TECHNOLOGICAL WANDERINGS IN THE HINTERLANDS OF CANADA

IN CHECKING ON MY NOTES, I WAS AMAZED TO DISCOVER THAT THE LAST TIME I SPOKE AT A SEMINAR HERE AT THE DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS WAS ON MAY 8TH, 1974. THEN I SPOKE ABOUT PROBLEMS PERCEIVED BY OUR NATIVE PEOPLES AS NORTHERN RESOURCES ARE DEVELOPED, AND HOW NEW TECHNOLOGY MIGHT ASSIST THEM - PARTICULARLY THE US/CANADA DIRECT BROADCAST SATELLITE KNOWN AS CTS OR "HERMES" (BY THE WAY IN THE END IT DIDN'T HAPPEN - THE INDIANS INFURIATED THE POLITICIANS SO MUCH, THEY CUT-OFF THEIR FUNDS). I ALSO SPOKE ABOUT THE APPLICATIONS OF ADVANCED TECHNOLOGY IN CANADA'S ARCTIC, AND THE ESTABLISHMENT OF DEVELOPMENT POLICIES FOR EXTRACTING RESOURCES, PARTICULARLY NON-RENEWABLE OIL AND GAS DEPOSITS BENEATH THE ARCTIC OCEAN. THE LATTER WAS FAR MORE SUCCESSFUL THAN THE WORK WITH NATIVE PEOPLES, AND TODAY I WOULD LIKE TO FOCUS ON SOME OF THE APPLICATIONS OF ADVANCED TECHNOLOGY ASSOCIATED WITH CANADA's ENERGY-RELATED RESOURCES IN THE FAR NORTH - THEIR EXTRACTION, UPGRADING AND TRANSPORTATION TO MARKET.

A LOT HAS HAPPENED IN THE PAST 6½ YEARS. OIL AND NATURAL GAS HAVE BEEN DISCOVERED IN COMMERCIALLY-SIGNIFICANT QUANTITIES IN THE ARCTIC: HYDROCARBON ENERGY PRICES HAVE BEEN MANIPULATED UPWARD BY THE OPEC CARTEL TO THE POINT WHERE ALTERNATE AND

SYNTHETIC FUELS HAVE BECOME ECONOMICALLY ATTRACTIVE AND TECHNICALLY FEASIBLE: A SWING MIGHT BE PREDICTED BACK TOWARD URANIUM AFTER THE ENVIRONMENTAL COSTS OF COAL-BURNING HAVE BEEN MORE FULLY RECOGNIZED: AND IMPORTANT STRIDES ARE BEING MADE TOWARD THE INTRODUCTION OF THE HYDROGEN ECONOMY AS THE TECHNOLOGIES FOR GENERATING AND APPLYING THIS ENERGY CURRENCY ARE MATURING. I INTEND TO TOUCH UPON ALL THESE SUBJECTS IN MY TALK TO YOU THIS AFTERNOON.

UNLIKE MOST OF ITS INDUSTRIAL PARTNERS, CANADA IS A NET EXPORTER OF ENERGY. IN 1979, ITS TRADE BALANCE IN ALL ENERGY COMMODITIES AMOUNTED TO A COMFORTABLE $3.8 BILLION, MOST OF WHICH WAS MADE UP OF NATURAL GAS ($2.9 BILLION). OTHER COMMODITIES ON THE POSITIVE SIDE WERE ELECTRICAL ENERGY AND URANIUM. THE MAIN NEGATIVE TRADE BALANCES IN ENERGY WERE PETROLEUM AND COAL. A SIGNIFICANT AMOUNT OF MY WORK OVER THE PAST FEW YEARS HAS BEEN DIRECTED TO SCIENCE AND TECHNOLOGICAL POLICIES ASSOCIATED WITH SUCH CANADIAN ENERGY ECONOMICS.

