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## TUFFp Talk



### TUFFP Hires New Computer Resources Manager

After an extensive search process, TUFFP has selected a new Computer Resources Manager. Jaime E Garces-Perez, a native from Guayaquil, Ecuador, will receive his B.S. degree in Computer Science, with a Math minor from the University of Tulsa in May, 1994. Jaime was recently elected recipient of the Ralph W. Veatch Award for Outstanding Academic Achievement in Computer Science. This last award, and many more received in High School and College, demonstrate his excellent record of high academic achievement.

Jaime has extensive experience using a variety of computers, ranging from early day computers to workstations. He has attended an HP training course to maximize his experience on TUFFP's new HPs. During his tenure at TUFFP, his duties include system maintenance, network administration, and training students and staff on using the HP workstations.

Jaime's hobbies include computers, reading and outdoor activities. He is a member of the Tau Beta Pi engineering society. His plans are to begin an M.S. program in Computer Science in May, 1994 and perhaps later to pursue a Ph.D.

## **BHRG Multiphase Conference in Banff Springs Canceled**

The multiphase flow conference scheduled for September 4 - 6, 1994 in Banff Springs and co-sponsored by BHRG, TUFFP, and Neotechnology has been canceled. Personnel changes within BHRG, potential hotel problems in Banff Springs and failures to complete a timely "call for papers" and establish an organizing committee precipitated the decision. It is possible that a similar meeting will be scheduled, perhaps in Banff Springs, in about two years.

## **Joint Project to be Initiated with TUALP**

The Tulsa University Artificial Lift Projects (TUALP) and TUFFP will soon begin a joint research project in the area of mechanistic modeling of multiphase flow through wellbores. We are currently searching for an appropriate student that will be given the responsibility of significantly expanding the new joint TUFFP/TUALP well data bank, updating the mechanistic models that have been developed by TUFFP and TUALP, and evaluating the models and empirical correlations using the new data bank.

## **Plans Underway for Wax Deposition JIP**

Following the November 1993 TUFFP Advisory Board meeting, approximately 25 people from 15 different companies met to discuss a possible joint industry project (JIP) to investigate the effect of two and three phase flow on wax deposition in pipes. At this intense meeting, the participants succeeded in identifying and prioritizing key technology developments needed to understand the thermodynamics and fluid mechanics associated with wax deposition problems. In addition, potential investigation sites were also identified.

Later, interested JIP companies suggested that TUFFP consider serving as a "general contractor" for the project with tasks not falling under their area of expertise being accomplished through sub-contracts with other centers. Additional meetings have been held at which objectives, timing and budgets have been further refined. In addition, a meeting was held with BDM in Bartlesville, Oklahoma to initiate the possibility of DOE cost sharing of the project.

No additional information is available at this time. However, several of the companies interested in considering the JIP have indicated that a possible kick-off date would be September 1, 1994 following the TU/SPE Centennial Petroleum Engineering Symposium and immediately preceding the TUFFP Advisory Board meeting. Additional information will be available in a newsletter that will be distributed to member companies in June, 1994.

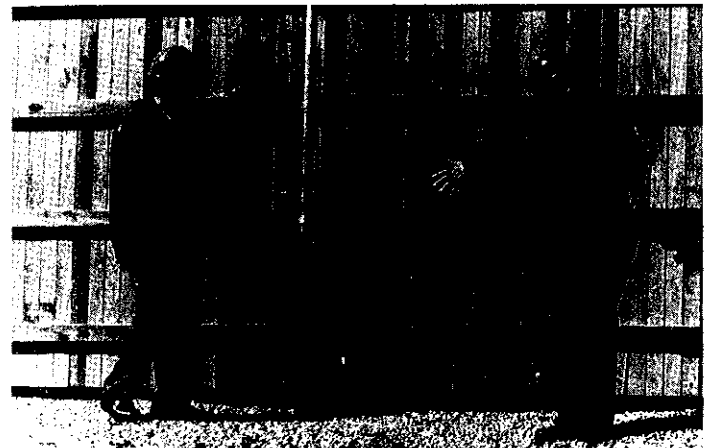
## **TUFFP Membership Increases**

Membership in TUFFP has increased from 31 members for 1993 to 32 members for 1994. We are pleased to announce that Baker Jardine and Associates has joined TUFFP effective January 1, 1994. A concerted effort is underway to obtain additional new members for 1994.

## **North Campus Beautification**

A major "Beautification of the North Campus" effort is well underway in preparation for the Centennial Symposium described later. Dr. Zelimir Schmidt is serving as the "Point Man" to evaluate conditions of buildings and grounds on the North Campus. He has formed a committee consisting of Don Richison (TUDRP), Homer Wheeler (TUALP) and Jerry Wilson (TUFFP).

