UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

December 22, 1987

MEMORANDUM FOR: Walter R. Butler, Director
Project Directorate I-2
Division of Reactor Projects I/II

FROM: Mohan C. Thadani, Project Manager
Project Directorate I-2
Division of Reactor Projects I/II

SUBJECT: MEETING WITH PENNSYLVANIA POWER AND LIGHT COMPANY TO DISCUSS INSIGHTS GAINED FROM SUSQUEHANNA INDIVIDUAL PLANT EVALUATION

On December 11, 1987, at the staff's request, the Pennsylvania Power and Light Company (PP&L) provided a briefing of (1) the methodology used to perform the Susquehanna Individual Plant Evaluation (IPE), (2) the results of the analysis, (3) the PP&L insights and interpretation of the results, and (4) the PP&L view of the risk assessment. Enclosure 1 is a copy of the viewgraphs used by the PP&L for the briefing, and Enclosure 2 is a list of attendees.

The PP&L indicated that one of its objectives in risk assessment was to assure that all possible capability of the plant will be utilized to prevent and mitigate the consequences of severe accidents. Its fundamental policy was to assure defense-in-depth for all equipment and procedures. The PP&L incorporated realistic human performance models which were subsequently verified by measurements on the Susquehanna simulator.

The results of the PP&L analysis indicated that by proper use of all the equipment and the plant capabilities core damage sequences can be arrested before vessel failure occurs 70% of the time, and by the proper use of the wetwell venting the containment overpressure failures for sequences which would result in core melt and vessel failure can be reduced by a factor of 10. Based on its experiences with the Susquehanna IPE analysis, the PP&L does not consider a low bottom line calculated frequency as a proof of adequacy. Rather, it considers that the IPE should be directed to evaluate the defense-in-depth which gives the best available protection against not only the analyzed sequences, but also unanalyzed sequences.

The PP&L thinks that the utilities can derive the greatest safety benefit from an IPE if they perform in-house analyses rather than assign full responsibilities to contractors. All accident sequences analyzed in the IPE should be carried to a stable state or failure to ensure that defense-in-depth capabilities of all equipment and procedures are identified and harnessed at each successive accident stage, in conjunction with the symptom based procedures.

The PP&L recommended that the Commission perform research to develop criteria which enhance core/vessel stabilization and core debris/containment stabilization. The IPE Generic Letter should require a phased approach and assure that each accident sequence be carried to a stable state or failure, and defense-in-depth for plant-specific equipment and procedures be demonstrated for all successive stages of accident sequences.

When asked to estimate the resources required to do the IPE, the PP&L replied that they had used five people for a cumulative one person-year effort. The level of effort was based on a high level of preparation and having a completed PRA.

/s/

Mohan C. Thadani, Project Manager
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As stated

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Previously concurred*

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12/22/87	12/22/87

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ENCLOSURE 1

OBJECTIVES

- O TO DESCRIBE PP&L RISK ASSESSMENT EFFORTS
  - OBJECTIVES
  - PROCESS
  - RESULTS
  - FUTURE ACTIVITIES

PRESENTATION OUTLINE

- INTRODUCTION - PP&L OBJECTIVES
- PP&L EXPERIENCE IN RISK ASSESSMENT
- PP&L APPLICATION OF THE IPE METHODOLOGY
- RESULTS OF THE SUSQUEHANNA IPE
- FUTURE DIRECTIONS FOR PP&L RISK ASSESSMENT
- SUMMARY

THE PP&L APPROACH
TO
RISK ASSESSMENT

INTENT

WE WISH TO ASSURE THAT ALL POSSIBLE CAPABILITY OF THE PLANT TO PREVENT OR MITIGATE THE CONSEQUENCES OF PLANT DAMAGE FOR ANY INITIATING EVENT AND ANY COMBINATION OF EQUIPMENT FAILURES WILL BE EFFICIENTLY AND EFFECTIVELY APPLIED.

