HOTLINE

PRINCETON PLASMA PHYSICS LABORATORY

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PDX Update

In experiments conducted during April 1981, the PDX tokamak achieved plasma ion temperatures of 5.6 keV (about 65 million degrees Celsius) by utilizing its four energetic neutral beam injectors, which delivered up to 7.0 MW of heating power into the plasma. In PDX, the beams are injected at an angle nearly perpendicular to the direction of the plasma current. To achieve the high temperature, deuterium beams at 50 keV energy were injected into an undiverted hydrogen target plasma at a plasma current of 500 kA and a toroidal magnetic field of 2.2T. The line-average electron density reached $4 \times 10^{13} cm^{-3}$ during the heating pulse and the central beta value (the ratio of plasma pressure, including the fast beam component, to the magnetic pressure)was estimated to be about 5%.

In a letter to PPL Director H.P. Furth, Edwin Kintner, Associate Director for Fusion Energy, USDOE/OER, stated "The recent neutral beam heating results on PDX are cause for congratulations, both to the operations group on PDX and to those who brought the PDX neutral beam project from design through engineering and fabrication and finally to successful operation on the tokamak."

The letter was also addressed to Dr. Murray Rosenthal of Oak Ridge National Laboratory (ORNL), in recognition of that laboratory's contributions to the PDX neutral beam systems.

The successful design, fabrication and operation of the PDX injectors is a credit to numerous PPL staff members. Most significant were the roles of the following personnel: R. Applebaugh, D.L. Ashcroft, J. Carson, W. Cary, F. Dahlgren, R. Dierenback, A. Dutton, J.W. Edwards, H. Eubank, P. Karitis, F. Kloiber, T. Kojieb, H. Kugel, G.D. Martin, M. Mozeleski, R. Newman, F. Polom, G. Rossi, E. Ryan, G. Schilling, R. Shoemaker, E.D. Simon, W. Sproul, J. Smolinski, T. Topoleski, A. Von Halle, M. Williams, R. Yager.

PLT Update

Investigations of radio-frequency (rf) heating, begun on PLT in 1978, are now assuming the central role in the PLT program. Lower hybrid heating experiments at 800 MHz and ion cyclotron resonance heating (ICRH) experiments at 25 MHz and 42 MHz are being conducted.

Physicists have been experimenting with ion cyclotron resonance heating of plasmas made up of two types of ions: a majority species, usually deuterium, which comprises about 90% of the plasma ions, and a minority species, usually hydrogen or helium-3, making up the remainder. The rf waves are used to heat the minority species, which, through collisions, heats the majority ions.

At 25 MHz, about 900 kW of rf power has been added to the plasma for pulse lengths of 150 msec. At these powers, the minority hydrogen ions were heated to 7-10 keV (in the high energy range) and the majority deuterium ions to 1.7 keV. At lower densities, 650 kW of rf power was added to the plasma, heating the helium-3 minority ions to 10 to 20 keV and the deuterium majority ions to 2.4 keV.

The 42-MHz system, used for second harmonic heating of majority ion species, was completed in May, 1980. Rated for power input of up to 4 MW, the system has to date reached levels of about 700 kW. Experiments over the next several months will focus on raising the power to the 4-MW level.

Other plans for ICRH studies include the addition of two or more antenna coils to supplement the four already on the machine. These will be used for studying second harmonic hydrogen heating at fields of 14 kG, second harmonic helium-3 heating at 21 kG, and heating of deuterium-majority hydrogen-minority plasmas at 28 kG.

This summer, investigators plan to conduct experiments using the 25 MHz and the 42 MHz systems in consort. This would involve heating the two minority ion species at their fundamental frequencies. A combined power input of 3 MW is planned.

Other avenues of research will involve the combined use of ICRH and neutral-beam injection for plasma heating. Also planned are studies of the use of waveguides to replace the antenna coils for ICRH experiments.

Lower hybrid heating, another form of rf plasma heating, has been in use on PLT since January. A six-waveguide array coupler, mounted on a bellows and inserted into a pump port on PLT is used to introduce 800-MHz waves into the plasma. The system, rated at 1 MW, has achieved power levels of about 200 kW and pulse lengths in the 400 to 500-ms range. The lower hybrid coupler is under investigation and is expected to be upgraded to the 1 MW level by the end of this year.

