BELGACEM HIZOUM: 910-508-1743
Hizoumk@ornl.gov

PROFILE

- Vast experience in application of numerical methods for solving engineering problems, with deep knowledge of finite element method, finite differencing, and finite volume methods code development
- Proficient in implementing physics into numerical models.
- Proficient in debugging huge undocumented legacy FORTRAN code, maintenance, enhancement, development, testing, and documentation preparation.
- Expertise in development, elaboration and implementation of finite element, Finite volume, finite differencing, and discontinuous Galerkin finite element methods code for solving engineering problems.
- Interdisciplinary knowledge in Mechanical Engineering, Electrical Engineering, and nuclear engineering.

EDUCATION:

- **Master's Degree in Mechanical Engineering**- Focused on Numerical Methods (Finite Elements, Finite Difference, Boundary elements, Finite Volume, Discontinuous Galerkin Finite element method) Applied to; Heat Transfer, Fluid Dynamic, and Solid Mechanics, University of New Orleans, Louisiana, 1998-November 2000.
  - Overall GPA. 4.0/4.0
- Thesis:
  - "Development of Hydrodynamic model for the Shallow water equation using Godunov finite volume method, Nov 2000"
- **Master's Degree in Nuclear Engineering**- Focused on Stress analysis, Development Center of Energetic Systems Institute, Algiers, Algeria- Oct., 1992
  - Overall GPA 4.0/4.0
- Thesis:
  - "Implementation and Improvement of finite Elements Software RE_FLEX -10/92"
- **Bachelor's Degree in Mechanical Engineering, Majoring in stress analysis** and **Minor in combustion Engine Design**, University of Sciences and Technology Houari Boumediene, Algiers, Algeria- July, 1991
  - Overall GPA 4.0/4.0
- Thesis:
  - " Study of the behavior of parallel axis gears using finite element methods- 7/91"
- **Certificate of Nuclear Reactor Operator**- Chinese Institute of Atomic Energy Beijing, China- June, 1995
- **Certificate of Nuclear Reactor Management and Maintenance**- Chinese Institute of Atomic Energy Beijing, China- March, 1993

WORK EXPERIENCE:

Senior Software engineer Thermal-Hydraulic, ORNL, Knoxville, Tn, 2020 to present

- ♦ Reviewed and assess CTF closure models to improve the code capability to predict correctly void fraction. The review revealed deficiency in the interfacial shear model and flow regime map. A drift flux approach was derived and implemented into the code for redistribution of the vapor produced by boiling across the channel, which incorporates a novel correction for the subcooled boiling region. Additionally, the flow regime map used by CTF has been significantly improved to provide more mechanistic predictions of changes in local flow conditions and topology. Testing of the code showed that the modifications incorporated to the code significantly improve the void fraction prediction. This work is being published in Nureth19 conference.
- ♦ Revised CTF numeric to resolve convergence issue and limited simulation time step. This includes Implementation of fast numeric's through enforcing fully implicit discretization of all terms in the conservation equations and introducing an outer iteration to ensure convergence before marching to new time step. The initial assessment of the improvement looks promising however still

development is needed to contain numerical pressure spike due to condensation of vapor which is currently leading to limiting the time step.

- Added to CTF pressure stretching model to contain pressure numerical spike and virtual mass model to preserve the hyperbolicity of conservation equations
- Provided support to expand code capability to handle simulation of bypass, water, and part length rods
- Led a team to Develop and implement a new two-phase flow multiplier correlation for the wall shear model to improved CTF pressure drop prediction. Assessment of the correlation showed remarkable improvement of CTF in pressure drop prediction. This work is schedule to be published.
- Contribute to the development and integration of a drift flux base subchannel code Alternate Non-linear Two-phase Solver (ANTS), into the CTF environment for future VERA applications and design scoping.
- Successfully interacted with outside company (Ge) and obtained void fraction experimental Data. The data was added to CTF test matrix and is being used for benchmarking and improvement of the subcooled boiling model and void drift & mixing.
- Reviewed CTF wall & Interface heat transfer, Grid loss, Mixing & Void drift. Recommendations were made to these models to improve the overall CTF predictive capability.
- Contributed to several proposals and provided Technical Support to CTF development and general thermal hydraulic consulting to resolve on timely manners challenging problems
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Senior Engineer, Thermal Hydraulic, GNF, Wilmington, NC, 2006 to 2020

Subchannel Code COBRGA Development:

