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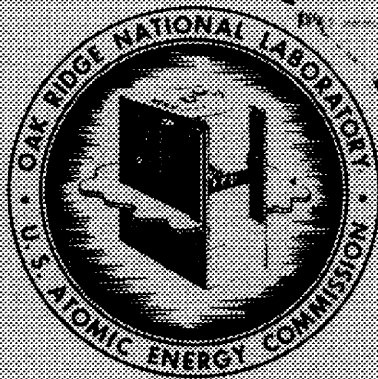
R. E. Thoma  
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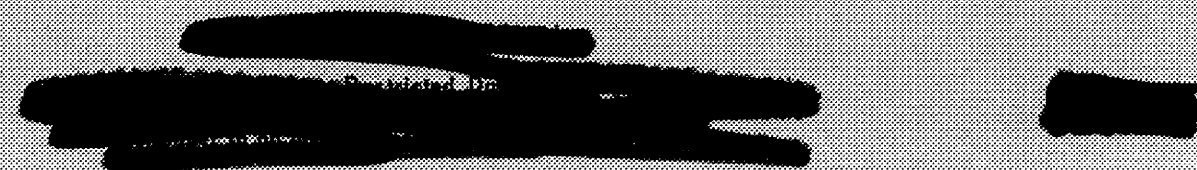
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PHASE EQUILIBRIUM DIAGRAMS FOR FUSED SALT SYSTEMS

R. E. Thoma  
W. R. Grimes

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PHASE EQUILIBRIUM DIAGRAMS FOR FUSED SALT SYSTEMS

Research on liquid fused salt fuels should begin with phase equilibrium studies. This report is a summary of the current status of the fused salt systems which have been under study in the ANP Chemistry Section during the last several years.

The inclusion of a phase equilibrium diagram in this report is not an indication that it represents a finished study. It has been necessary to minimize the emphasis on several systems as it became clear that these systems promised small returns to the ANP fuels program.

Discussions regarding the extent of the study and phase characteristics of each of these systems are to be found in the references listed in the Table of Contents.

A large number of people have contributed to an understanding of these phase relationships. A partial list of major contributors to these studies includes C. J. Barton, F. F. Blankenship, L. M. Bratcher, V. S. Coleman, H. A. Friedman, H. Insley, B. S. Landau, T. N. McVay, R. E. Moore, R. F. Newton, B. J. Sturm, J. Truitt, G. D. White, and W. C. Whitley.

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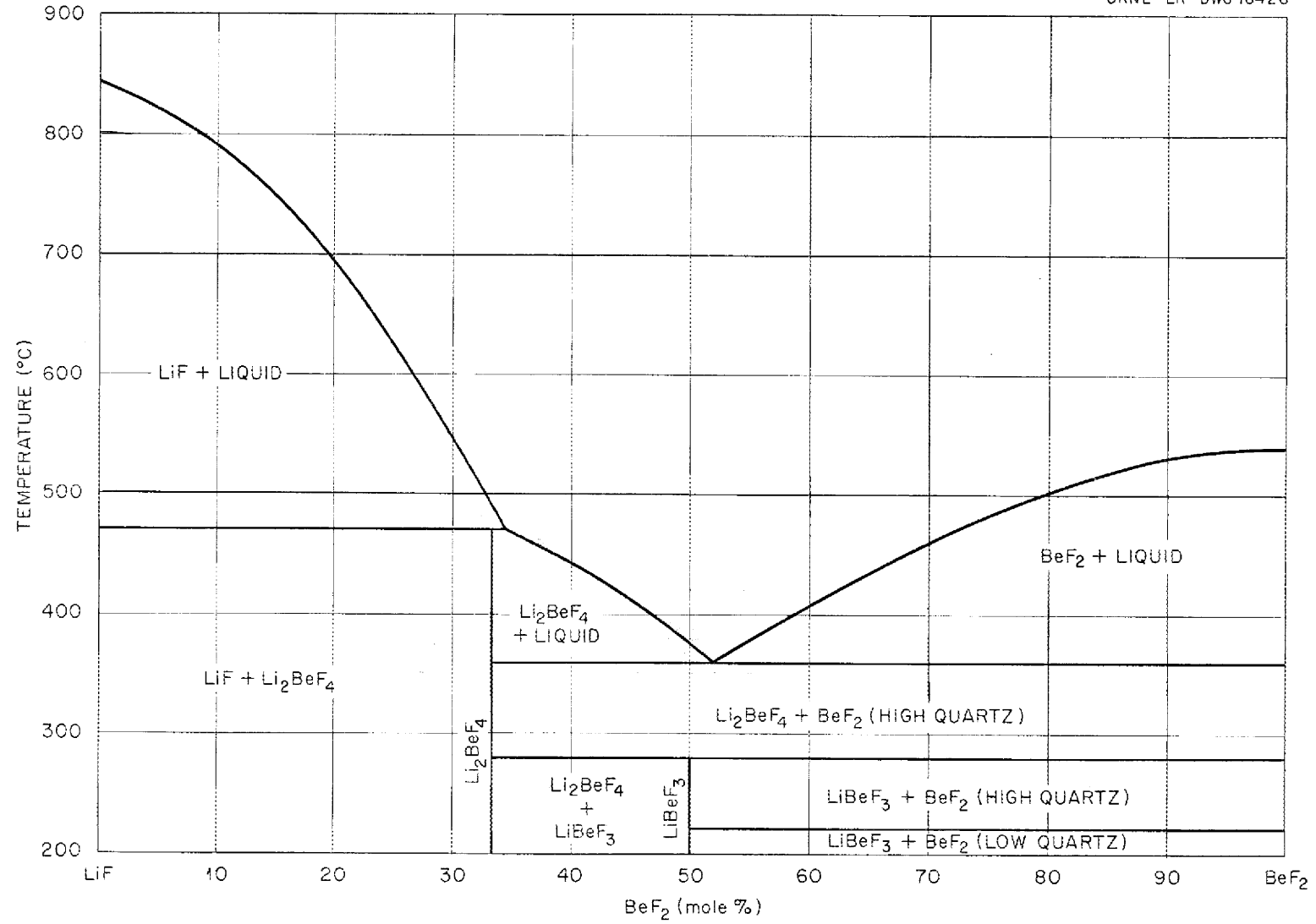


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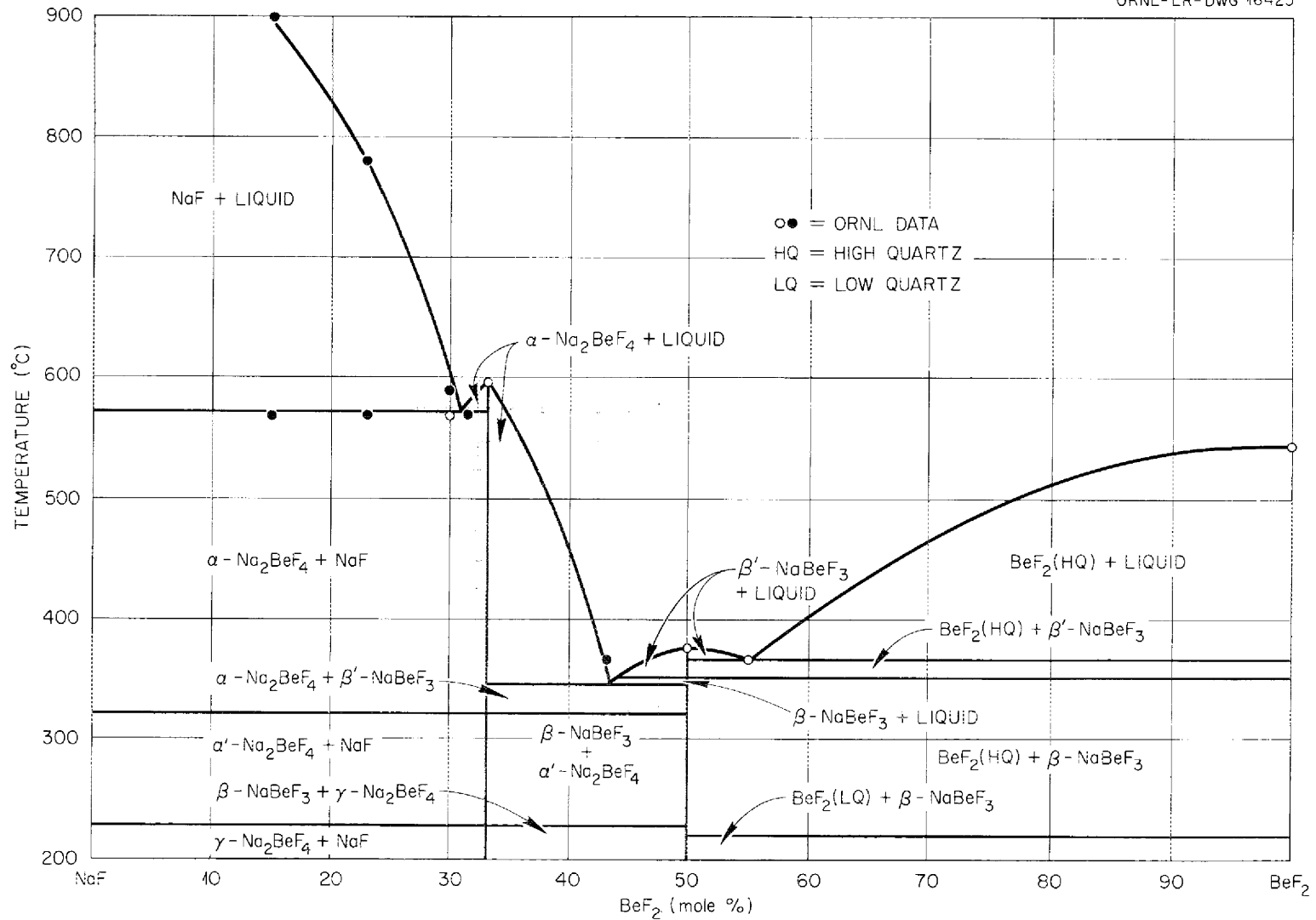
\* Final diagram on these systems not determined at ORNL.

\*\* The determination of the incongruent nature of 2LiF·BeF<sub>2</sub> was made by Mound Laboratory, by ORNL, and also by J. L. Speirs, "The Binary and Ternary Systems Formed by CaF, LiF, and BeF<sub>2</sub>: Phase Diagrams and Electrolytic Studies", Ph.D. thesis, Michigan State College, 1952.

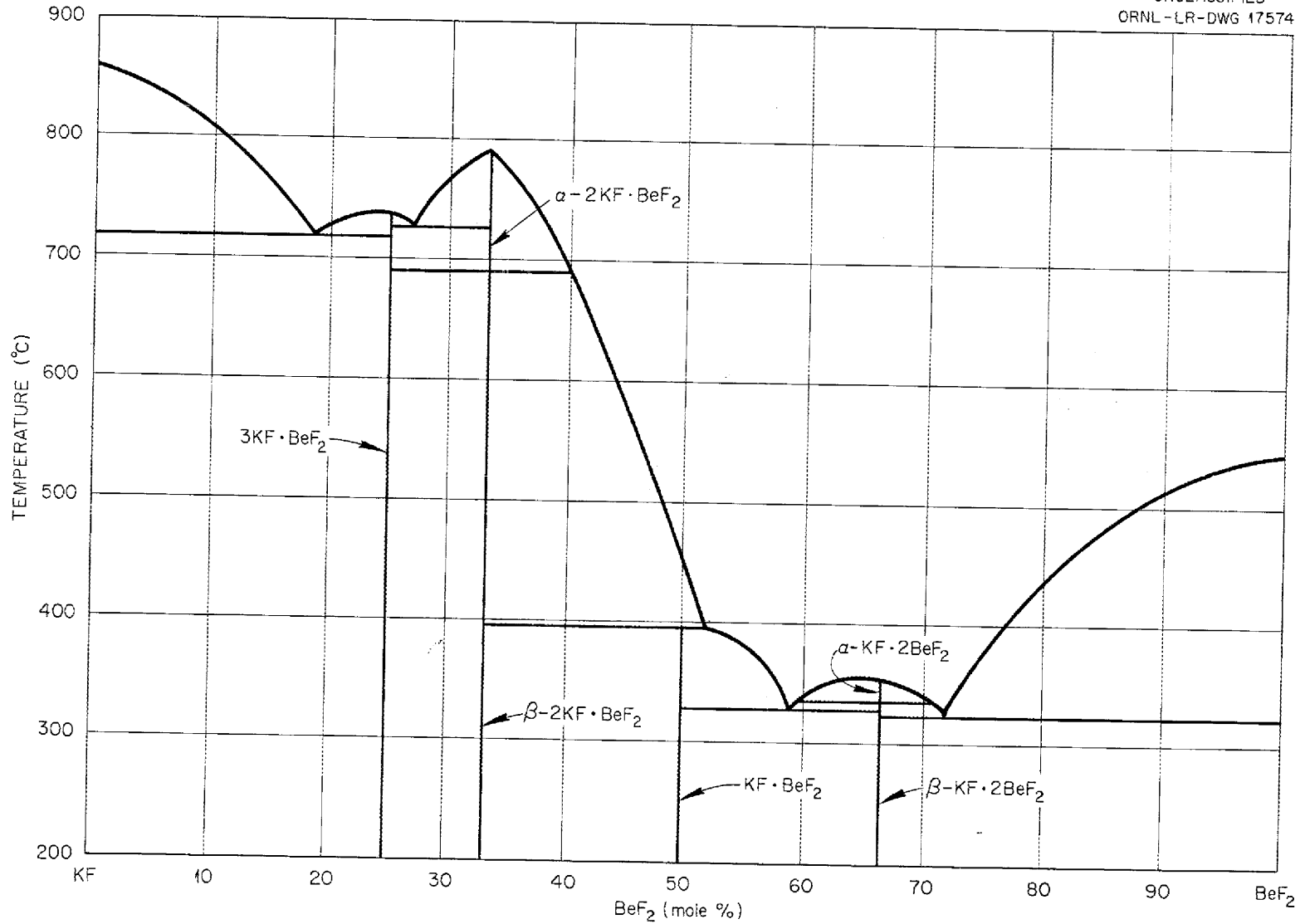




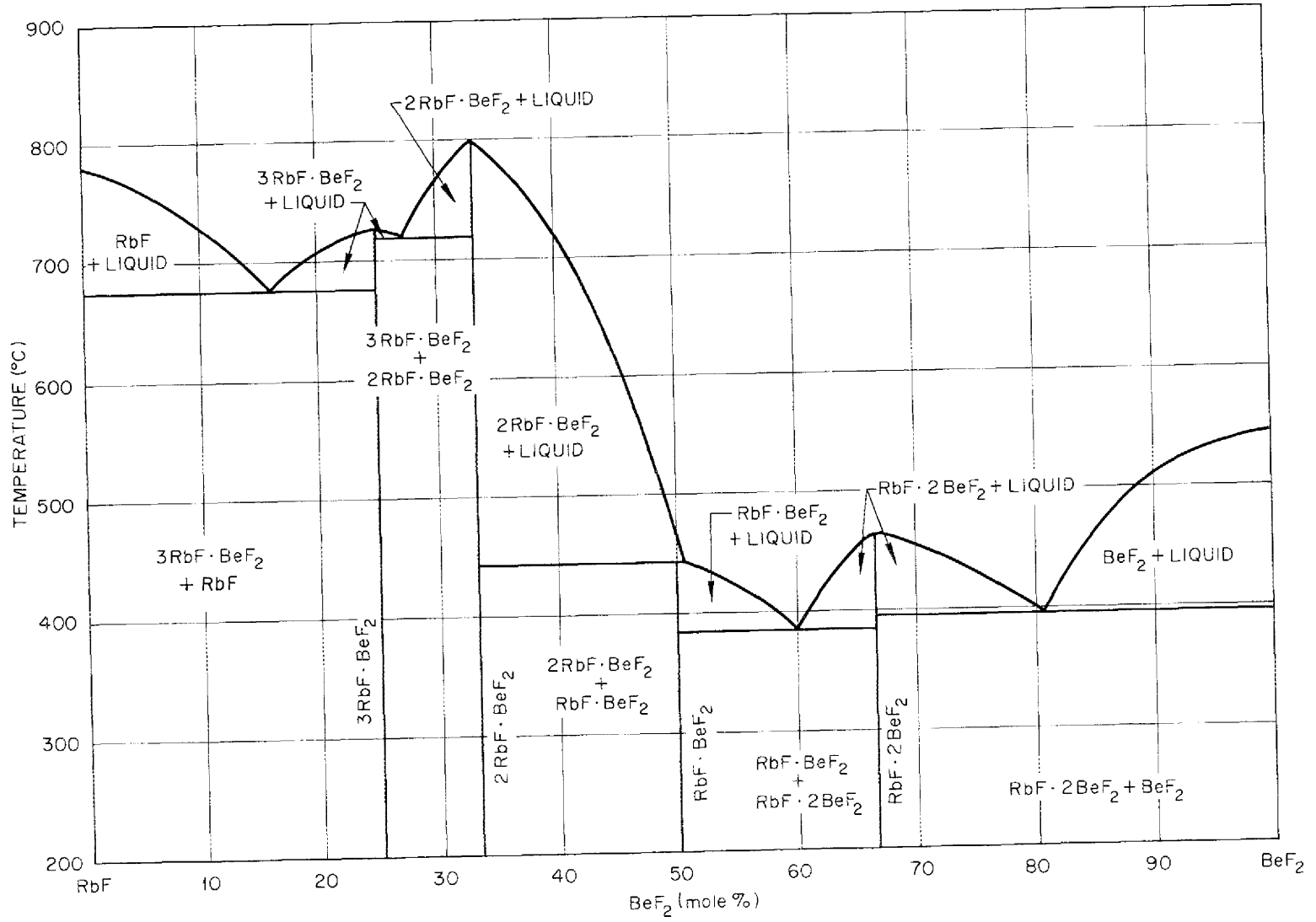
The System LiF-BeF<sub>2</sub>. Composite diagram from: D. M. Roy, R. Roy, and E. F. Osborn, *J. Am. Ceram. Soc.* **37**, 300 (1954); Novoselova, Simanov, and Yarembash, *J. Phys. Chem. USSR* **26**, 1244 (1952); and unpublished data, Oak Ridge National Laboratory.



The System NaF-BeF<sub>2</sub> According to Roy, Roy, and Osborn [ J. Am. Ceram. Soc. 36, 185 (1953) ] .

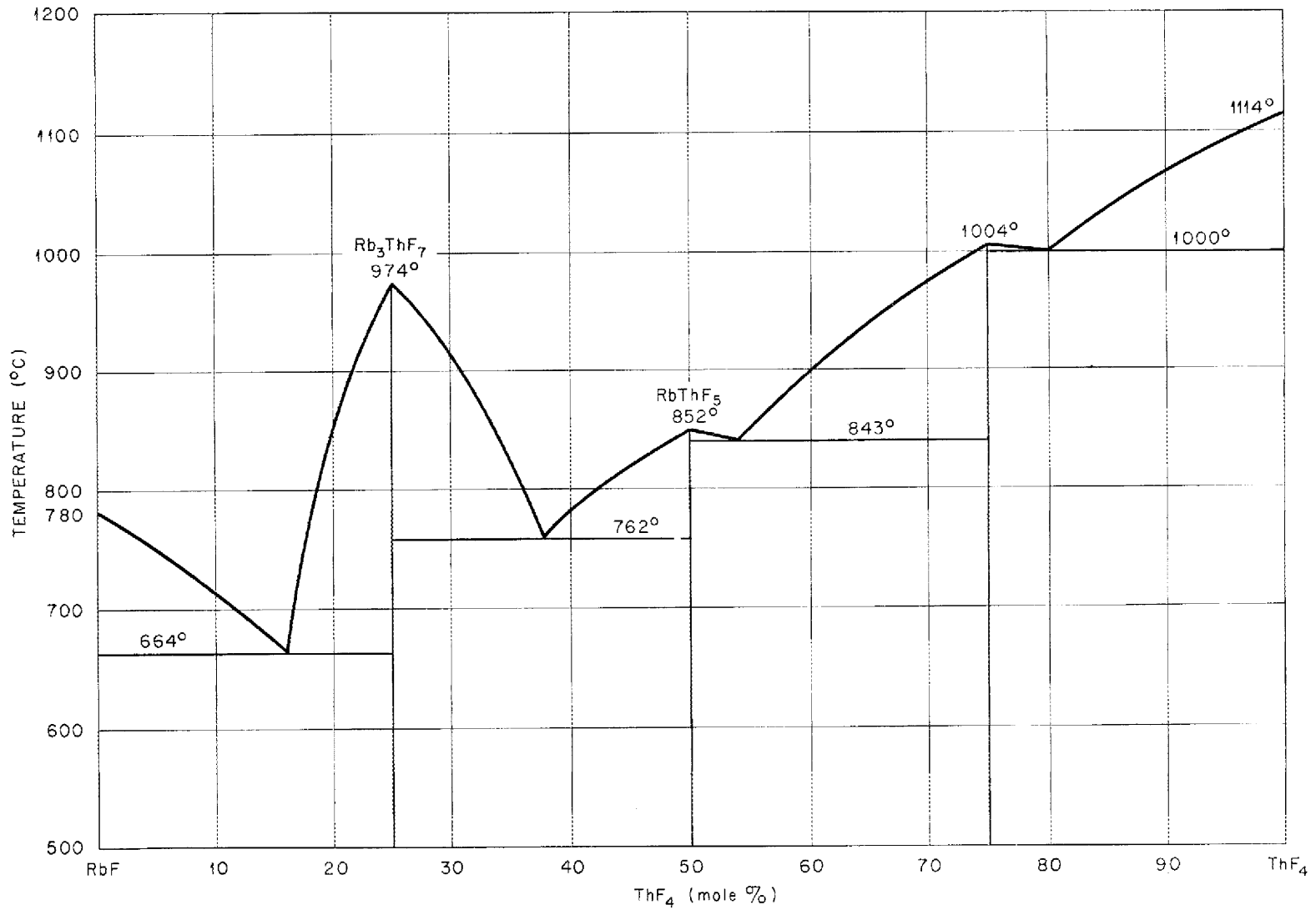


The System  $\text{KF}-\text{BeF}_2$ .

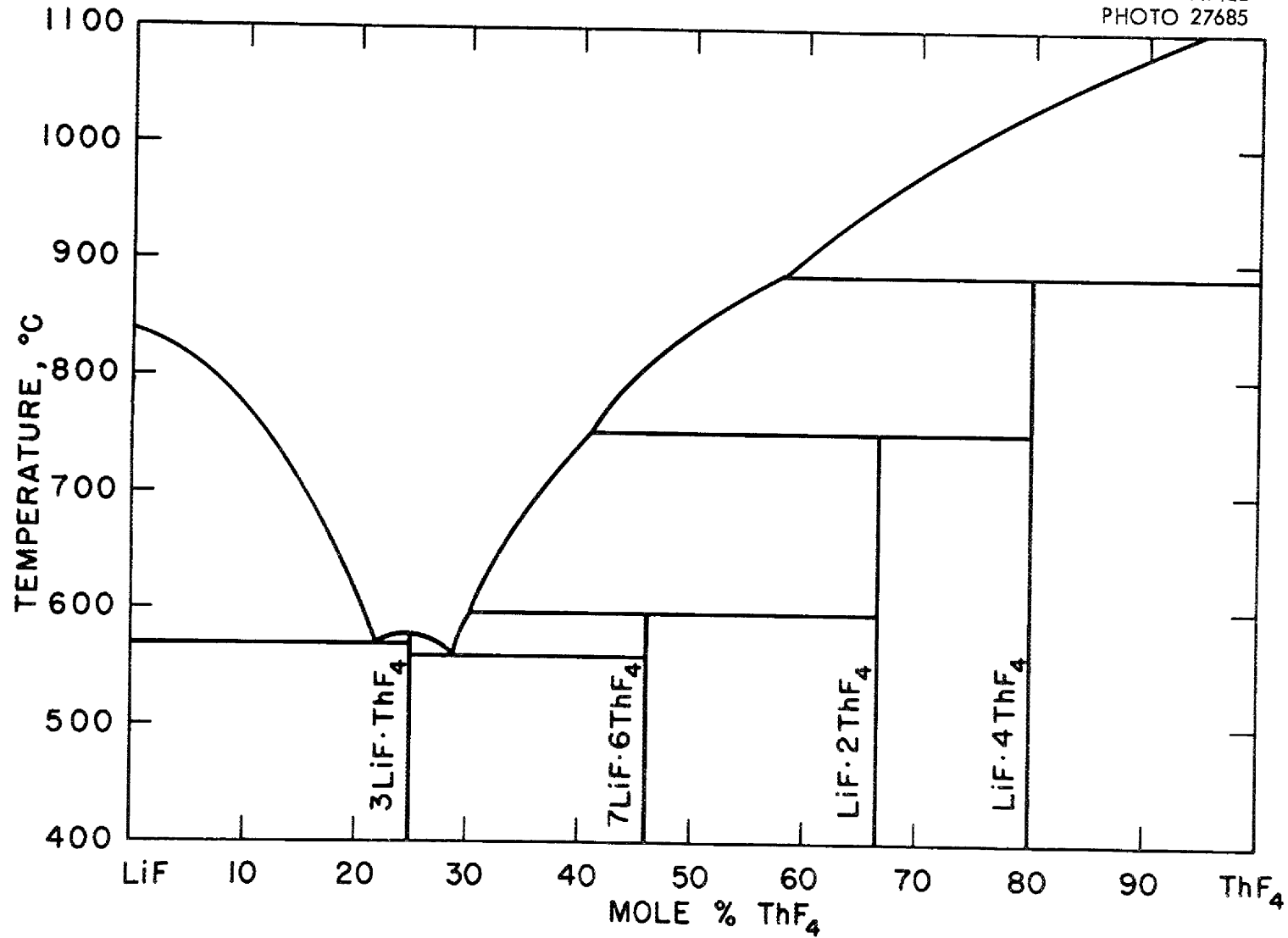


The System RbF-BeF<sub>2</sub>.