An inspection of all North Campus facilities generated a four page list of maintenance, repairs and new facilities needed. This winter several activities were initiated towards getting the North Campus ready for the centennial festivities. TUFFP has removed five old temporary buildings, constructed a privacy fence compound for open storage of materials and equipment, and contracted for weed control around the new down-flow facility. The ARCO building has been cleaned out and is being reorganized for efficient storage of instruments, documents and other items requiring covered storage. The Physical Plant, under the direction of Mr. Bill Johnson, plans to paint the Drill building and the Model Lab, and replace the chain-link fence along the east boundary of the North Campus. The new fence will be a privacy, picket type fence similar to the existing fence around the remainder of the North Campus. These improvements and maintenance items should make the North Campus look as good as the quality research performed at this University of Tulsa location.



*Dr. Cem Sarica and Jerry Wilson measure the new storage compound for placement of test facility materials.*

## Research Associate Leaving TUFFP

We were sad to learn that Dr. Dennis Cai will be leaving TUFFP on April 1, 1994. Dennis has been on our research staff since November 1993 with primary responsibilities on the GRI PCB migration research project. On April 1st he will join Texaco Exploration and Production Technology Division in Houston, Texas in their multiphase flow research group.

Although, we will miss Dennis, this is one example of how a successful academic research organization should function. We achieve part of our objectives by taking graduate students and Post Doctoral Research Associates, adding value and making them available to our supporting companies. Although Dennis was not a petroleum engineer, he learned a great deal about multiphase flow applications in the petroleum industry during his sixteen months with TUFFP. Of special interest, he will be replacing a previous Ph.D. graduate from The University of Tulsa, Dr. Guohua Zheng, who also performed his research in TUFFP. Dr. Zheng is transferring to another part of the Texaco organization.

## TU/SPE Centennial Petroleum Engineering Symposium Update

As part of The University of Tulsa's 100th Anniversary Celebration, the department of Petroleum Engineering is co-sponsoring, with the Society of Petroleum Engineers, a Centennial Petroleum Engineering Symposium. The symposium will be held August 29 - 31, 1994 at the Doubletree Hotel at Warren Place in Tulsa, Oklahoma. Included in the conference will be a broad range of research topics that span the expertise within the department: multiphase flow, artificial lift, drilling, reservoir characterization and well test analysis.

An opening plenary session on Monday, August 29th will focus on "The Future State of Petroleum Technology: 2020". Panelists include Gustavo Inciarte (President - INTEVEP); Joe Mach (Vice President - Dowell Schlumberger); Bennie DiBona (President - BDM Oklahoma, Inc.); Roy Knapp (Professor of Petroleum Engineering - The University of Oklahoma); John Mihm (Vice President for Research - Phillips Petroleum Company) and Steve Jones (Oklahoma Independent Petroleum Association).

The symposium will begin with a tour of The University of Tulsa's Main Campus and experimental facilities on the North Campus. Between now and late August, a concerted effort will be made to clean up the entire North Campus to maximize the impact of our first class test facilities on the participants of the tour. Essentially all of the TUFFP test facilities will be in the process of generating data so persons taking advantage of the tour will have a unique opportunity to see a variety of multiphase flow test facilities in operation.

A symposium banquet will be held on Monday evening,

August 29th. The featured keynote speaker will be T. Don Stacy, Chairman, Amoco-Eurasia. Don has also served as a Petroleum Engineering faculty member at Mississippi State University, Manager, Production Research at Amoco Production Research Company; and as a past SPE President. A cocktail reception for alumni and friends of The University of Tulsa will be held on Tuesday evening. Technical sessions will be held on Tuesday and Wednesday, August 30 and 31st. Advertisements for the Tulsa University/SPE Centennial Petroleum Engineering Symposium have already begun to appear in SPE literature. A preliminary technical program will be distributed to most SPE members and other interested persons later this spring. Stay tuned!

## Enrollment Period Underway for TUFFP Short Course

Final details have been completed for the TUFFP 1994 Short Course scheduled in Tulsa, Oklahoma May 9 - 13, 1994. The course will be held at the Doubletree Hotel at Warren Place.

The purpose of this course is to give participants a well-grounded understanding of the fundamentals of two-phase flow through pipes and restrictions and Inflow Performance Relationships. Completed and current TUFFP research projects permit teaching the latest techniques for designing multiphase flow piping systems for the production and transportation of oil and gas. Upon completion, the participants will be able to apply knowledge gained to design fluid flow conduits encountered in petroleum, natural gas, and chemical engineering operations. The same pricing schedule that was used for the 1993 course will be retained for 1994 and is given below.

### TUFFP Member Companies:

Per Person \_\_\_\_\_ \$950

Group Discount - Per Person \_\_\_\_\_ \$850

### Non-Member Companies:

Per Person \_\_\_\_\_ \$1,445

Group Discount - Per Person \_\_\_\_\_ \$1,195

Brochures have now been mailed to members and other potential participants.

We urge member companies to enroll engineers as soon as possible to assist us in planning for the course. If an insufficient number of enrollments is received by May 1, 1994 the course will be canceled. Members can enroll by contacting the Continuing Education Department at The University of Tulsa, (918) 631-2347, sending a fax to (918) 631-2154, or by sending a telex to 497543.

