 873 and 923K at four stress levels each. Strain controlled low cycle fatigue tests will be conducted at 823 and 873K at four strain amplitudes. Micro mechanisms of deformation and fracture will be evaluated.
2 PRVR	Characterization of mechanical properties of modified 9Cr-1Mo steel and its applications	IGCAR will supply four heats of Mod.9CrlMo steel 3 for the evaluation of tensile and creep properties. Tensile properties will be evaluated at various temperatures in the range 300-923K. Creep properties will be evaluated at 773, 823 and 873K. Micromechanisms of deformation land fracture will be evaluated and the role of nitrogen and silicon will be studied on the precipitation and deformation behavior.
3 KVK	Electromagnetic multi-parametric approach to material characterization	.It is proposed to use Magnetic Barkhausen Emission (MBE) and Eddy Current (EC) techniques and input the NDE parameters from the heat treated specimen to an artificial neural network for on-line quantitative evaluation of microstructural degradation and materials properties. NIIT will procure raw material required and prepare all the samples. It will do all the heat treatments and optical microscopic evaluation and then the NDE measurements will be done at IGCAR. Then NIT will develop an artificial neural network that takes measured NDE parameters as input and gives desired materials properties or microstrucral attributes as output.
4 KVK	Electrochemical impedance spectroscopy (EIS) and electrochemical noise (ECN) techniques to evaluate sensitization in stainless steels	At IGCAR lots of data have been generated on the degree of sensitization on different types of stainless steels with various amount cold work using ASTM standard test (A-262 practice E) and electrochemical potentiokinetic reactivation (EPR) techniques. For monitoring and early evaluation of sensitization process, work was initiated utilizing EIS and ECN methods in collaboration with NIT-Nagpur. EIS studies have already been carried out on 316LN stainless steels for which the previous data with other techniques are available. It is planned to carry out further work on cold worked material and use of ECN technique

5 KVK	Structure and engineering of metallurgical database through CODATA	The CODATA addresses the international information society with quantitative data resulting from the experimental measurements or observations in various fields of science and engineering. Particular emphasis is on the data management problems common to different scientific and engineering discipline and on the generated data which can be used outside its field. India has a large source of materials property data. Work has been initiated by a national team with Dr. Dayal as convener to collect the data from various important laboratories in India, particularly on mechanical and corrosion metallurgy. The collected data are tabulated in form of data sheets which contain relevant material properties like Creep, Fatigue, Tensile, Fracture and Corrosion. Since a large amount of work is needed in this area, it has been planned to seek the financial and manpower support from DST. The principal investigators and collaborators for to carry out this work will be taken from IGCAR, NML and NIIT Surathkal.
6 KVK	Equal channel angular extrusion process for production of ultra-fine grained Ti-Ta-Nb alloy	Equal Channel Angular Extrusion (ECAE) is one process through which ultra fine grain size could be easily achieved. In international level, the process has come at a stage when nanostructured materials are considered for varied applications. ECAE provides an opportunity to achieve significant improvement in mechanical propertiesIt is reported that a ten-fold increase in yield stress, can be achieved in ECAE in comparison to conventional material. In the present project proposal, TiTaNb alloy has been chosen as the material. The development of the process to produce structurals- rods and tubes, is attempted in the proposed work. NITK will do ECAE of the alloy; IGCAR supports on characterization.

10 NPP accident

Sr. No	Project title	Scope of work
1 KBD	Analysis for 540 MWe PHWR / 700 MWe Calandria – End Shield assembly to study the pressure and Calandria tube rupture resulting in pressure developed in the Calandria	In case of a postulated accident involving a PT rupture, the CT may or may not rupture. If it is assumed that a Pt and its surrounding CT rupture simultaneously, the hot D_2O coolant (300^0C) at high pressure (11 MPa) gets released into the moderator. Thus the moderator gets hotter and pressurized. The internal pressure of the calandria acts externally on other CTs and guide tubes (GT) various vertical reactivity devices. To limit the external pressure on these components even under assumed accidental conditions, four rupture disks are provided on the calandria shell. These rupture discs burst at 1.4 Kg./sq.cm (g).
2 KBD	Experimental and analytical studies on pressure tube behaviour under accident condition leading to partial coolant in the pressure tube (stratified condition) with decay heat generation from fuel bundle in the pressure tube	Assessment of pressure tube behavior under various decay heat (1% to 3% FP) with different water levels (20% - 70%) resulting into large circumferential temperature variation is an important safety aspect which need to be studied. The experimental studies would be required with the coolant temperature range from 160^0C to 250^0C with corresponding saturation pressure (5.2 kg. /cm^2(g) to 39 kg./cm^2(g)). At the junction between water & steam interface sudden variation in temperature & stresses are expected which may lead to failure/no failure of pressure tube which is required to be established by experiment. Further, these results are to be incorporated in the analytical software.