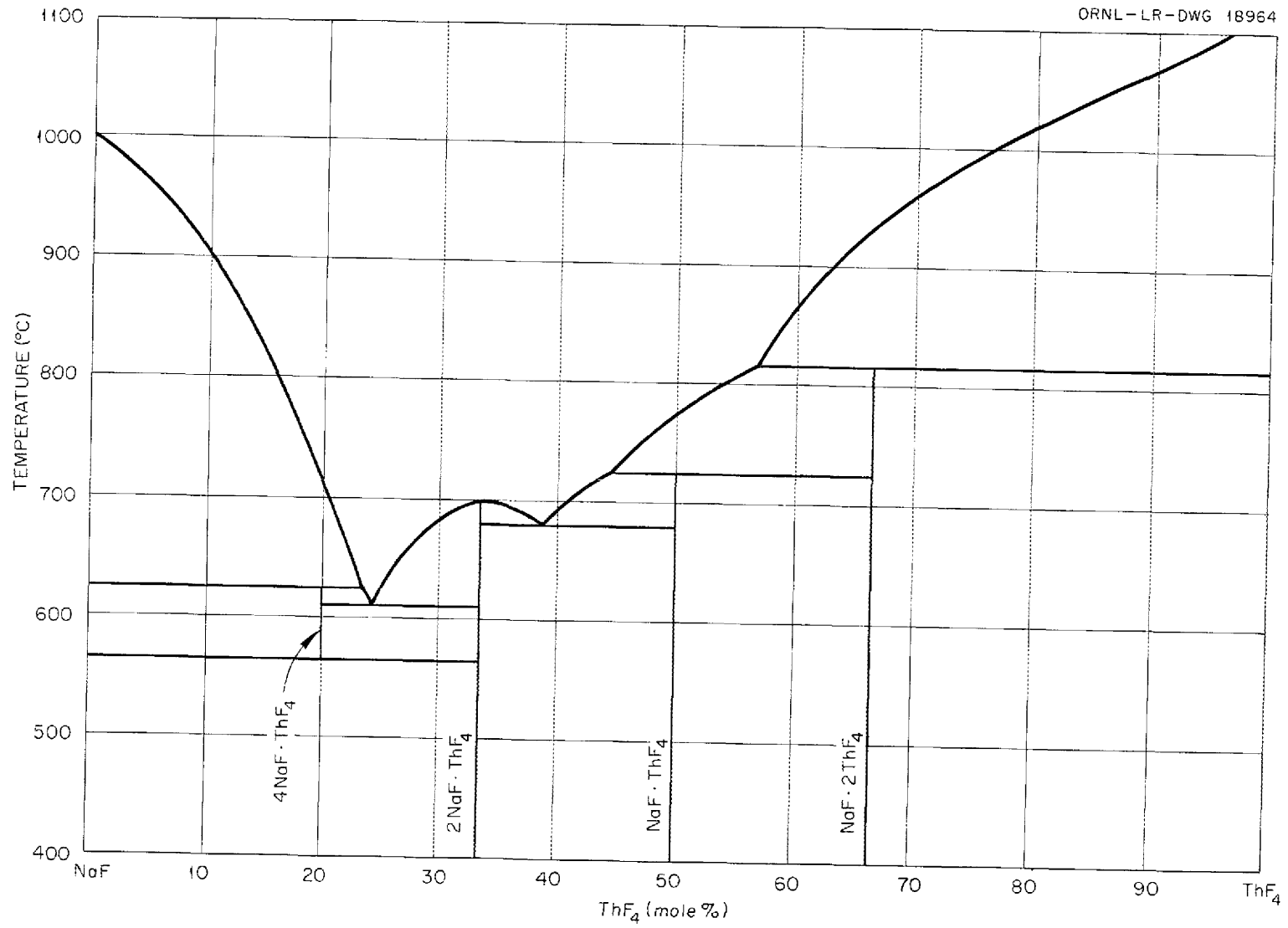




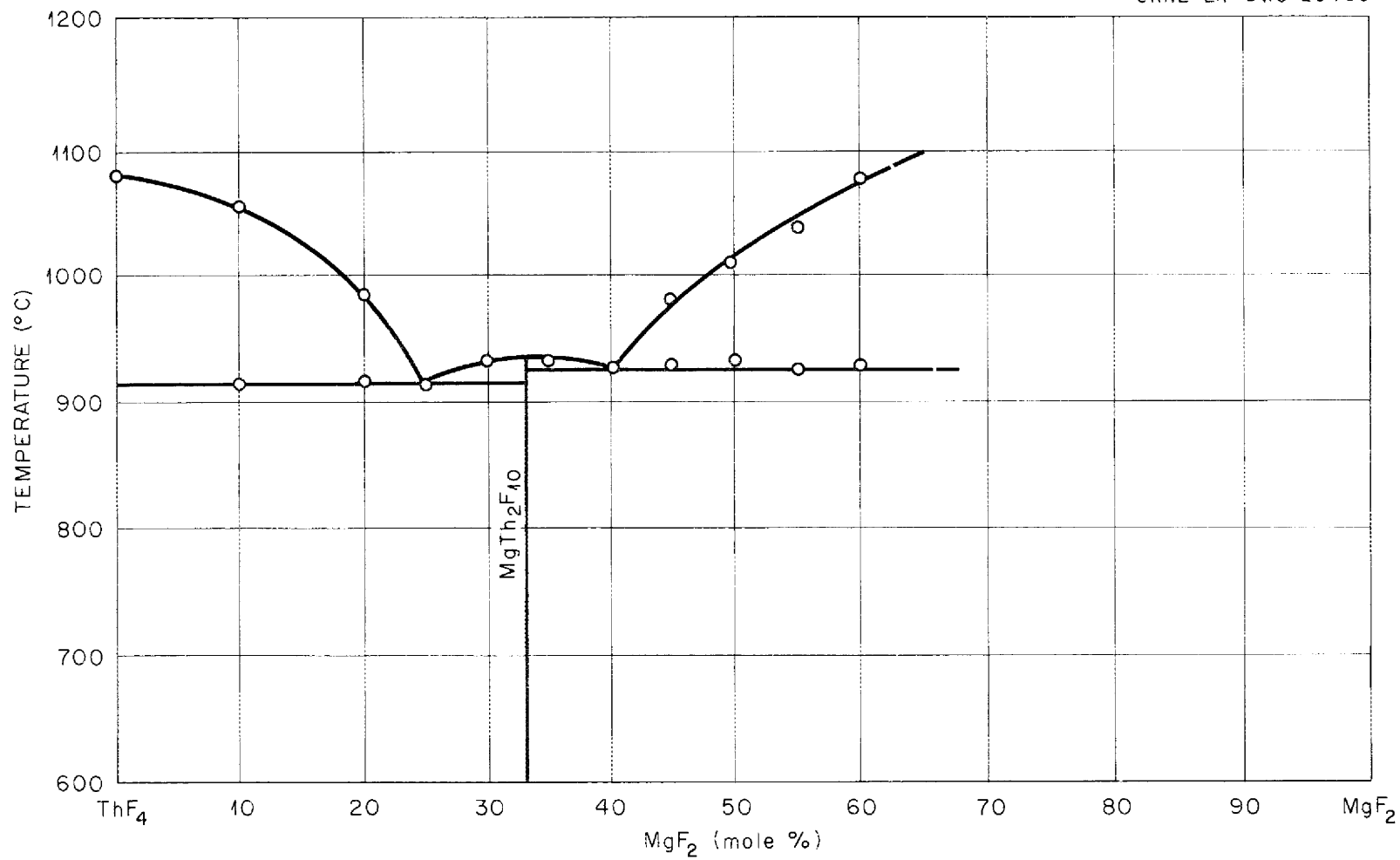
The System RbF-ThF<sub>4</sub>.



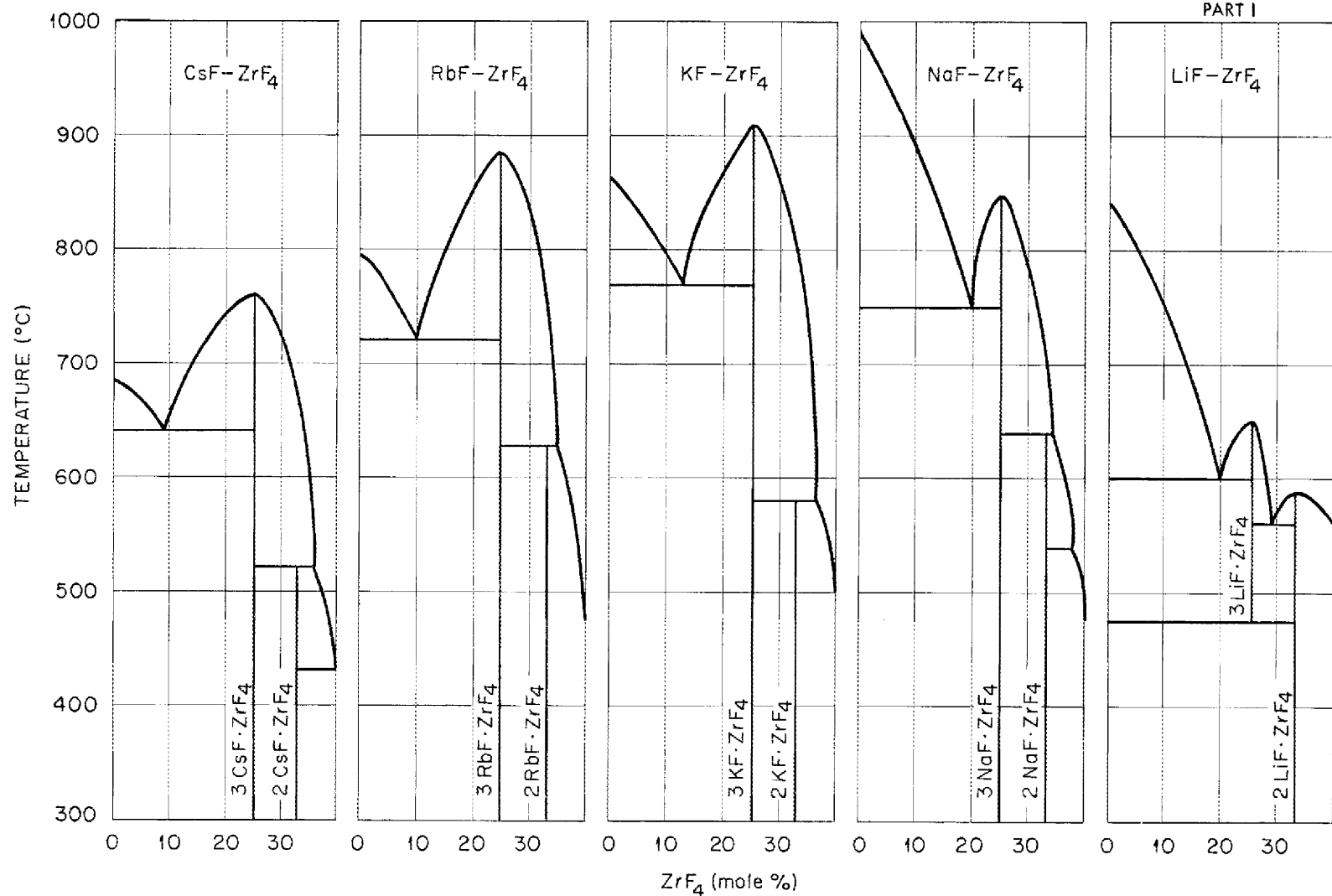
The System LiF-ThF<sub>4</sub>.



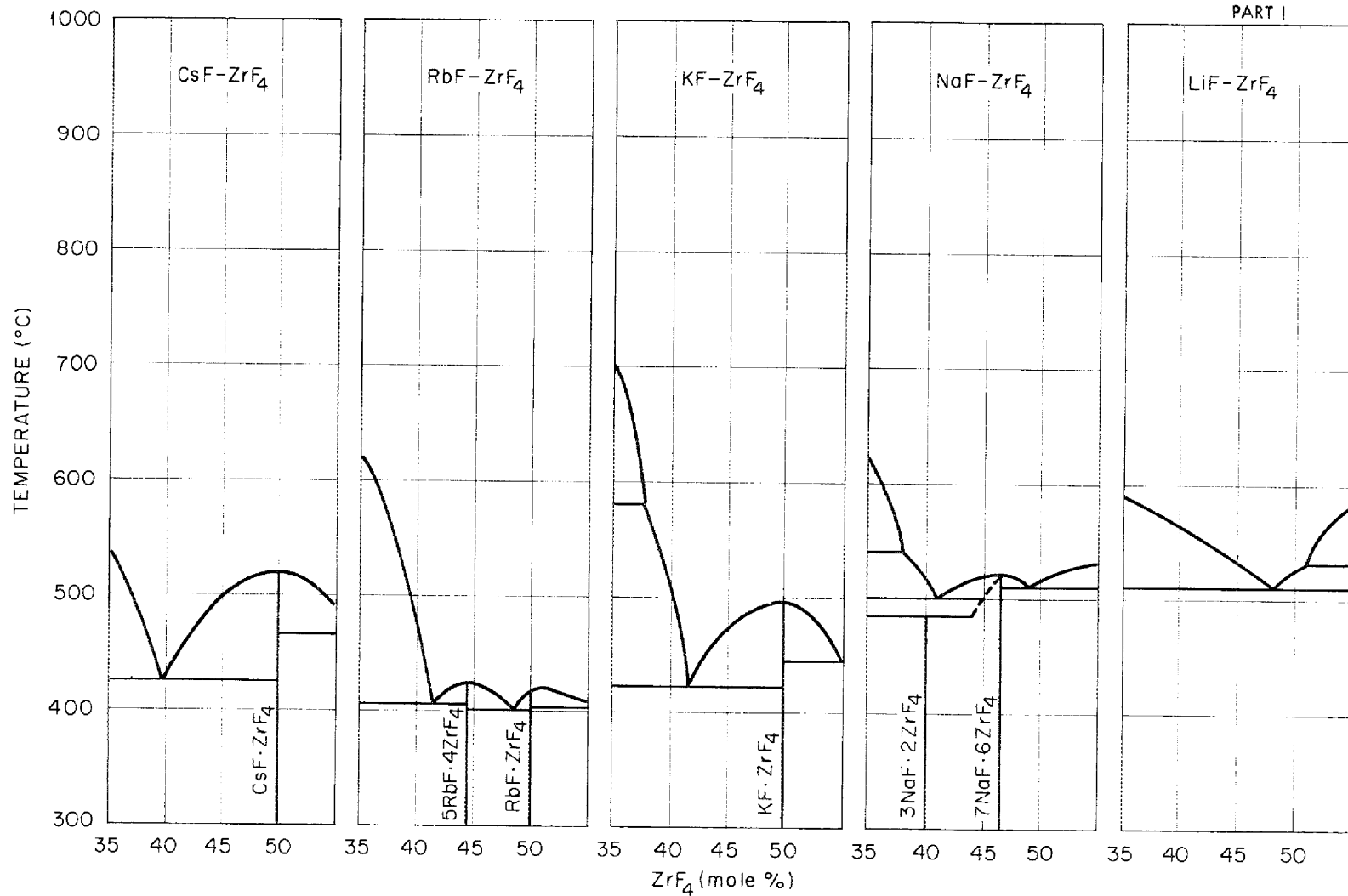
The System NaF-ThF<sub>4</sub>.



The System ThF<sub>4</sub>-MgF<sub>2</sub>.

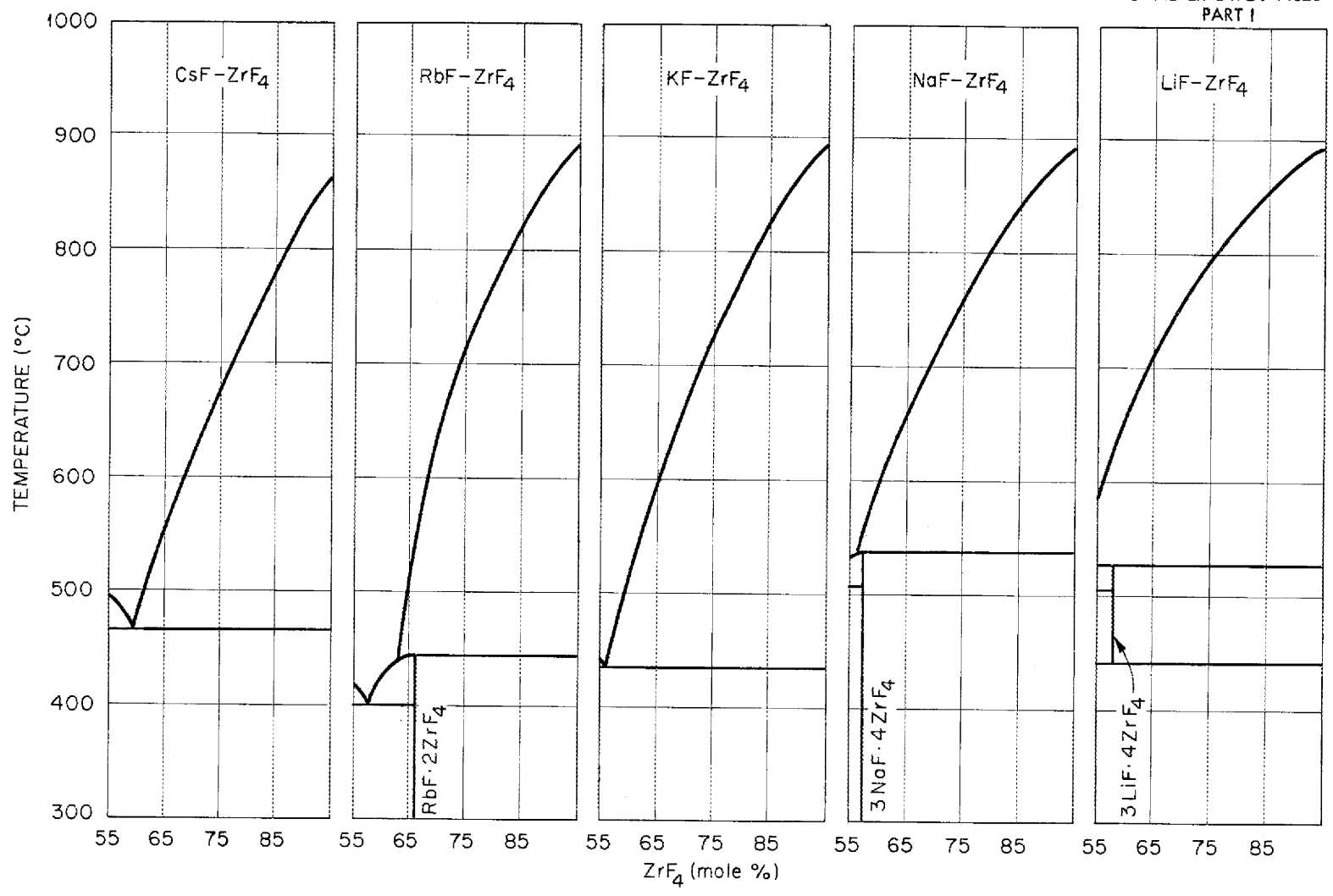


The Systems Alkali Fluorides-ZrF<sub>4</sub>.

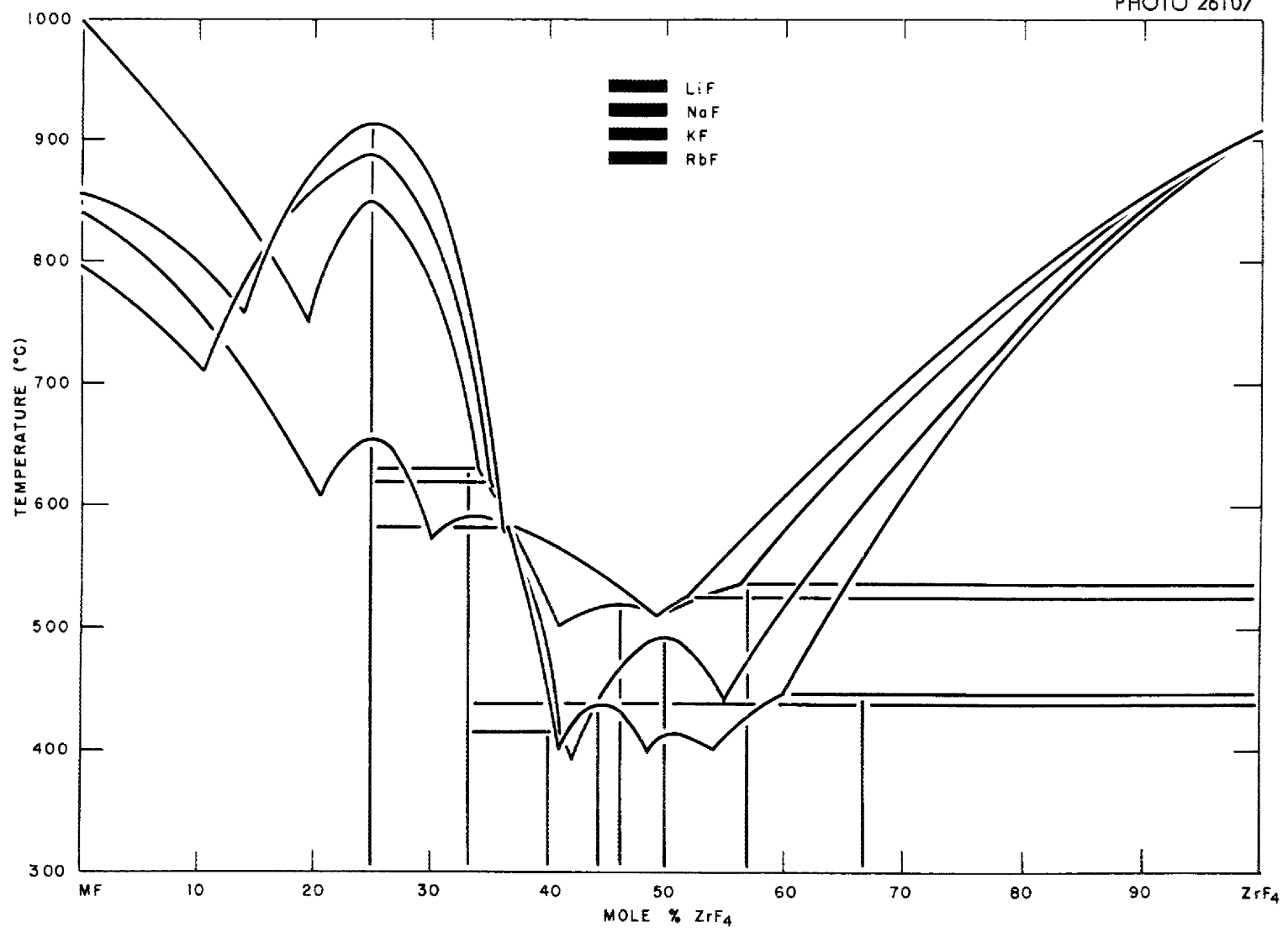


The Systems Alkali Fluorides-ZrF<sub>4</sub>.