## TUFFP Participates in Several Technical Conferences

Papers based on TUFFP research have been submitted to various technical meetings since the last newsletter. In addition, TUFFP personnel are involved in planning for several conferences that will include sessions on multiphase flow through pipes. Following is a summary of these activities.

The University of Tulsa will sponsor, with the Society of Petroleum Engineers, a Centennial Petroleum Engineering Symposium August 29 - 31, 1994. The meeting will be held at the Doubletree Hotel at Warren Place in Tulsa, Oklahoma. One technical session will be on multiphase flow through pipes. Two related technical sessions will be on the general topic of Production and on Artificial Lift.

### *"Downward Co-Current Slug Flow in Inclined Pipes"*

P. Roumazielles, J. Yang, X. Chen, J. Wilson, C. Sarica and J. P. Brill, accepted for SPE Annual Technical Conference and Exhibition, September 25 - 28, 1994, New Orleans, Louisiana.

### *"Film Thickness Distribution for Annular Flow in Directional Wells - Horizontal and Vertical"*

R. Paz and O. Shoham accepted for SPE Annual Technical Conference and Exhibition, September 25 - 28, 1994, New Orleans, Louisiana.

### *"Mechanistic Modeling of Multiphase Flow in Wells"*

J. P. Brill, talk presented at the Gas Lift Workshop for the ASME-ETCE, January 24 - 26, 1994, New Orleans, Louisiana and as a seminar to graduate and undergraduate students at Ohio University, Marietta College, West Virginia University, and Penn State University.

### *"PCB Migration in Natural Gas Pipelines"*

J. P. Brill, M. Adewumi, S. Tian, X. Cai, C. Sarica and N. Nor-Azlan, presented at 1993 PSIG Annual meeting, October 13 - 15, 1993, Pittsburgh, PA.

### *"PCB Migration Modeling for Gas Transmission Pipelines"*

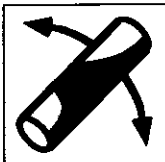
M. Adewumi, S. Tian, N. Nor-Azlan, J. P. Brill, X. Cai, X. Chen, presented at GRI/PCB Workshop, January 27, 1994, San Antonio, Texas.

## 1994 TUFFP Members

Amoco Production Company  
 Arabian Oil Co., Ltd.  
 ARCO Oil and Gas Company  
 Baker Jardine & Associates  
 British Gas Corporation  
 BP Exploration  
 Chevron Petroleum Technology Company  
 Chiyoda Corporation  
 Conoco, Inc.  
 ECOPEtrol/Instituto Colombiano del Petroleo  
 Elf Aquitaine  
 Exxon Production Research Company  
 Institut Francais du Petrole  
 Institute of Oil & Gas Production Technology Oil  
 & Natural Gas Commission  
 Instituto Mexicano Del Petroleo  
 INTEVEP  
 JGC Corporation  
 Japan National Oil Corporation  
 Marathon Oil Company  
 Mobil Research and Development Corporation  
 NKK Corporation  
 Norsk Hydro  
 Pertamina  
 Petrobras  
 Petronas  
 Phillips Petroleum Company  
 Saudi Arabian Oil Company  
 Shell Internationale Petroleum MIJ B.V.  
 Simulation Sciences  
 Texaco  
 TOTAL  
 UNOCAL