OBJECTIVES OF RISK ASSESSMENT AT PP&L

- WE USE RISK ANALYSIS METHODS TO:
  - EVALUATE ALTERNATIVES FOR PLANT MODIFICATIONS
  - DEVELOP OPTIMAL EMERGENCY OPERATING PROCEDURES
  - DEVELOP OPERATOR TRAINING PROGRAMS TO ASSURE OPERATOR KNOWLEDGE OF CRITICAL RESPONSE ACTIONS
  - IDENTIFY POTENTIAL MINOR MODIFICATIONS WHICH CAN REDUCE THE FREQUENCY OF OR MITIGATE THE CONSEQUENCES OF SIGNIFICANT SEVERE ACCIDENT SEQUENCES
  - TRAIN AND INFORM MANAGEMENT TO ASSURE PROPER COORDINATION OF RISK IN DECISION MAKING
  - ASSURE "DEFENSE IN DEPTH" IN OUR EQUIPMENT AND OUR PROCEDURES.
  - DEMONSTRATE A HIGH LEVEL OF SAFETY IN SUSQUEHANNA OPERATIONS.

DEFENSE IN DEPTH DEFINITION

EQUIPMENT:

- PLANT DAMAGE WILL OCCUR ONLY AFTER INDEPENDENT FAILURE OF REDUNDANT AND DIVERSE EQUIPMENT
- IN THE ABSENCE OF ADDITIONAL FAILURES BEYOND THOSE CAUSING CORE DAMAGE, THE CORE DAMAGE SEQUENCE CAN ALWAYS BE ARRESTED BEFORE REACTOR VESSEL FAILURE
- NO COMBINATION OF FAILURES CAUSING CORE DAMAGE CAN CAUSE UNAVOIDABLE CONSEQUENTIAL CONTAINMENT FAILURE

PROCEDURES:

- NO PROCEDURE WILL HAVE ADVERSE CONSEQUENCES IN THE CASE OF ADDITIONAL EQUIPMENT FAILURES BEYOND THOSE OCCURRING INITIALLY
- THE NECESSARY ANTICIPATORY ACTIONS WILL BE PERFORMED TO AVOID LOSS OF ADDITIONAL EQUIPMENT
- THE NECESSARY ANTICIPATORY ACTIONS WILL BE PERFORMED TO PERMIT SUCCESSFUL RESPONSE TO POTENTIAL ADDITIONAL FAILURES.

PP&L EXPERIENCE - PRA

- PP&L CONTRACTED IN 1980 FOR A LEVEL 3 PRA WITH NUS CORPORATION.

- THIS EVOLVED INTO A JOINT PP&L-NUS EFFORT IN 1983 WHICH RESULTED IN A DRAFT DOCUMENT.

- WHILE THE NUS WORK WAS PERFORMED COMPETENTLY IN ACCORDANCE WITH ACCEPTED PRA PRACTICE, PP&L HAD RESERVATIONS ABOUT HOW ACCURATELY SUSQUEHANNA HAD BEEN REPRESENTED.

- OUR INITIAL IN-HOUSE EFFORT WAS TO REVISE THE DRAFT DOCUMENT TO BETTER REPRESENT OUR PLANT EQUIPMENT RESULTING IN A REVISION 0 LEVEL 1 PRA DOCUMENT.

- OVER THE PERIOD 1981 - 1985 WE HAD PERFORMED EXTENSIVE STUDIES ON STATION BLACKOUT AND ATWS FOR SUSQUEHANNA AND HAD DEVELOPED TRANSIENT ANALYSIS METHOD FOR THESE TRANSIENTS.

LESSONS LEARNED - PRA

- BASED ON OUR EXPERIENCES IN REVIEWING NUS WORK, WE DETERMINED THAT IN THE PERFORMANCE OF THE IPE WE WOULD:
  - ASSURE FULL USE OF ALL PLANT CAPABILITY IN RESPONSE TO AN ACCIDENT.
  - ASSURE THAT OUR PROCEDURES WOULD ACCOMPLISH THIS.
  - PERFORM SUSQUEHANNA SPECIFIC ANALYSIS TO ASSURE USE OF CREDIBLE SUCCESS CRITERIA.
  - EXPLICITLY REPRESENT THE TIMING OF CORE DAMAGE AND CONTAINMENT FAILURE.
  - CARRY THE ANALYSIS TO A STABLE OR COMPLETELY FAILED PLANT CONDITION.
  - AVOID CONVENTIONAL CONSERVATISMS RELATING TO COMMON MODE FAILURE.
  - UTILIZE THE MAAP CODE AS THE BASIS FOR CORE DAMAGE PROGRESSION.