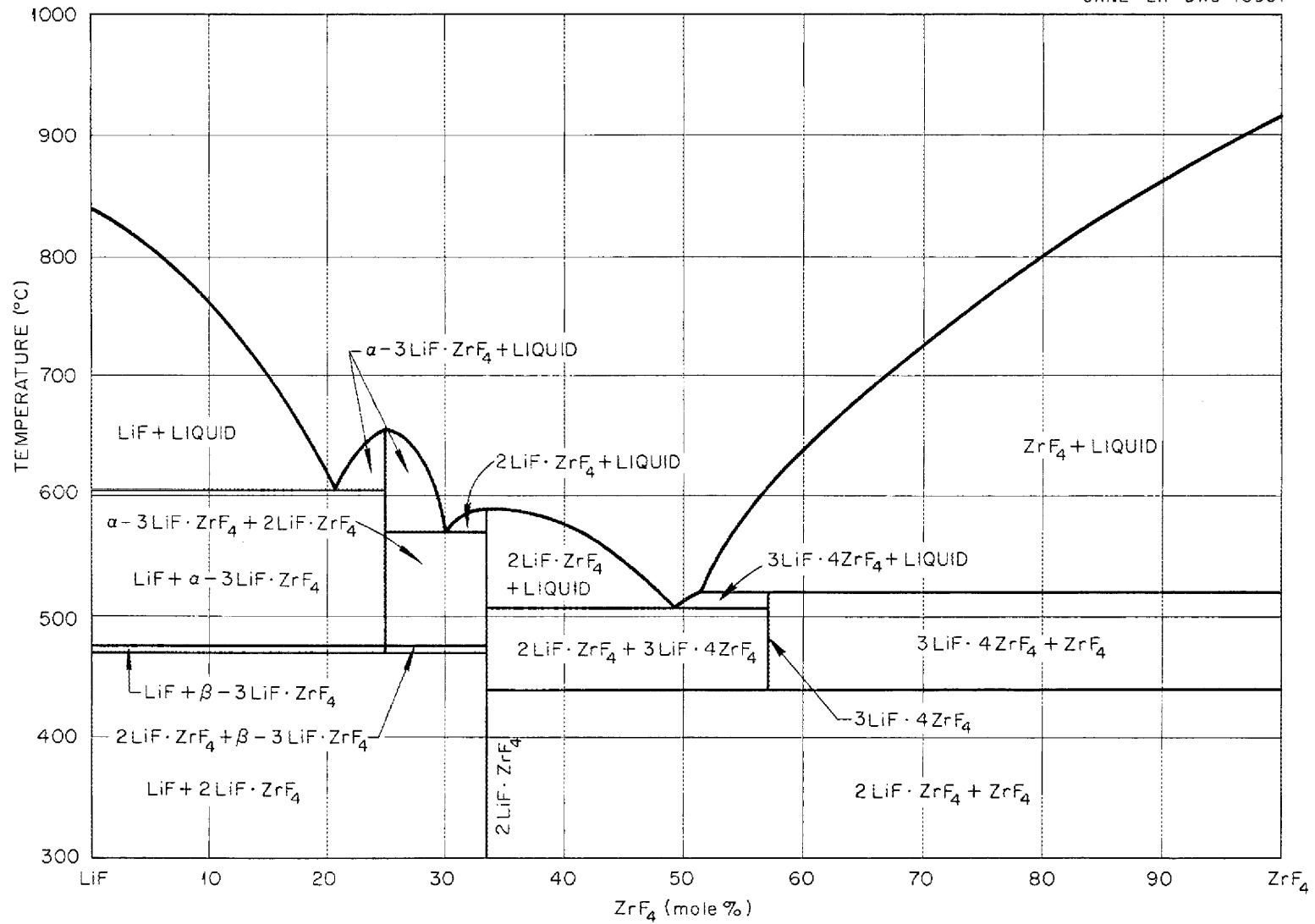




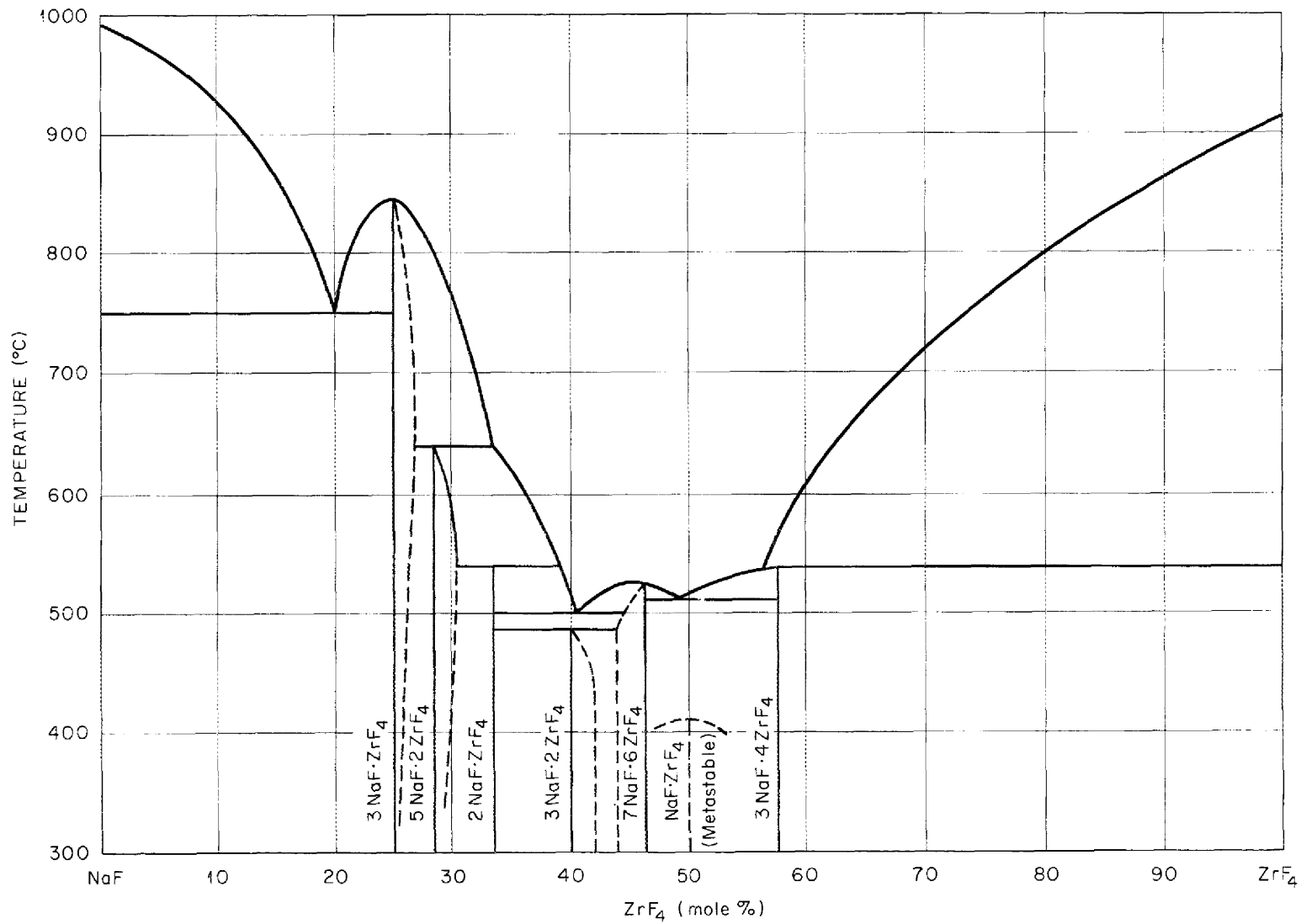
The Systems Alkali Fluorides-ZrF<sub>4</sub>.



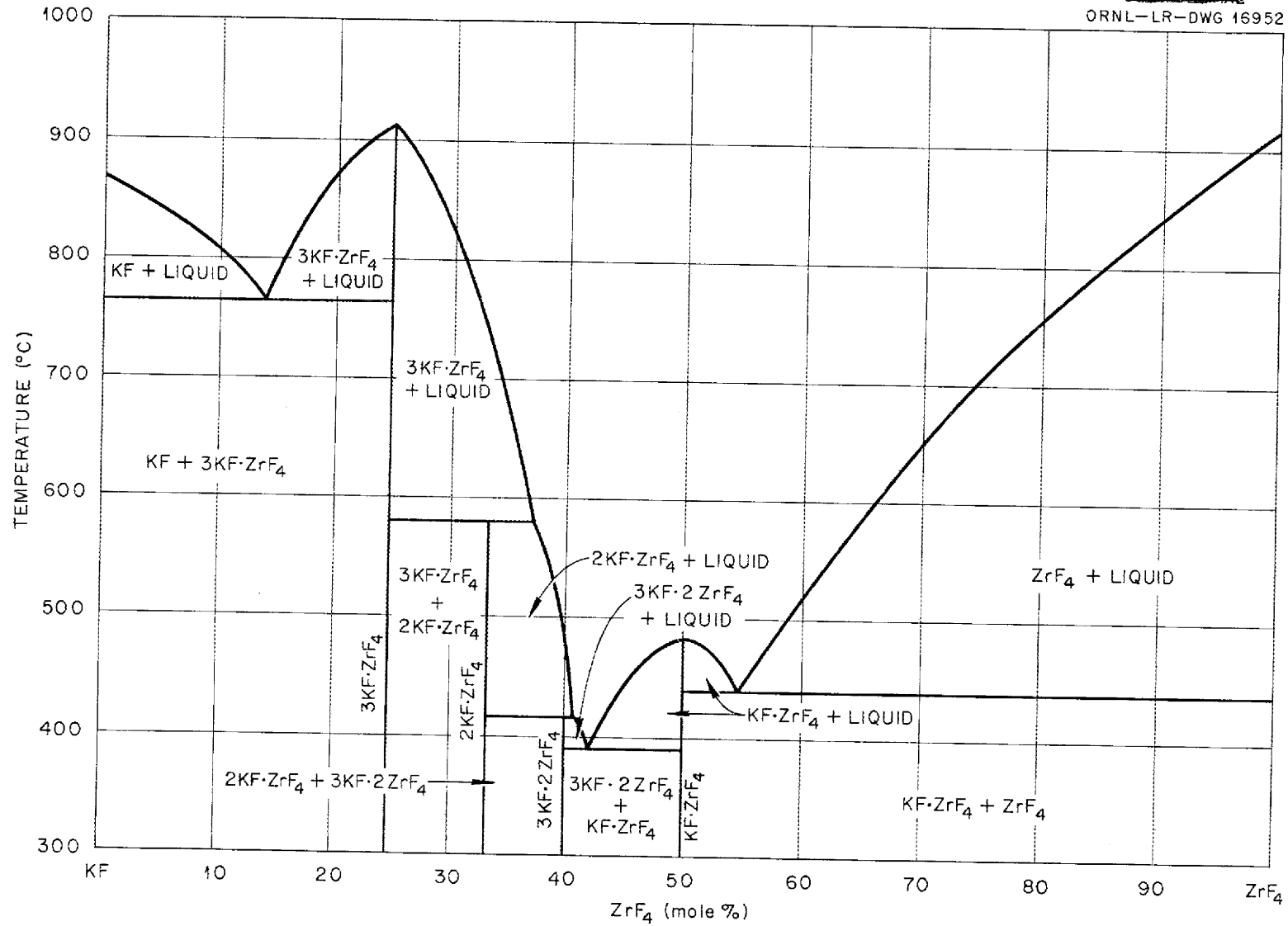
The Systems Alkali Fluorides-ZrF<sub>4</sub>.



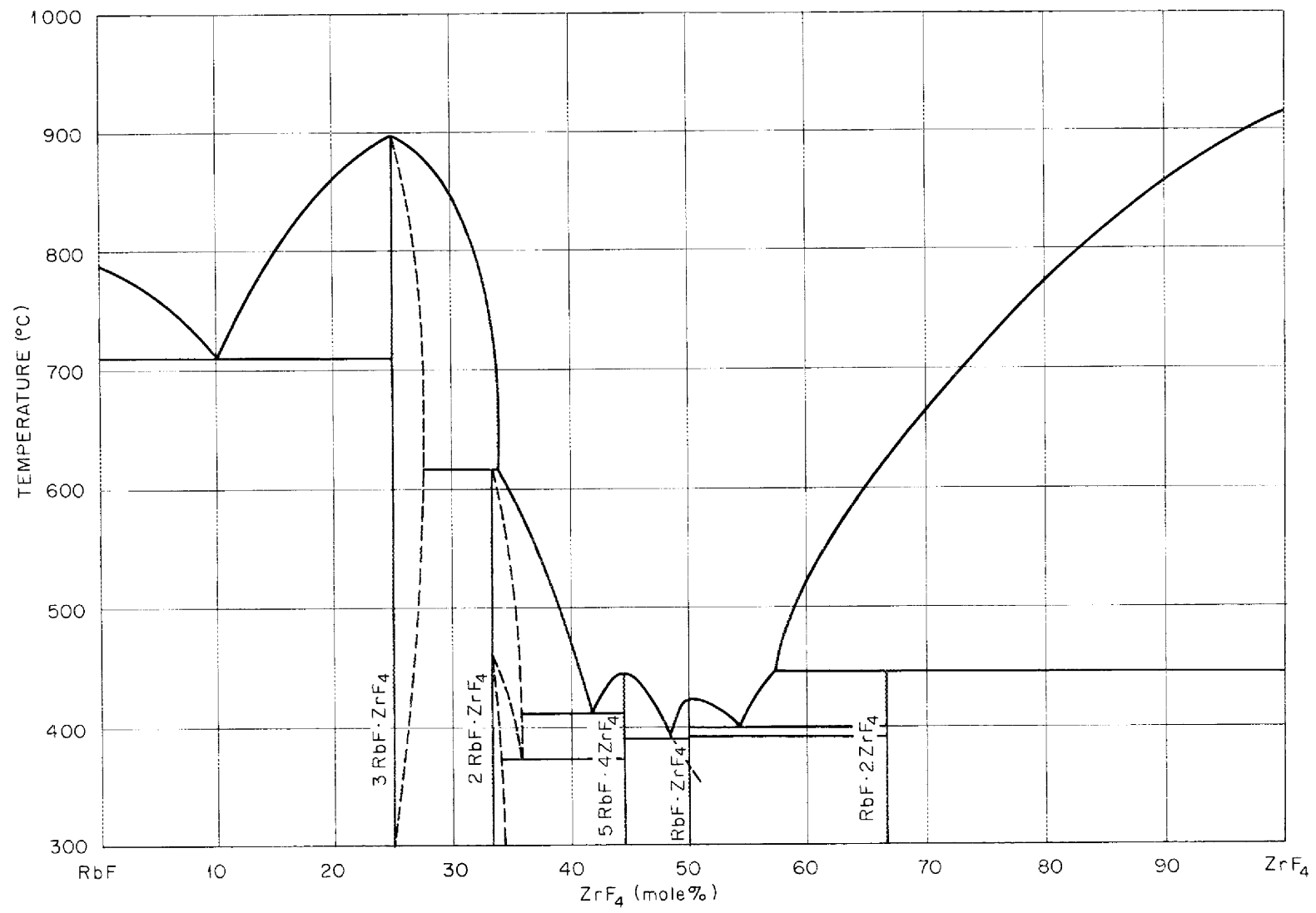
The System LiF-ZrF<sub>4</sub>.



The System NaF-ZrF<sub>4</sub>.

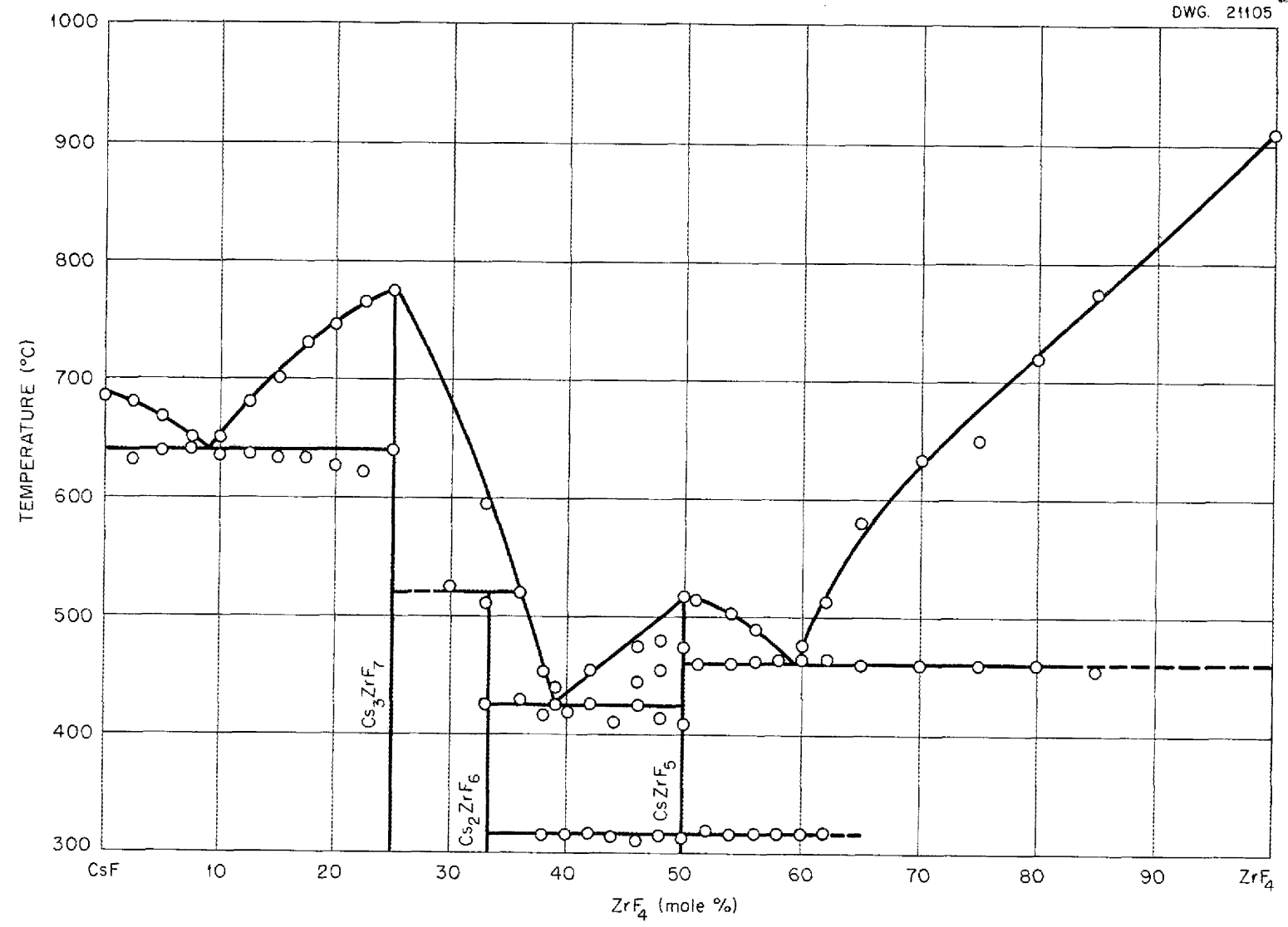


The System KF-ZrF<sub>4</sub>.

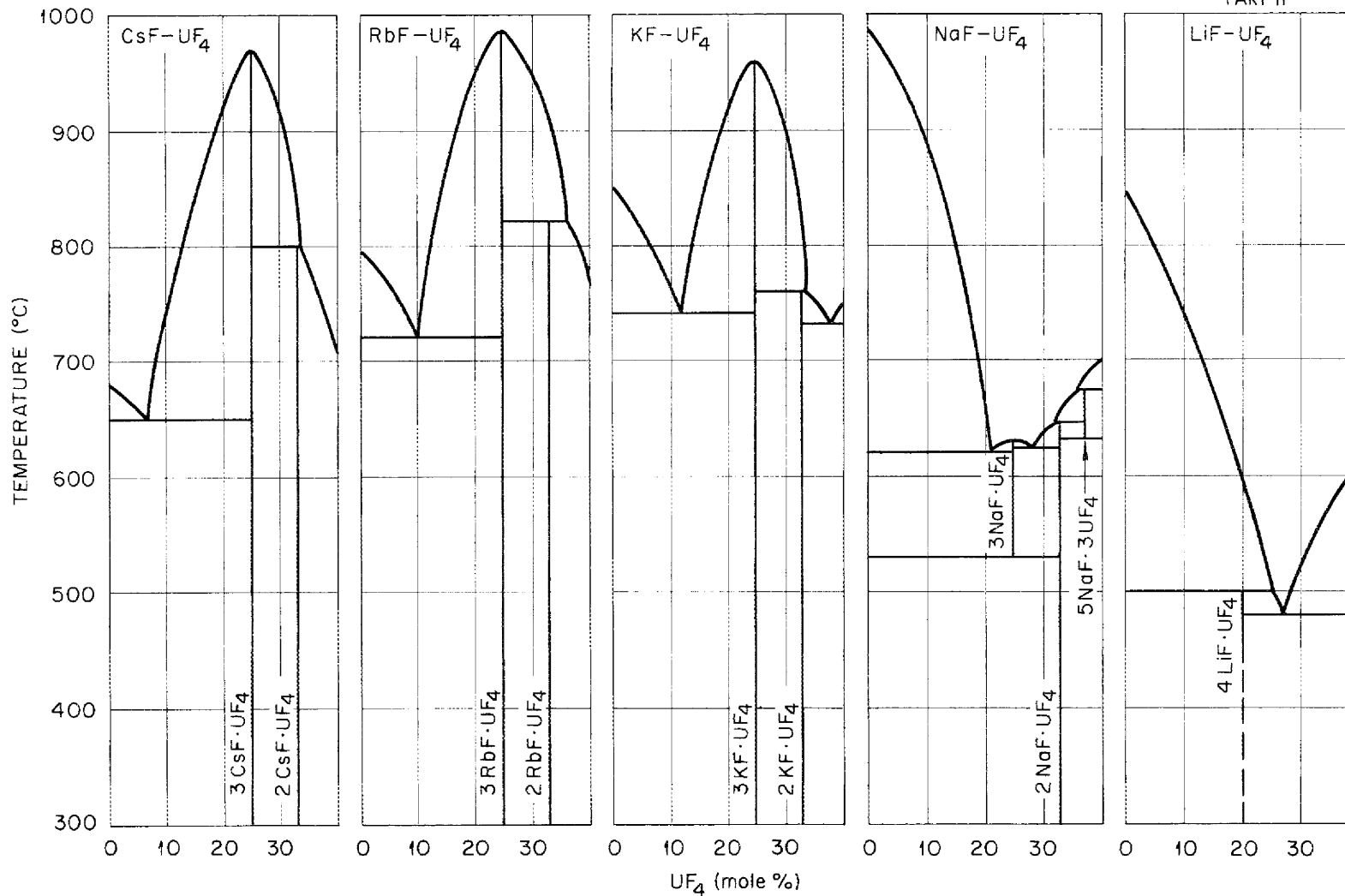


The System RbF-ZrF<sub>4</sub>.