OIL AND GAS

CANADA'S CURRENT ANNUAL CONSUMPTION OF OIL AMOUNTS TO ABOUT 1.8 MILLION BARRELS PER DAY, BUT WHILE IT IMPORTS SOME 425,000 BARRELS A DAY THROUGH ITS EASTERN PORTS, IT EXPORTS TO THE US FROM ALBERTA SO THAT NET IMPORTS AMOUNT TO 215,000 BPD. A RECENT STATEMENT BY THE CANADIAN GOVERNMENT HAS SET A GOAL OF

COMPLETE OIL INDEPENDENCY BY 1990 - A TALL ORDER CONSIDERING THAT UNDER CURRENT TRENDS AND WITH CURRENT POLICIES, NET IMPORTS WOULD BE EXPECTED TO REACH 600,000 BPD BY 1990.

CANADA EXPECTS TO ACHIEVE THIS AMBITIOUS GOAL OF FINDING 600,000 BPD BY A NUMBER OF TECHNIQUES:

- BY MOUNTING A MAJOR OFF-OIL PROGRAM, PARTICULARLY TO SWING FROM OIL TO NATURAL GAS FOR SPACE HEATING AND COAL FOR ELECTRICAL GENERATION,
- BY ACCELERATING THE SWING TO RENEWABLES AND TO ALTERNATE FUELS FOR TRANSPORTATION SUCH AS PROPANE, ALCOHOL AND LATER CROGENIC FUELS SUCH AS LNG, SNG AND HYDROGEN.
- BY MOUNTING MAJOR INITIATIVES IN EXTRACTING CRUDE OIL FROM THE ATHABASCA TAR SANDS IN NORTHERN ALBERTA.
- BY ACCELERATING EXPLORATION AND EXTRACTION OF FRONTIER OIL AND GAS IN CANADA'S ARCTIC, PARTICULARLY THOSE OFFSHORE.
- BY ESTABLISHING A PROGRAM TO EXTRACT AND UPGRADE HEAVY OILS TOO VISCIOUS TO EXTRACT WITH CONVENTIONAL TECHNOLOGY.
- AND OF COURSE, BY MOUNTING MAJOR ENERGY CONSERVATION PROGRAMS AND EFFICIENCY ENHANCEMENT EFFORTS SUCH AS OIL-FURNACE EFFICIENCY IMPROVEMENTS.

MY PARTICULAR INTEREST AND INVOLVEMENT IS IN ASPECTS OF EXPLORATION, EXTRACTION AND TRANSPORTATION OF OIL AND GAS FROM CANADA's ARCTIC. IT IS HERE THAT ADVANCED AEROSPACE TECHNOLOGIES WILL BE CALLED UPON. THE PROBLEMS OF EXPLORATION AND DEVELOPMENT DRILLING USING THE NEW DYNAMICALLY-POSITIONED DRILL SHIPS IN DEEP WATER ARE NO DIFFERENT IN CANADIAN WATERS THAN IN OTHER PARTS OF THE WORLD WITH ONE MAJOR DIFFERENCE - THE THREAT OF ICE. DRILLING TECHNIQUES NOW HAVE ADVANCED TO THE STAGE WHERE DRILL SHIPS CAN

RAPIDLY WITHDRAW FROM A DRILLHOLE WITHOUT CONCERN FOR A BLOWOUT SHOULD THERE BE A THREAT CAUSED BY HIGH SEAS, DRIFTING ICE FLOES OR ICEBERGS AND LATER RESUME DRILLING. HOWEVER, THERE IS NEED FOR AT LEAST AN HOUR'S WARNING OF AN IMPENDING ICE THREAT TO A DRILLSHIP, BUT OF COURSE THE LONGER THE LEAD TIME, THE BETTER.