- Responsible engineer of sub-channel code COBRAG. This included error correction, enhancement and documentation preparation.
- Led a team effort to improve the overall predictive capability of COBRG01A with most of the investigations centered toward removing COBRAG empirical correlation and replace them with better first principal models. This included:
- Successfully Improved COBRG Film spreading to reduce the spread in the predicted critical film thickness at higher mass flux.
- Implement, tested and Enhanced heat flux-based entrainment to improve COBRG02P critical power prediction at high mass flux.
- Developed and implement a new deposition Model: Benchmarking of COBRAG showed weakness of COBRAG deposition model to predict accurately entrainment fraction. Several publicly open correlations have been tried, and testing. Results showed that these correlations although may give satisfactory result for entrainment fraction but failed to predict correctly critical power. Thus, led us to develop a new deposition correlation that satisfies prediction of both entrainment fraction and critical power.
- Improved COBRG01A void drift model. Assessment of COBRG showed weakness of void drift model to predict correctly local subchannel void fraction. The improved void drift proposed in showed good agreement with the data.
- Successfully, derived, implemented, and tested a mechanistic film dryout correlation based on selected non-dimensional conditions parameters at which the liquid film in annular flow breaks down. Results of comparison to experimental data improves the accuracy of dryout predictions
- Diligently contribute to development of customer CTQ for COBRAG application methodology. The development envisaged establishing high level acceptance criteria to each application categories and incorporates these in COBRG02P Software Requirements Document (SRD) and/or Software Test Plan (STP). The proposed CTQ was presented, reviewed and approved at Special Purpose Technical Design Review meeting.
- Established scientifically demonstrated COBRAG validation process through expanding its test matrix to provide sufficient of the predictive capabilities of the code for separate effect and integrated systems.

- Developed and implement a liquid partition model: Scrutiny of COBRAG predictions showed shortcoming of COBRGA in the partition of liquid at the onset of annular flow regime which is very important to obtain good prediction of critical power. To overcome this, a new in-house correlation based on experimental data was developed and implemented into the code. Assessment of the code indicates that this model gave satisfactory results.
- Implemented and tested GNF3 Subchannel pattern for use in optimization of the GNF3 design.
- Successfully Converted COBRG02P to Intel compiler. Implemented OpenGE source control utilizing Git modern source control platform. This provided a streamlined process to archive and truck code changes and hence cut time in finding root cause of unexpected problems.
- Provided consulting and support in development and implementation of a new method-D correlation for accurate prediction of local loss pressure drop at high power.

- Corrected number of errors and resolved on timely manner unexpected challenging problems such as convergence due to introduction of new model, modeling issue or existing problems such as asymmetry in void in both developmental version and the current level 2 codes and file a problem report.
- Provide Support to COBRAG post-processing Code CABALT and participate in the level 2 processes. This included testing, documentation and verification.
- Successfully implemented and tested Transient capability in the subchannel code COBRA.

COBRAG Application

Provided Support to COBRAG users for its application to fuel design improvement and other special projects. This included:

- The use of COBRG02P to limit the testing on the most suitable 5x5 configuration with cold rods that can best simulates steam vent around the water rod. The results were used for design optimization of the GNF3 bundle.
- Analyzing the mal distribution of the sub-channel flow of GNF2 and GE14 fuel bundles. The results were used to improve the design of the GNF3 bundle.
- COBRAG simulation of a variety of part length locations for wide range of mass flux to determine the optimum design (better flow distribution) of the Gnf3 design.

Core Monitoring code AETNA Development:

- Responsible engineer for the thermal hydraulic model review, enhancement, testing and deployment of the BWR Core Simulator (AETNA).
- Participated in reviewing and revising AETNA level one documentations (HSSS, SMP). Established AETNA thermal hydraulic software requirements (SRD).
- Assessed the adequacy, improved and implement several Models in AETNA. This included Prime, Niter 24, Single channel T.H, non Ge water rod, code convergence, void fraction effect on pin power, bypass modeling options, heat transfer, self-identified and corrected several flaws. Peer reviewed T.H code changes and implementation of some iscore functionality, Gesam and P11 errors correction and enhancement.
- Reviewed and revised AETNA MDD and STP related to the TH. solution. Established scientifically demonstrated validation process for AETNA TH. Through expanding its test matrix using experimental data for pressure drop and void fraction which will provide sufficient of the predictive capabilities.
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Dryout Model Development and Deployment (GEXL MODULE)

- Designed, tested and delivered two GEXLMODULES on x32 and x64 Platforms along with the required documentations STP, STR and Interface Specification. Manage to involve customer in the preliminary testing, which helped reducing handover time of two MODULES to half time of delivering one module.

MISCELLANEOUS

- Stepped up to help with emergent work. This included code review of the entire TRACG code, GESAM and completed several verifications vital to meet customer deliverables

- Give technical support and consulting for an in house Phd dissertation on COBRAG transient version to implement a new quenching model. This work can be used as basis to improve TRACG quenching model or to expand COBRG application.