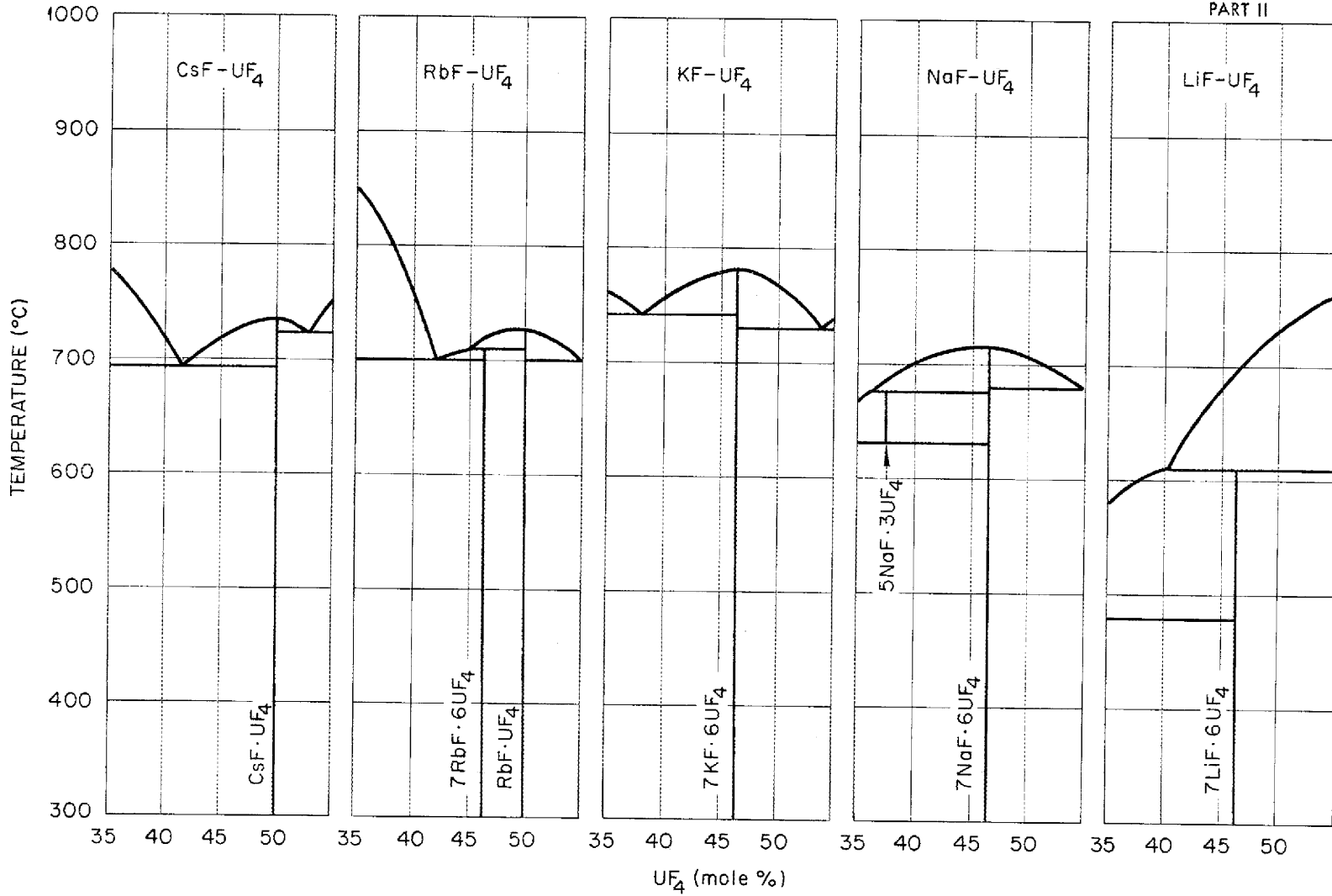




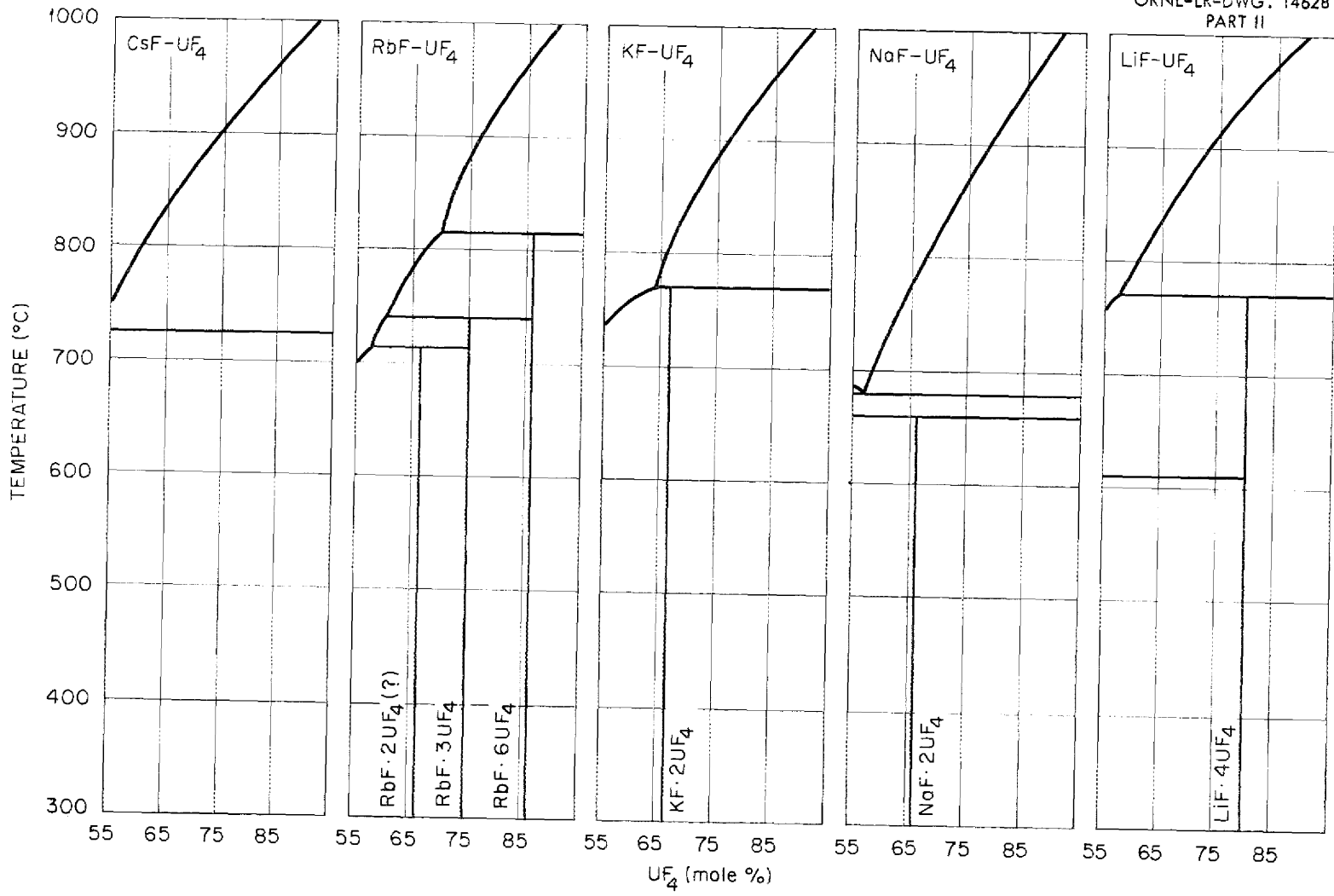
The System CsF-ZrF<sub>4</sub>.



The Systems Alkali Fluorides-UF<sub>4</sub>.

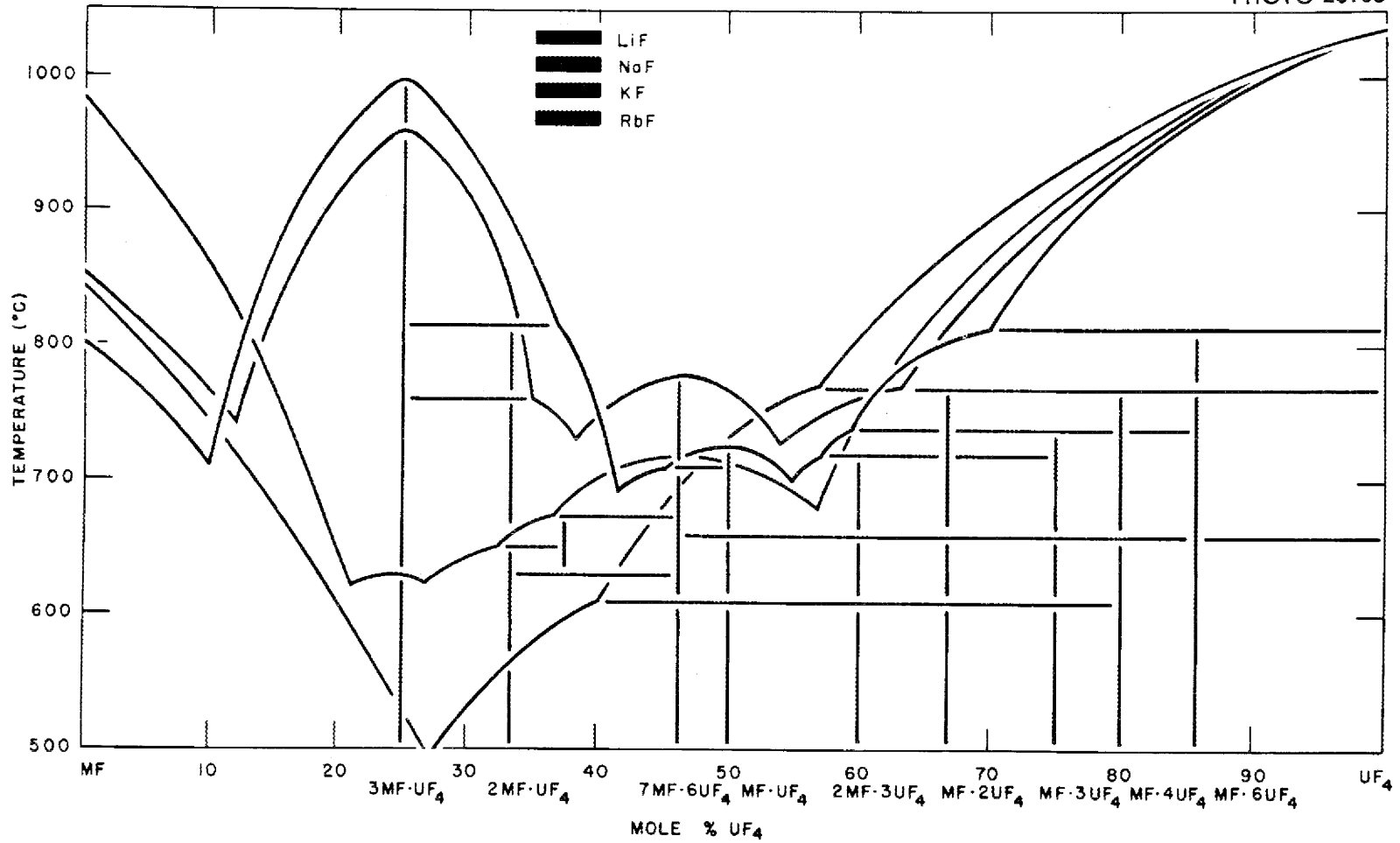


The Systems Alkali Fluorides-UF<sub>4</sub>.

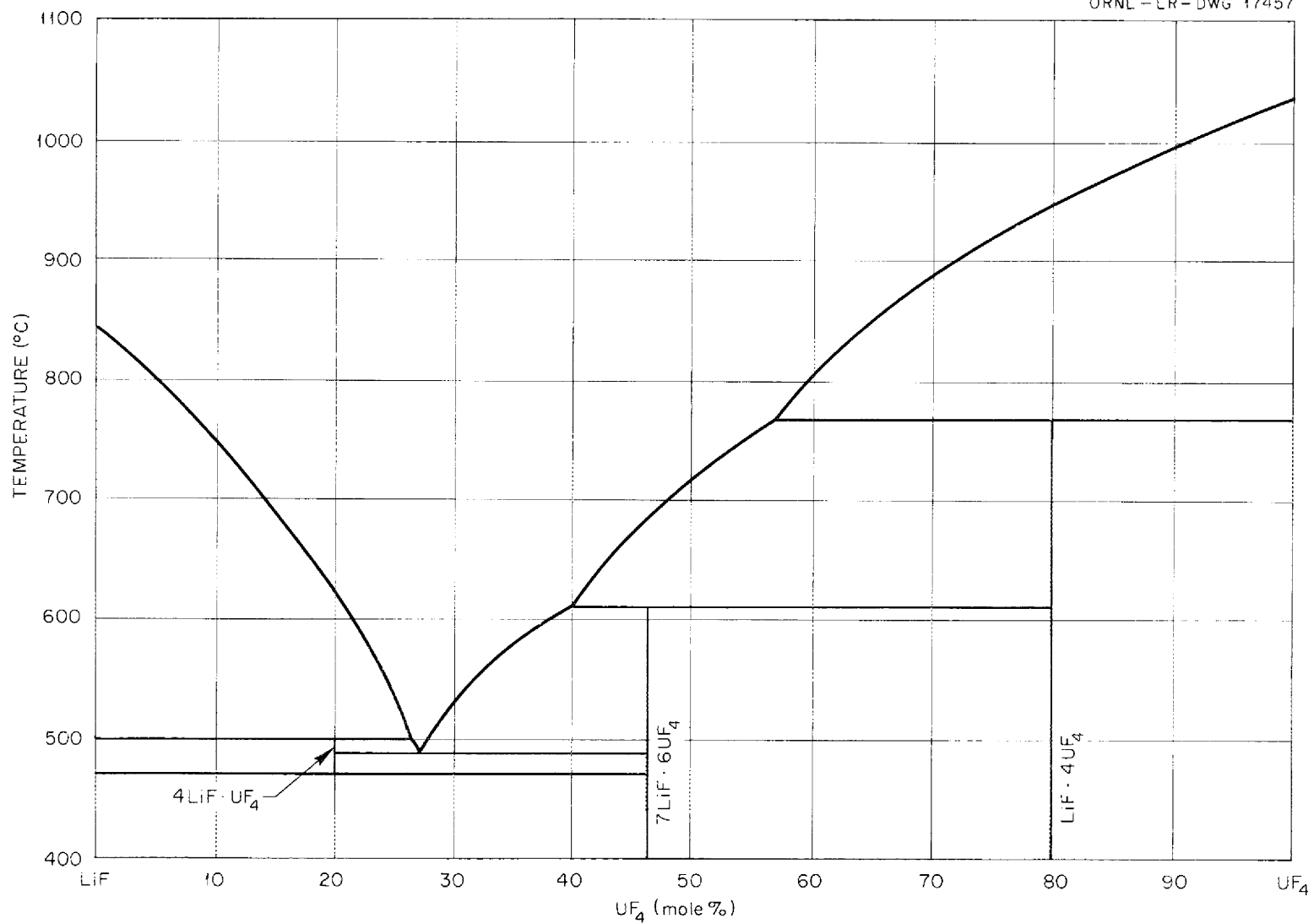


The Systems Alkali Fluorides-UF<sub>4</sub>.

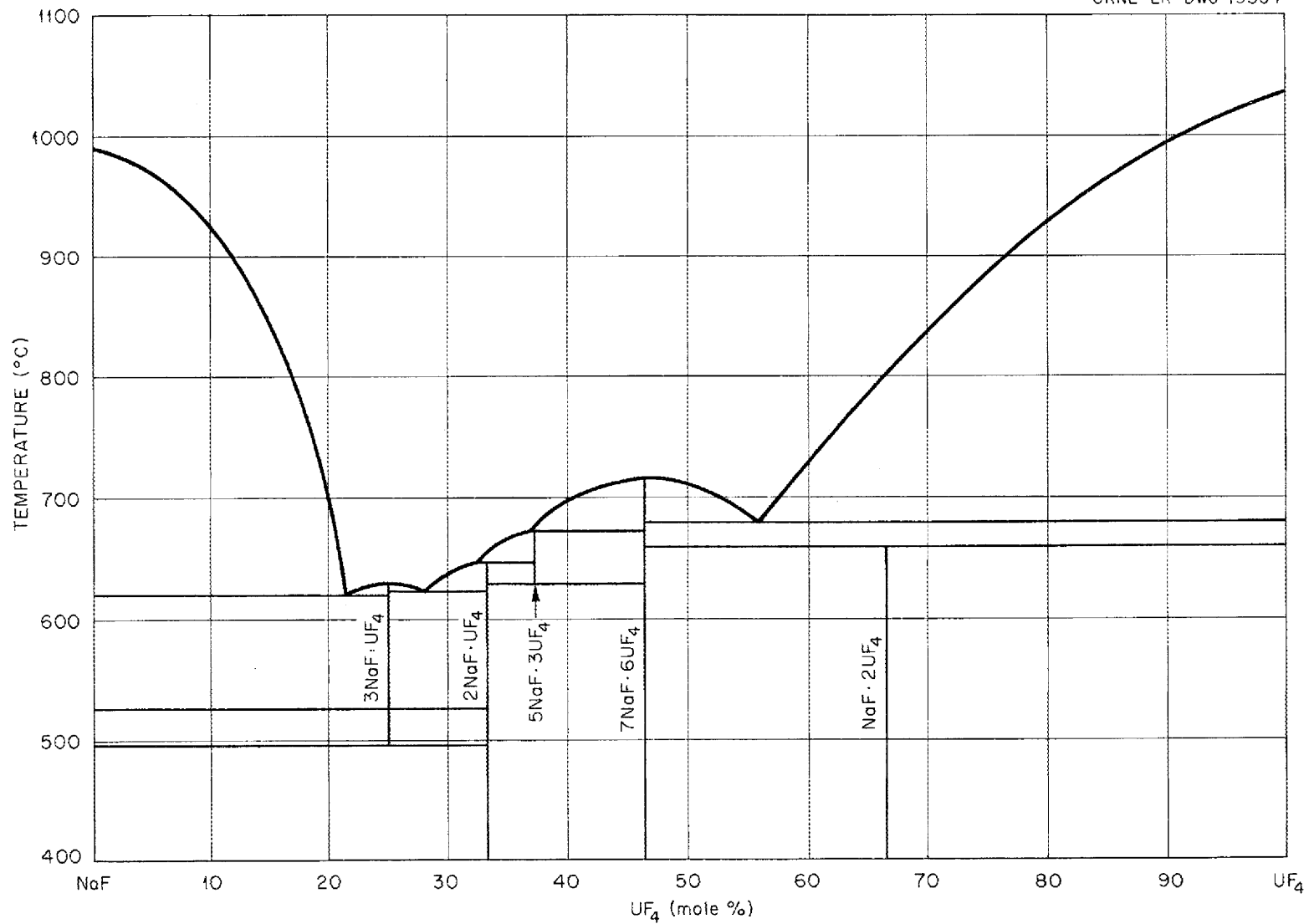
PHOTO 26106



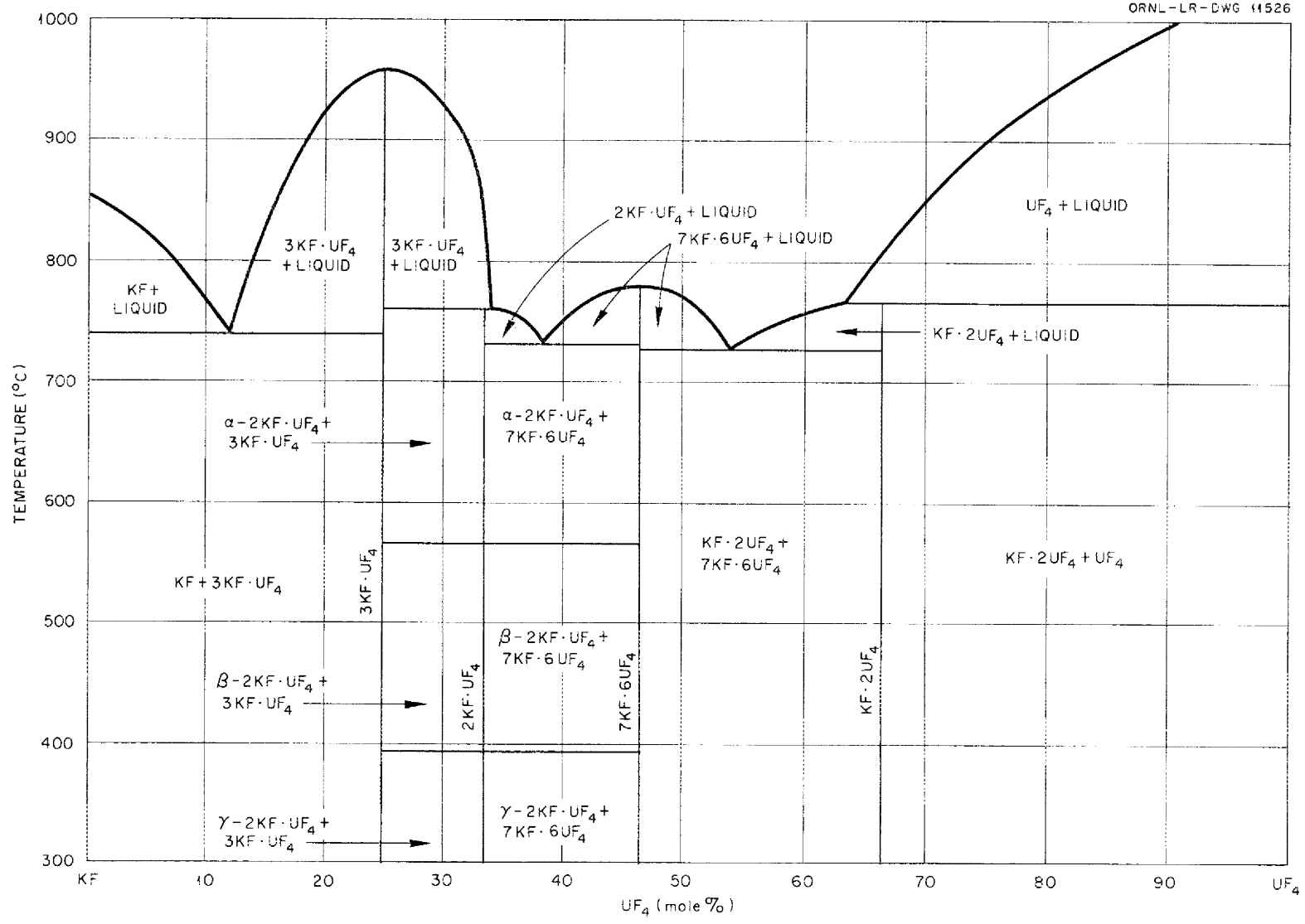
The Systems Alkali Fluorides- $UF_4$ .



The System LiF-UF<sub>4</sub>.

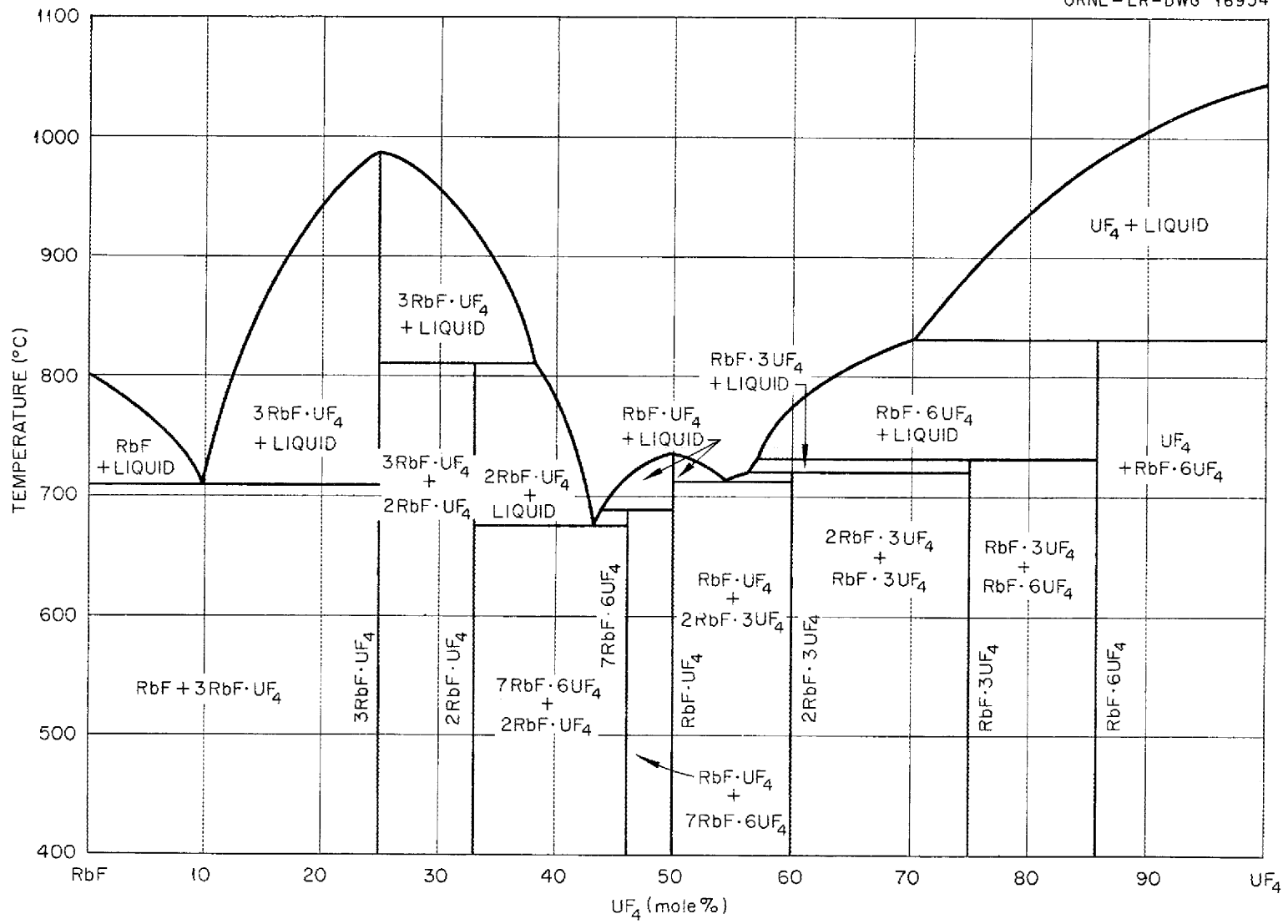


The System NaF-UF<sub>4</sub>.