WHILE DRILLSHIPS NEED TIMELY AND ACCURATE ICE INFORMATION FOR THEIR SAFE OPERATION, SO ALSO DO VESSELS OPERATING IN ARCTIC WATERS - PARTICULARLY IN TIMES OF DARKNESS AND POOR VISIBILITY WHICH ARE COMMON CONDITIONS IN THE ARCTIC WINTER. AT THE PRESENT TIME, THERE ARE INSUFFICIENT DISCOVERIES OF OIL RESERVES TO JUSTIFY EITHER A PIPELINE OR OIL TANKER OPERATION TO REMOVE OIL FROM CANADA'S ARCTIC. THE SITUATION IS VERY DIFFERENT FOR NATURAL GAS. PROVEN CURRENT MARKETABLE NATURAL GAS RESERVES ARE BETWEEN 18 AND 24 TRILLION CUBIC FEET - WELL ABOVE THE THRESHOLD OF 14 TCF CONSIDERED THE MINIMUM AMOUNT NEEDED TO JUSTIFY A PIPELINE OR LIQUID NATURAL GAS (LNG) TANKER PROJECT.

TWO SUCH PROJECTS ARE NOW BEING FUNDED - THE POLAR GAS PIPELINE, A Y-SHAPED SYSTEM FROM THE DEEP ARCTIC AT MELVILLE ISLAND AND FROM TUKTOYAKTUK ON THE BEAUFORT SEA JOINING IN THE BARREN LANDS NEAR GREAT BEAR LAKE AND EXTENDING SOUTH AND EAST TO MARKETS, AND THE ARCTIC PILOT PROJECT WHERE LNG WILL BE TANKERED

THROUGH THE NORTHWEST PASSAGE FROM MELVILLE ISLAND STARTING IN 1985.

SUCH MASSIVE PROJECTS WILL INVOLVE THE USE OF SUPERTANKERS, LNG CARRIERS AND RESUPPLY VESSELS CAPABLE OF BREAKING THROUGH 10 FEET OF ICE. ALL SUCH OPERATIONS WILL BE HEAVILY RELIANT ON TIMELY ICE RECONNAISSANCE. WE ARE PLANNING FOR BOTH A SATELLITE AND AN EXPANDED AIRCRAFT ICE RECONNAISSANCE OPERATION. BECAUSE YEAR-ROUND, ALL-WEATHER ICE INFORMATION IS NEEDED, BOTH PLATFORMS WILL CARRY RADAR - SYNTHETIC APERTURE RADAR FOR HIGHEST RESOLUTION, CALLED SAR.

THE AIRBORNE SAR WILL BE A DUAL-FREQUENCY (X AND C BAND) DUAL POLARIZATION SYSTEM FLOWN AT 40,000 FT. USING ON-BOARD, NEAR REAL-TIME PROCESSING - THIS WILL USE CIRCUITRY CAPABLE OF UP TO 140 MEGA OPERATIONS PER SECOND. IMAGERY WILL BE TRANSMITTED DIRECTLY TO THE VESSELS AND ALSO TO AN ICE FORECASTING CENTRE FOR GENERATING FORECAST PRODUCTS NEEDED BY ARCTIC MARINERS. DEVELOPMENT OF THE AIRBORNE SAR PROCESSOR IS JUST COMMENCING.

WHILE AIRCRAFT CAN GIVE TACTICAL ICE DATA, TOO MANY WOULD BE REQUIRED TO COVER ALL THE ARCTIC AREAS THAT NEED TO BE SERVICED. THE IDEAL COMBINATION IS TO MIX STRATEGIC IMAGERY AVAILABLE FROM A SATELLITE WITH AIRCRAFT TACTICAL DATA. CANADA IS ABOUT TO DESIGN AND DEVELOP ITS OWN SATELLITE FOR STRATEGIC ICE RECONNAISSANCE OPERATIONS. CALLED RADARSAT, IT WILL NOT USE ON-BAORD, REAL TIME

PROCESSING WHICH WOULD REQUIRE CIRCUITRY 10-20 TIMES FASTER THAN THAT NEEDED ON THE AIRCRAFT PROCESSOR. IT WILL DRAW UPON THE SUCCESS OF SEASAT 1 WHICH PROVIDED A LARGE AMOUNT OF VALUABLE RADAR IMAGERY OF CANADA'S ARCTIC ICE. RADARSAT WILL HAVE SUFFICIENT RESOLUTION (50-70 METERS) TO BE USEFUL IN THE EVENT THAT THE AIRCRAFT OPERATIONS ARE CLOSED DOWN DUE TO LOCAL WEATHER.