THE PP&L APPLICATION OF THE IPE METHODOLOGY

- WE CONSIDERED THE BWR IPE METHODOLOGY TO BE DEFINED BY:
  - THE SYSTEM DEPENDENCY MATRICES
  - THE QUANTIFIED FUNCTIONAL FAULT TREES
  - THE QUANTIFIED EVENT TREES
- THESE WERE COMPARED TO SSES SYSTEMS AND PROCEDURES AND MODIFIED TO REFLECT DIFFERENCES IN:
  - SYSTEM DEPENDENCE
  - PLANT SYSTEMS
  - PLANT OPERATION
  - OPERATING PROCEDURES
- SUSQUEHANNA SPECIFIC INFORMATION WAS USED TO DEVELOP SYSTEM DEPENDENCIES AND QUANTIFY THE FUNCTIONAL FAULT TREES
- EXTENSIVE ANALYSIS WAS PERFORMED TO ESTABLISH REALISTIC SUCCESS CRITERIA
- CORE STABILIZATION CRITERIA TO PRESERVE REACTOR VESSEL INTEGRITY WERE DEFINED.
- AN ACCIDENT CLASSIFICATION SCHEME WAS DEVISED.
- A MEANS FOR ASSIGNING CONDITIONAL PROBABILITY TO VESSEL FAILURE AND LOSS OF CONTAINMENT INTEGRITY WAS DEVISED FOR SEQUENCES WHICH ENDED IN CORE DAMAGE.
- DEFINED FOUR PLANT DAMAGE CATEGORIES
  - CORE DAMAGE (CLAD ONLY OR LIMITED MELT)
  - CORE MELT AND VESSEL FAILURE
  - WETWELL VENT WITH CORE MELT AND VESSEL FAILURE
  - CONTAINMENT OVERPRESSURE FAILURE WITH CORE MELT AND VESSEL FAILURE

THE PP&L APPLICATION OF THE IPE METHODOLOGY

ANALYTICAL APPROACH

- THE PP&L APPROACH WAS DOMINATED BY PRIOR WORK ON NON-PROBABILISTIC RESPONSE STRATEGY EVALUATIONS FOR STATION BLACKOUT AND ATWS.

- AN ATTEMPT WAS MADE TO RECOGNIZE AND AVOID CONVENTIONAL PRA CONSERVATISMS AND ASSUMPTIONS WHICH HAVE A STRONG INFLUENCE ON EVENT SEQUENCE PROGRESSION.

- WE HAVE EXAMINED ALL EVENT SEQUENCES TO ASSURE THAT OUR PROCEDURES LEAD TO THE CORRECT AND TIMELY RESPONSE ACTION.

- WE HAVE DEVELOPED SUSQUEHANNA UNIQUE SUCCESS CRITERIA BASED ON SUSQUEHANNA EQUIPMENT PERFORMANCE.

- WE HAVE USED OPERATING EXPERIENCE IN PREFERENCE TO THEORETICAL MODELS FOR EQUIPMENT UNAVAILABILITY.

THE SUSQUEHANNA IPE

UNIQUE FEATURES

- o HUMAN ERROR
  - ERRORS DURING NORMAL PLANT OPERATIONS ARE CONSIDERED AND ARE IMBEDDED IN EQUIPMENT UNAVAILABILITIES, AND INITIATING EVENTS.
  - CONTROL ROOM OPERATORS WERE ASSUMED TO FOLLOW EMERGENCY OPERATING PROCEDURES WITHOUT ERROR.
  - CONTROL ROOM OPERATORS AND SUPPORT PERSONNEL FAIL TO EXECUTE PROCEDURES ONLY WHEN TIME IS LIMITED.
- o DECAY HEAT REMOVAL
  - QUANTIFIED RHR UNAVAILABILITY BY PRECURSOR METHODS.
  - INTRODUCED USE OF THE RWCU BLOWDOWN MODE FOR DECAY HEAT REMOVAL FOR TRANSIENT INITIATORS.
  - WETWELL VENT WAS INTRODUCED FOR LOCA AND STATION BLACKOUT EVENTS.