11 Corrosion

Sr. No	Project title	Scope of work
1 KBDVK	Study of corrosion behavior of Zircaloy	Zircaloy corrosion tests in hydrogen water chemistry with pH 10-10.5 and oxygen water chemistry wigh pH around 7.0, under water and in steam – water mixture tests at different Temperatures upto 400^0C to be conducted/studied. Both uniform corrosion and nodular corrosion to be evaluated during the tests/studies. Effect of surface condition of the tube also to be studied.
2 KVK	Diffusion, oxidation and corrosion studies on amorphous and nano-crystalline materials	It would involve synthesis of amorphous and nano-crystalline materials by plasma processing/laser processing and look for an enhancement in their oxidation/corrosion properties. Effects of ion beam irradiation (both low and high energy) on surface sensitive properties of amorphous alloys and their crystalline counterparts will also be investigated. The alloys of interest are Zr, Ti, Fe and Ni based amorphous and nano-crystalline alloys.

12 Cn I D

Sr. No	Project title	Scope of work
1 KBD	Fractional order PID control system	The research project shall aim to find out the practical advantages in adapting a fractional PID controller over a conventional PID for a control loop. A control algorithm using fractional PID can be developed for a simple control system involving level control or pressure control or motion control. A physical setup/model of the process shall be made and also a mathematical model of the process shall be worked out. A computer based control system can be developed with data acquisition, validation, processing/computation and generation of outputs. The algorithm for control shall be developed with conventional PID and also with fractional PID. The computer shall be capable of executing any of the desired algorithms. A comparison of the two algorithms shall be prepared. The study shall validate the mathematical model which can be used for comparing the two algorithms with the model and for demonstration. It shall also bring out the comparison with respect to tuning of the control loop.
2 RKP	Development of Token Passing Protocol on Ethernet	The main advantages offered by Ethernet technology like very high communication bandwidth, easy availability and low cost can be utilized to meet hard real time communication requirements by developing a deterministic arbitration mechanism for Ethernet. The immediate choice is industry proven token passing protocol based on 802.4 standards. Hence development of token passing protocol on Ethernet is proposed. This protocol has to be implemented in software at MAC layer such that while meeting the deterministic real time data communication requirements, it will provide communication API to higher layers. The design should be efficient and shall impose minimum communication overhead. After detailing the requirements of token passing protocol based on 802.4 standards, the proposed protocol should be developed and implemented on Ethernet hardware readily available in the market as well as on the in-house developed hardware.
3 RKP	Development of an alarm management, optimization and presentation software suite	The software shall be developed on windows OS. Following sub-modules are envisaged in the proposed software suite. (a) Automatic Data Collection and Archive: this module shall capture and archive alarms, operator action, and system events from the plant database through OPC or any other

