

TUFFP NEWSLETTER



A Semiannual Publication of the Tulsa University Fluid Flow Projects

August 1988

Volume 2, Number 2

Directory

TUFFp Talk	1
Status of Research Projects	7
Hilly Terrain Slug Flow	7
Slug Flow Splitting	8
Directional Wells	8
Severe Slugging	9
Vertical Flow Models	9
Low Velocity Pipelines	10
Pigging Dynamics	10
TUFFP Computer Network	11
TUFFP Member Companies	12
Map of Test Facilities	12

Director: Dr. J. P. Brill

Associate Director: Dr. O. Shoham

Research Associate: Dr. Y. Taitel

Administrative Secretary:
Rosa Jackson

Technicians: C. Ingle
D. Robinson

Research Assistants:

I. Alves	A. Ansari
K. Minami	S. Arirachakaran
C. Sarica	S. Vierkandt
G. Zheng	J. Xiao
F. Jansen	C. Daza

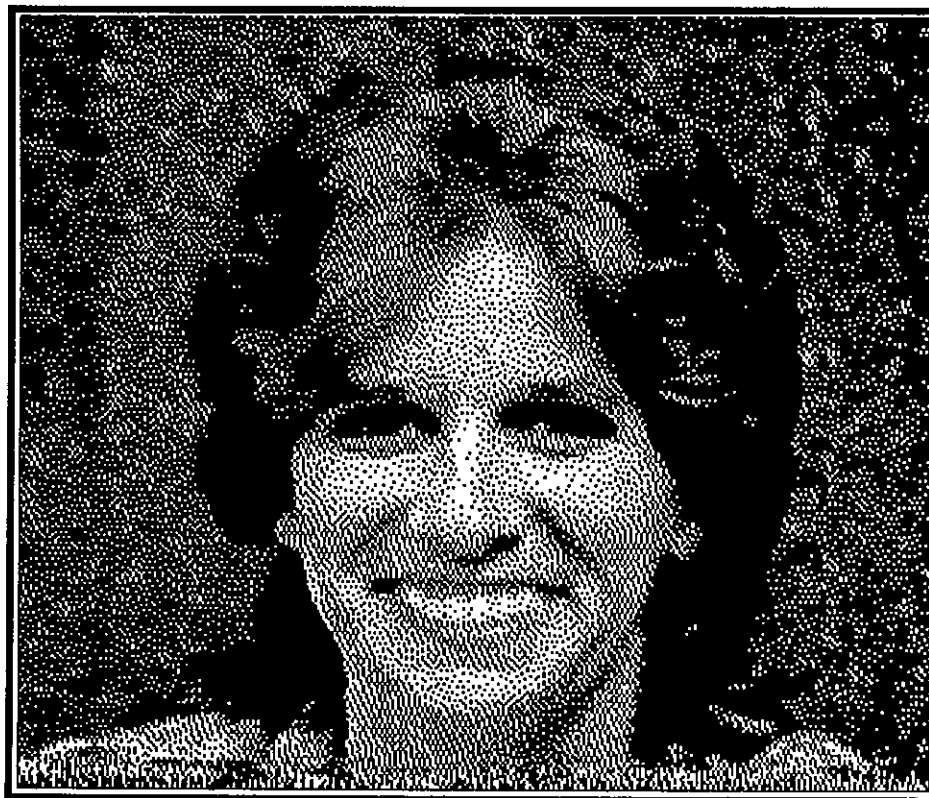
Computer Resources Manager:
Lorri Jefferson

Secretaries:

R. Minami N. Arirachakaran

600 South College Avenue
Tulsa, Oklahoma 74104
918-631-3040
Telex: 747135
Fax: (918)-582-9588

TUFFp Talk



New Girl In Town

On May 9, 1988 TUFFP welcomed Rosa Jackson to the "team" as Administrative Secretary. Rosa has assumed Betty Pence's duties since her retirement May 31, 1988. Although Rosa was not an "official" employee of TUFFP she has lent a helping hand more than once during her seven years at The University of Tulsa. Many times over the past six years, Rosa has helped out during vacations, sicknesses, and during times when an extra hand was needed. Of the 28 TUFFP reports published since December 1981, Rosa has typed 18 of them as well as over 40 publications for SPE, CES, ASME and other journals. So, although she is the "New Girl in Town" officially, unofficially she is an "Old Hand" at this job.

TUFFP Adds Three New M.S. Students

Mr. Jin Jang Xiao, an M. S. student funded primarily by the Chinese Government, has been selected to work on a new TUFFP project to be selected later. Mr. Xiao has also been awarded a partial research assistantship funded by Amoco Production Company Research Center. He began his graduate program in the Fall, 1987 and has nearly completed all academic preparation for conducting his M.S. research project.

Mr. Finn Eric Jansen from Norway has also been selected to work on a TUFFP M.S. research project. Mr. Jansen has been awarded a teaching assistantship from The University of Tulsa for the 1988-89 academic year. At the present time, plans are to have Mr. Jansen continue work on the project involving stability criteria of severe slugging in pipeline-riser pipe systems.