THE SUSQUEHANNA IPE

UNIQUE FEATURES (CONTINUED)

- o ANTICIPATORY ACTIONS
  - ACTIONS REQUIRED TO PREVENT PREDICTABLE LOSS OF EQUIPMENT.
  - ACTIONS REQUIRED TO ASSURE MITIGATION CAPABILITY IN THE EVENT OF ADDITIONAL EQUIPMENT FAILURES.
  - THE TRIGGER FOR SUCH ACTIONS IS SYMPTOM BASED.
- o ATWS TREATMENT
  - THE NECESSARY RESPONSE PROCEDURES ARE STRONGLY DEPENDENT ON THE TYPE OF ATWS AND COINCIDENT EQUIPMENT FAILURES.
  - WE HAVE PARTITIONED ATWS EVENTS ON THE BASIS OF ISOLATION STATUS, SCRAM RELAY FAILURES, SINGLE SDV FAILURE, DOUBLE SDV FAILURE.
  - WE ASSUME THE ABILITY TO MANUALLY DRIVE RODS IN WITH THE CRD PUMPS WHEN AVAILABLE.
  - WE POSTULATE MECHANICAL CLAD DAMAGE WHEN THE REACTOR MUST BE DEPRESSURIZED IN A CRITICAL CONDITION.

THE SUSQUEHANNA IPE

UNIQUE FEATURES (CONTINUED)

- o EVENT SEQUENCE CLASS DEFINITIONS
  - CLASS SPECIFIES STATE OF CORE, REACTOR VESSEL, AND CONTAINMENT AND TIME OF DAMAGE TO CORE AND CONTAINMENT.
  - PLANT STATUS FOR EACH EVENT SEQUENCE KNOWN PERMITTING MINIMUM EFFORT TO DETERMINE CONTAINMENT DISPOSITION.
  - THE CONTAINMENT QUANTIFICATION WAS PERFORMED IN THE SSES IPE.

EVALUATION OF ATWS EVENTS

- PARTITIONING

  ELECTRICAL/MECHANICAL = 2:1
  SINGLE SDV/TWO SDV = 100:1
  RANDOM FAILURE = 0

- TRANSIENT ANALYSIS

  EVALUATE ALTERNATIVE RESPONSE ACTIONS

  EXAMINE DEGRADED PLANT CONDITIONS

- DEPRESSURIZATION

  RAISED HCTL CURVE

  DEPRESSURIZE ONLY WHEN HCTL IS EXCEEDED OR WHEN HIGH PRESSURE INJECTION IS LOST

- MANUAL ROD INSERTION

  ALWAYS SUCCEED BEFORE CONTAINMENT FAILURE

- ANTICIPATORY ACTIONS

  CAN ALWAYS AVOID LOSS OF INJECTION

APPLICATION TO ATWS

	CORE DAMAGE	CD + COPF *
PRESENT IPE	9.3×10^{-9}	2.2×10^{-11}
SINGLE SLCS PUMP	1.8×10^{-8}	2.2×10^{-11}
NO ARI	2.2×10^{-7}	6.3×10^{-11}
NO PARTITIONING	2.2×10^{-6}	7.2×10^{-11}
NO HPCI BYPASS	4.5×10^{-5}	7.2×10^{-11}
PROCEDURAL ERROR (10%)	4.1×10^{-5}	2.0×10^{-5}
WASH - 1400	-	1.3×10^{-5}
NUREG - 1150	-	1.0×10^{-6}

* CORE DAMAGE WITH CONTAINMENT OVERPRESSURE FAILURE

SUSQUEHANNA SIMULATOR MEASUREMENTS

BACKGROUND

- o A SYSTEM 1 VALIDATION PROGRAM HAD BEEN PLANNED FOR EARLY 1987 TO DEMONSTRATE THE ADEQUACY OF OUR PROCEDURES, OPERATOR TRAINING, AND CONTROL ROOM FACILITIES TO COPE WITH A SEVERE ACCIDENT.