MY MAJOR PROJECT OVER THE NEXT 18 MONTHS WILL BE TO SET OUT THE USER REQUIREMENTS FOR RADARSAT, AND INTEGRATE THAT PROGRAM WITH THE AIRCRAFT PROGRAM AND CANADA'S EFFORTS IN ICE FORECASTING.

URANIUM

ANOTHER ENERGY PROJECT OF CURRENT INTEREST TO ME IS ASSOCIATED WITH THE NUCLEAR POWER INDUSTRY. ASIDE FROM PLANT OPERATIONAL PROBLEMS SUCH AS THOSE ENCOUNTERED AT THREE MILE ISLAND, THE MAJOR IMPEDIMENT TO THE GROWTH OF NUCLEAR POWER, CERTAINLY IN CANADA, IS THE SAFE DISPOSAL OF NUCLEAR WASTES AT BOTH ENDS OF THE FUEL CYCLE. CANADA'S HEAVY-WATER MODERATED AND COOLED REACTORS, CALLED CANDU, BURN NATURAL URANIUM. HIGH-LEVEL WASTES FROM THESE REACTORS ARE CURRENTLY STORED TEMPORARILY UNDER WATER IN LARGE SWIMMING POOLS AWATING THE DEVELOPMENT OF A SAFE DISPOSAL TECHNIQUE. THE ATOMIC ENERGY OF CANADA - CANADA's GOVERNMENT-OWNED NUCLEAR POWER COMPANY - IS CONDUCTING INTENSIVE RESEARCH ON THE USE OF DEEP-ROCK DEPOSITORIES IN PLUTONS WHICH ARE LARGE, STRUCTURALLY-SOUND ROCK STRUCTURES, LIKELY TO REMAIN INTACT WELL

BEYOND THE NEXT ICE AGE IN REGIONS WHERE THE PROBABILITY OF AN EARTH QUAKE IS VIRTUALLY ZERO. HALF-LIVES OF SOME RADIONUCLIDES EXTEND FOR THOUSANDS OF YEARS, THUS NECESSITATING SUCH PRECAUTIONS.

HIGH-LEVEL WASTES ARE ONLY HALF THE STORY. AT THE FRONT END OF THE FUEL CYCLE, THERE IS THE MINING AND MILLING OF URANIUM FUEL. CANADA HAS SIGNIFICANT DEPOSITS OF URANIUM WHICH, IN 1979, CONTRIBUTED NEARLY $1 BILLION TO CANADA'S TRADE SURPLUS IN ENERGY COMMODITIES. THE MINING OF URANIUM IS HEAVILY DEPENDENT ON WORLD PRICES. BACK IN THE 1950's, URANIUM OXIDE SOLD FOR ABOUT $10 PER POUND. BY THE EARLY 1960s, PRICES STARTED TO FALL TO THE POINT WHERE, BY THE EARLY 1970s, WORLD PRICES DROPPED TO LESS THAN $5/LB. DURING THAT PERIOD MINES THAT WERE PROSPEROUS IN THE 50s AND 60s STARTED TO CLOSE DOWN. HOWEVER, AFTER OPEC IN 1973-74, PRICES ADJUSTED UPWARD TO $20/LB, AND CONTINUED TO RISE TO AS HIGH AS $40/LB BY MID 1976 WHERE THEY REMAINED UNTIL LATE 1979. SINCE THEN THEY HAVE DECLINED TO WHERE NOW, THE PRICE IS IN THE ORDER OF $30/LB. THE PRESENT OVERSUPPLY LIKELY WILL DIMINISH DURING THE 1980s, AND PRICES MAY AGAIN RISE.