Mr. Carlos Daza from Colombia is the most recent graduate student selected to conduct research for TUFFP. Sponsored by ECOPETROL, Mr. Daza began his M.S. program in the Fall, 1987 and has completed most of his academic preparation for conducting research. A research project will be selected for him later.

Dr. Brill Selected to Coauthor SPE Monograph

Dr. James P. Brill and a former TUFFP research assistant, Dr. Hemanta Mukerjee, have been selected to coauthor a new SPE Monograph on "Multiphase Flow in Wells". For the past year and a half they have been developing detailed outlines and schedules for the Monograph, along with preparation of the first two chapters. The initial chapters have now been accepted by SPE clearing the way for the official commissioning of the Monograph. The current schedule calls for completing the Monograph in mid 1989.

TUFFP Announces Dates for Advisory Board Meetings

The next two Advisory Board meetings will be held November 1-2, 1988 and May 9-10, 1989. Both meetings will be held at the Sheraton Kensington Hotel in Tulsa, Oklahoma. Request for Information forms will be mailed to member companies approximately six weeks prior to each meeting to determine attendance. The forms will be accompanied by information pertaining to the Sheraton Kensington Hotel reservations, and accommodations to and from the airport.

The meetings will begin at 8:30 a.m. and adjourn at 4:30 p.m. A pre-meeting cocktail party will be held at the Sheraton Kensington Hotel from 5:30-7:30 on Tuesdays, November 1, 1988 and May 9, 1989. Tours of TUFFP test facilities will also be held on Tuesday afternoons from 3:00-4:30 p.m.

The above meeting dates were selected to accommodate those member companies who also attend Advisory Board meetings of other cooperative research programs at The University of Tulsa. Following is a summary of these meetings for November 1988.

Erosion/Corrosion	Monday, October 31
Drilling	Tuesday, November 1
Fluid Flow	Wednesday, November 2
Artificial Lift	Thursday, November 3
Reservoir Exploitation	Friday, November 4

TUFFP Advisory Board meeting brochures will be mailed to all members prior to the meetings. They will contain sufficient information to enable each attendee to actively participate in discussions on current and future research projects, financial matters and operating procedures. Brochures containing slide copy for all presentations will be distributed at the meetings but will not be mailed to members.

Calendar for Two-Phase Technical Meetings

Numerous conferences are scheduled for the remainder of 1988 and early 1989 which include technical sessions involving multiphase flow in pipes. A calendar of these events is given below.

1988		
Sept. 6-8	Two-Phase Annular & Dispersed Flows	Oxford, UK
Sept. 14-15	BHRA Offshore Multiphase Production	London, UK
Oct. 2-5	SPE Annual Fall Meeting	Houston, TX
Oct. 20-21	PSIG Meeting	Toronto CANADA
Oct. 31- Nov. 5	SPE China Meeting	Tianjin, PRC
Nov. 2	TUFFP ABM	Tulsa, OK
Nov. 3	TUALP ABM	Tulsa, OK
Nov. 27- Dec. 2	AICHe Meeting	Washington, D.C.

1989		
Jan. 22-25	ASME - ETCE	Houston, TX
March 12-14	SPE Production Operations Symposium	Oklahoma City, OK
May 10	TUFFP ABM	Tulsa, OK
May 11	TUALP ABM	Tulsa, OK
May 22-26	TUFFP Short Course	Tulsa, OK
June 12-16	TUFFP Short Course	London, UK
June 19-21	BHRA 4th International Conference on Multiphase Flow	London, UK

TUFFP Short Courses

For the first time in 15 years it was necessary to cancel the TUFFP Short Course "Two-Phase Flow in Pipes" that was scheduled for May 2-6, 1988. There was insufficient enrollment to prevent a significant financial loss. Although the course was cancelled, TUFFP still incurred expenses of \$4,561 for printing and mailing of brochures.

TUFFP plans to teach its course on "Two-Phase Flow in Pipes" at two locations during 1989. The course will be taught in Tulsa at the Sheraton Kensington Hotel May 22-26, and in London at the Kensington Close Hotel June 12-16. The London course will again be jointly sponsored by BHRA. The dates of the London course were selected to coordinate with the 4th International Conference on Multiphase Flow sponsored by BHRA that will be held the following week.

The purpose of these courses is to give participants a well grounded understanding of the fundamentals of two-phase flow through pipes and restrictions. Completed and current research projects permit teaching the latest techniques for designing multiphase flow piping systems. Upon completion, the participant will be able to apply knowledge gained to design fluid flow conduits encountered in petroleum, natural gas and chemical engineering operations.

As in the past, TUFFP member companies will be permitted one free enrollment in the Tulsa course. Enrollment fees for additional TUFFP member participants or non-member enrollees at both the Tulsa and London courses will be determined at a later date. Brochures for the courses will be available for distribution at the November Advisory Board meeting.

A decision has been made to have TUFFP resume the administration of our short courses. For the past several years the courses have been administered by The University of Tulsa Continuing Education Department. Resuming administration within TUFFP will help control costs and improve communications with potential enrollees.