Future plans call for combining lower hybrid heating with neutral beam injection and for studies of current drive by lower hybrid waves. If all goes well, another waveguide coupler, one that will introduce waves at a 90^{o} phase difference, will be installed for current drive experiments sometime this autumn.

Design and construction of the rf heating equipment was done by the Radio Frequency Section of the Engineering Division, under John Lawson. The key engineers for the ICRH systems are Tony Sivo, Nevell Greenough, and William Newman; those for the lower hybrid system are Nelson Bowen, Frank Schnabl, and Allen Martin.

Chemical Spill

Prompt action by the PPL Emergency Services Unit (ESU), and the Health and Safety Branch (H&S), coordinated by Emergency Coordinator Jack Anderson and his Deputy Harry Howe, averted any health hazard from a recent fire and chemical spill in the Matterhorn Building.

The fire and spill occurred between 5 p.m. June 26 and 7 a.m. June 29, according to Jack. The fire was apparently caused by a resistive heater submerged in a solution of chemicals in a segmented vat in a printed circuit plating lab.

Chief Anderson said the fire probably built up a "high temperature" in the closed room, causing the plastic legs of the vat to collapse. The vat then tipped over, and the chemical solutions and water that it held extinguished the fire. This was not the end of the problem, however, since several of the chemicals in the vat (which included hydrochloric and sulfuric acid) emitted toxic chemical vapors into the room.

Fire Chief Jack Anderson checks the seals on Joe Pownall's face mask during cleanup operations after a chemical spill in the Matterhorn Building.

Jack thanked FMC fire chief John O'Neill for allowing PPL's ESU to use FMC's chemical and acid suits for protection during cleanup operations. FMC made the first entry into the building with Ray Jeanes of PPL H&S to take air samples in the room.

The ESU installed a smoke ejector into a ventilation pipe outside of the room, in order to clear the room prior to the beginning of cleanup operations. At no time during the incident was there any danger to C-Site personnel, although buildings on B-Site were evacuated as a precaution until the extent of the emergency could be evaluated.

Two three-man search and rescue teams (equipped with turnout gear and Scott air packs) entered the building. Cleanup crews hand-pumped each section

of the vat out into separate 55 gallon plastic lined drums to prevent chemical mixing. Crews were rotated into the building in 15 minute shifts, with half hour rest periods between shifts. Approximately 78 bottles of breathing air were used during the operation.

The quarter-inch sponge rubber flooring in the lab was cut into sections and disposed of in separate drums. A total of 18 hours was spent in cleanup, with the cooperation of Health and Safety, Maintenance and Security. Jack also commended Ben Velivis and Bill Perseley of the MG Room for their aid in de-energizing the Matterhorn Building.

The lab was reopened at 9:30 a.m. June 30 after air samples were taken in the area. An investigative committee, composed of Health and Safety's Harry Howe, John Lawson (ENG), Marvin Richey (FOM) and Frank Fumia (PE), will determine the cause of the incident and make recommendations for prevention of a recurrence.

Jack had the highest praise for the performance of the emergency crews during the cleanup. "They were working in a potentially hazardous situation," he emphasized, "and they came through with no injuries. We never trained for anything like this, and it goes to show the caliber of our people. You throw them a curve, and they hit a grand slam!"

"They had real confidence in themselves and their equipment," the chief concluded, "and they did one fantastic job! It's a great privilege to work with such people."

Chief Anderson asks that anyone dealing with hazardous substances call him at ext. 3166.

TFTR Tours

Have you ever wondered what they're doing "out back" at C-Site? Now's your chance to find out!

Although construction is continuing at a rapid pace, TFTR Construction Coordinator Al Swain will be conducting tours of the TFTR construction site for PPL employees. Tours will begin each Wednesday at 3:15 p.m., leaving from the LOB lobby, where hardhats will be issued. To ensure your safety, these regulations are in effect:

- Hard hats will be provided and must be worn at all times.
- Appropriate footwear is imperative for both men and women: NO SANDALS, NO OPEN-TOED SHOES, NO HIGH HEELS.
- Stay with the group; do not wander away.

Because TFTR is an active construction area, groups will be limited to 15 people. No more than three people from the same department should sign up for a single tour.