		standard connectivity. (b) Rules and Logic Editor – this editor module shall facilitate to implement the rules and logic of alarm filtering, suppression and prioritization algorithms (development of algorithms are not in the scope) (c) Alarm Analysis – this module benchmarks alarm system performance vs. established standards. (d) Alarm Documentation and Rationalization – optimizes and documents alarm system configuration as per engineering practices. (e)Audit and Enforce – shall maintain a desired alarm strategy by protecting alarm settings from improper change. (f) Alarm Shelving – shall identify and handle nuisance alarms in real-time to enables the operators to focus where needed.(e) State-Based Alarms & Alarm Flood Suppression – this module shall dynamically adjusts alarm settings to match plant operations and manages alarm floods during process upsets. (f) Alarm Viewer – provides performance visualization and advisory/knowledge support.
4 RKP	Development of RTOS	We need to develop an RTOS that will (a) Manage the interface to the underlying computer hardware. (b) Schedule and pre-empt tasks (c) Provide Inter-task communication services. (d) Manage Memory with protection(space Partitioning) (e) Provide Temporal partitioning to ensure services received from shared resources (such as processor) by the software in one partition cannot be affected by the software in another partition. (f) Provide common services like file system support, I/O to standard devices such as keyboards, CRT displays, printer etc. including RS-232 communication and network service for TCP/IP on Ethernet. (g) Support standard POSIX (IEEE Std 1003.1) API for the application programs but limited to the POSIX option group applicable for Real-time application.
5 RKP	RTOS viewing tool	The viewing/monitoring tools shall provide (a) Facility to receive, display, store the RTOS events (task switching, interrupt) (b) Precision time stamp (~ 0.1 ms) received from target hardware. (c) Good GUI (Graphical User Interface) with zoom-in/zoom-out for data display windows. (d) Display both in graphical &tabular form with configurable history storage (e) Communicate to the target hardware via RS-232C as well as Ethernet.
6 RKP	Development and implementation of Filed bus algorithm for nuclear power plant	The scope of work is to develop the necessary algorithm (based upon a suitable protocol such as Flexray-Time Triggered or Profibus etc.) and implement it in an FPGA. Hardware language used for implementation should be Verilog. The implementation has to be tested by simulation and deployment.
7 RKP	Robust shape based part recognition system	Nature of work (i) Class of work: computational AI – Algorithm development, stable and rugged feature definition formation, search technique development. (ii) Platform: Desktop computing system P4 – 3.2 GHz, Windows o/s, Open GL / graphics libraries. (A) Theoretical work/ code development (Phase I) (1) Algorithm development (2) Raw Data definition formulation for sensing. (3) feature visualization for test/ validation (4) Knowledge base structure formulation (5) (a)Search method

		development (b) Partial data based match wigh merit indication (B) Experimental work (Phase II) (1) Sampling and data generation (2) best match recovery (3) Match validation through graphics model.
8 RKP	Implementation of REED-SOLOMON coding in VHDL	Read-Solomon codes are block-based error correcting codes with a wide range of applications in digital communications and storage. Reed-Solomon codes are used to correct errors in many systems including: (i) Storage devices (including tape, Compact Disk, DVD barcodes, etc) (ii) Wireless or mobile communications (including cellular telephones, microwave links etc.) (iii) Satellite communications (iv) Digital television / DVB (v)High speed modems such as ADSL, xDSL etc.
9 RKP	On line mimics as part of computer based control systems	On line mimics of machine operation is now becoming part of the control system and training simulators. The development of mimic algorithm involves using open GL 3D graphical library functions on VC++. Advanced techniques like Bump Mapping in 3 D graphics has hardware acceleration support on the latest Graphics cards. Iy adds minute details on an object, which would otherwise require a large number of polygons. Knowledge of graphics pipeline fundamentals, matrices operation concepts, Phong-Blim lighting models, texture mapping, multi texturing, cube mapping techniques etc is used. Knowledge of vectors and matrices operations, object oriented programming and strong mathematical background is prerequisite.
10 RKP	Development of an algorithm to determine function block execution sequence	Function block diagram (FBD) is one of the recommended graphical language for programming PLC. The FBD network can be emulated by a directed graph model where a large number of nodes (representing blocks) connected randomly with each other with directed lines, where the direction of arrows denotes the dependency. This model is to be analysed to find the sequence in which the nodes can be called for execution.

13 Computer / Database

Sr. No	Project title	Scope of work
1 KBD	Real time database for information system used in nuclear power plants	There are approximately 50,000 parameter which are monitored by computerized information system in modern Nuclear Power Plants. Data for all the parameter is collected at one-second interval. It is observed that with use of standard database engines, data updating at 50000 records per second and then retrieval of records of selected parameters, in acceptable time limit becomes very difficult. In traditional Information systems this problem is over come by using not using standard database and customized files are used to handle the higher data transfer rates. Draw back of this scheme is we can not used standard SQL commands for processing, and it becomes difficult to use it for data warehousing and mining purpose. This project aims to find or develop database, which can handle 80000 records per seconds so that it can be used in real timke application, using Open Source Database and Linux Operating system.
2 KBD	Development of open source MMI component library	There are approximately 50,000 parameter which are monitored by Computerized Information System in modern Nuclear Power Plants. Data for all the parameter is collected at one-second interval. The parameters are displayed on various displays using various standard displays such as “Real Time Graphical trend”, “Bar Graph”’ “Tabular Display”, “System MIMIC display”, Meters etc. This project aims to find or develop Open Source component library for Linux Operating System, so that the Display software of any computer based system can be developed easily. This Project will also include development of components for standard protocols such as MODBUS, MODBUS TCP, OPC etc.
3 KVK	Network security monitoring and management	a) The complete understanding of the TCP/IP protocols, SNMP protocols, the hacking attempts, the virus & worm propagation etc. (b) Development of software for analyzing the traffic in the network, compare it with known hacking event signatures and kill the connection. If the intrusion attempts are continued, the packets from the source address shall be blocked. In case the attempts are from intranet, the corresponding port shall be disabled in the switch. (c) Monitor continuously the traffic