## Research Progress

### R E P O R T S

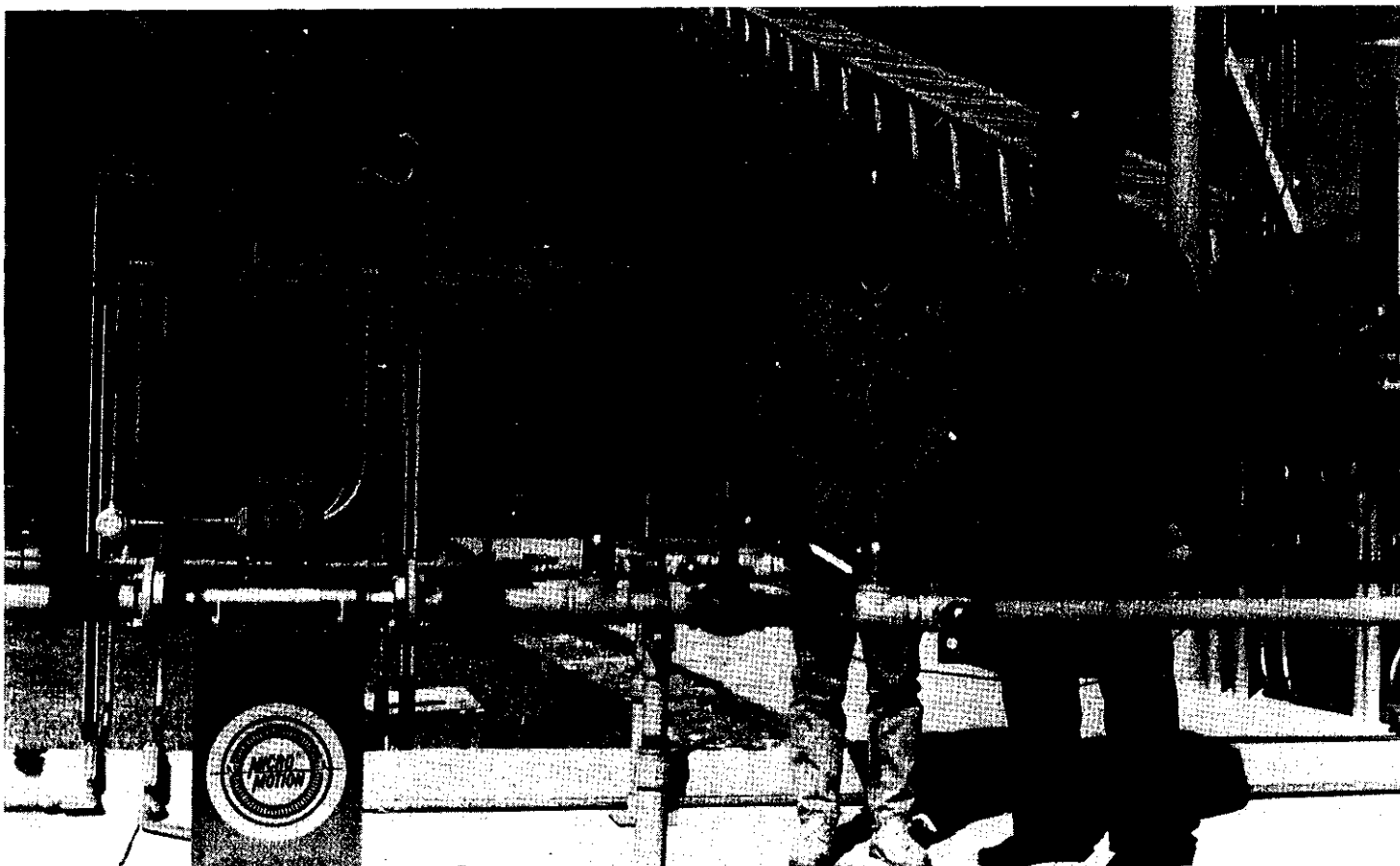


## Downward Two-Phase Flow in Inclined Pipes

The objective of this project is to study, experimentally and theoretically, two-phase flow in downward inclined pipes. The initial part of the project concentrates on downward intermittent flow and includes measurements of liquid slug holdup, pressure gradient and translational slug velocity for different operating conditions. The entire range of inclination from horizontal to vertical downward is considered.

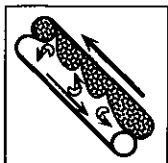
The first goal for this research project was to design and construct a test facility to acquire necessary data and develop a preliminary model for subsequent evaluation with experimental data. Construction of the new test facility has been completed.

Calibration of all pressure transducers and thermocouple have been accomplished. The electronic design of the capacitance sensors has been modified to eliminate unreasonable drift and noise from the output signal. The capacitance sensors now show a very good repeatability with an accuracy of about  $\pm 1\%$ . A series of intermittent flow experiments, including dynamic calibration of the capacitance sensors, has already been conducted for the horizontal case. A mechanistic slug flow model featuring new translational slug velocity and liquid slug holdup correlations is under development. All the results will be presented at the next Advisory Board Meeting.



# Research Progress

## R E P O R T S



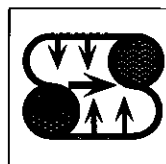
### Experimental and Theoretical Investigation of Non-Emulsified Oil-Water Flow Patterns in Pipes

The need for reliable design methods has been the driving force behind a very large research effort in two-phase gas-liquid flow over the past 30 years. Recently, the industry has turned its attention towards the understanding of the simultaneous flow of gas-oil-water mixtures. However, the limiting case when no gas phase is present has received inadequate attention. The flow structure of oil-water mixtures in pipes is quite different than that of gas-liquid mixtures. The different flow structure is mainly caused by the large water momentum transfer capacity and small buoyancy effects. Also, the small free energy at the interface allows the formation of shorter interfacial waves that affect the flow pattern transition mechanisms. Therefore, gas-liquid flow studies can not readily be applied to oil-water systems.

The objective of this project is to investigate the non-emulsified oil-water flow patterns in pipes. Experiments will be carried out to study the characteristics of the flow patterns for a wide range of inclination angles, from horizontal to vertical, for one set of fluid

properties and 2 in. diameter transparent pipe. The mechanistic modeling approach, based on physical phenomena, will be used to model the oil-water flow pattern transitions.