- Mentor several Edison and intern students for subject related to thermal hydraulic
- Engaged as coach for COBRAG, AETNA, ISCOR thermal hydraulic knowledge capturing transfer efforts, and pipeline & talent development.
- Constantly Leveraging Chief Engineer expertise and consulting engineer in the thermal hydraulic fields related to subchannel code, ISCOR02P, AETNA, TASC and TRACG.
- Analyzed an evaluated GNF3 R-factor uncertainty and Channel Bow (SLMCPR Uncertainties)

Senior Mechanical Engineer, Entergy, New Orleans, April 2000 to 2006

- Perform Design reviews of large new and rebuilt Transformers using Andersen finite element methods program. This included a stresses analysis, and thermal analysis due to a short circuit. In every case of a new or rebuilt transformer an improvement to the unit was prompted, at no additional cost to Entergy, due to the design review. The benefits of such work have increased DSUB reliability and reduced costs.
- Enhanced the Andersen transformer short circuit code to perform winding buckling analysis under free and supported Buckling analysis based on the theory of buckling of close ring subject to an inward radial pressure.
- Enhanced the Andersen transformer short circuit code to perform conductor-tipping analysis.
- Improved the capability of the Andersen transformer short circuit code to perform winding thermal analysis. The improvement included an approximation of the winding hottest spot temperature gradient using the calculated average winding to mean–oil temperature gradient combined with the maximum and average eddy losses.
- Caught and corrected a software design flaw in the Andersen code, which allowed the code to model the case of: fault on a secondary terminal with high side ignored. The Authors recognize this improvement and offered copy of the new version free of charge.
- Support personnel to provide substation technical field support in regard to reviewing equipment test data and troubleshooting of special equipment problems.
- Analysis of substation equipment failure, followed up by a recommendation to prevent reoccurrence.
- Developed an Algorithm based on reliability analysis to prioritize oil circuit breakers maintenance. The program is currently implemented into the Computerized Maintenance Management System replacing the traditional time-based maintenance. It is used as a tool to trigger the need for a maintenance based on the probable condition of the breaker. The program allowed a significant reduction in the company's maintenance costs.
- Developed a code (written in FORTRAN) to calculate fault currents during a short circuit on an autotransformer with direct or indirect regulation on the low voltage winding. The program used extensively the method of symmetrical components. It is used to determine the worst case scenario short circuit and feeds fault current data to the Andersen program. This project enabled increasing calculation accuracy and reducing 50% of the time allocated for design reviews
- Performed quarterly transformer oil analysis using Transformer oil Analyst (TOA) software on a population of 5000 transformers to assess the general condition of equipments and identify an earlier detection of incipient-fault condition. The oil diagnostic testing, allowed to implement condition based maintenance and as a result optimized workforce utilization by focusing on the equipment that is in most need of maintenance **(**workforce availability were increased by 50%).
- Responsible for maintaining the company website.
- Performed transformers plant audit
- Responsible on Witnessing transformers Testing
- Involved in Standard reviews.

Graduate Assistant, Department of Mechanical Engineering, University of New Orleans, May 1998 to Nov. 2000 :

- Involved in elaboration of a code for solving the Shallow Water equations, using finite Volume

Methods based on first and second order Godunov type scheme on unstructured and structured grids.

- Researched and developed a large code for solving Euler equations using an upwinding finite volume scheme.
- Developed a Finite differencing computer code for solving the vorticity equations using explicit scheme.
- Developed a Finite differencing computer code for solving the two-dimensional Navier Stokes equations using implicit scheme.
- Developed a finite element program using triangular element to determine the unsteady state temperature distribution of a food can. The program was used to analyze the effect of food sterilization. The results were found to correlate with Ansys 5.5.
- Developed a finite element and a finite differencing program to optimize the thickness of multiple insulation layers of a liquid oxygen tank separated by heat-absorber liquid. The problem was formulated as a 2-dimensional steady state. Both programs gave comparable results.
- Developed a code for solving the cavity problem using penalty finite element model.
- Directed two PhD students on completing their modeling Computer codes.
- Directed 3 graduate students on completing their Thesis.

Mechanical Engineer, Consoer Townsend Envirodyne Engineers, INC. New Orleans. July 1998-May 1999.

- Designed, tested, and debugged an interactive Access database for sanitary sewer field and test data for the Gentilly service basin of the New Orleans Sewerage and Water Board. Data included 15,000 digital photographs and field data for over 2,700 Manholes 720,000 linear feet of pipe. This database is used by sewer water board of New Orleans as maintenance and rehabilitation tools for the gentilly service basin.