Amoco Foundation Awards Computer Grant to Petroleum Engineering

In June 1987 Dr. Brill submitted a proposal to the Amoco Foundation for enhancing computer facilities in Petroleum Engineering. The funds will be used primarily to expand the Apollo computer network in Petroleum Engineering to better serve both the undergraduate program and graduate research efforts. Funds in the amount of \$30,000 have been provided to help accomplish these goals.

Although the majority of these funds will be used on the main campus, part of the funds will be used to further enhance the existing Apollo network in TUFFP and communications between the two networks. In an attempt to further strengthen the Apollo networks in Petroleum Engineering, a proposal will soon be submitted to Apollo Computer Co. requesting the donation of several additional computer nodes and peripheral equipment.

A subcommittee has been formed within TUFFP consisting of the Computing Manager and several Ph.D. students with Dr. Brill as an ex-officio member. The function of the subcommittee is to analyze the long term computing needs of TUFFP and determine the most efficient use of existing equipment. Currently, decisions have been made to purchase the following items:

- *PC Designs* AT PC
- Macintosh SE
- Plotting Software for the Macintosh
- Miscellaneous Disk Protection Software for the Macintosh and PC
- PC printer
- Graphics monitor for data acquisition PC

The new PC will provide another node to the Apollo Computer network, using the PCI8 communication link, and will be used primarily as a software development PC. The new Macintosh will eliminate an existing bottleneck in database, spreadsheet and word processing activities.

TUFFP Adds Fax Capabilities

After polling members in 1986 on the use of facsimile machines, requests for fax communications have been monitored closely. A significant increase in fax requests this summer resulted in TUFFP purchasing an Omnifax 9S in August. Companies can now transmit fax documents to TUFFP at (918)-582-9588. This number may change when the new telephone system is implemented (see *TUFFP Newsletter*, page 5).

Membership Outlook Continues to Improve

Three new TUFFP members have now been obtained for 1988. These are Exxon Production Research Company, who renewed their membership after a lapse of one year, China National Oil and Gas Exploration and Development Corporation, and the Kerr-McGee Corporation. In addition, a positive response has been received from YPF in Argentina of intent to join in 1989. A response from AGIP suggests that they too may join TUFFP in 1989.

We have not yet received notification of intent to terminate membership for 1989 from any existing TUFFP members. Members are reminded that the deadline for notification of intent to terminate membership is October 1.

Membership Fees Increase for 1989

TUFFP members are reminded that the membership fees for 1989 will increase to \$16,000. Membership fees have not been increased for three years and the increase was necessary to permit balancing the budget by the end of 1989. Invoices for membership fees will be submitted to member companies on approximately October 14, 1988 to accommodate those members that pay 1989 membership fees from 1988 budgets.

Tulsa University Installs New Telephone System

The University of Tulsa is making a major change in its telephone system. The new system will have many new features, including direct dialing and voice activated mail. The voice activated mail feature will hold 35 hours of information for the entire campus. The installation is expected to be completed by August 27.

The new telephone numbers for TUFFP are as follows:

Dr. James P. Brill, Director
(918) 631-3100

Dr. Ovadia Shoham, Associate Director
(918) 631-2468

Rosa Jackson, Administrative Secretary
(918) 631-3040

Prudhoe Bay Data Scheduled for Distribution

Distribution of the Prudhoe Bay data last scheduled for March 1988 suffered additional delays due to problems in completing the user's manual and computer problems pertaining to maintenance of a cartridge drive. A report is nearing completion and a decision has been made to distribute the data on a single 9-track, 6250 bpi magnetic tape. We now hope to distribute the report and data during September 1988.

Steven Vierkandt Accepts Position with Chevron, U.S.A

Steven Vierkandt, a TUFFP research assistant studying Severe Slugging, has accepted a position with Chevron U.S.A in New Orleans, Louisiana. He will begin work as a production engineer for the Eastern region, upon completion of his master's thesis (hopefully in September). As a production engineer, Vierkandt will be in charge of several off-shore wells, day to day production and well completions.

1988 Questionnaire

The 1988 Questionnaire was distributed to the official Advisory Board representative for each member company with this Newsletter. Members were asked to express their relative interests in both existing and possible future research projects. Results will be tabulated and summarized in the November Advisory Board meeting brochure.

TUFFP Represented at Technical Meetings

Dr. O. Shoham and Dr. J. P. Brill will present technical papers at the SPE Annual Technical Conference and Exhibition in Houston, Texas, October 2-5, 1988. Dr. Shoham will present a paper titled, "Prediction of Dispersion Viscosity of Oil-Water Mixture Flow in Horizontal Pipes". Dr. Brill will present a paper titled, "Dynamic Simulation of Slug Catcher Behavior".

An abstract of a paper based on the Ph.D. Dissertation completed by Dr. Elisio Caetano F. on two-phase flow in a vertical annulus has been submitted for the BHRA 4th International Conference on Multiphase Flow. This meeting will be held in London, England, June 19-21, 1989. Dr. Shoham will present the paper and Dr. Brill, who is on the Organizing Committee for the Conference, will probably serve as a Session Chairman.

