

Summary Information for the Experiment:

UK-JAPAN FAST CRITICAL EXPERIMENTS IN SUPPORT OF MONJU DESIGN. THE ZEBRA MOZART PROGRAMME, PART 1. ASSEMBLIES MZA AND MZB, ZEBRA 11 AND 12.

1. Experiment Identification Number
ZEBRA-LMFR-EXP-002
CRIT-SPEC-REAC-COEF-RRATE
2. Date 1971 to 1973
3. Name of Experiment The ZEBRA MOZART Programme, Part 1, MZA and MZB.
 - 3.1. Purpose of Experiment
This Joint UKAEA - PNC Japan Programme of Experiments was in support of the reactor physics aspects of the design of the MONJU reactor
The purpose was to provide a basis for validating the methods and nuclear data used in the neutronics design of the MONJU sodium cooled fast reactor.
 - 3.2. Phenomena measured and Scope:
To test fast reactor neutronics methods for calculating criticality, reaction rate ratios and distributions and the reactivity effects of small samples of different materials.
In the MZC phase of the programme, which is the subject of a second document, ZEBRA-LMFR-EXP-003, measurements were made of control rod reactivity worths and reaction rate distributions within and near to the rods. These control rods simulated those proposed for the design of MONJU and were of boron carbide (at a range of enrichments) and tantalum.
4. Name or Designation of Experimental Programme
The ZEBRA MOZART Programme, Part 1, MZA and MZB.
5. Description of Test Facility
The ZEBRA Zero Energy Critical Assembly Facility was sited at the Winfrith Atomic Energy Establishment of the United Kingdom Atomic Energy Authority and was designed to accommodate assemblies, up to 3 m cube in size, simulating fast reactors, and to test the methods and nuclear data used in fast reactor design and operational calculations. The assemblies were built from 5 cm square plates of various thicknesses stacked in square tubes made of stainless or mild steel. Alternatively arrays of pins could be assembled in the square tubes.
6. Description of Test or Experiment
 - 6.1. Experimental Configuration
 - 6.1.1. Types of Assemblies
The first assembly in the series, MZA (or ZEBRA 11) had a single core zone and was surrounded by axial and radial blanket zones and steel plenum or reflector regions simulating the empty tubes which are continuations of the fuel pins in a fast reactor to accommodate fission gas release from the fuel. The second assembly, MZB (or ZEBRA 12) had a two zone core and the size was similar to that of the MONJU reactor design. The elements used in the outer core were the same as those used in the core of MZA. The inner core had a lower fissile enrichment.
 - 6.1.2. Assembly Details
 - 6.1.2.1. Type
Fast Reactor
 - 6.1.2.2. Fuel
Uranium dioxide, plutonium metal plus U-PuO₂
 - 6.1.2.3. Moderators
Sodium, Steel, Graphite
 - 6.1.2.4. Absorbers
Boron and Tantalum were used in the MONJU simulation rods and reactivity perturbation measurements.

- 6.1.2.5. Critical Mass
MZA, ~300 kg Pu239+Pu241, MZB, ~800 kg Pu239+Pu241.
- 6.1.2.6. Core Volume
MZA, 560 litres, MZB, 1800 litres
- 6.1.2.7. Blanket
In a sector of the radial blanket of MZB three different designs were studied. These contained, respectively, depleted uranium oxide plates, natural uranium oxide plates and natural uranium metal plates. Outside the radial blanket sector natural uranium metal plates were used, as in MZA.
- 6.1.2.8. Reflectors
Steel
- 6.1.2.9. Reactivity adjustment
Calibrated control rod
- 6.1.2.10. Other
- 6.1.3. Assembly Variants
MZA Single region core.
MZB Two region core with 3 different radial blanket sectors.
MZC Arrays of MONJU mockup control rods
(see ZEBRA-LMFR-EXP-003 for the MZC measurements)
- 6.2. Core Lifecycle
BOL
- 6.3. Experimental Limitations or Shortcomings
- 7. Phenomena measured
 - 7.1. Description of Results and Analysis
 - 7.1.1. Data Measured
 - 7.1.1.1. Reactivity Control for Criticality
Regulating control rod calibrated by period measurements, interpreted in terms of delayed neutron data.
 - 7.1.1.2. Reaction rates/ratios
Capture - ^{238}U
Fission - ^{235}U , ^{238}U and ^{239}Pu
 - 7.1.1.3. Reactivity Worth
Sodium voiding
Control absorbers
Core materials
 - 7.1.1.4. Sample Doppler Reactivity
No measurement
 - 7.1.1.5. Temperature Coefficients
Measured only in MZB, to provide corrections to criticality
 - 7.1.1.6. Control Rod or Rod Banks Reactivity Worths
Boron and Tantalum rods in the MZC phase
(see ZEBRA-LMFR-EXP-003).
 - 7.1.1.7. Soluble Boron Worth
No measurements
 - 7.1.1.8. Gamma heating Distributions
In the shielding experiments phase
(not treated in the present document)
 - 7.1.1.9. Neutron Spectrum
Several different techniques were used
 - 7.1.1.10. Kinetics parameters
Control rod calibration was based on period measurements.
 - 7.1.1.11. Reactor Power Distributions
No measurements.

- 7.1.1.12. Isotopic Measurements
No measurements.
- 7.2. Special Features and Characteristics of Experiment.
 - 7.2.1. Moderator/Fuel Ratio
Fast reactor spectrum system
 - 7.2.2. Spectral index
Spectrum measurements were made in MZA using a variety of techniques.
Reaction rate ratio measurements were made in central regions of the two cores.
- 7.3. Measurement System and Uncertainties:
Sources of uncertainty are discussed for each measurement
- 8. Duplicate or Complementary Experiments / Other Related Experiments
The CADENZA Programme ZEBRA-LMFR-EXP-001
The MZC Programme ZEBRA-LMFR-EXP-003
- 9. Status of Completion of the Evaluation
Completed
- 10. References.
The UKAEA AEE Winfrith series of Mozart Technical Notes, denoted by MTN, and other documents are referenced.
- 11. Authors/Organisers
 - 11.1. Establishment
The UKAEA Atomic Energy Establishment, Winfrith, Dorchester, Dorset, UK.
 - 11.2. Staff Involved in Experiment
Staff of the UKAEA Winfrith and a team from PNC Japan.
 - 11.3. Contact information
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 - 11.4. Reviewers of Compiled Data
Internal Reviewer: Atsushi Zukeran,
Reviewers: Masayuki Nakagawa, Peter Smith and Udo Wehmann.
- 12. Material Available
 - 12.1. Data and Format
Dimensions and compositions of all components, together with the configurations of these in the assemblies, are provided.