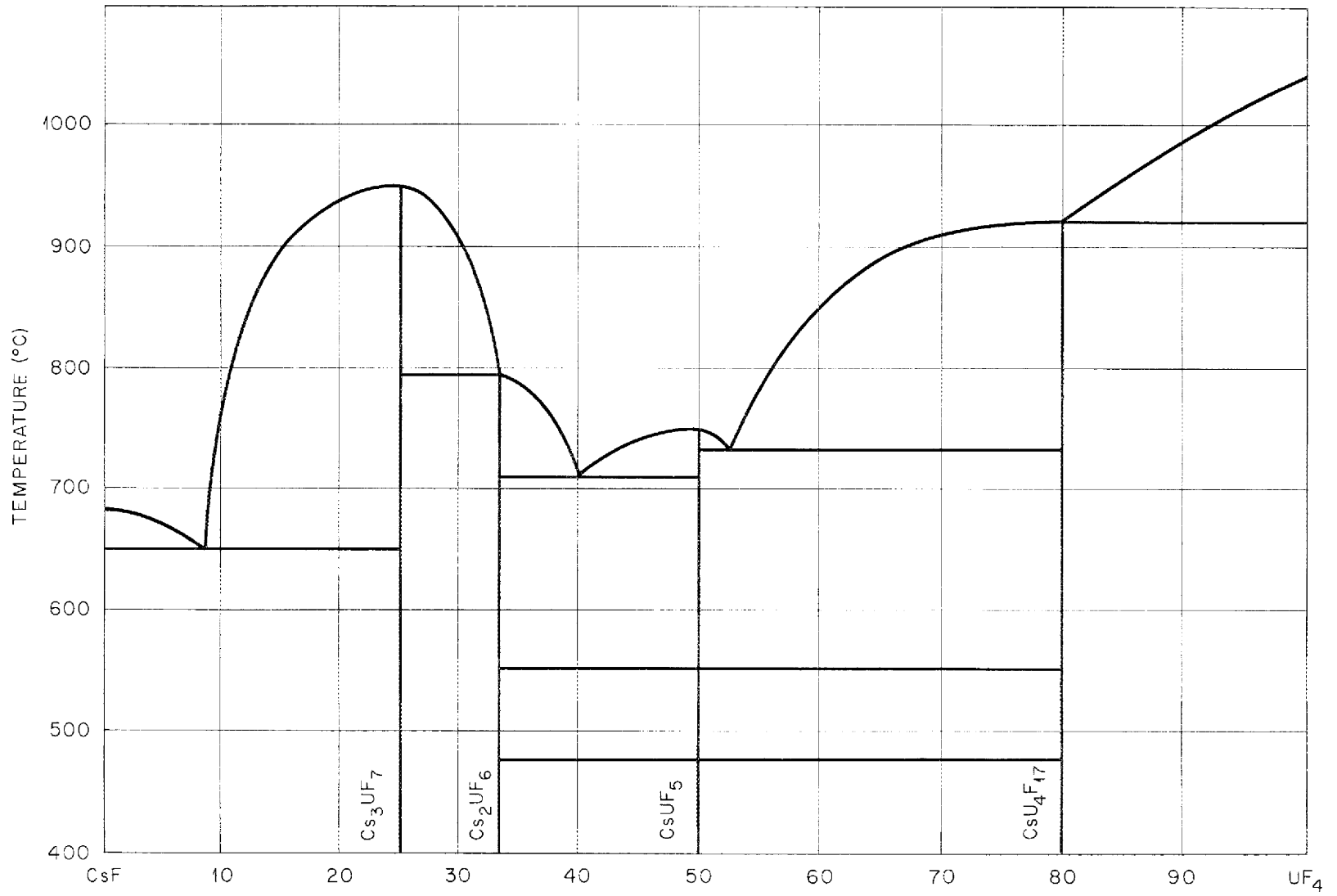


The System KF-UF<sub>4</sub>.

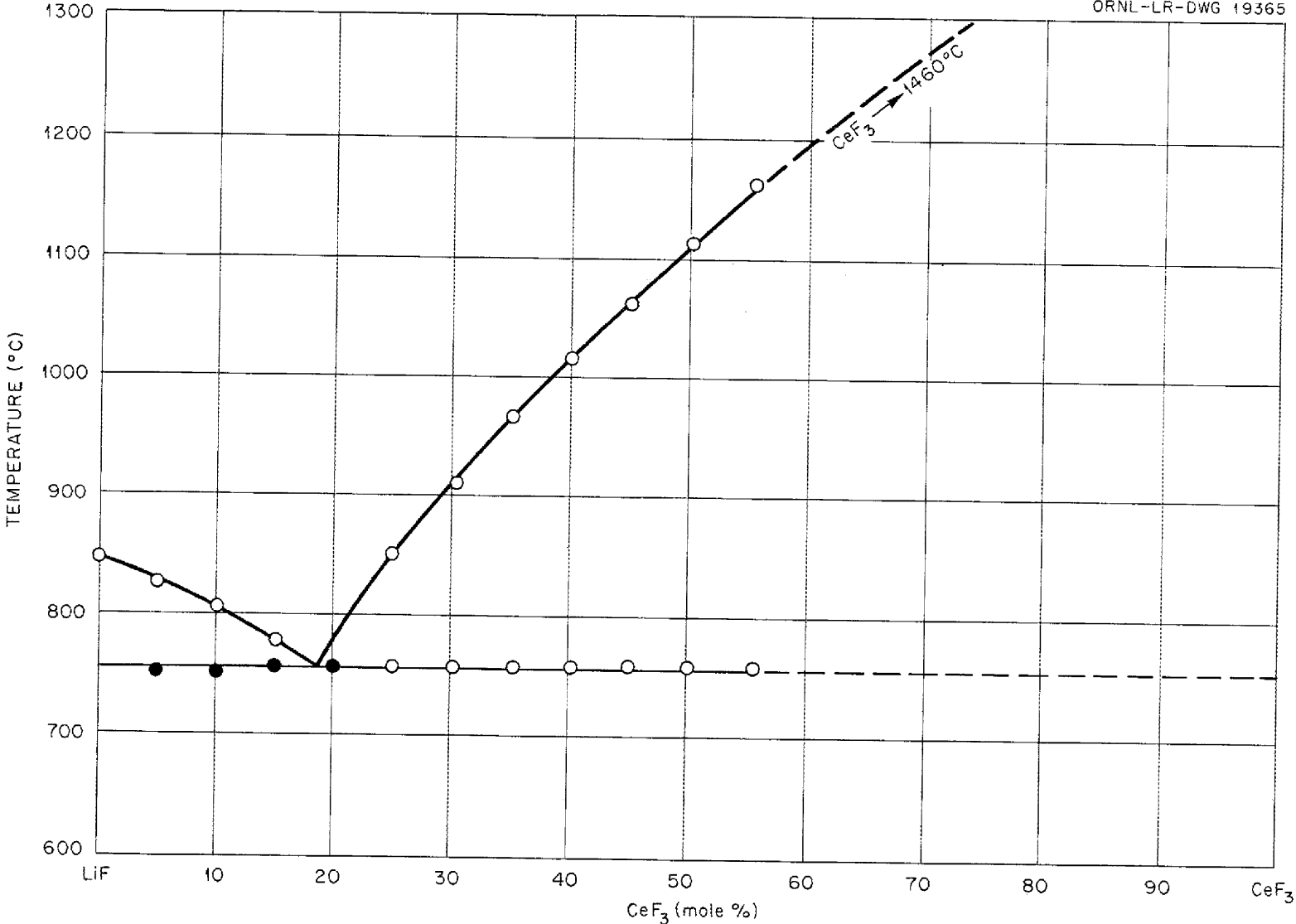




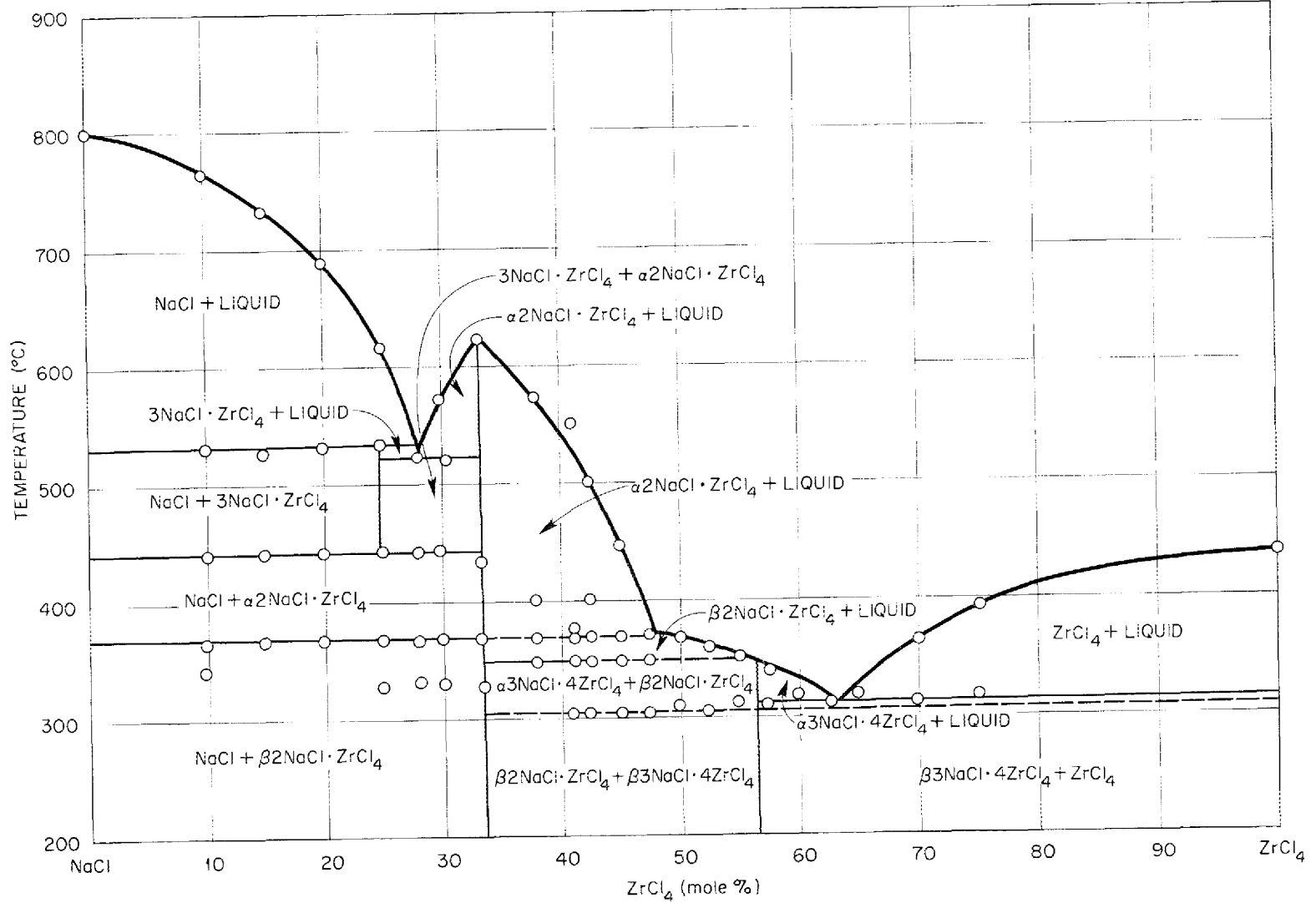
The System RbF-UF<sub>4</sub>.



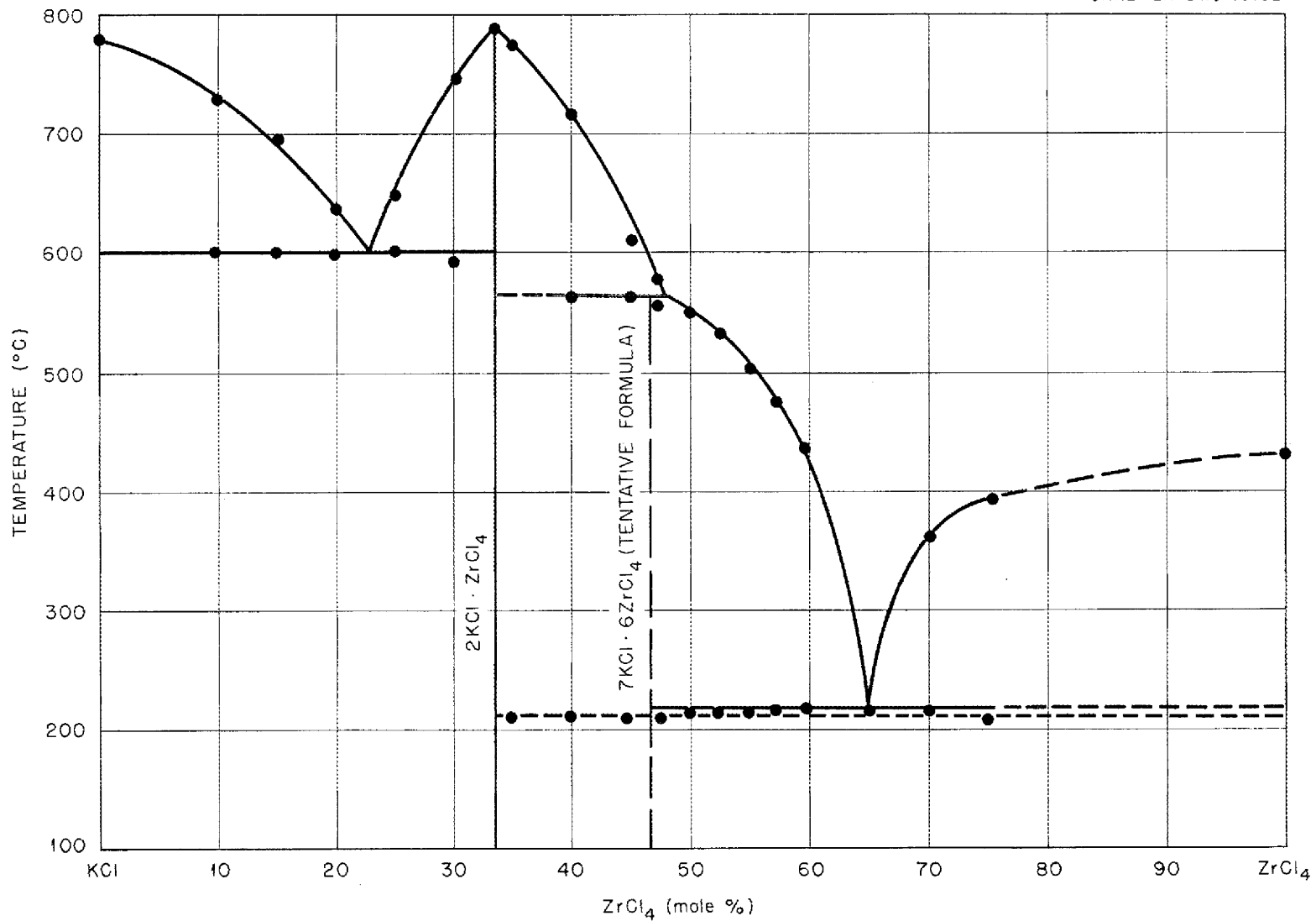
The System CsF-UF<sub>4</sub>.



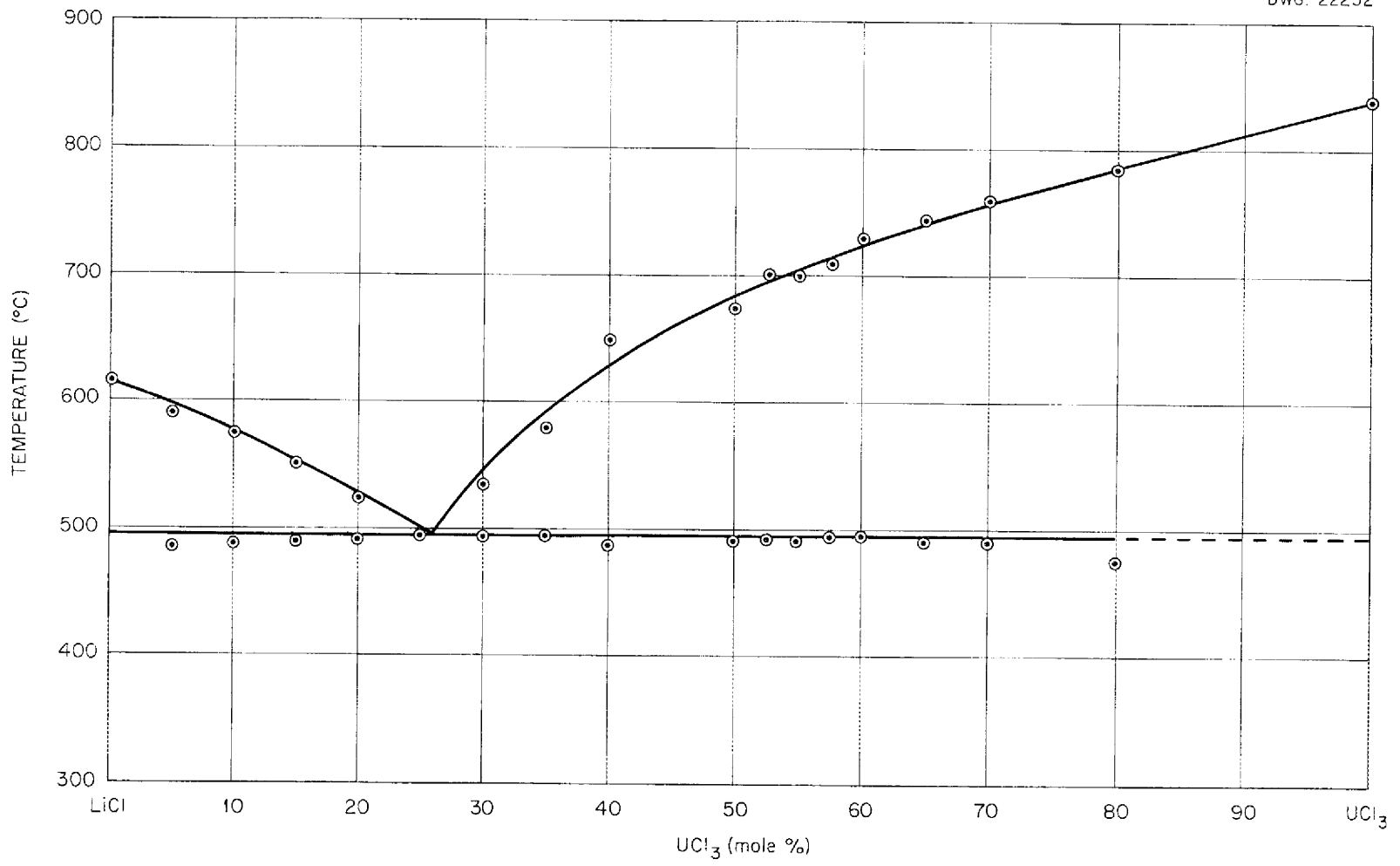
The System LiF-CeF<sub>3</sub>.



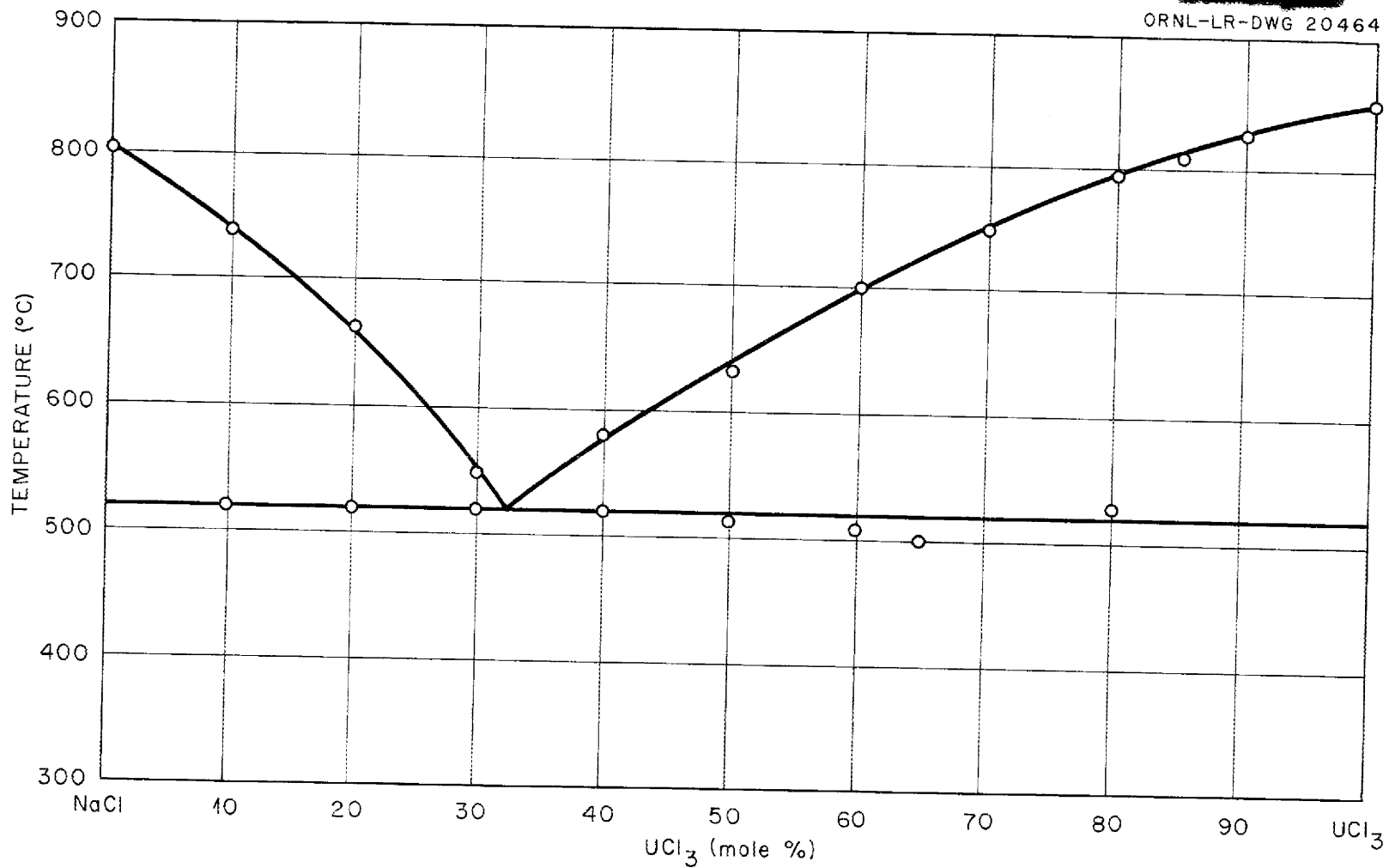
The System NaCl-ZrCl<sub>4</sub>.



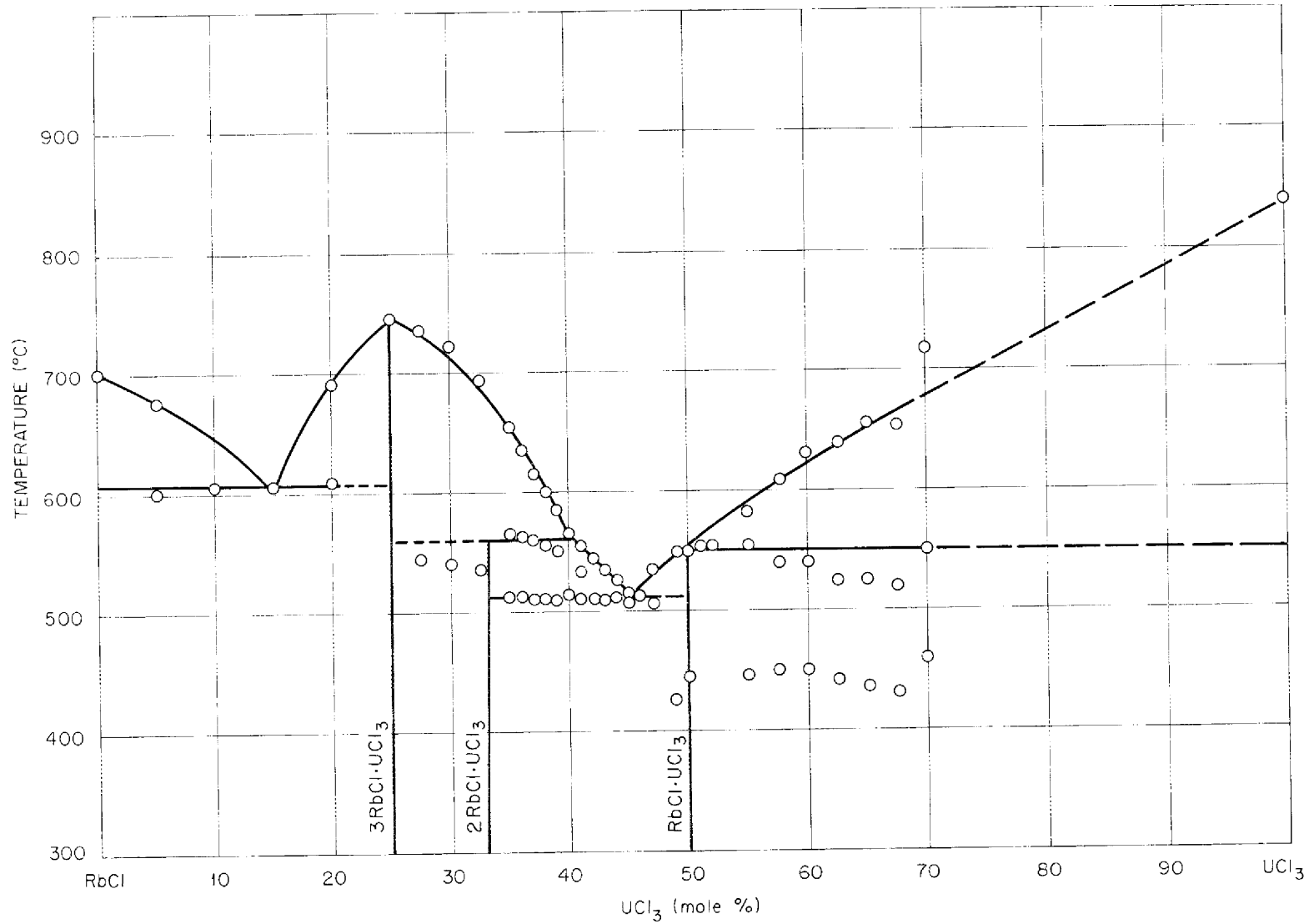
The System KCl-ZrCl<sub>4</sub>.