An abstract of a paper entitled "An Analysis of Oil-Water Flow Phenomena in Horizontal Pipes" has been submitted for the SPE Production Operations Symposium in Oklahoma City, March 12-14, 1989. This paper is based on earlier research conducted at TUFFP on oil/water flow in pipes by Malinowski, Oglesby and Arirachakaran.

Dr. Gene Kouba Accepts Position with Chevron, U.S.A.

After spending an extremely interesting and productive year at the Harwell Atomic Energy Laboratory in England, Dr. Gene Kouba has accepted a position with Chevron U.S.A. in Houston, Texas. His new assignment will begin September 1 and involves working with Chevron's Pipeflow program.

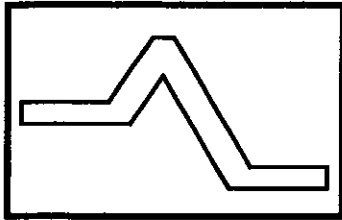
Graduate Seminar Program Continues

Numerous TUFFP Graduate Seminars have been held since the May Advisory Board meeting, and several more are scheduled for this fall. Many of the Seminars were presented by TUFFP Research Assistants. Following is a summary of talks presented and scheduled.

TIME	SPEAKERS	TOPIC
June 10 3:00 p.m.	Cem Sarica	<i>Two Phase Flow: A New Approach for Finger Storage Slug Catcher Design</i>
July 15 3:00 p.m.	Ibere Alves	<i>Two Phase Flow: Directional Wellbore Modified Heat Transfer Model</i>
July 29 3:00 p.m.	Dr. Gene Kouba Distinguished Lecturer	<i>Two Phase Flow: Research Activity at Harwell - An Update</i>
August 12 3:00 p.m.	Dr. Y. Taitel Distinguished Lecturer	<i>Two Phase Flow: Modifications of Severe Slugging Model</i>
August 26 3:00 p.m.	Kazuioshi Minami	<i>Two Phase Flow: Gas Flow Through Stagnant Liquid in Inclined Pipes</i>
September 2 3:00 p.m.	Dr. J.P. Brill	<i>Two Phase Flow: Research Activities of Selected TUFFP Member Companies</i>
September 9 1:30 p.m.	Guohua Zheng	<i>Oral Examination: Two Phase Slug Flow in Upward Shallow Inclined Pipes</i>
September 16 3:00 p.m.	Steven Vierkandt	<i>Oral Examination: Stability of Severe Slugging in Pipeline-Riser Pipe Systems</i>
September 23 3:00 p.m.	Dr. J.P. Brill Dr. O. Shoham	<i>SPE Fall Meeting Presentations:</i> <ul style="list-style-type: none"> • Slug Catcher Behavior Simulation • Prediction of Oil-Water Dispersion Viscosity
October 7 1:30 p.m.	Asfandiar Ansari	<i>Oral Examination: Comprehensive Mechanistic Model for Upward Two Phase Flow</i>
October 21 3:00 p.m.	Guohua Zheng	<i>Two Phase Flow: Review of Creare Model for Flow in Pipelines</i>
November 4 3:00 p.m.	Dr. J.P. Brill Dr. O. Shoham	<i>General: Discussion of TUFFP Advisory Board Meeting</i>
November 11 3:00 p.m.	Ibere Alves	<i>ASME Winter Meeting Presentation: Modeling Annular Flow Behavior for Gas Wells</i>



Research Projects

Two Phase Slug Flow in Hilly Terrain Pipelines

Field pipelines are seldom horizontal. Often they exhibit hilly terrain variations. Hydrodynamics of slug flow become more complicated in such pipelines and have not yet been studied. This project attempts to investigate two-phase flow in hilly terrain pipelines, and to provide means for predicting the flow behavior in such systems.



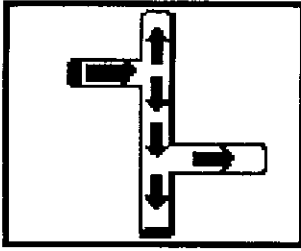
G. Zheng

The first phase of this project is to experimentally and theoretically examine the effect of pipe inclination on slug characteristics in upward shallow inclined pipelines. For this purpose, a large, versatile test facility was fabricated which enables inclination angles from -1° to $+5^\circ$ from horizontal. The test facility can also be easily modified for later studies of hilly terrain configuration. Extensive instrumentation, including nine ring capacitance sensors and eight pressure transducers, were installed for two-phase flow meas-

urements. A microcomputer based data acquisition and control system was utilized.