The test facility design has been completed. Procurement of new equipment items and modifications of the test loop are underway. The construction phase will be finished by mid July

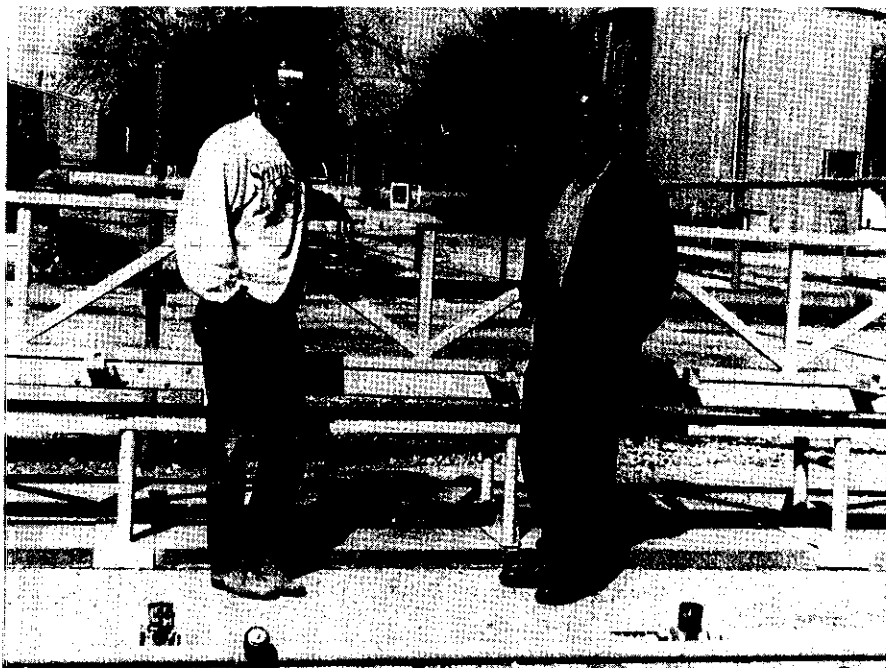


### Flow Behavior in Horizontal Wells

Horizontal wells can have very complex flow geometries, in part due to interaction between the main flow stream and the influxes along the wellbore, and also due to completion type.

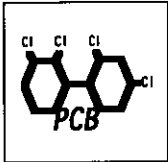
A survey of the literature reveals that no experiments have been conducted for relatively low Reynolds numbers, including the laminar flow region, in perforated horizontal pipes with fluid injection. The objective of this project is to investigate, experimentally and theoretically, flow behavior in horizontal wells. The effect of influxes on horizontal well flow at practical influx to main flow ratios will be investigated in both laminar and turbulent flow regimes for three different pipe perforation densities.

Design of the test facility is finished. Test pipe, test fluid, pumps and measurement devices have been selected. At present, the flow behavior in horizontal wells is being investigated using the principles of conservation of mass, momentum and energy. A new friction factor expression for horizontal well flow is being developed.



# Research Progress

## R E P O R T S

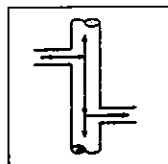


### GRI Liquid Transport Tests

Initial research for the GRI sponsored "Experiments for Liquid Transport in Gas Transmission Pipelines" has recently been completed.

The work began with modification of the TUFFP 1400 ft-long loop, constructing a valley section, and installation of instrumentation and a new LabVIEW™ based data acquisition system. The study was mostly qualitative and semi-quantitative in nature. Video tapes were obtained at the transparent valley section to record observed flow behavior. Two main categories of flow situations in the valley were described. One was the case where there was no incoming liquid flow; the other case was where there were various low liquid flow rates. A flow behavior map was established. Gas critical and blow out velocities were obtained. Pressure gradients for two-phase flow in the horizontal section were also measured.

The first year of a proposal for the period 1994-1996 to provide improved constitutive equations for two-phase flow models with low liquid loading has also been funded. Penn. State University serves as the prime contractor for the project with TUFFP being the subcontractor. Michael Adewumi of Penn. State and Dr. Brill serve as Co-principal Investigators.



### Two-Phase Flow Splitting at a Reduced Tee Junction with an Inclined Side Arm

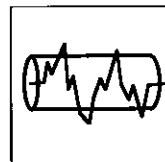
The objective of this study is to investigate experimentally and theoretically two-phase flow splitting at a reduced side-arm tee junction for horizontal, upward and downward inclinations of the side arm. The study is restricted to the stratified wavy flow pattern upstream of the tee junction. Both the gas and the liquid splitting ratios and the pressure drop measurements will be taken. A mechanistic model for the splitting behavior and the

pressure drop prediction will be developed.

Since the last Advisory Board meeting, efforts were focused on calibration of all the instruments required for monitoring the phase distribution and pressure drop at the tee junction. These instruments include orifice meter, flow provers, turbine meter, differential and absolute pressure transducers and thermocouples. The data acquisition system has been modified to acquire the pressure drop data at the tee junction.

Currently, an attempt is underway to reproduce the existing regular (2" x 2") horizontal tee data acquired previously by Penmatcha and Ashton. Two different liquid velocities have been tested at different gas splits. The current data matched very well with the previous data. This ensures that the entire facility including all the instruments are performing well.