		for virus or worm patterns and alert the system administrator through E-Mail or alarm. (d) In case the virus or broadcast traffic goes beyond a set limit, the corresponding port in the switch shall be disabled. (e) Even in normal scenario, it shall collect the statistics of utilization from each port inform the administrator on request.
4 KVK	Alternative public key cryptographic algorithm for DAE	A Public Key Cryptosystem uses asymmetric encryption of confidential messages and transaction, to authenticate the origin of such data, and to guarantee data integrity. Public key techniques are typically much more computationally intensive and substantially slower in performance than symmetric algorithms. This project involves formulating a new public key cryptographic method with improved security and performance features. It entails evolving an alternative scheme based on study and analysis of various computational problems upon which their security is based. The security of the underlying algorithm is vital to the security of higher-level protocols and applications. Concerns about security and the relatively slow operation of asymmetric crypto algorithms motivates us to propose an alternative design which is impervious to different cryptanalysis methods and relatively fast. Though most widely used and best-analyzed asymmetric ciphers like RSA are resistant to cryptanalysis, it's not beyond the bounds of reason that the code might be cracked in the foreseeable future with the existing key size. Also RSA implementations with recommended key size (1024/2048 bits) are not available to DAE.
5 KVK	Development of C cross-compiler	The scope of the project involves developing individual components like front-end, code generator, optimizer and assembler tools and porting libraries for the specific processor(s) complete compiler tool-chain. This project focuses on developing production C compiler that complies with ANSI standard for generating code for Motorola 68020/68030 architecture. It should run on commonly available Intel x86 platform and compile code for Motorola 68xxx platform. The design shall use well established compiler techniques, consisting of a target-independent front-end and a target-dependent back-end modules packaged together as single program coupled with user interface. Since it is designed as multi-target compiler, it can be enhanced in future to produce code for different microprocessor architectures (like IA-32, IA-64).
6 KVK	Development of simulation tool for FBR	The scope of the project includes development of Simulation tool by porting the available TECHCOMM simulation source code of all the important components and devices to a PC based system. Additional features like GUI will also be included to make the Simulation tool more user friendly. The proposed Simulation tool will consist of the following important features: (i) Creation & configuration of Process Models. (b) Generation of Proce4ss Flow Sheet using drag and drop option of models. (c) Profile viewing of process models using static & dynamic

		variables/parameters. (d) Generation of Logic Sheet using drag & drop option of logic devices. (e) Generation of Virtual Panel using drag & drop option of components/devices. (f) Interfacing with the database. (g) Development of Instructor station module.