Since the last Advisory Board meeting more than 30 tests have been conducted, resulting in a large amount of high quality data for various pipe inclinations (0° , 0.5° , 1° , 2° , 5°). Each test sampled at least 50 slugs, and sometimes up to 200. To ensure accuracy, each test also included dynamic calibration data for the capacitance sensors performed on at least 10 slugs, and daily single-phase air and single-phase liquid checks on the instruments. Representative tests were also video taped for each pipe inclination. Visual observations and initial analyses have revealed some interesting phenomena never reported before. "Normal slugs" from the upstream horizontal pipe tend to grow in length as they flow in the inclined pipe. However, the average liquid holdup within a slug tends to decrease. Besides these normal slugs, small slugs are generated in the inclined pipe and attempt to become stabilized as they travel up the pipeline. More detailed analysis of the data is under way along with model development.

The report for the first phase of this project will be presented at the November Advisory Board meeting. More comprehensive data will be taken next summer for two-phase flow in hilly terrain pipelines after modification of the test facility.



Slug Flow Splitting Phenomena in Side-Arm & Impacting Tees

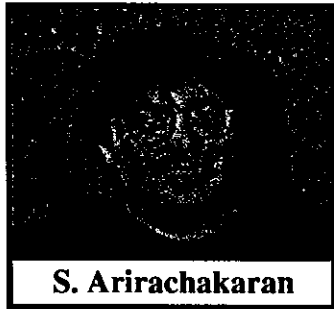
Investigations of slug flow splitting at a regular horizontal side-arm tee and elbow effects on slug flow splitting at a regular horizontal impacting tee are the two primary objectives of this study. Models which describe preferential liquid movement through these pipe tees will be developed, and verified with the acquired and published experimental data.

Two sets of liquid level controllers and accompanying pressure-actuated control valves for the continuous-mode separators were received from C-E Invalco in June. These were installed in the slug flow splitting flow loop and tested. Only a minor mechanical fine-tuning is required for the liquid level controller in the run arm before the flow loop is completely operational. This task should be accomplished by early August.

A majority of time and effort is now devoted to calibrating the installed flow meters for both liquid and gas, and also to interfacing most instruments to the PC data acquisition unit. The calibration process will also serve as a test to evaluate the controlling software routines developed for this data acquisition system. Most of this is expected to be completed by the end of August, when the first batch of splitting data is scheduled to be collected.

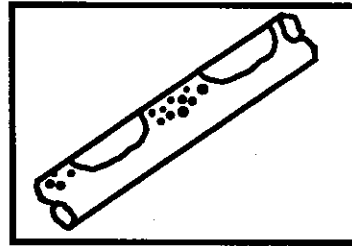
The slug flow splitting model and its mathematical representations are under development. As a preliminary step, fortran coding of horizontal slug characteristics prediction models are currently underway since this slug characteristics information will be required by the proposed model. Other published models and correlations are also being investigated, and applicable ones will be included in the splitting package for future comparison.

Johansen's raw slug flow splitting data at a 2" x 2" horizontal side-arm tee (TUFFP Report No. 18 - 1979)



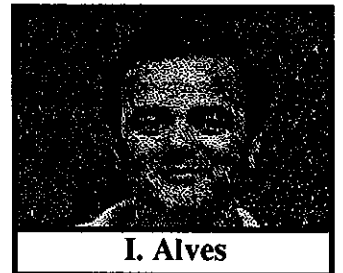
S. Arirachakaran

was processed to yield pertinent experimental data, which could be used to evaluate the proposed slug flow splitting model. Other available published data are being investigated for possible inclusion to this slug flow splitting database, and the compatible data will also be processed into a standard format suitable for the future model evaluation.



Slug Flow in Directional Wells

The first phase of the long term project on two phase flow in directional wells is the study of slug flow in inclined pipes. Slug flow is frequently encountered in both pipelines and wellbores, over a wide range of flow conditions.



I. Alves

The design and construction of the test facility for the slug flow study is underway. The inclined test facility used by Dr. Mukherjee and Dr. Caetano will be modified by removing the old annulus system, the metering sections and the instrumentation building. The instrumentation building used by Dr. Kouba will be moved to the inclined system area by late August. This building will house the IBM PC-AT computer based data acquisition system and will enable better conditions for acquiring the data and controlling the flow system.

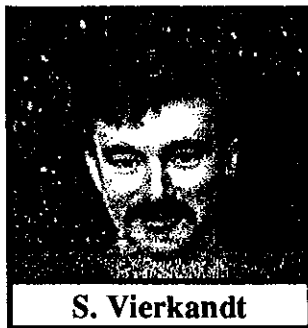
The new test section will have a 2 in. diameter transparent pipe where all the sensors will be placed, and a 3 in. diameter return line to reduce siphon effects. A new metering section will be constructed using a different design to increase flexibility and reliability. The data acquisition package that will be used is LABMASTER, the standard one at TUFFP.

Parallel to the construction of the new facility, efforts are underway to carry out a literature review and collect the important papers published on the subject.



Severe Slugging in a Pipeline-Riser Pipe System

The objective of this study is to investigate, experimentally and theoretically, the elimination of severe slugging in pipeline-riser pipe systems. To accomplish this, a small scale test facility was designed and constructed to enable the acquisition of pertinent data for severe slugging.