Once the regular horizontal tee data is reproduced, the regular tee will be replaced by a reduced tee (2" x 1"). The reduced tee data acquisition will be completed by May 1994.



### Transient Two-Phase Flow In Horizontal Pipes

The objective of this study is to experimentally investigate transient two-phase flow phenomena in horizontal pipes and compare the acquired data with predictions of available transient two-phase flow simulators such as OLGA, PLAC, TACITE, and a TUFFP simplified transient code.

Final modifications and instrumentation of the existing 1378-ft-long, 3.068-in.-diameter, experimental test facility have been completed. This facility is now fully operational to generate transient data. These data comprise measurements of liquid holdup, pressure drop, outlet liquid rate, and visualization of flow patterns.

A new generation of capacitance sensors has been developed to measure liquid holdup and is showing an accuracy of  $\pm 1\%$ .

A series of transient tests for stratified flow has already been conducted. These experimental runs consisted of gas and liquid flow rate change and pipeline start-up for different initial conditions. All results will be presented at the next Advisory Board Meeting.

# CON ALLEY

## NEW HARDWARE AND SOFTWARE

In our continuing effort to maintain reliability, two new 128MB optical drives for the Macintosh have been purchased. These drives utilize a new disk that reportedly has a life of 40 years. These drives also give us the capability of quicker and more reliable back ups for TUFFP computers not yet connected to the network (down-flow facility and technician shop computers). Our mainstay graphics program, Canvas, has been upgraded to version 3.5 and an Aldus Premier 3.0 upgrade has also been purchased. A few new programs have been added to our software library, including Fox Pro, a relational database, and Claris Impact, a business graphics program. Our old NEC Silentwriter printer died this winter and we have replaced it with a new Apple Laserwriter Pro 630. This printer is a 600dpi machine and has built in Ethernet to interface with the new network. The quality of Advisory Board Brochures should improve with this new addition. Jim Brill, Jerry Wilson, Cem Sarica and Linda Jones now have Centris 650 Macs, some with CD ROMs. Since many software packages now come on CD, it is a necessity to have CD ROMs.



## NEW COMPUTER CHIEF ON BOARD

In December, we also lost Yesenia Rincon. She was the glue that kept our computer network "Networking". Yesenia received her BS in Management Information Systems and returned to Maracaibo, Venezuela with her husband, Rafael Paz, and son, Rafael Paz Jr. We wish her, Rafael Sr. and Jr. the very best. Of course, Yesenia's departure left a huge void at TUFFP. Prior to her departure, we were able to recruit Jaime Garces who will graduate in Computer Science with a minor in math this spring. Jaime has worked as a software instructor, data acquisition software designer and is proficient in computer maintenance. He attended the HP Workstation Administrator's school in Atlanta, GA this winter and has an excellent Unix and DOS background. He is also a proficient programmer in C, Pascal, Fortran, Cobol and Basic. We are very fortunate to have a person with Jaime's background on board at TUFFP. Jaime will receive a Research Assistantship to stay at TUFFP after graduation and continue his education at the Master's level. With the new workstations, Ethernet network and the rapid changes in the computer game, Jerry sez "Thank God for Jaime!"

## HP WORKSTATION IN DEMAND

TUFFP's new Hewlett Packard Apollo 9000, Model 715-50 Workstation and Model 700/RX terminal are getting more and more usage. Jaime Garces, our new Computer Network Chief, has installed a new Internet software package that enables TUFFP personnel easy access and better navigation of the Internet. The "Mosaic" package was developed by Marc Andreessen et. al at the University of Illinois and is public domain. Jerry Wilson and Jaime Garces have joined an HP user group which meets at the HP headquarters in Tulsa. The group has members from a number of local industry and government agencies and we hope to gain from the collective knowledge and meeting interchange of the membership. All Apollo tapes are in the process of being transferred to the new DAT tape format. This transfer will improve our "shelf life" and assure that our past files and data are preserved.



## VIDEO LCD PROJECTOR ON BOARD

A new InFocus LitePro 550LS projector has been added to the TUFFP fleet. This projector will enable us to project directly from a computer program in addition to normal VCR projection. The LitePro also has a built in disk drive enabling a presenter to merely take a floppy disk along with a presentation captured on it. In some instances, the floppy disk could be used in lieu of toting a computer or VCR to the presentation site. This capability will give us access to multimedia, QuickTime movie clips and many other new presentation methods. Although our slide presentations of the past were of excellent quality and will continue to be part of our meetings, the new projector will open up many new possibilities. The new projector will also be used by Dr. Brill in his classes for software demonstrations and by the TUFFP staff for instructions on LabView, HP Workstations, and Macintosh software. In addition to the LitePro, a remote control mouse has been purchased. This hardware will enable instructors to operate the computer from the screen and do anything you can do with the computer mouse. We are looking forward to a very high utilization of this new instrument.