THIS UP AND DOWN KIND OF EXISTENCE CAUSES SOME DEGREE OF INSTABILITY IN THE MINING INDUSTRY. HOWEVER, UP TO THE PRESENT, URANIUM MINES IN CANADA HAVE DEPOSITED A MASSIVE 100 MILLION TONNES OF MINE AND MILL TAILINGS ON THE SURFACE WHICH, WHEN DUMPED FROM THE MILL, CONTAIN A NUMBER OF POLLUTANTS INCLUDING

RADIONUCLIDES (MAINLY RADIUM 226, THORIUM 230 AND LEAD 210) HEAVY METALS, SULPHIDES, ARSENIDES AND OTHER CONTAMINANTS, ALL OF WHICH MAY FIND PATHWAYS TO THE BIOSPHERE. SUCH TAILINGS PILES MAY BE "MANAGED" WHILE THE MINES ARE OPERATING: BUT AFTER THE MINE IS CLOSED DOWN (FOR WHATEVER REASON) THERE IS GREAT CONCERN AS TO WHAT TO DO WITH ALL THE TAILINGS.

I AM HEADING UP A FEDERAL/PROVINCIAL TECHNICAL PLANNING GROUP ATTEMPTING TO DEFINE AND ORGANIZE AN R AND D PROGRAM DESIGNED TO MITIGATE THE ENVIRONMENTAL IMPACT OF SUCH TAILINGS. IF URANIUM PRICES FOLLOW EXPECTED TRENDS, THERE WILL BE OVER A BILLION TONNES ON THE SURFACE BY YEAR 2000!

THE PATHWAYS THROUGH WHICH CONTAMINANTS CAN REACH MAN ARE GROUPED INTO FIVE REGIMES:

- AIR TRANSPORT (PRINCIPALLY RADON GAS)
- SURFACE WATER TRANSPORT (RAIN RUNOFF)
- GROUNDWATER TRANSPORT
- FOOD CHAIN (ANIMALS EATING VEGETATION ON TAILINGS)
- DIRECT RADIATION

IN THE US, URANIUM OCCURS IN DESERT AREAS WHERE THE WATER TABLE IS VERY LOW: WHEREAS IN CANADA OFTEN THE WATER TABLE IS IMMEDIATELY AT OR ABOVE THE BASE OF THE TAILINGS PILES WHICH GREATLY COMPLICATES OUR PROBLEM.

IF SOLUTIONS ARE NOT FOUND FOR THE LONG-TERM MANAGEMENT OF URANIUM TAILINGS, THE ENVIRONMENTAL DANGERS COULD BE SUFFICIENTLY SIGNIFICANT TO CLOSE-DOWN OR DRASTICALLY CURTAIL URANIUM PRODUCTION.

HYDROGEN AND ELECTRIC POWER

AS A FINAL EXAMPLE, IT WOULD LIKE TO TOUCH ON A PROJECT I AM CURRENTLY TRYING TO PUZZLE THROUGH. IT IS TO DEFINE WHAT CANADA SHOULD BE DOING ABOUT HYDROGEN AS AN ENERGY SOURCE, OR PERHAPS MORE ACCURATLEY AS AN ENERGY "CURRENCY". THE PRESENT MARKETS FOR HYDROGEN ARE TYPICAL, RANGING FROM ITS USE IN PETROLEUM REFINING, HYDROGENATION OF OILS AND FATS, LARGE ELECTRIC GENERATORS, EVEN WEATHER BALLOONS. THAT MARKET FOR HYDROGEN IS LIKELY TO GROW AT A RATE COMPARABLE TO GNP. HOWEVER, IN CANADA, THERE IS A VERY REAL NEED FOR LARGE QUANTITIES OF HYDROGEN ALMOST IMMEDIATELY FOR THE EXTRACTION AND UPGRADING OF HEAVY OILS. IN SASKATCHEWAN'S LLOYDMINSTER AREA, A TOTAL OF 1000 MW OF HYDROGEN IS NEEDED.