The System LiCl-UCl<sub>3</sub>.

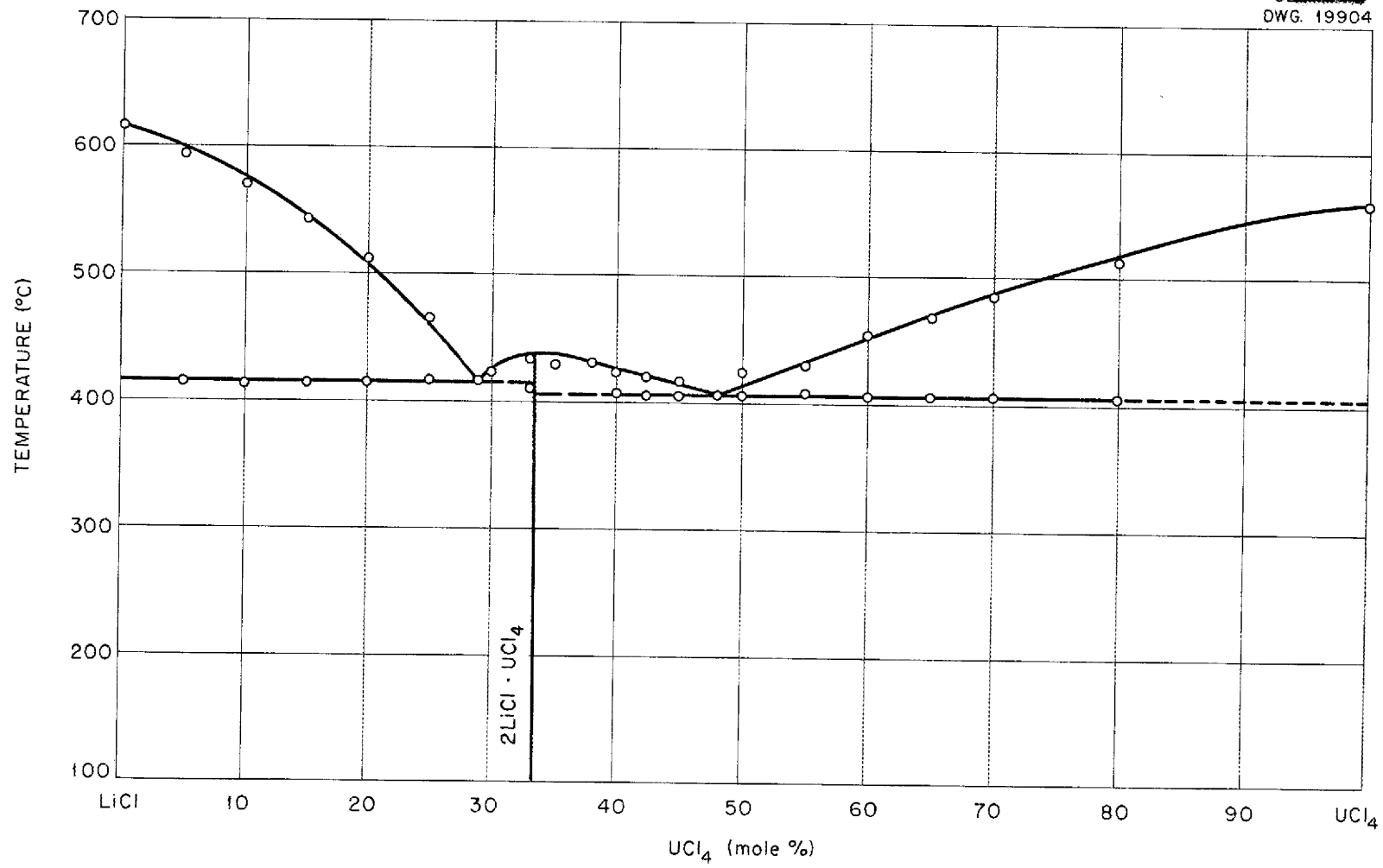


The System NaCl-UCl<sub>3</sub>.

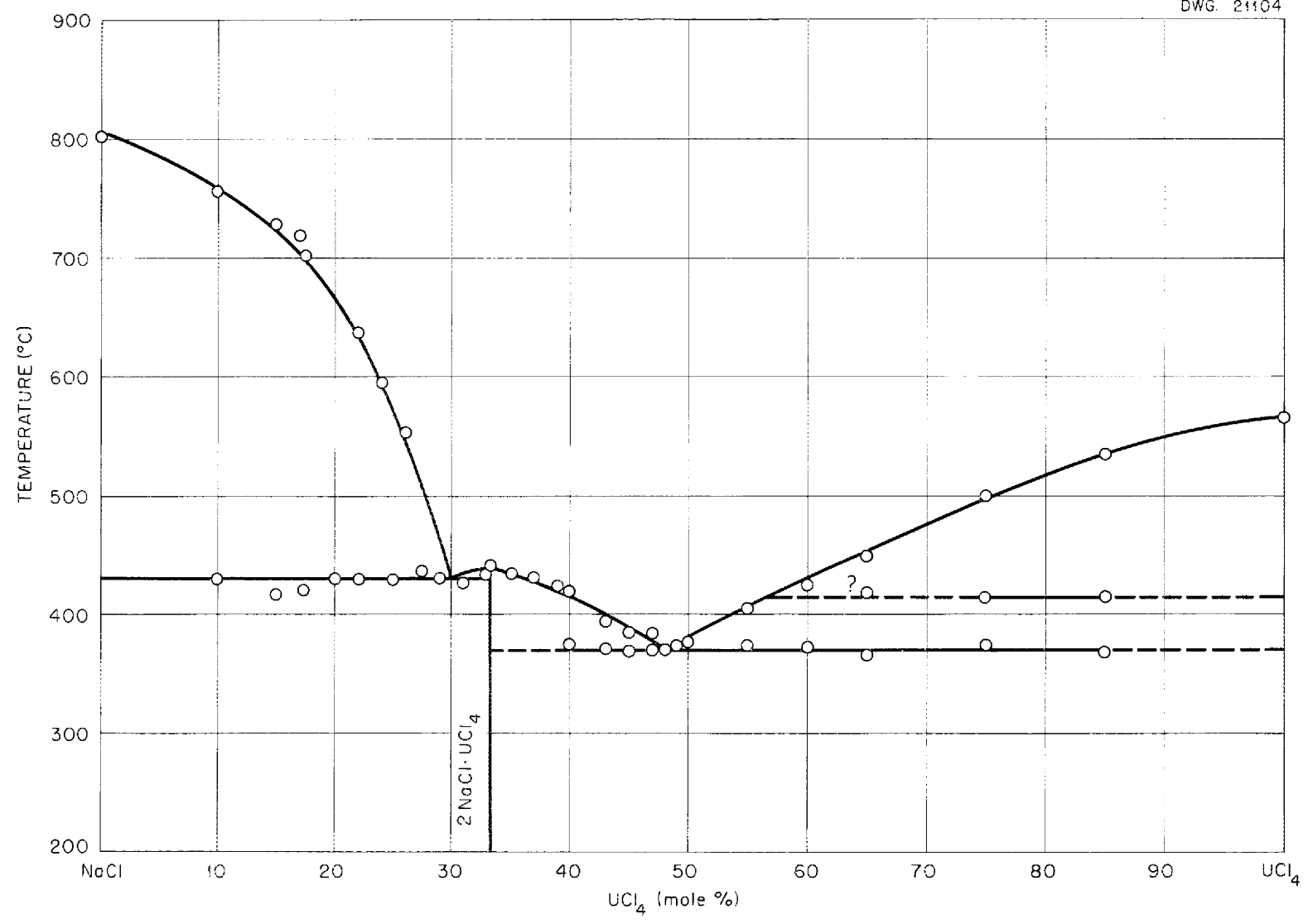


The System RbCl-UCl<sub>3</sub>.

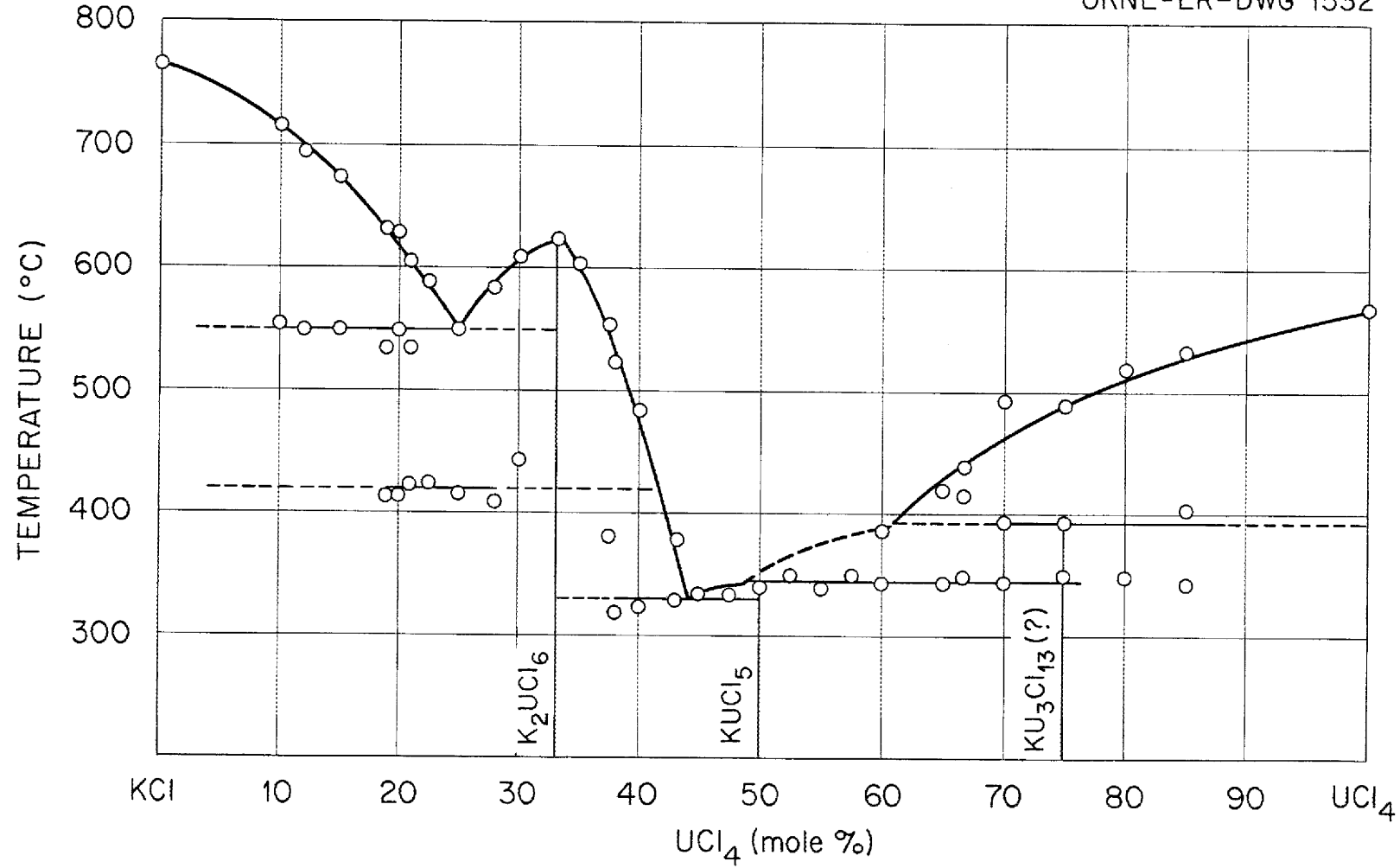




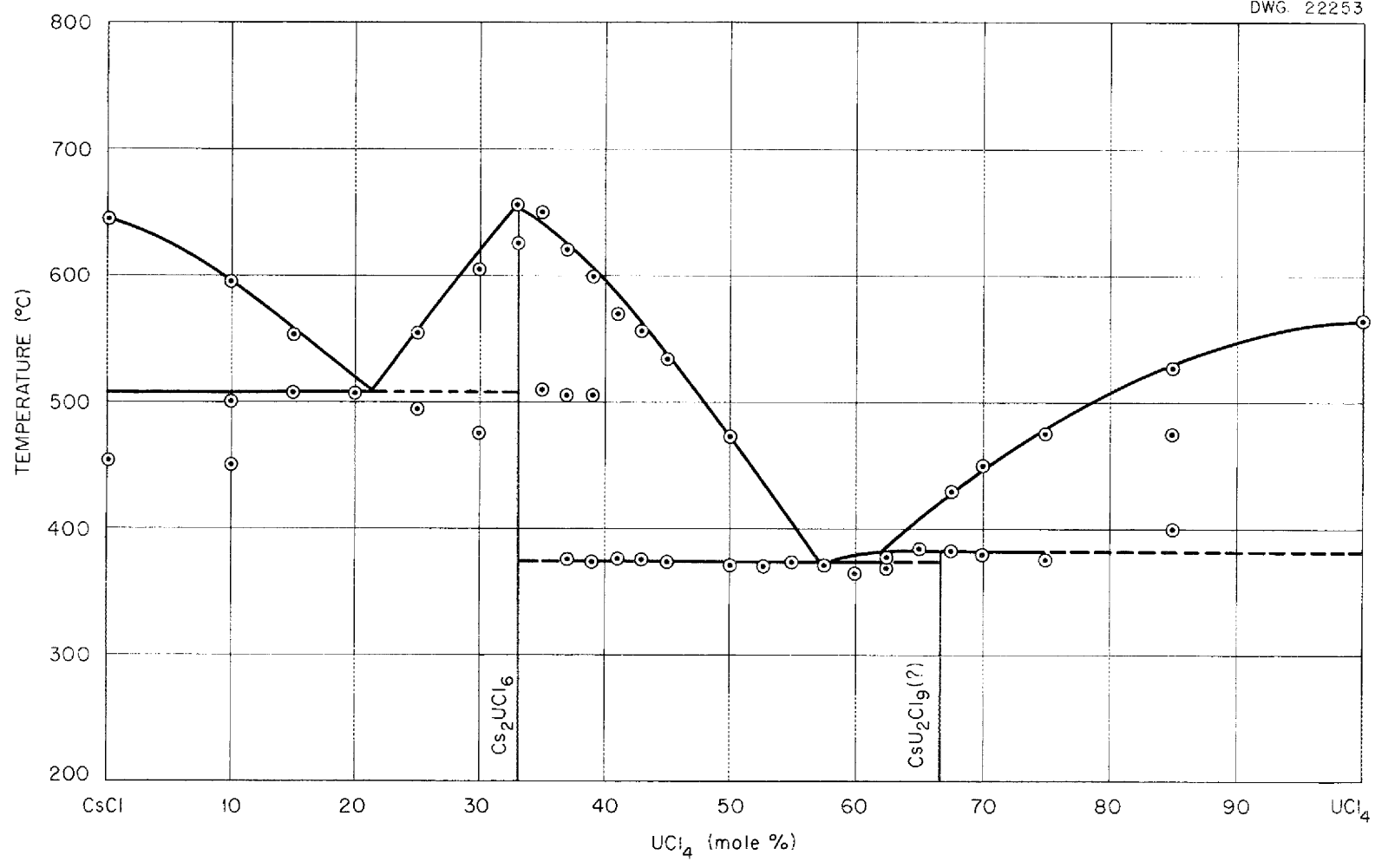
The System LiCl-UCl<sub>4</sub>.



The System NaCl-UCl<sub>4</sub>.

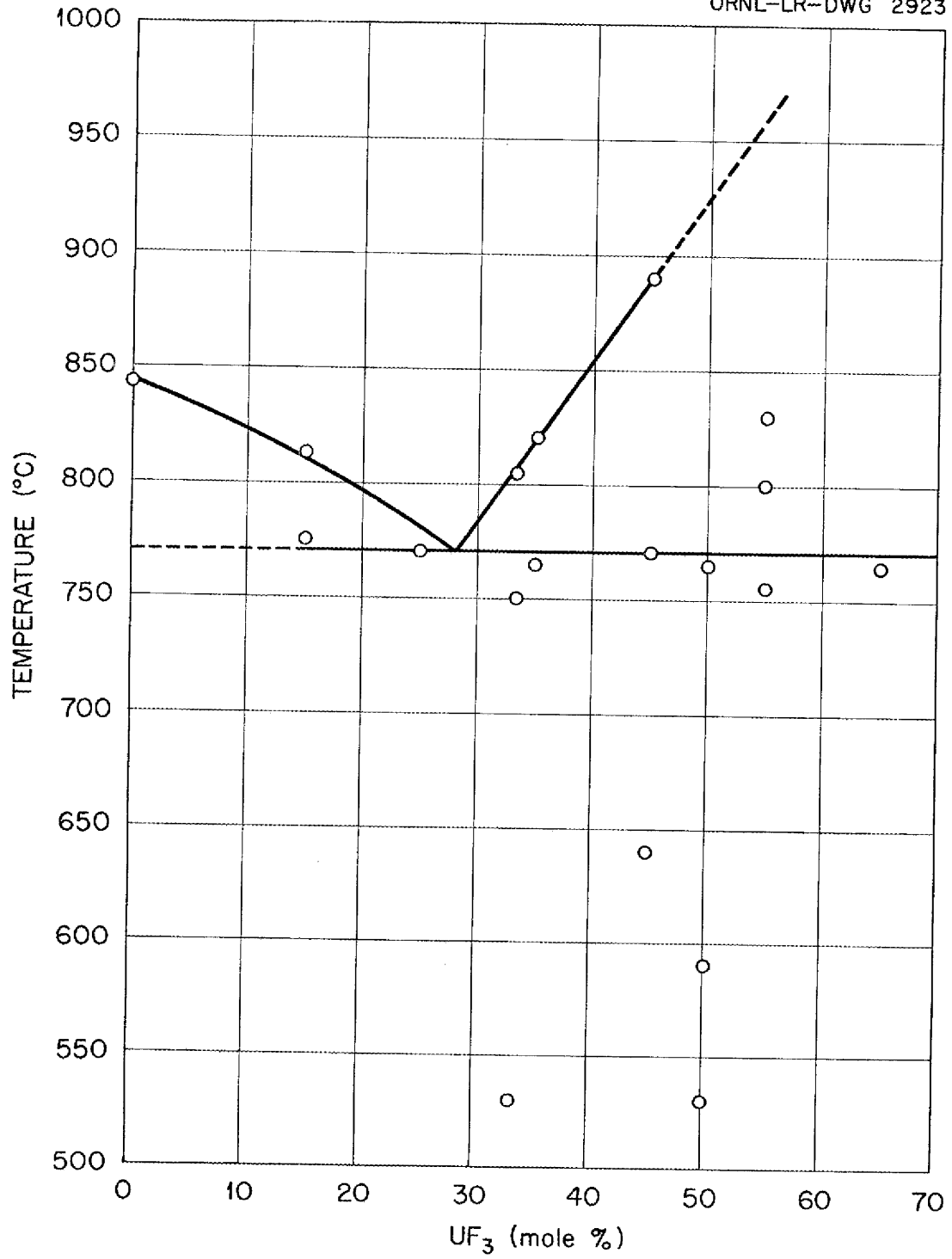


The System KCl-UCl<sub>4</sub>.

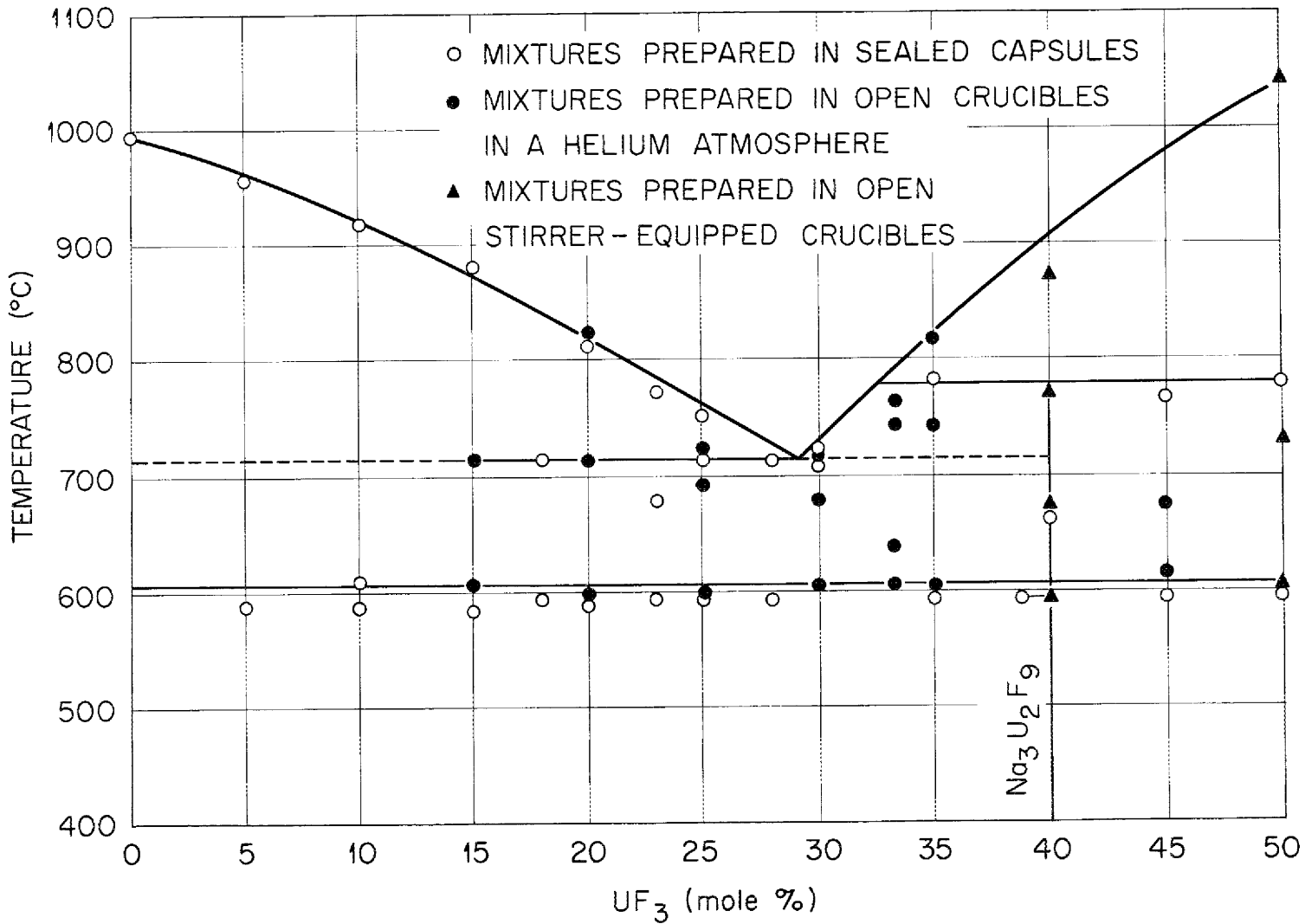


The System CsCl-UCl<sub>4</sub>.