## GRI VIDEO PRESENTATION

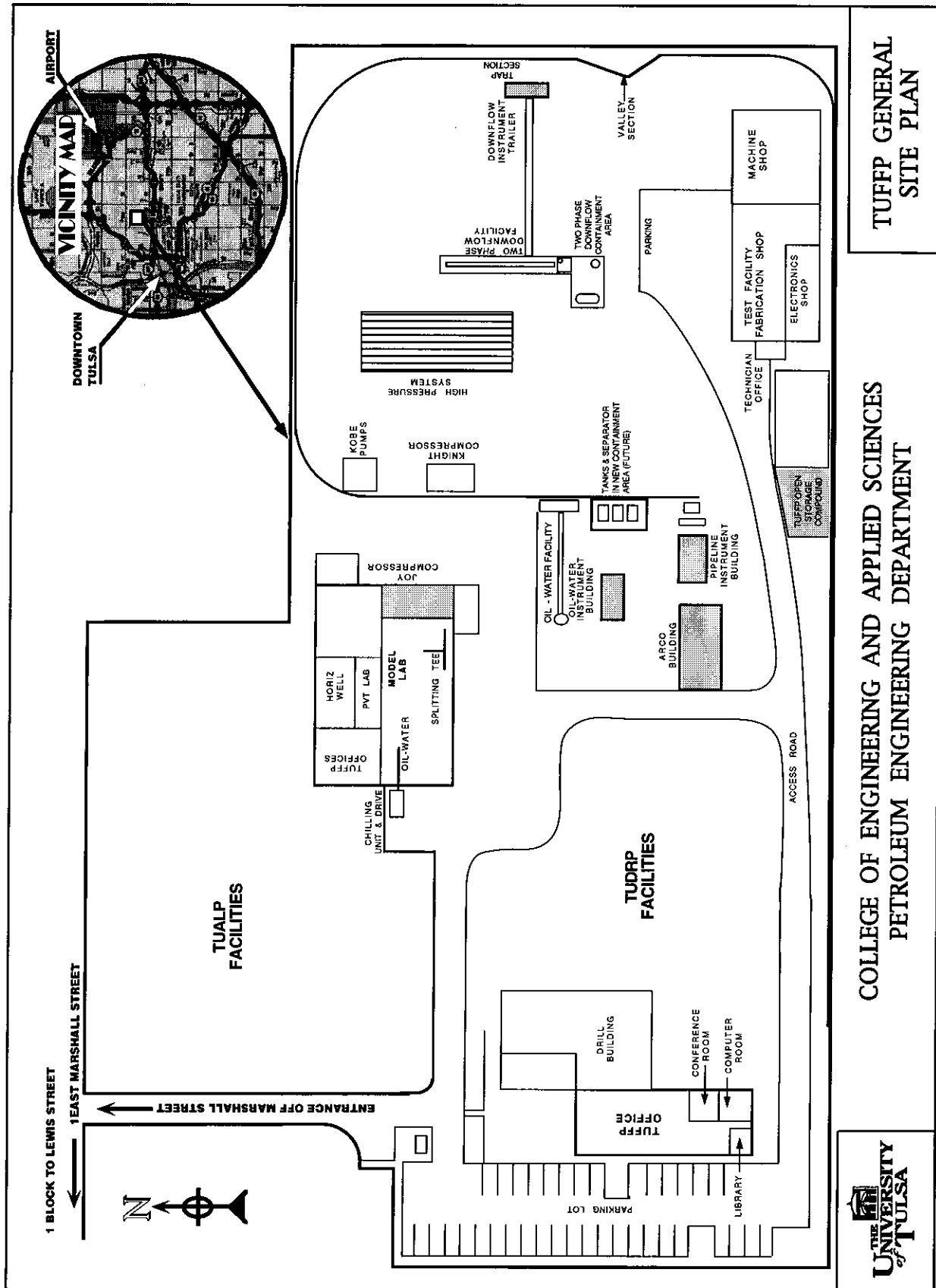
Dr. Dennis Cai utilized our new Hi8mm camera to capture some excellent video of two-phase flow phenomena in a valley section of the TUFFP 1400 ft long pipeline. The Hi8 videos were dubbed down, edited, and graphics were added by Stegman Productions of Tulsa. This video was presented at a GRI PCB workshop in San Antonio, Texas. We believe that multimedia and video are here to stay and plan to utilize these new technologies in our program.

## COMPUTER NETWORK EXPANSION

Our computer network master plan includes having an entirely Ethernet system. A big step in this direction is currently in the works. A work order has been sent to the University Computing and Information Resources Department for hooking up the existing 10BaseT wiring and router in the Drill Building to our Macintosh computers and printers. All necessary transducers and interface boxes are on hand and we should be wired within a few weeks. One major improvement with this new network will be having the capability of interfacing with all the networks on the main campus. We currently have to do Internet and communication with the main campus through modems, a slow and painful process! Although our old LocalTalk network has served us well, it is slow and we do experience an occasional network loss due to connection failure. File and print serving reliability and speed will vastly improve when the new network is in place.

