

THE BASCOCK & WILCOX COMPANY  
POWER GENERATION GROUP

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To	G. A. MEYER, MANAGER, T-H ENGINEERING UNIT	THE-79-190
From	<i>P. J. Henningson</i> P. J. HENNINGSON, T-H ENGINEERING UNIT, EXT. 3515	12E12.13 805 663.3
Cust.	TMI-2	File No. 36-1100502-00 or Ref. 660-021A
Subj.	DAMAGE MODEL - FLUIDIZED BED	Date APRIL 10, 1979

This letter is copy one customer and one invoice only.

- REFERENCES:
- 1) MEMO, CORE CONDITION TASK FORCE TO J. S. TULENKO, "CURRENT ASSESSMENT OF CORE CONDITION, APRIL 7, 1979 (1800)," APRIL 7, 1979 (7:48 PM)
  - 2) PERRY'S CHEMICAL ENGINEERS HANDBOOK, FOURTH EDITION, PP. 549 - 551.
  - 3) MEMO, P. J. HENNINGSON TO G. A. MEYER, "POSSIBLE MODE OF INCREASED T.C. READINGS," APRIL 7, 1979.

THE DAMAGED TMI-2 CORE WAS HYDRAULICALLY MODELED AS A PACKED BED. THE MECHANISM OF FUEL FAILURE WOULD RESULT IN APPROXIMATELY THIS GEOMETRY AND BE LOCATED IN THE UPPER REGION OF THE CORE. BRIEFLY THE CORE WOULD BE CONFIGURED AS UNDAMAGED FUEL UP TO A HEIGHT WITH DAMAGED FUEL (FUEL PARTICULATES AND CLADDING) ABOVE THIS RESEMBLING A POROUS MASS:

THE BASIC CONFIGURATION OF THE CORE WAS OBTAINED FROM REFERENCE 1. THE CORE WAS ASSUMED UNDAMAGED AT THE PERIPHERY WITH INCREASING FAILURE TOWARDS THE CENTER. PARTICLES OF FAILED FUEL WHICH COMPRISED THE FLUIDIZED BED WERE ASSUMED TO EVOLVE FROM THE FOLLOWING FAILURE MECHANISM:

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THE FUEL CRACKED ALONG TWO PERPENDICULAR AXES LENGTHWISE AND  
ALONG THREE <sup>PLANES</sup> ~~AXES~~ PERPENDICULAR TO ITS AXIS.

THE MASS OF FUEL WOULD THEN CONSTITUTE THE MAJORITY OF THE  
CONGLOMERATE WITH CLADDING FRAGMENTS ASSUMED TO HAVE A SIMILAR  
GEOMETRY.

A SUITABLE CORRELATION FOR PRESSURE DROP THROUGH A PACKED BED  
WAS OBTAINED FROM REFERENCE 2. THIS CORRELATION (ATTRIBUTED TO LEVA)  
WAS APPLICABLE IN THE HIGH REYNOLDS NUMBER RANGE EXISTING IN THE  
DAMAGED CORE (RE ~ 10,000 ). IT IS IMPORTANT THAT THE RANGE OF  
REYNOLD'S NUMBER APPLICABILITY BE ASCERTAINED FOR A GIVEN CORRELATION.  
THE SENSITIVITY OF THE FRICTION FACTOR <sup>TO</sup> ~~IS~~ CHANGES IN FLOW FROM  
VISCIOUS TO TURBULENT IN THE PACKED BED CANNOT BE NEGLECTED.

AN ATTEMPT TO MODEL THE CORE AS DEFINED IN REFERENCE 1 WAS MADE.  
THE LOW RESISTANCE IN THE PERIPHERAL BUNDLE CAUSED THIS  
METHOD TO FAIL. IT WAS THEN ASSUMED THAT FAILED FUEL (OR A CONGLOMERATE  
OF PARTICLES) EXISTED AT THE PERIPHERY. THE CORE TOOK ON THE FOLLOWING  
SHAPE:

CENTRAL BUNDLES (116)	4 FEET OF FAILED FUEL BELOW THE UPPER END FITTING (PACKED BED)
REMAINING BUNDLES	2 FEET OF FAILED FUEL BELOW THE UPPER END FITTING

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THE GENERAL SHAPE AND RECOMMENDATION OF A FOUR FOOT HEIGHT WAS OBTAINED FROM REFERENCE 1.

A TRIAL AND ERROR APPROACH WAS USED. THE VOID FRACTION OF THE PACKED BED WAS VARIED AND A CORE  $\Delta P$  CALCULATED. THE FINAL RESULT WAS THAT FOR THE ABOVE CONFIGURATION A CORE  $\Delta P = 14$  PSI WAS OBTAINED FOR A CORE FLOW OF  $13.1 \times 10^6$  LBM/HR. THE FLOW IN THE CENTRAL BUNDLES (61) WAS  $.058 \times 10^6$  LBM/HR AND IN THE OUTER BUNDLES  $.082 \times 10^6$  LBM/HR. THIS WAS FOR A PACKED BED HEIGHT OF FOUR FEET AT THE CENTER 61 BUNDLES AND TWO FEET ON THE REMAINDER OF THE CORE. A VOID OF 60% WAS USED WHICH COMPARED WELL WITH THE 50% RECOMMENDED IN REFERENCE 1.

NO FURTHER ATTEMPTS WERE MADE TO MATCH PRESENTLY ASSUMED CORE CONDITIONS  $\Delta P \sim 16.0$  PSI, CORE FLOW  $\sim 14.10^6$  LBM/HR. VARIOUS ASSUMPTIONS CAN BE MADE CONCERNING THE GEOMETRY AND MAKEUP OF THE FAILED FUEL WHICH IS ASSUMED TO RESEMBLE A PACKED BED. WHAT IS IMPORTANT IS THAT:

- 1) CORE CONDITIONS COULD BE APPROXIMATED WITH THE PACKED BED ASSUMPTION,
- 2) FAILED FUEL (OR A HIGH RESISTANCE EXISTS ACROSS THE CORE). THE FUEL AT THE PERIPHERY COULD BE UNDAMAGED WITH A LAYER OF PARTICULATES BENEATH THE CORE SUPPORT PLATE ALTHOUGH IT SEEMS UNLIKELY THAT THE MATERIAL WOULD BE THAT NON-HOMOGENEOUS.

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FURTHERMORE, IF THE FAILURE MODE OF THE CORE DESCRIBED IN REFERENCE 1 IS ASSUMED, THEN IT APPEARS THAT THE THERMOCOUPLES COULD BE SURROUNDED BY  $UO_2$ . THIS WOULD EXPLAIN THEIR HIGH READINGS. THE EFFECT OF  $UO_2$  SURROUNDING THE THERMOCOUPLE WELL WAS DESCRIBED IN REFERENCE 3.

PJH/sgb

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QA: THE METHODS PRESENTED HAVE BEEN REVIEWED FOR APPLICABILITY AND THE CALCULATIONS SPOT-CHECKED FOR ACCURACY AND CONSISTENCY. THE METHOD IS DEEMED APPROPRIATE FOR THIS PARTICULAR APPLICATION.

JCMoxley by G. S. Clevinger DATE 4/10/79

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