S. Vierkandt

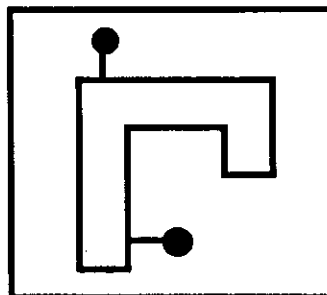
A large amount of data has been collected with the test facility during the past few months. Most of the data has been collected for the three chosen angles of interest: -1° , -2° , and -5° . Also, various pipeline lengths have been simulated for each angle using variable volume tanks. From this we can see the effect of pipeline length on the severity of the terrain induced slugging. The elimination of severe slugging by back pressure and gas lift has also been tested for the base angle of -2° and for a set equivalent pipeline length using the variable volume tanks. As yet, the effect of choking has not been investigated.

Currently we are working to establish a link between the IBM PC-AT that was used to collect the data, and the TUFFP APOLLO network. Once this link becomes completely operational the data will be transferred to the APOLLO network and a complete data base for the severe slugging project will be developed.

An analysis of the collected data is also underway. With the help of Dr. Y. Taitel, a close inspection of the severe slugging phenomenon is revealing some interesting results. The original model that was suggested by Dr. Taitel has undergone some modifications. It has been shown that when operating in what was thought to be the stable region, one does not experience a completely stable slug or bubble flow up the riser. Instead, one encounters a "cyclic steady state", which closely resembles severe slugging, but lacks the violent blowout

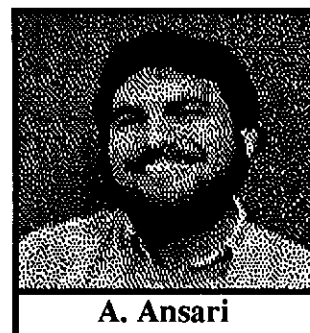
that occurs in the unstable region.

Future work will include the conclusion of the model modifications, construction of the severe slugging data base, and writing of the final report. Completion of the study is scheduled for late September.



Comprehensive Mechanistic Model for Upward Two-Phase Flow in Pipes

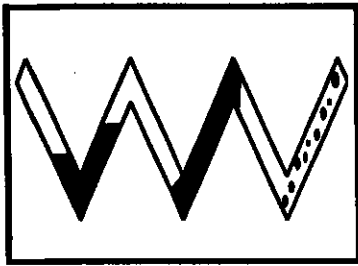
The formulation of a comprehensive model for upward vertical flow in pipes has been completed and a preliminary evaluation of the model is underway. During the evaluation it was found that the incorporated annular flow model did not perform well with the data. The model was replaced by one developed by Ibero Alves (M.S. Thesis, U.F.O.P., Brasil, 1987). With this modification the performance of the comprehensive model has improved.



A. Ansari

The databank with which the final evaluation of the comprehensive model will be carried out has been updated. The number of well cases has increased from 1191 to 1775. The new data include 213 well cases from published field data of Govier et al, Ashiem et al, Reinicke et al and Chierici et al. The rest of the new data are 371 well cases from the Prudhoe Bay field provided by ARCO.

The final task is to run the comprehensive model with the updated databank and evaluate its predictions against the measured pressure drops as well as against the predictions of commonly used correlations. This task will be accomplished in September. The final report on the project will be presented at the November Advisory Board meeting.



Two-Phase Flow in Low Velocity Hilly Terrain Pipelines

Hilly terrain pipelines with low flow rates are often encountered during the early and late stages of offshore oil and gas fields. In these systems, liquid tends to accumulate in the lower sections or valleys, with gas flowing above the liquid.



C. Sarica

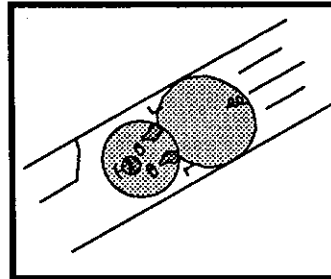
The system will exhibit a transient behavior when the liquid and gas are initially introduced to the hilly terrain pipeline. Later, either a steady state could be reached or unsteady state could continue.

Severe slugging in a pipeline-riser system can be considered as a special case of flow in hilly terrain pipelines. Severe slugging has been analyzed both experimentally and theoretically (i.e. Schmidt et al 1980, Taitel 1986, Fabre et al 1987, Taitel et al 1988). A new study by Taitel et al including an analysis of the flow behavior in hilly terrain pipelines for low flow rates was distributed to member companies in April 1988. However, the Taitel et al model is not complete. To predict flow behavior for design purposes, a more complete model is needed. Development of the complete model is the main objective of this study.

Since the May 1988 Advisory Board meeting, the computer code of the Taitel model (1988) has been transferred to the Apollo computer network. The code was improved by incorporating stability analysis in the upward inclined sections. In the future the following studies will be conducted.

1. Implementation of the new developments in the severe slugging theory (See Vierkandt report on Severe Slugging).
2. Definition of low velocity flow conditions for which the proposed model is applicable.
3. The effect of dynamic forces such as friction and interfacial shear on the flow behavior.