- o THE SUSQUEHANNA IPE TOOK A NEW APPROACH TO QUANTIFICATION OF OPERATOR ERROR.

  - MAINTENANCE AND SURVEILLANCE ERRORS ARE IMBEDDED IN HISTORICAL DATA ON UNAVAILABILITY AND INITIATING EVENTS

  - CONTROL ROOM OPERATOR

    ERROR DURING NORMAL OPERATION IS IMBEDDED IN INITIATING EVENT RECORDS

    ALWAYS FOLLOWS PROCEDURES IN RESPONSE TO AN INITIATING EVENT

    ONLY FAILS TO EXECUTE A PROCEDURE WHEN TIME IS LIMITED

- o PP&L MANAGEMENT SAW A NEED TO DEVELOP SUPPORTING INFORMATION FOR THE SUSQUEHANNA IPE AND APPROVED USE OF THE SYSTEM 1 VALIDATION FOR THIS PURPOSE.

SUSQUEHANNA SIMULATOR MEASUREMENTS

PRELIMINARY OPERATOR PERFORMANCE OBSERVATIONS

- NO CLEAR CASE OF PROCEDURAL ERROR WAS OBSERVED OUT OF APPROXIMATELY 1650 PROCEDURAL STEPS.

- A FEW INSTANCES WERE OBSERVED WHERE PROCEDURAL AMBIGUITY OR LACK OF PRECISION CAUSED QUESTIONABLE RESPONSE ACTIONS.

- OUR GENERAL PERCEPTION OF THE UNANALYZED EXECUTION TIME DATA IS THAT THE SUSQUEHANNA IPE IS PROBABLY CONSERVATIVE.

- THERE MAY BE DEFICIENCIES IN OPERATOR PERFORMANCE IN TAKING ANTICIPATORY ACTIONS.

SUMMARY OF IMPORTANT RESULTS

- TOTAL PLANT DAMAGE FREQUENCY HAS BEEN REDUCED BY 100
- ATWS AND TRANSIENTS HAVE BEEN ELIMINATED AS DOMINANT CONTRIBUTORS (CONVENTIONAL RESULTS SHOW IMPORTANCE OR DOMINANCE)
- CONTAINMENT FAILURE HAS BEEN SHOWN TO OCCUR IN ONLY 2.5% OF PLANT DAMAGE SEQUENCES (CONVENTIONAL RESULTS ARE NEAR 100%)
- THE CORE DAMAGE SEQUENCE CAN BE ARRESTED BEFORE REACTOR VESSEL FAILURE ABOUT 70% OF THE TIME (CONVENTIONAL RESULTS ARE 0%)

  SAR Code may show that it may go up to 99%
- STATION BLACKOUT HAS BECOME THE DOMINANT CONTRIBUTOR TO PLANT DAMAGE (WITH FAILURE OF HPCI AND RCIC TO START)
- THE WETWELL VENT (AS ASSUMED IN THE STUDY) HAS REDUCED CONTAINMENT OVERPRESSURE FAILURE WITH CORE MELT AND VESSEL FAILURE BY ABOUT 10. (RESOLUTION OF THE VENTING ISSUE IS BEING STUDIED.)
- VULNERABILITIES HAVE BEEN DISCOVERED FOR VARIOUS ACCIDENT SEQUENCES WHICH CAN BE ELIMINATED THROUGH PROCEDURES, TRAINING, AND MINOR PLANT MODIFICATIONS

PLANT VULNERABILITIES IDENTIFIED BY THE SUSQUEHANNA INDIVIDUAL PLANT EVALUATION

- EMERGENCY SERVICE WATER FAILURES
- DC POWER ENDURANCE IN STATION BLACKOUT
- STATION BLACKOUT WITH FAILURE OF HPCI/RCIC START
- RESET ON HIGH LEVEL FEEDWATER TRIP
- SUCTION TRANSFER OF HPCI ON HIGH SUPPRESSION POOL LEVEL
- LOW PRESSURE ECCS INJECTION PERMISSIVE
- LOSS OF DECAY HEAT REMOVAL