Senior Engineer, Algerian Center of Development, Energetic Systems Institute, Ain-Oussera, Djelfa, Algeria, Nov. 92 - June 96

Four years' experience in progressively responsible position, in engineering technical management related to design, development, operation, exploitation and maintenance of nuclear test loops testing the performance of fuel rods for nuclear reactors. Duties included:

- Supervise, direct, control, review, and approve the design engineering tasks and activities of the engineers and designers in the Civil Structural and mechanical Design Engineering group. Major responsibilities include conceptual designs, feasibility studies, engineering analyses, calculations, technical evaluations, specifications, modifications, drawings, and technical procedures.
- Administered pre-commissioning, including feasibility; safety operation, design of fluid pipe systems and start-up of nuclear test loops.
- Commissioning, including: system pressure tests, reliability, quality control and final nuclear testing for test loops.
- Project manager of an out of Pile test loop project that tested the Mechanical, Chemical and Thermal behavior of PWR. fuel rod. This included pipe stress analysis, and equipment design.
- Responsible for the technical direction, review, and approval of outside consultant activities and deliverables when required.
- Instructed classes on operation regulations, management of pressure tanks and maintenance of nuclear test loops.

PUBLICATIONS:

- **B. Hizoum, V. Kumar, Robert Salko**, "CTF Improved Drag Model and Flow Regime Transition Criteria", The 19th International Topical Meeting on Nuclear Reactor Thermal Hydraulics (NURETH-19) Log nr.: 19001, Brussels, Belgium, March 6 - 11, 2022
- **R. Salko, B. Hizoum, D. Kropaczek. M. Asgari,** "Verification of the Alternative Nonlinear Two-phase Subchannel (ANTS) code", Nuclear Engineering and Design, Volume 397, 111930, October 2022
- **V. Kumar, B. Hizoum, R. Salko**, "Development of CTF Modeling of Interfacial Drag, Wall Shear, and Interfacial Heat Transfer for Bubbly and Annular Mist Flow Regimes", Oak Ridge National Laboratory, ORNL/TM-2021/2113

- **K. Kumar, W. Gureckly, Robert Salko, B. Hizoum**, "Improvement of two-phase closure models in CTF using Bayesian inference", Nuclear Engineering and design, 2022, Vol.398(1))
- **B. Hizoum, D. Miranda, K. Kang, S. Oh, J.G.M. Andersen, S. Bowman**, "Transient Subchannel Analysis of BWR Fuel Thermal Hydraulic Performance", The 19th International Topical Meeting on Nuclear Reactor Thermal-Hydraulics, NURETH-18, Portland, OR, August 18, 2019
- **S. Oh*, B. Hizoum, P. Saha, B. Dooies, D. Miranda**, "Film-droplet split model at the onset of annular-mist", the 16th International Topical Meeting on Nuclear Reactor Thermal Hydraulics (Nureth (16)\
- **B. Hizoum, P. Saha, J. G. M. Andersen and K. Whitlow**, "Droplet Entrainment and Deposition rate Models for Determination of Boiling Transition in BWR Fuel Assembly", NURETH-14-387, September 2011.
- **B. Hizoum, Jens Andersen, Asuka Sakoda, Scott Bowman**, *COBRG Subchannel Analysis of BWR fuel thermal Hydraulic Performance,* Proceedings of 2010 LWR Fuel Performance/TopFuel/WRFPM, September 2010.
- **Martin J Guillot and Belgacem Hizoum**, "Application of a Discontinuous Galerkin Method to the 1-D Shallow Water Equations", ASCE *Manuscript number:* HY/2002/023043, journal of Hydraulic
- **S. Oh, B. Hizoum, K. Kang, D. Miranda, J. Andersen, S. Bowman**, "Application of the COBRAG Subchannel Code to Fuel Design," 18th Int. Topical Meeting on Nuclear Reactor Thermal Hydraulics, Portland, Oregon, USA (2019). Engineering.
- **R. Salko, V. Kumar, B. Hizoum**, "Improvements to CTF Closure Models for Modeling of Two-Phase Flow", Technical Report, ORNL/TM-2020/3, Oak Ridge National Laboratory, July 2020
- **R. Salko, B. Hizoum**, **B. Collins, M. Asgari,** "Improvements to CTF for modeling of boiling Water Reactor Geometry and Operating Conditions", Technical Report ORNL/TM-2020/1746, September 2020
- **R. Salko, B. Hizoum**, **A. Graham, B. Collins, M. Asgari,** "Summary of CTF Modeling and Numerical Improvements for Boiling Water Reactor Simulation", Technical Report, ORNL/TM-2021/2004, April 2021
- **V. Kumar, B. Hizoum, R. Salko**, "Development of CTF Modeling of Interfacial Drag, Wall Shear, and Interfacial Heat transfer for Bubbly and In Annular Mist Flow Regimes"**,** Technical report**,** ORNL/TM-2021/2113, July 2021