4. Consideration of real gas behavior and multi component phase behavior.
5. Accumulation mechanism for liquid at the bottom of the pipe.
6. Modeling blow out-fall back process.
7. Development of a comprehensive simulator.



Modeling Pigging Dynamics in Two-Phase Pipelines

Complex transient phenomena occur when two-phase pipelines are pigged. Immediately after a pig is introduced in a pipe, a relatively fast transient takes place, with rapid change in the pipeline liquid holdup



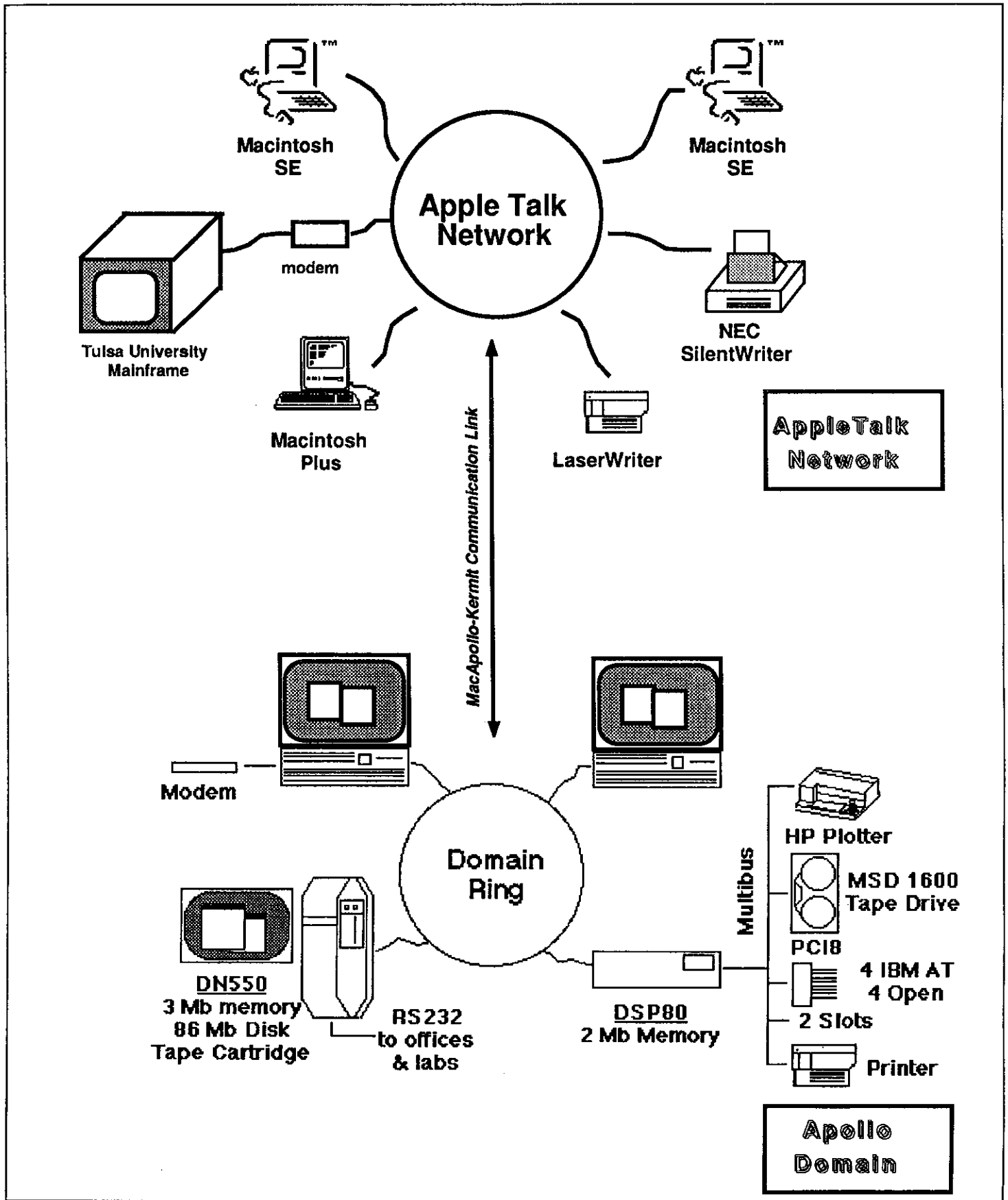
K. Minami

and pressure. The effect of pigging can be felt for a long time, even after the pig has exited the pipeline.

The objective of this project is to investigate experimentally and theoretically the dynamics of pigging operations. The effect of hilly terrain pipelines on the pigging process will also be investigated.

The experimental part will include collecting transient flow and pigging data on the 1400 ft long, 3 in. diameter pipeline with or without hills, using a kerosene-air mixture. The theoretical part will include the development of a model to predict pressure, liquid holdup and velocity along the pipe.

During this summer, efforts have been made to become familiar with the PC-AT based, LABMASTER Data Acquisition System, and to plan the modifications to be made in the existing facility. The simplified transient work developed by Taitel (distributed in April, 1988 to TUFFP member companies) and its computer code have been studied. The pigging model will utilize this simplified transient code to predict the hydrodynamic behavior behind the pig.