LESSONS LEARNED - IPE

- ASSUMPTIONS OFTEN DRIVE RESULTS
- MUST INVOLVE PLANT PERSONNEL IN REVIEW OF ACCIDENT SEQUENCES
- DEMONSTRATION OF "DEFENSE IN DEPTH" SHOULD BE OUR OVERALL OBJECTIVE
- COMBINATIONS OF FIXES CAN HAVE MUCH GREATER IMPACT THAN THE SUM OF THE INDIVIDUAL EFFECTS
- SUPPORT STATE METHOD IS EXACTLY EQUIVALENT TO MORE CONVENTIONAL METHODS
- NEED MORE DETAIL IN SUPPORT STATE DEFINITION
- LESS SEVERE FAILURES CAN REPRESENT GREATEST THREAT
- SHOULD PROGRAM THE CALCULATION TO:
  - REDUCE ERRORS
  - SIMPLIFY RECALCULATION
  - PERMIT MONTE CARLO UNCERTAINTY ANALYSIS
- BINNING AND CONTAINMENT EVENT TREES ARE INEFFICIENT AND ERROR PRONE AND PREVENT EFFICIENT TABULATION OF ACCIDENT SEQUENCES
- LCO CONSTRAINTS CAN BE DIRECTLY INCORPORATED INTO THE COMPUTATION AND ILLEGAL FAILURE COMBINATIONS ARE THUS READILY ELIMINATED
- DEVELOPED A GOOD FEEL FOR THE IMPORTANT CONSERVATISMS

THE PP&L VIEW
OF
RISK ASSESSMENT

- WE DO NOT KNOW THE ACTUAL EXPECTED FREQUENCY OF PLANT DAMAGE TO SUSQUEHANNA BECAUSE OF THE LACK OF COMPLETENESS IN OUR ANALYSIS AND BECAUSE OF THE POSSIBILITY OF ERRORS IN ANALYSIS OR DATA.

- WE DO BELIEVE THAT THE CALCULATED FREQUENCY OF PLANT DAMAGE IS AN ACCURATE ASSESSMENT WITHIN THE LIMITS OF OUR ASSUMPTIONS AND ANALYTICAL ACCURACY.

- WE BELIEVE THAT OUR MODELS AND ASSUMPTIONS YIELD THE MOST ACCURATE PICTURE OF THE CAPABILITY OF OUR PLANT EQUIPMENT AND PROCEDURES OF ANY ANALYSIS METHOD CURRENTLY KNOWN.

- WE BELIEVE THAT OUR USE OF THE IPE TO EVALUATE "DEFENSE IN DEPTH" OF BOTH EQUIPMENT AND PROCEDURES GIVES US THE BEST AVAILABLE PROTECTION AGAINST BOTH ANALYZED AND UNFORESEEN EVENTS BECAUSE OF THE USE OF SYMPTOM BASED PROCEDURES.

FUTURE DIRECTIONS FOR PP&L RISK ASSESSMENT

- THE INITIAL PP&L PERFORMANCE OF AN IPE WAS LACKING IN SEVERAL POTENTIALLY IMPORTANT AREAS

- WE ARE CURRENTLY DEVELOPING TECHNIQUES TO ELIMINATE THE MOST IMPORTANT PERCEIVED DEFICIENCIES IN THE METHODOLOGY

- WE WILL PERFORM AN IPE USING PP&L DEVELOPED ACCIDENT CLASSES AND DISPOSITIONING TECHNIQUES TO DEVELOP THE DESIRED SPECTRUM OF PLANT STABLE STATES

- WE WILL USE THE SUPPORT STATE METHODOLOGY WHICH PERMITS NUMERICAL CALCULATION OF THE STABLE PLANT STATES

- THERE IS EXTREME FLEXIBILITY IN THE CHOICE OF FINAL PLANT STATES

- THE CALCULATIONS CAN ALL BE PROGRAMMED FOR COMPUTER AND ARE RELATIVELY SIMPLE AND FLEXIBLE

- THE MOST EFFECTIVE WAY FOR THE NRC TO DEVELOP CONFIDENCE THAT THE PP&L APPROACH IS SOUND WOULD BE TO ASSIGN AN NRC EMPLOYEE TO PARTICIPATE IN THE ANALYSIS