# T U F F P

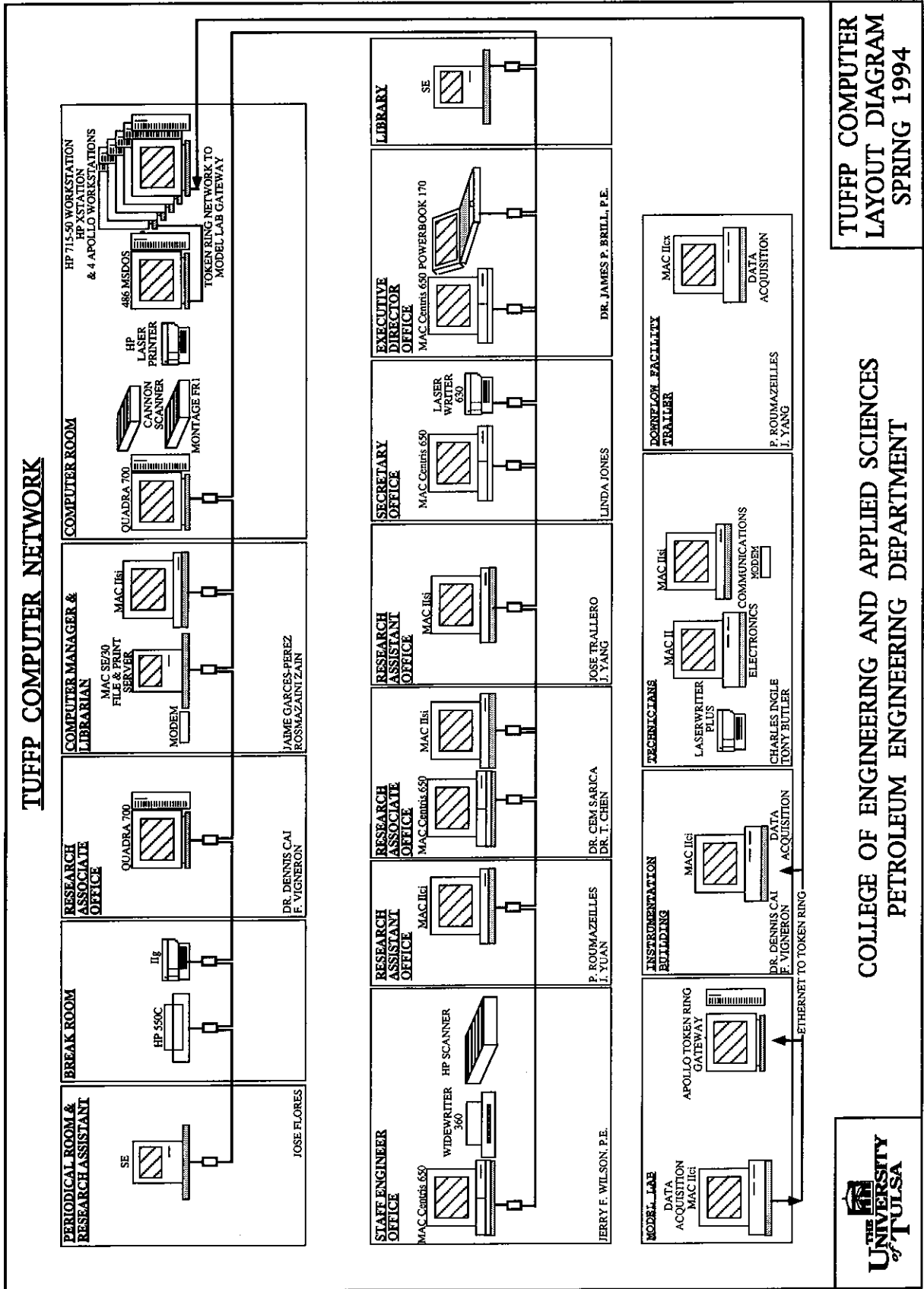
Executive Director:	James P. Brill
Staff Engineer:	Jerry F. Wilson
Research Associates:	Stefan Z. Miska Yehuda Taitel
Visting Scholar:	Fabrice Vigneron
Post Doctoral Research Associates:	X. Dennis Cai X. Tom Chen Cem Sarica
Administrative Secretary:	Linda Jones
Technicians:	C. Ingle T. Butler
Research Assistants:	P. Rournazeilles S. Marti J. Trallero J. Yang H. Yuan
Computer Resources Manager:	Jaime Garces-Perez
Part-time Employees:	Johan Johan Robert Marcano



TUFFP GENERAL SITE PLAN

COLLEGE OF ENGINEERING AND APPLIED SCIENCES  
 PETROLEUM ENGINEERING DEPARTMENT





TUFFP COMPUTER LAYOUT DIAGRAM SPRING 1994

COLLEGE OF ENGINEERING AND APPLIED SCIENCES  
PETROLEUM ENGINEERING DEPARTMENT



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