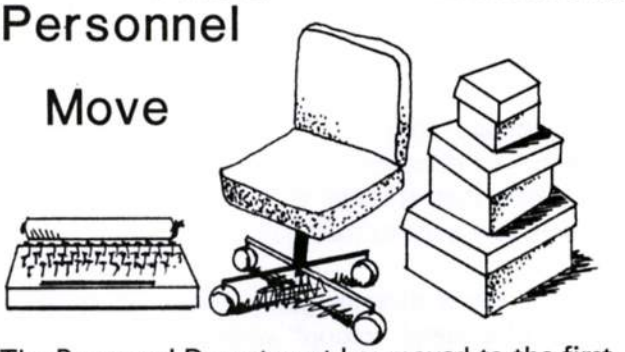
To reserve a tour spot, call Suzen Bayer, Information Services Department, ext. 2751. Reservations are a must.

Van Pool

Two seats are currently available in a van pool which leaves Mt. Holly and arrives at PPL at approximately 7:30 a.m. The van's schedule is flexible according to passenger need. The cost will vary from $65 per month per rider for 11 passengers to $82 per month per rider for 9 passengers.

Those interested in this van pool, or in pools for other areas, should call Stephen May of Van Pool of NJ, 882-5900, for further information.

Personnel Move



The Personnel Department has moved to the first floor of the Sayre Hall Building. The telephone extensions will remain the same.

John Schivell

What do physicists do to relax? If they're like PPL physicist John Schivell, they relax by thinking about offshoots of their main interest in physics. Consideration of one such offshoot—non-magnetic divertors—produced the concept that has humorously been dubbed the Schivell Shovel.

John came to PPL from Fermilab eight years ago "because fusion was growing." He started as an assistant to Don Grove on PLT; now he's a project physicist on the Engineering and Scientific staff, responsible for developing bolometers for TFTR.

A bolometer is a device which monitors the plasma, absorbing radiation over a wide range of wavelengths. Analysis of the bolometer readings can reveal the total radiation being emitted by the plasma.

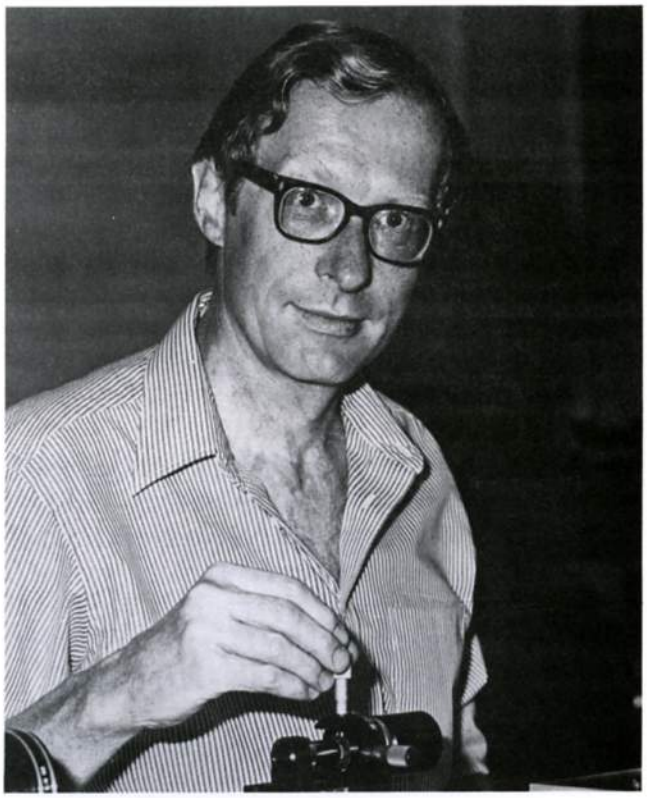
His side interest, however, is what led him toward the concept of a mechanical divertor. "When I came here," he explained, "I became interested in impurity control, limiters and divertors, as a sideline to my work on PLT. I started thinking about and developing the idea of a functional divertor which wouldn't require the magnetic fields of a coil divertor."

Divertors are one method of controlling impurities entering the plasma. A sufficient concentration of impurities (which can arise from various sources) could prevent ignition of the entire plasma.

Divertors, as generally used on a tokamak, are shaped magnetic fields located at the outer layer of the plasma. As particles lose their energy through collisions, they drift toward the outer edge of the plasma and are led into a disposal chamber by the divertor. The drawback to the system lies in the complexity that another set of magnetic fields (the divertor) adds to tokamak geometry.