14 Chemical Engineering

Sr. No	Project title	Scope of work
1 DSS/ BPS	Kinetics of Bunsen section reactions	Kinetic data of Bunsen reaction and other Sulfur and Hydrogen sulphide forming side reactions are scanty. Research project envisages devising suitable experimental set up with appropriate analytical facility such as Potentiometric and Karl Fisher titrators, UV-VIS-NIR spectrophotometers, GC-MS and programme to generate quantitative data of reaction rates, under operating conditions of 20^0C – 125^0C and pressures up to 10 bar.
2 DSS/ BPS	Measurement and modeling of vapour liquid equiliria and liquid – liquid equilibria of HI + I2 + H2O (HIx) system VLE at temperature of 115 – 320 C & pressure 1 – 50 bar. LLE at temperature of 115 – 320 C	Hydriodic Acid phase (HIx) concentration and subsequent decomposition of HI, is one of the challenging jobs in the development of I-S process. Various process flow sheet options have to be evaluated for their process complexity Vs. energy consumption for a given capacity of HIx processed. VLE & LLE of HIx lphase is the most important database required for carrying out the process flow sheet alalysis and process selection. The project involves compilation of available data on HIx mixture and development of new thermodynamics database for HIx for larger [HI]/[H_2O] ration & Iodine contents including the total pressure and partial pressures. Also the database generated shall be modeled using suitable electrolytic / chemistry models for predictions of VLE & LLE. The VLE measurement shall be carried out in 3 steps. Step: 1 Measurement of total pressure of HIx up to 50 bar and 300^0C so as to determine the azeotropic concentration versus temperature and [I_2] / [H_2O] ratio. Step: 2 Measurement of partial vapor pressure around the amnbient pressure. This data in combination with the total pressure data in step 1 will form a crucial database for model improvement. Step: 3 Measurement of partial pressure up to 50 bars to complete the database.
3 DSS/	Measurement and modeling of vapour-liquid and liquid-liquid equilibria of H2SO4 HI – I2	In Bunsen reaction of I-S process, Hydriodic acid and sulfuric acid are produced as per the following equation. ($9I_2$) + (SO_2) + (16 H_2O) → (2HI + 10 H_2O + 8I_2) + (H_2SO_4 + 4H_2O). The vapor liquid and liquid-liquid equilibria of H_2SO_4 – HI – I_2 – H_2O system is essential for the optimization of Bunsen

BPS	H2O system – VLE at 70 -125 C and pressure upto 10 bar. LLE at 70 – 125 C	section process flow sheet. The project involves the experimental measurement of VLE & LLE data and the development of suitable models for the same.
4 KVK	Study of chemical reaction runaway of TBP-dilute nitric acid – nitrate salts –water system at elevated temperatures	Tributyl phosphate solvent dissoled in aqueous solutions is known to form explosive mixtures under certain conditions with nitric acid and metal nitrates. The conditions that lead to this under various parametric conditions and the energy release have to be modeled so that they can design inputs for design of evaporators.
5 KVK	Purification of degraded solvent	Tributyl phosphate gets degraded chemically as well as radiolytically. Along with the solvent, the diluent also gets degraded. Various methods are adopted for purification of this degraded solvent. One such method is vacuum distillation. VLE data to be established and a vacuum distillation unit is to be designed and demonstrated.
6 KVK	Design and development of annular linear induction pump for SGDHR system	Annular Linear Induction Pump (ALIP) for Safety Grade Decay Heat Removal Circuit in PFBR have been developed with capacities from 5 to 170 m^3/hr. The scope of this project includes: Design and development of ALIP of specified capacity Mathematical modeling and simulation for the specified ALIP Prediction of performance for variable voltage operation using autotransformer for the ALIP Prediction of performance using variable voltage variable frequency (V/f) drive for the ALIP Prediction of forbidden zone for the ALIP Thermal analysis of specified ALIP and evaluation of blower capacity for safe operation of ALIP
7 KVK	Cavitation studies on centrifugal pumps	The objective are to: To estimate the erosion rate in a pump impeller from measurements of the collapse pressure of cavitation bubbles using state of the art measurement techniques.: Some techniques, which can be used, are (a) piezoelectric transducers (b) fibre optic transducers (c) pressure sensitive photographic film (i) To measure the temperatures generated during final stages of bubble collapse. (ii) To measure the pressure and velocity patterns in the flow passages in the impeller/ diffuser and compare with results from CFD analysis. This will be of use in improving blade design. (iii) Comparison of above results with that from a liquid metal such as Na-K alloy or any other liquid that has fluid dynamic properties similar to that of sodium (the reactor coolant) and can be handled with minimum fuss in the laboratory. Type and size of pump : A vertical pump of specific speed close to 50 (metric units) of suitable size (power rating ` 500 kW) may be used for the tests.
8	Development of radiation	The aim is to develop glasses with varying optical properties like refractive index, Abbe number, etc.

KVK	resistant optical grade glasses	with very good spectral transmittance. Availability of a combination of large variety of optical glasses with varying properties are essential, for designing aberration free lens systems for a variety of nuclear applications – for example lens for cameras, microscopes, viewing systems, periscopes etc.