FUTURE OBJECTIVE

- WE WISH TO ACHIEVE CLOSURE ON: "HOW SAFE IS SAFE ENOUGH?"
  - WE DO NOT CONSIDER A LOW BOTTOM LINE FREQUENCY AS PROOF OF ADEQUACY
  - WE WISH TO DEMONSTRATE "DEFENSE IN DEPTH" AS THE MEASURE OF ADEQUACY OF SUSQUEHANNA OPERATIONAL RISK
  - IF WE DEMONSTRATE "DEFENSE IN DEPTH" WE BELIEVE:
    - THE FREQUENCY OF PLANT DAMAGE FROM INTERNAL EVENTS WILL BE FOUND TO BE EXTREMELY LOW
    - OFF-SITE CONSEQUENCES WILL BE FOUND TO BE EXTREMELY LOW BY ANY REASONABLE ANALYSIS.

FUTURE APPROACH

- WE WILL PERFORM A PROBABILISTIC RISK ASSESSMENT (IPE) TO DERIVE ALL CREDIBLE EVENT SEQUENCES WHICH CAN LEAD TO PLANT DAMAGE.

- WE WILL USE THE SUPPORT STATE METHODOLOGY.

- WE WILL PROPAGATE EACH EVENT TREE END POINT, INDIVIDUALLY, TO DEVELOP THE ENTIRE SPECTRUM OF FINAL STABLE PLANT STATES:

  - FUEL DAMAGE
  - FUEL DAMAGE WITH VESSEL FAILURE
  - CONTAINMENT FAILURE
  - CONTAINMENT VENTING
  - VARIOUS DEGREES AND COMBINATIONS OF THE ABOVE

- FOR EACH FINAL PLANT STATE OF EACH END POINT WE WILL DEMONSTRATE THAT "DEFENSE IN-DEPTH" WAS MET BEFORE THE END POINT RESULT COULD OCCUR.

DEMONSTRATION OF SUCCESS

- O WE PREPARE A TABLE OF ACCIDENT SEQUENCES AND DEMONSTRATE THAT "DEFENSE IN DEPTH" WAS MET FOR EACH.

- O WE INDICATE WHAT EQUIPMENT AND WHAT PROCEDURES WERE INVOLVED USING NUMBER AND LETTER CODES.

- O WE INCLUDE ALL SEQUENCES ABOVE A CUTOFF FREQUENCY.

- O WE INCLUDE AT LEAST 2 SEQUENCES FOR EVERY INITIATOR REGARDLESS OF FREQUENCY.

PROPOSED TABULAR DISPLAY
OF
"DEFENSE IN DEPTH"

EVENT * SEQUENCE	DEFENSE IN DEPTH COMPONENT					
	EQUIPMENT			PROCEDURES		
	1	2	3	1	2	3
SEQUENCE 1	7	5	N.A.	A	D	N.A.
SEQUENCE 2	5	N.A.	N.A.	B	N.A.	N.A.
SEQUENCE 3	6	5	2	C	E	G
ETC.						

* ALL SEQUENCES HAVING FREQUENCY > 10^{-4} OF TOTAL OF ALL SEQUENCES AND TOP 2 SEQUENCES OF EACH INITIATOR.

VERIFICATION OF ANALYSIS

- THE FIDELITY OF MODELING OF PLANT SYSTEMS WILL BE EXPLICITLY REPRESENTED IN THE IPE AND ITS SUPPORTING FILES.

- THE ADEQUACY OF OUR PROCEDURES WILL BE DEMONSTRATED BY OUR TRANSIENT ANALYSIS OF PLANT RESPONSE AND VERIFICATION THAT ASSUMED OPERATOR ACTIONS WOULD BE REQUIRED BY PROCEDURES.