The mechanical divertor/pump limiter concept consists of a metal "scoop" with a duct in the back, which would be inserted into a port on the tokamak. The scoop extends into the plasma scrape-off layer, diverting ions onto a neutralizer plate. An attached pumping system cycles the neutral atoms into a disposal chamber.

The original concept was developed in 1976, and only dealt with cleaning the plasma. Getting rid of helium "ash" (a byproduct of the fusion process which can cool off the reaction) is also an important consideration. A cyclic flow pattern is therefore being considered for use with the limiter. The helium would be extracted at the same time as fresh fuel is injected into the plasma, either by pellet injection or infusion of additional gas.



Development of the mechanical divertor/pump limiter presently centers on finding out how efficiently it collects plasma from the scrape-off layer. It is also being integrated into plasma modeling to predict its effect on future reactors.

John may have introduced the concept, but the idea has since acquired a life of its own. John Schmidt, Michael Ulrickson and Harold Furth all developed the scheme further. Dr. Furth's suggestion, according to John, involves a blanket of light impurities at the very outside edge of the plasma. The impurities should cool the plasma edge sufficiently to reduce the heat load on the neutralizing plates to manageable levels.

A limited trial on PDX (consisting of setting a box with a slot cut into it against the plasma) showed that the scoop does collect plasma fairly well. A more involved test with a pumping system is being planned for the future.

Bowling News

The Guttersnipes, winners of the PPL Women's Bowling League, pose with their trophy. Pictured left to right are Pat Melsky, Madge Curtis and Mary Alice Eubank. Not pictured is Sara Paterson

The Guttersnipes finished at the top of the PPL Women's Bowling League this year, compiling a season record of 56½-45½. The team, which consists of Mary Alice Eubank, Sara Paterson, Madge Curtis and Pat Melsky, was honored at the league banquet held recently at the Renaissance Restaurant in Hopewell.

Second place in the league standings went to the Bouncers (Ilse Gusciora, Mary Jane Hollendonner, Bobbie Cruser and Kim Prutky), with Strike 4 (Sue Wilkinson, Beth Crosby, Anne Golden and Patti Pugliesi) finishing third. The Alleycats (Chris Ritter, Terri Temkin and Betty Cary) rounded out the four-team field.

Terri Temkin won awards for having the high series (529), the highest number of pins over her average (83) during the season, and for rolling a 211 game.

Trophies went to Bobbie Cruser as the most improved bowler, and to Kim Prutky as the bowler with the highest average. Ilse Gusciora, who bowled a 206 game, and Madge Curtis, who rolled a 200 game, also received awards at the banquet.

Mary Alice Eubank is the outgoing president of the league, with Bobbie Cruser serving as secretary and Terri Temkin as treasurer. Anyone interested in participating in the league next year should contact Mary Alice at ext. 2555 or Bobbie at ext. 2101.

Terri Temkin

In the PPL Men's Bowling League, Castoro's capped the 35-week season with a rolloff win against the PPL Heroes, the league's first half victors. Members of the league champion Castoro's team are Sal DiMeglio, Alberto Petrella, Vince Baldino, Doug Bosley and Jeff Mulford.

The PPL Heroes consists of Bill Dix, Ken Emley, Bob Barbour, DickYager, Frank Polom and Mike Knorr. The remainder of the 14-team league in order of finish includes Power Engineering, Security, PJCJ's, Tech 2, Powerhouse, Bigawatts, Controllers, School of Engineering, Tech 1, The Old Men, C.O.B., and the Crescents.

Joe Pfister and Fran Dodd won high individual game honors with a 278 and a 267 respectively. Bob Popp's 691 series and Rich Huston's 677 series took high individual series awards, and Ken Strine was named the most improved bowler.

Awards were presented at the league's banquet June 1 at the Italian American Sportsman's Club in Trenton.

Outgoing league officers are president Ken Emley, vice president Dave Marusco, secretary Mike Knorr and treasurer Gill Ireland. Anyone interested in bowling on the league next year should contact Dave Maruso at ext. 3068.

To The Editor Of Hotline:

Our present outmoded casual approach towards chronic diseases causes about ten premature deaths per year among the readers of HOTLINE and their families, ten times more than accident fatalities.

The Engineering Approach

Deaths from the big three killers (stroke, cancer, and heart disease) can be reduced in numbers by the application of existing medical knowledge. About one hundred lives can be saved within the PPL family in the next ten years, as shown in the chart.