NORMALLY HYDROGEN FOR THIS PURPOSE MIGHT BE OBTAINED FROM NATURAL GAS FROM NEIGHBORING ALBERTA. HOWEVER, THE PREMIER OF THAT PROVINCE WILL NOT PERMIT HIS GAS TO BE USED FOR THAT PURPOSE - HE EITHER WANTS TO SELL IT TO THE US, OR USE IT AS FEEDSTOCK TO A FLEDGLING ALBERTA PETROCHEMICAL INDUSTRY. THE ONLY OTHER PRACTICAL SOURCE FOR HYDROGEN IS THROUGH ELECTROLYSIS - BUT THIS IS WHERE CANADA HAS SOME UNIQUE SITUATIONS.

THERE IS AN ABUNDANCE OF HYDROELECTRIC POWER IN CANADA, BUT UNFORTUNATELY IT IS NOT CLOSE TO MARKET. THE LONG-DISTANCE TRANSMISSION COSTS TOO MUCH IN LOSSES, AND SO MANY RIVERS IN THE HINTERLANDS HAVE NEVER BEEN HARNESSED. INSTEAD, WE HAVE TURNED TO NUCLEAR, COAL, GAS, OIL AND EVEN GARBAGE TO FUEL OUR ELECTRIC GENERATORS AS LOADS HAVE GROWN PAST LOCAL HYDRAULIC SOURCE CAPABILITIES.

ONE RIVER WITH HIGH POTENTIAL FOR FUTURE MAJOR HYDROELECTRIC DEVELOPMENT IS THE NELSON IN NORTHERN MANITOBA. THERE ARE STILL FOUR 1000 MW SITES ON THE LOWER NELSON WHICH MIGHT BE DEVELOPED IF THAT POWER COULD BE EMPLOYED EFFECTIVELY. AT PRESENT, CANADA'S FOUR WESTERN PROVINCES ARE CONTEMPLATING THE ESTABLISHMENT OF A WESTERN POWER GRID, JOINED TOGETHER BY AN 1800 MILE, 500 VOLT DC BACKBONE TRANSMISSION LINE. SUCH A NETWORK COULD COUPLE THE LOWER NELSON WITH LOADS IN NORTHERN SASKATCHEWAN. THUS THE SASKATCHEWAN NEEDS FOR HYDROGEN COULD BE SATISFIED USING ELECTROLYSIS POWERED BY ENERGY FROM THE LOWER NELSON.

IN A VERY GENERAL SENSE, CANADA CAN MAKE USE OF ITS STILL AVAILABLE HYDRAULIC CAPACITY TO GENERATE ELECTROLYTIC HYDROGEN. REMOTE SITES NEAR EXISTING GAS PIPELINES CAN PUMP LOCALLY-GENERATED HYDROGEN DIRECTLY INTO THE LINE, AND THERE ARE NOW MECHANISMS FOR SELECTIVELY REMOVING THE HYDROGEN DOWNSTREAM AT OR NEAR THE

MARKET. THE GAS PIPELINE PLANNED THROUGH THE YUKON, AND THE POLAR GAS LINE REFERRED TO EARLIER ARE LOGICAL CANDIDATES WHICH PASS BY A NUMBER OF EXCELLENT BUT HERETOFOR USELESS SITES BECAUSE OF THEIR REMOTENESS.