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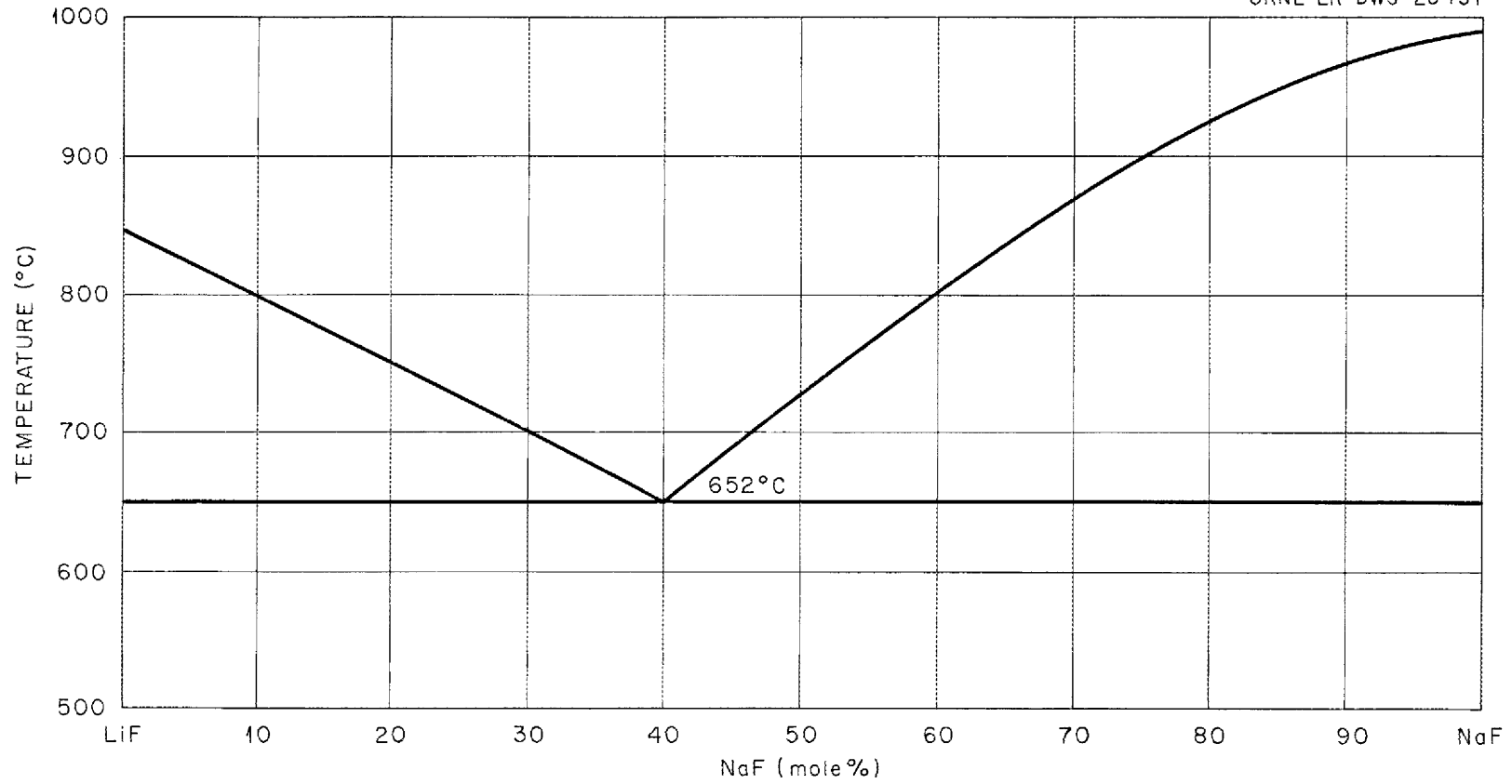


The System LiF-UF<sub>3</sub>.

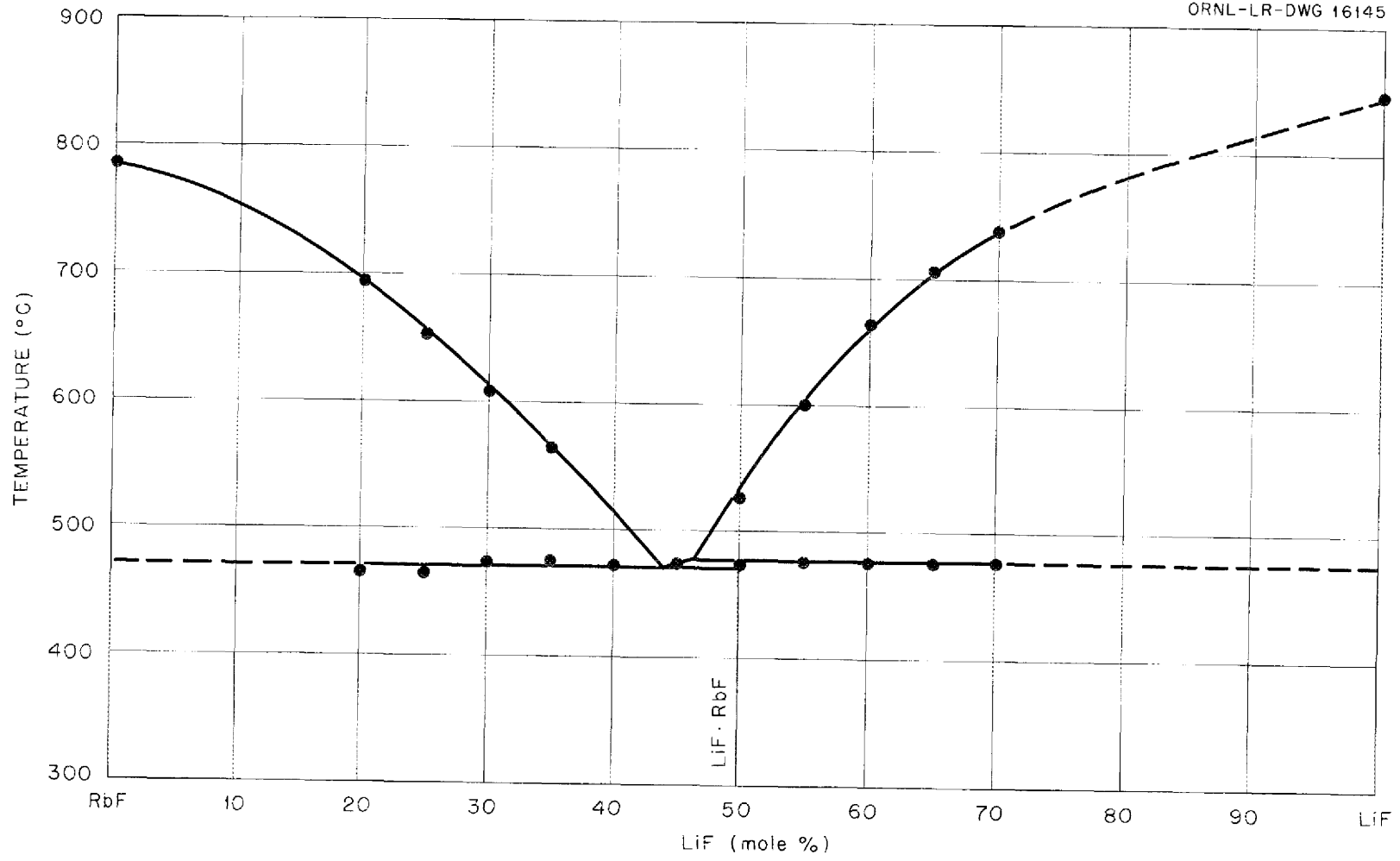


The System NaF-UF<sub>3</sub>.

Na<sub>3</sub>U<sub>2</sub>F<sub>9</sub>

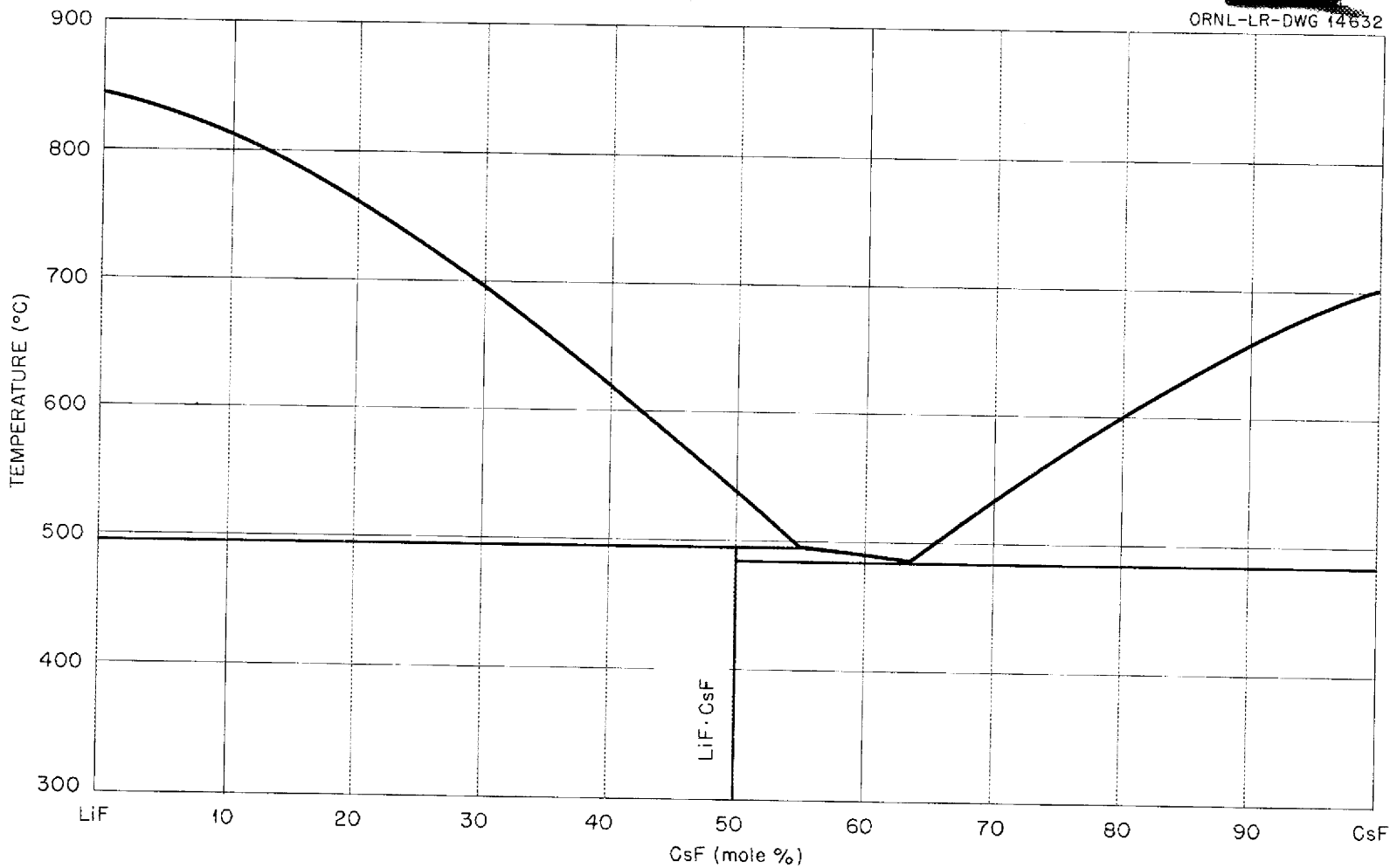


The System LiF-NaF.

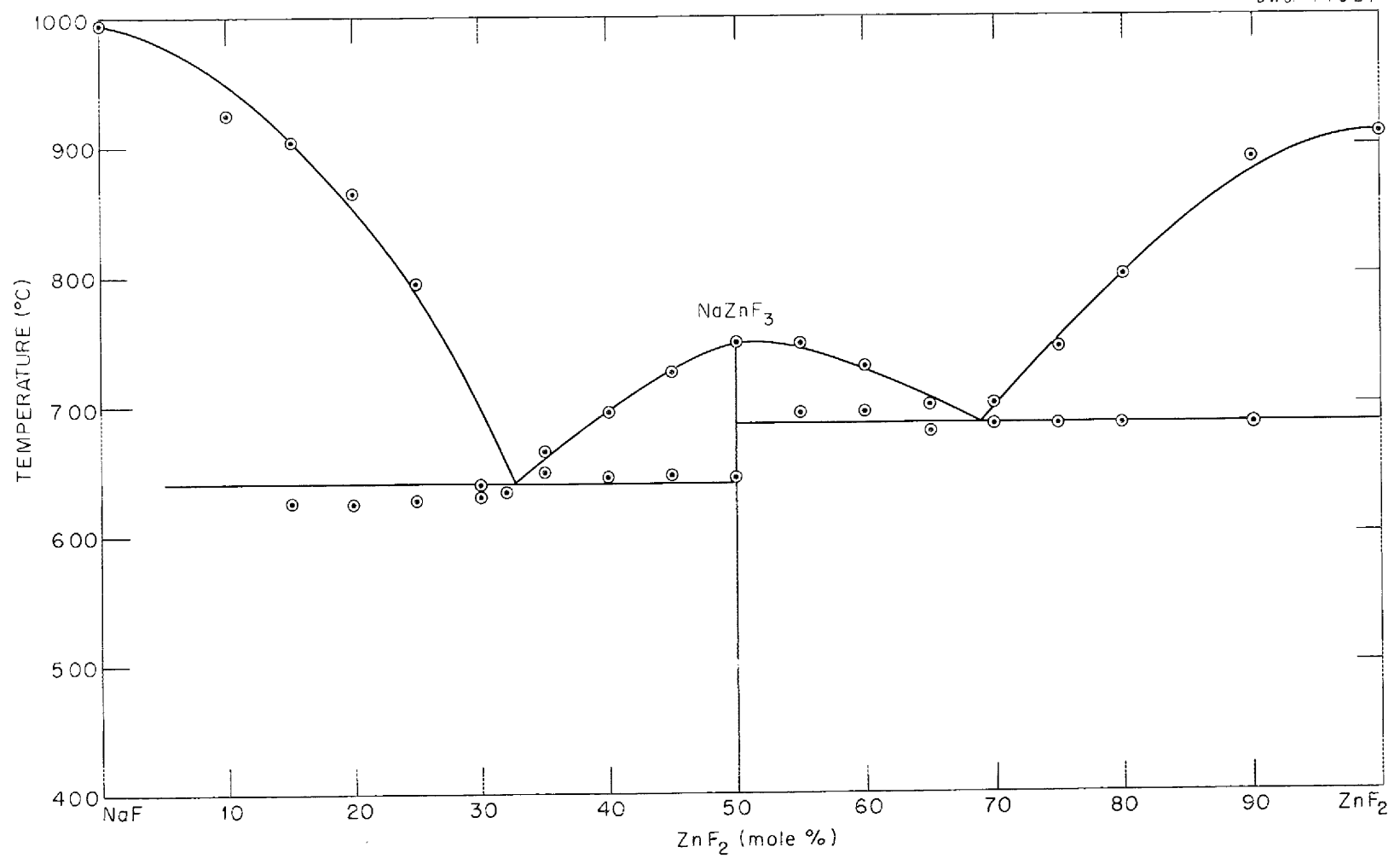


The System RbF-LiF.

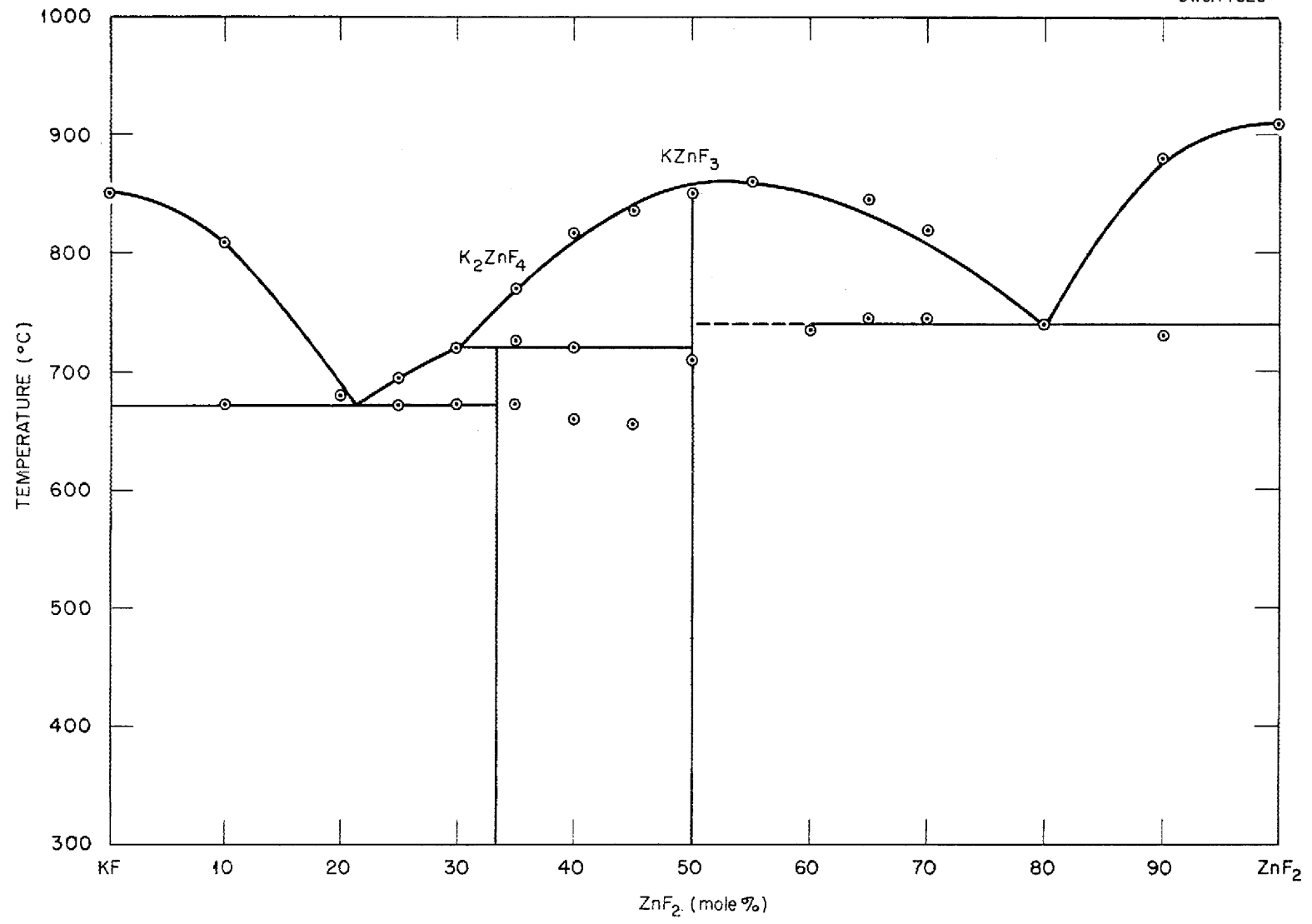




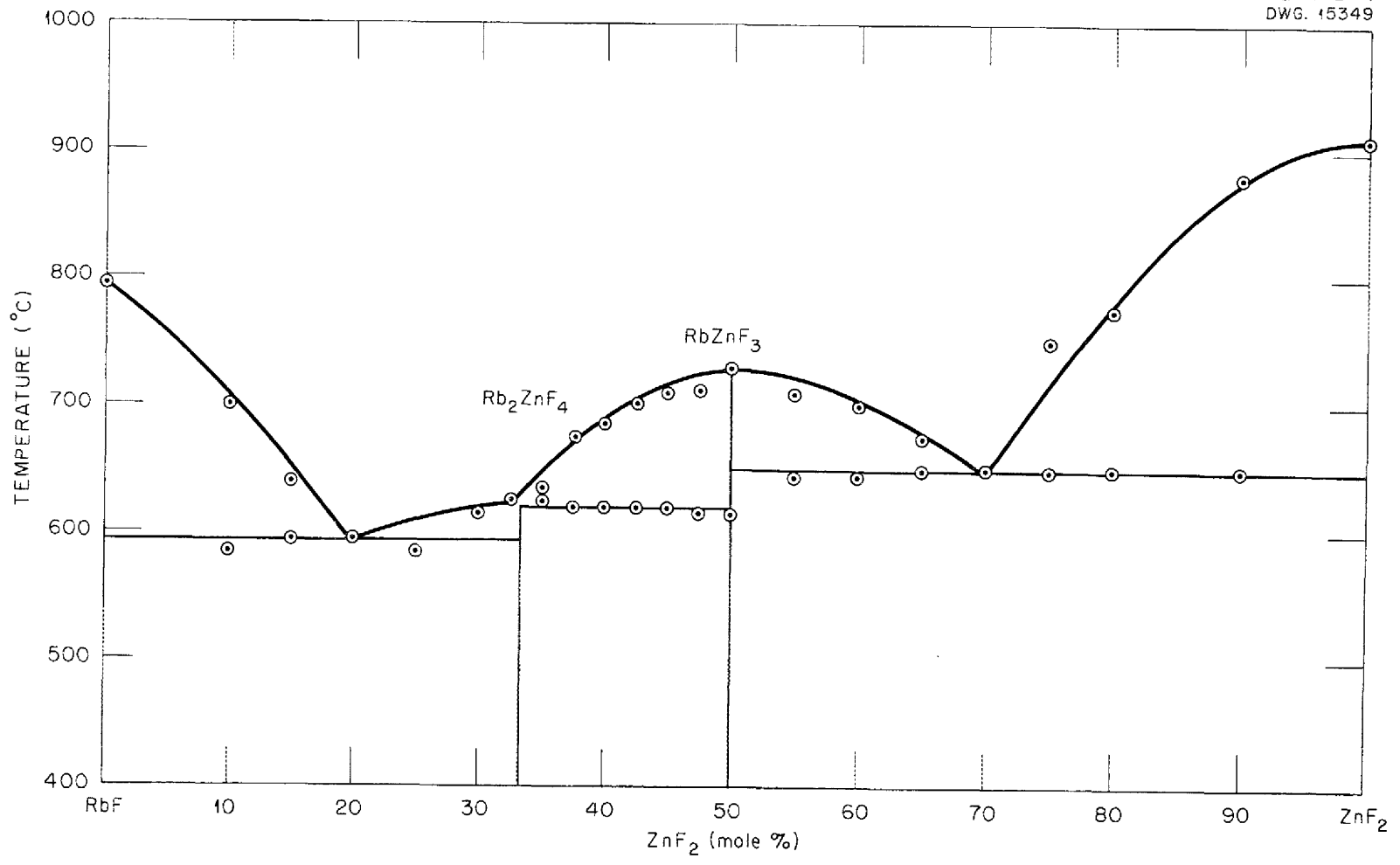
The System LiF-CsF.



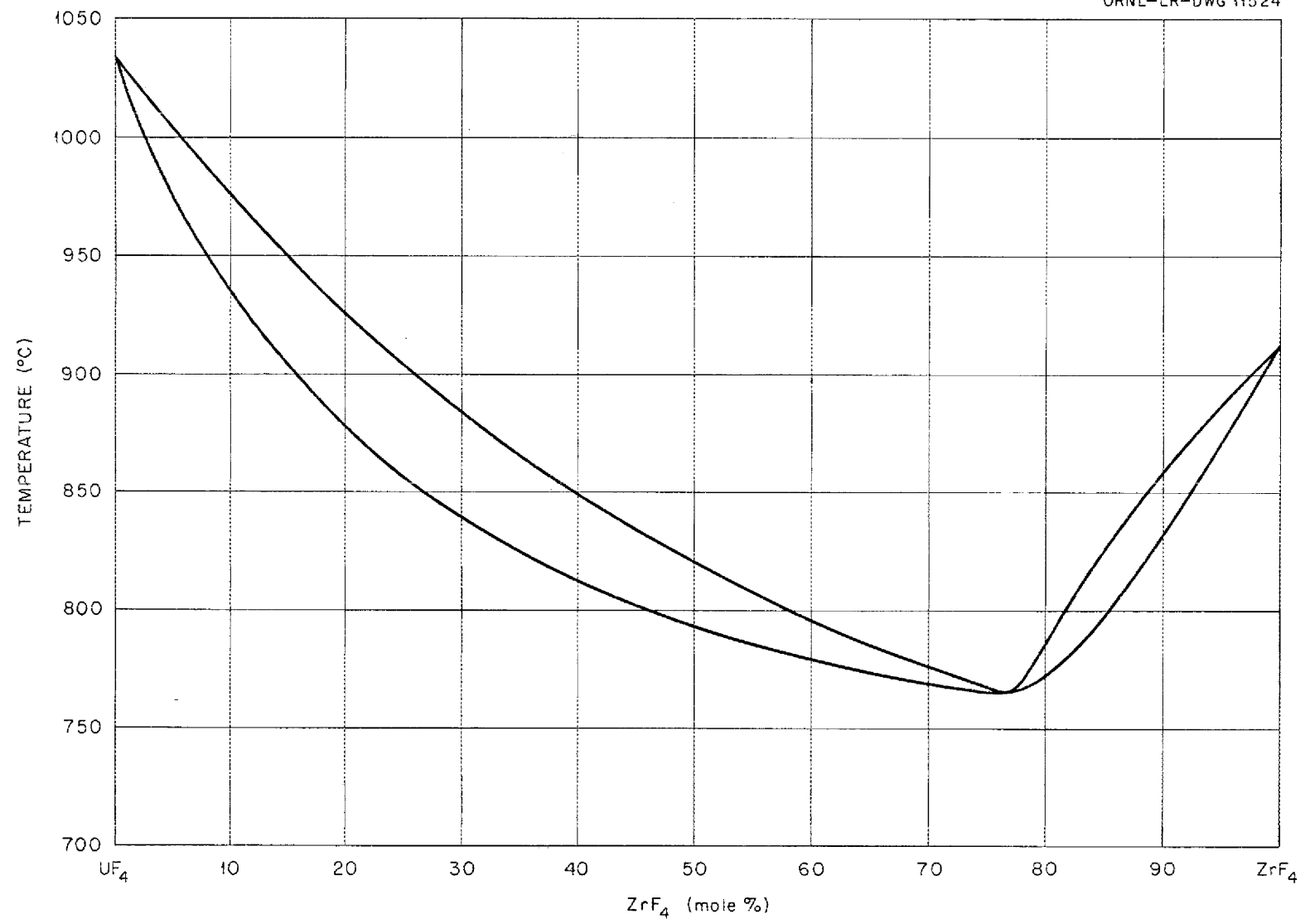
The System NaF-ZnF<sub>2</sub>.