In earlier letters, I have shown that the big three each need their own preventive method.

Stroke is an obstruction or blowout in a small artery in the brain, caused by an errant pressure regulator. The defense consists of reading and controlling blood pressure.

Cancer can be fought through early detection and moderation in cigarette smoking.

Heart trouble can be minimized if Supermarket Man alters his life style.

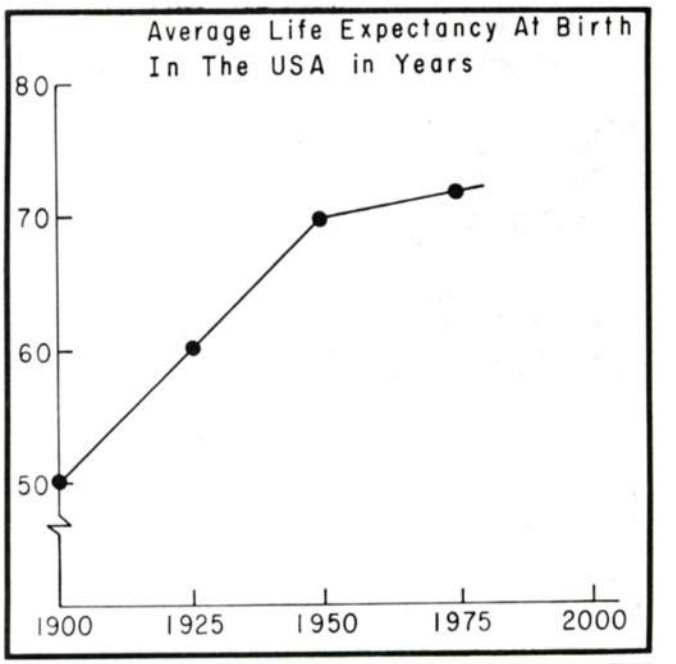
Group Reinforcement

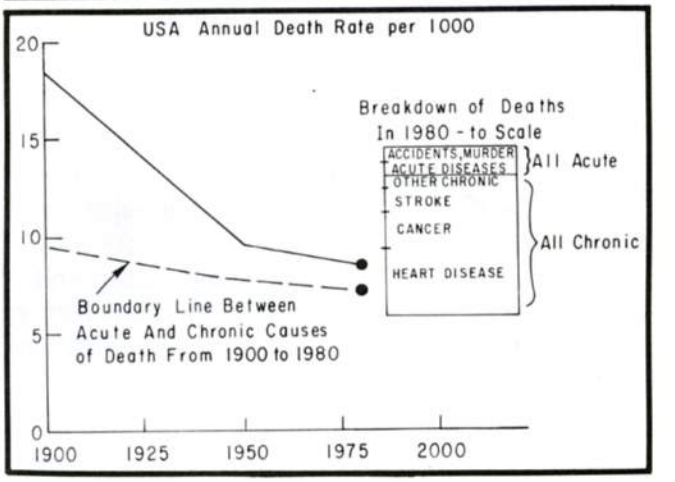
If the technical solutions are so straightforward, why then do we have the problem in the first place?

I think that it is in part a matter of timing. Someone who spoils an expensive instrument may lose his job right away. But if he spoils his body by oversmoking, Nature may wait twenty years before she fires him for good. Not every individual has the will power to stay with a proper health plan when the visible pay-off is decades away. However, for a large number of people improved health becomes statistically visible very quickly. We should therefore take advantage of the fact that we are members of the PPL family and let the group guide us towards better health.

The Shift in Causes of Death Since 1900

From 1900 to 1950, the average life expectancy at birth in the U.S.A. climbed from 50 to 70 years. Presently it is 72* (see figure 1). The companion graph of death rates shows an equally impressive change: from 17.6 to 9.6 in 50 years (figure 2).





Note that most of the improvement in death rates since 1900 has occurred on the acute side of the boundary line, until by now there is little left to squeeze. Even so the acute situations, including accidents, continue to receive the bulk of our attention. It would make sense if we now privately and publicly go after the chronic diseases.

*This relatively small improvement in the last 30 years stands in contrast to the ten fold increase in medical expenses—from $80 per person per year in 1950 to $800 in 1980.

What is really interesting is that the ratio of acute to chronic causes of death has shifted from an even split in 1900 to a ratio of 1:8 in 1980. Most of the improvements in medicine and public health since 1900 have reduced the acute sector, so much that there is now little left to squeeze out.