- THE ADEQUACY OF OPERATOR TRAINING AND THEIR PERFORMANCE IN EXECUTING PROCEDURAL GUIDANCE WILL BE MEASURED BY WRITTEN TESTS OF OPERATOR KNOWLEDGE AND MEASUREMENTS OF OPERATOR PERFORMANCE IN SIMULATOR TRAINING FOR COMPARISON TO ANALYSIS ASSUMPTIONS.

MAINTAINING THE ANALYSIS

- ALL PLANT EQUIPMENT OR PROCEDURAL MODIFICATIONS WILL BE REVIEWED TO DETERMINE IMPACT ON SEQUENCE FREQUENCIES.

- THE ANALYSIS WILL BE UPDATED ON A PERIODIC BASIS (FOR EXAMPLE ON THE REFUELING CYCLE).

- THE ANALYSIS WILL BE PROGRAMMED FOR THE COMPUTER SO THAT RE-ANALYSIS WILL REQUIRE MINIMAL EFFORT.

- WE WILL CONTINUE TO DEVELOP METHODS TO EXTEND THE COMPLETENESS OF THE ANALYSIS AT A REASONABLE LEVEL OF EFFORT.

  - GREATER SUPPORT STATE DEFINITION
  - LOSS OF INSTRUMENTATION
  - INFLUENCE OF CREW SUBSTITUTIONS
  - MORE DEFINITIVE EVALUATION OF SEVERE WEATHER EFFECTS
  - ETC.

SUMMARY

- WE FIRMLY ENDORSE A MODIFIED VERSION OF THE IDCOR BWR-IPE METHODOLOGY.

- WE BELIEVE THAT ALL ACCIDENT SEQUENCES SHOULD BE INDIVIDUALLY CARRIED TO STABLE PLANT CONDITIONS.

- ANALYSIS ON THE BASIS OF INDIVIDUAL SEQUENCES TO ASSURE EXPLOITATION OF ALL PLANT CAPABILITY HAS SHARPLY REDUCED CALCULATED PLANT DAMAGE FREQUENCIES.

- THE FUNDAMENTAL REASON FOR THIS IS THAT "DEFENSE IN DEPTH" HAS BEEN ACHIEVED.

- WE EXPECT SEQUENCES FOR WHICH "DEFENSE IN DEPTH" HAS NOT BEEN MET TO HAVE THE HIGHEST FREQUENCIES FOR ANY GIVEN INITIATOR.

- THIS APPROACH OFFERS A LOGICAL AND CREDIBLE BASIS FOR ACHIEVING CLOSURE ON INTERNAL EVENT SEVERE ACCIDENTS.

RECOMMENDATIONS

- PERFORM RESEARCH TO SUPPORT ESTABLISHMENT OF CORE/VESSEL STABILIZATION AND CORED DEBRIS/CONTAINMENT STABILIZATION CRITERIA
- IMPLEMENT A PHASED APPROACH IN THE IPE GENERIC LETTER
- REQUIRE THAT EACH ACCIDENT SEQUENCE BE CARRIED TO A STABLE STATE OR FAILURE
- REQUIRE DEMONSTRATION OF DEFENSE IN DEPTH FOR DOMINANT SEQUENCES

OBSERVATIONS

- TO ACCOMPLISH THE RECOMMENDED REQUIREMENTS A TRANSPARENT METHODOLOGY MUST BE USED
- UTILITY PARTICIPATION IN THE IPE PROCESS SHOULD BE ENCOURAGED
- INTERNAL UTILITY TRANSIENT ANALYSIS CAPABILITY IS HIGHLY DESIRABLE

Enclosure 2

DECEMBER 11, 1987

PP&L BRIEFING ON IPE INSIGHTS

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Gary L. Merrill	PP&L
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Tom Murley	NRR
Mark Caruso	NRR
John C. Lane	RES/SAIB
William Beckner	RES/RHFB
James Norberg	NRR/DEST
Cecil Thomas	NRR/PTSB
Wayne Hodges	NRR/DEST/SRXB
Glenn Kelly	NRR/DREP/RAB
W. R. Butler	NRR/PDI-2
Bruce Boger	NRR/ADRI
Franklin Coffman	RES/RMFR
Ron Hernan	NRR/PMAS