TUFFP Computer Network Systems

1988 TUFFP Members

Amoco Production Co.
 Arabian American Oil Co.
 Arabian Oil Co., Ltd.
 ARCO Oil and Gas Co.
 British Petroleum International Ltd.
 British Gas Corp.
 Britoil
 Chevron Oil Field Research Co.
 China National Oil & Gas Exp. & Dev. Corp.
 Chiyoda
 Conoco Inc.
 Exxon Production Research Co.
 Instituto Mexicano del Petroleo
 Intevep

JGC Corp.
 Japan National Oil Corp.
 Kerr-McGee Corp.
 Mobil Research and Development Corp.
 Nippon Kokan K.K.
 Norsk Hydro
 Pertamina
 Petrobras / Cenpes
 Phillips Petroleum Co.
 Shell Internationale Petroleum MIJ B.V.
 Statoil
 Texaco
 Texas Gas Transmission Corp.
 Unocal

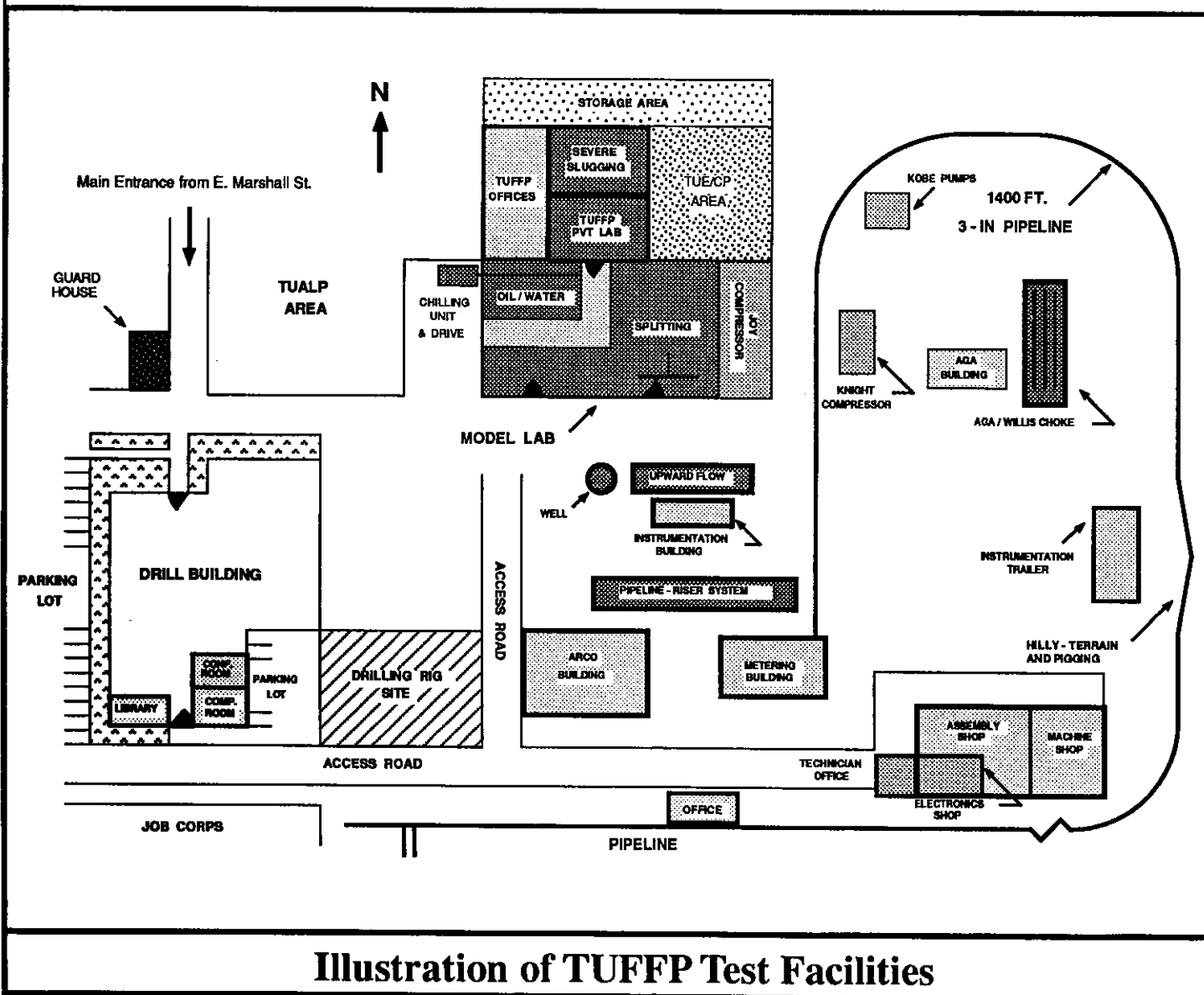


Illustration of TUFFP Test Facilities