The ratio of deaths from accidents to deaths from chronic diseases is 1:16. If we ignore the potential reduction in deaths from chronic diseases, we lose ten members of the PPL family needlessly each year.

The Blurred Borderline

At one time, work-related illnesses were considered "employer problems", while chronic diseases and lawn mower accidents were "personal". We can still make that distinction as to causes, but no longer as to results. The fringe benefits, sick leave, health insurance and so on have changed all that.

The disturbance at work caused by an employee's absence is the same, no matter what the cause. The only difference left is the name of the insurance company that covers the cost, but even they are not overly concerned. The company that has the larger claims (bad experience) simply raises the rates for PPL (and the company with the good experience lowers its rates, one may presume). What is more, there is less and less difference between the employee and the family members. "I have to take my wife to the hospital" is about as compelling a reason for absence as "I am sick".

At one time acute health problems—be it accidents or diseases—were considered aberrations or unnatural conditions, while chronic diseases were considered "natural". I hope the data I have presented in the charts demonstrates that we do not have to accept the latter statement passively.

Specific Recommendations

Improvements are possible only if individual employees are fully committed to better health and longer life, and if such commitment is centrally supported by management. The following recommendations can be implemented independently; the more that are adapted the better the results.

As is normal, there is no free lunch. Better health requires effort and (minor) sacrifices, but then what else is new?

1. For staff members over 40, an annual physical examination would be obligatory; one every second year for those from 30 to 40. For spouses and retirees, such physicals would be optional. All physicals to be free of charge, with results remaining confidential. (And while the physical may be obligatory, there will be no requirement that the staff member do something about negative findings. My experiences with screenings of 5000 people with the Somerset County Heart Association has shown that almost all people who learn about a problem will take treatment.)

2. Staff who place themselves in high risk categories through a wrong life style would pay a proportionally higher health insurance premium. Increases could be hefty, as much as 50 to 100% over present rates. Health insurance premiums for those who are more physically fit than average would be lowered.

3. Cigarette machines would be phased out at PPL and cigar machines phased in. Cigarette smoking should be discouraged at lab sites.

4. If an insured completely flouts medical advice and becomes very ill as a result, his major medical deductible would be raised from $100 to $1000.

5. Smoke Enders and Weight Watcher courses would be encouraged.

6. We should encourage people working at C-Site to walk or bike to the B-Site cafeteria for lunch and vice-versa. Walkers can take the shuttle back if they so desire.

7. Courses in longevity would be made available.

The Eighties and Nineties

Nuclear projects generally have an excellent safety record because safety is almost a way of life there. Some of that lifestyle carries over to the home; I wear my safety shoes when I mow my lawn.

Because of the success with safety, chronic diseases now stand out as our major hurdle in reaching and enjoying old age. If we collectively put our organizational and technical skills to work on health, PPL can become the healthiest work place in the nation.

(1)	(2)	(3)	(4)	(5)
	TOTAL	PROJECTED DEATHS PRESENT CONDITIONS	PROJECTED DEATHS IMPROVED CONDITIONS	LIVES SAVED
A. PPL Staff	1400	86	48	38
B. Spouses	1025	50	25	25
C. Children	1875	1	1	0
D. Retirees and others 75 and over	450	100	75	25
E. Retirees and others 75 and over	250	187	175	12
TOTAL	5000	438 (note 2)	338 (note 3)	100

Notes

1. The PPL Family consists of staff, spouses, children and sufficient retirees and others over 65 to make a sample of 5000 persons with the same age distribution as the nation as a whole. For the purpose of this chart, the staff is assumed stable at 1400, which is about 125 above the present level.

2. The figures in column 3 are national rates applied to the sample. An indication that this practice is permissable comes from the seven deaths among PPL staff in 1980, which equalled the national rate times the approximately 1100 PPL staff in 1980.

3. "Improved Conditions" means that all existing realistic ways to precent death from chronic diseases have been applied. Medical breakthroughs are not included, and the amount of money per person (in 1981 dollars) spent on health care is the same throughout the 10 year period.

E. de Haas

The PPL Hotline is issued by the Princeton University Plasma Physics Laboratory, a research facility supported by the U. S. Department of Energy. Correspondence should be directed to PPL Information Services, Module 2, C-Site, James Forrestal Campus, ext. 2754.