I SHOULD ADD ALSO THAT IN ONTARIO AND QUEGEC, CANADA HAS IN BEING OR IN CONSTRUCTION A NUMBER OF NUCLEAR STATIONS. LIKE SOME HYDRAULIC SOURCES, NUCLEAR STATIONS SUPPLY BASE LOAD ENERGY TO THE POWER GRID - THEY CANNOT READILY BE TURNED OFF OR CRANKED DOWN. PRESENTLY THE CAPACITY OF COMBINED HYDRAULIC AND NUCLEAR FACILITIES DOES NOT EXCEED MINIMAL DAILY LOADS, BUT AS MORE NUCLEAR CAPACITY COMES ON STREAM, THE TIME WILL COME WHEN BASE LOAD CAPACITY WILL EXCEED MINIMAL LOADS AND EXCESS CAPACITY WILL RESULT, NECESSITATING SOME FORM OF LOAD SHEDDING. SUCH A SITUATION IS MOST LIKELY TO OCCUR WHEN LOAD GROWTH FALLS BELOW LEVELS ANTICIPATED BEFORE CONSTRUCTION OF NEW GENERATION FACILITIES WAS STARTED. OFF-PEAK BASELOAD CAPACITY CAN BE READILY USED TO GENERATE ELECTROLYTIC HYDROGREN, AND CANADA IS EXPECTED TO HAVE SIGNIFICANT QUANTITIES OF SUCH POWER BY THE END OF THE 1980s.

ELECTROLYTIC HYDROGEN IS KNOWN AS "CLEAN" HYDROGEN - IT IS PURE AND FREE FROM METHANES AND OTHER CONTAMINANT GASES. ON THE OTHER HAND, HYDROGEN DERIVED FROM NATURAL GAS IS "DIRTY" - IT CONTAINS OTHER GASES WHICH MAKES IT UNSUITABLE FOR SOME APPLICATIONS. THE MOST SIGNIFICANT OF THESE IS THE HYDROGEN-OXYGEN

FUEL CELL WHICH REQUIRES CLEAN HYDROGEN WHICH, WHEN COMBINED WITH OXYGEN GIVES ELECTRICAL ENERGY AND WATER.

HYDROGEN-OXYGEN FUEL CELLS HAVE BEEN USED IN THE SPACE PROGRAM, BUT NOW THEY ARE FINDING INCREASED NUMBERS OF APPLICATIONS COMMERCIALLY. IN THE US, THEY ARE BEING PLANNED FOR PEAK SHEDDING IN ELECTRICAL UTILITIES - THAT IS, ELECTRICAL ENERGY IS STORED IN THE FORM OF HYDROGEN AT OFF-PEAK HOURS, AND THEN TRANSFORMED BACK TO ELECTRICITY DURING PEAK PERIODS.

IN CANADA, WITH LARGE AMOUNTS OF CLEAN HYDROGEN AVAILABLE AT LOW COST, THE APPLICATIONS ARE LIKELY TO BE FOCUSSED ON TRANSPORTATION. THE USE OF METAL HYDRIDES TO STORE HYDROGEN MAKES POSSIBLE ITS USE IN VEHICLES - MOST LIKELY COMMUTER TRAINS. R AND D IS NEEDED ON THE SAFE, MOBILE STORAGE OF HYDROGEN BEFORE IT WILL FIND WIDESPREAD USE IN AUTOMOBILES, AIRCRAFT AND THE LIKE. IT IS HERE AT THE CUTTING EDGE OF THIS TECHNOLOGY THAT CANADA IS MAKING ITS R AND D PLANS. I SUSPECT THAT THERE ARE GROUNDS FOR COLLABORATIVE WORK WITH OUR COUNTERPARTS IN THE U.S.

I'M AFRAID THAT I HAVE TOUCHED UPON A SEEMINGLY RANDOM RANGE OF SUBJECTS, ALL WITH A COMMON THEME - ENERGY. HOWEVER THAT IS A MAJOR PRE-OCCUPATION WITH US IN CANADA TODAY AS IT MUST BE EVERYWHERE. CANADA IS IN A UNIQUE POSITION AMONGT MOST WESTERN COUNTRIES IN THAT IT COULD BECOME OIL INDEPENDENT WITHIN A DECADE. HOWEVER, THERE STILL ARE CENTRIFUGAL POLITICAL FORCES

FORCES AT WORK THAT ARE DRIVEN BY THE ENERGY ISSUE. IT IS GOING TO TAKE A LOT OF STRONG WILL AND LEADERSHIP TO HOLD US TOGETHER THROUGH THE FOLLOWING TWO DECADES.

PHILIP A. LAPP

DECEMBER 10, 1980