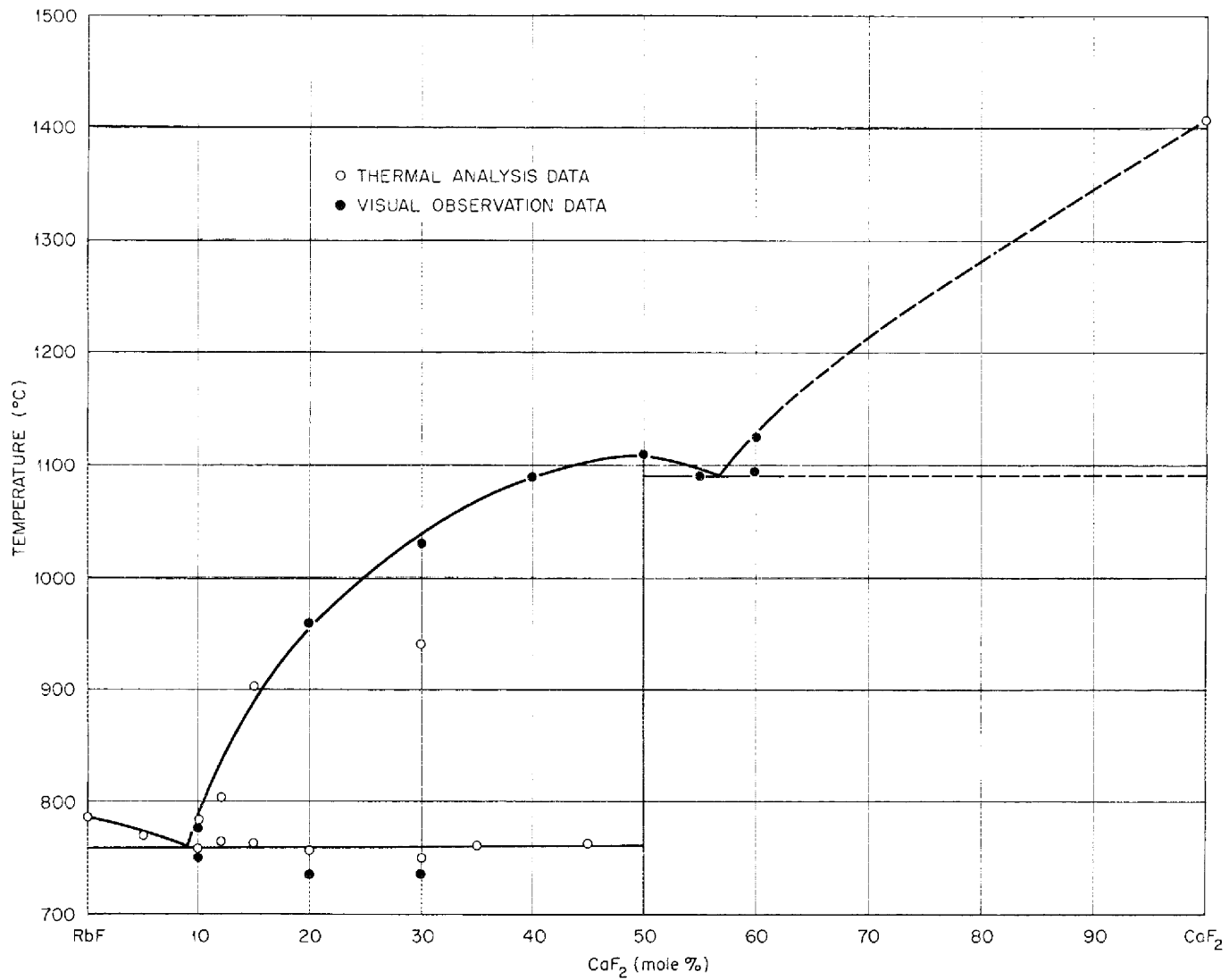
The System KF-ZnF<sub>2</sub>.



The System RbF-ZnF<sub>2</sub>.

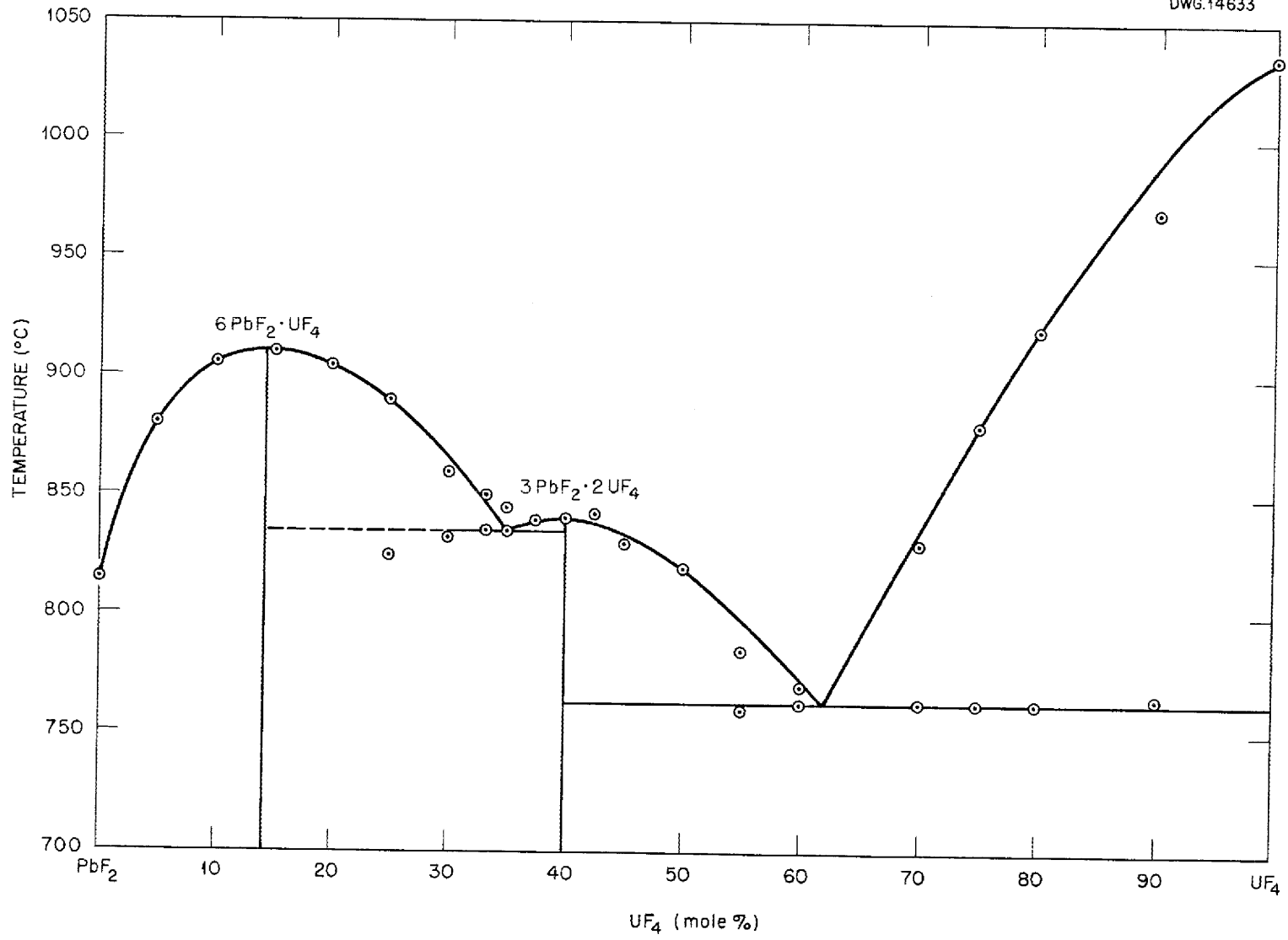


The System  $UF_4-ZrF_4$ .

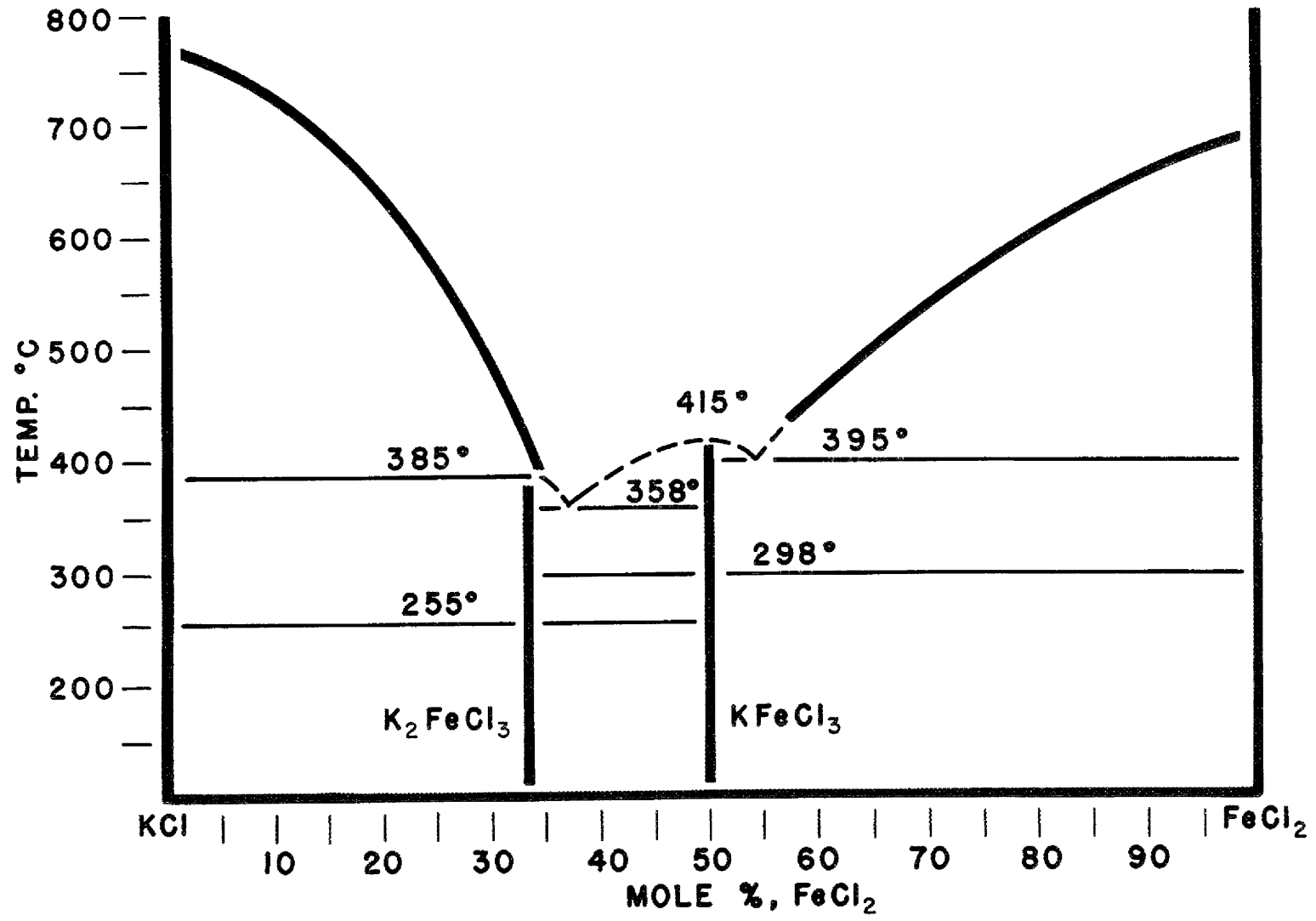


The System RbF-CaF<sub>2</sub>.

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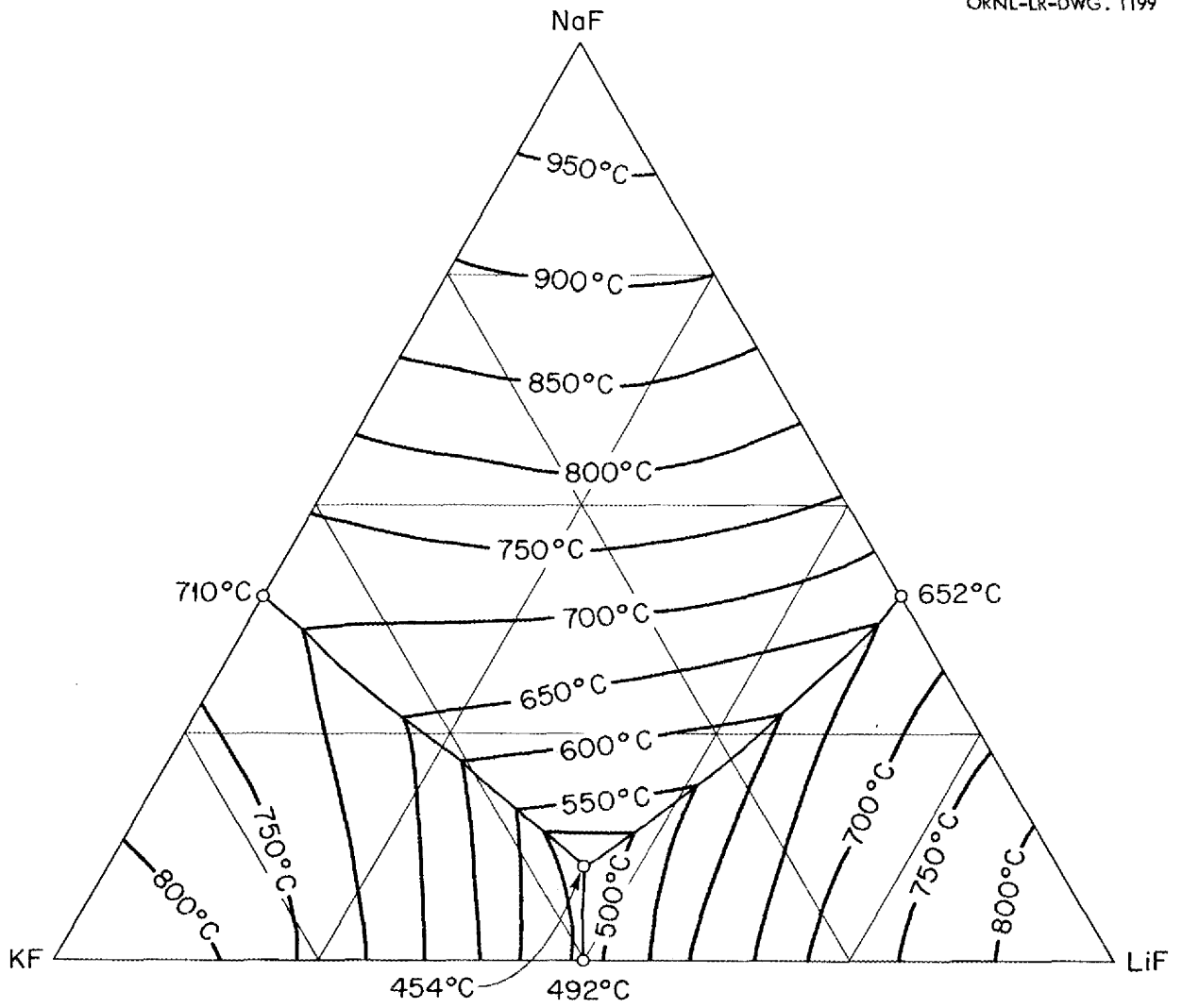
The System  $\text{PbF}_2\text{-UF}_4$ .



The System KCl-FeCl<sub>2</sub>.

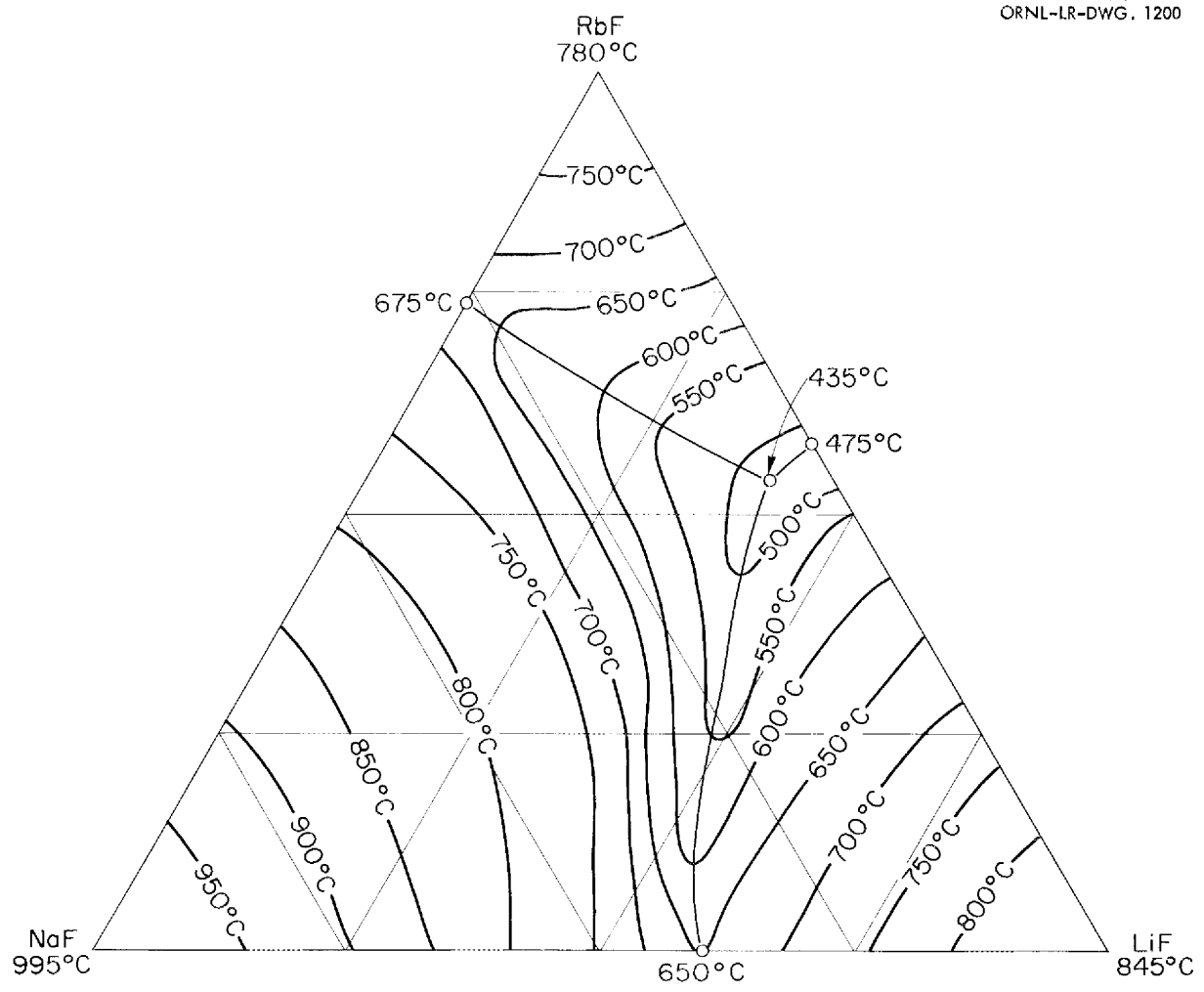


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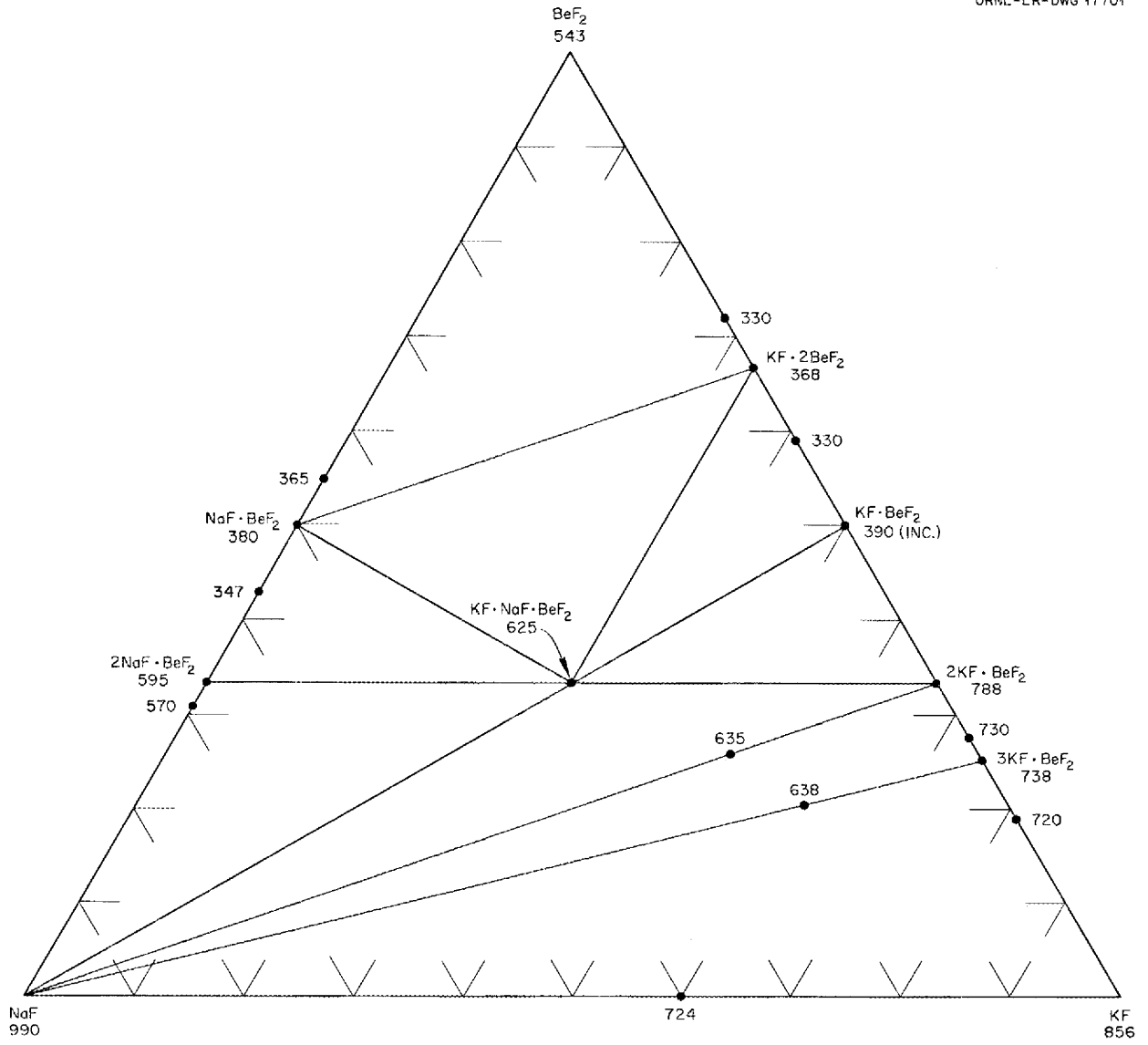


The System KF-LiF-NaF.

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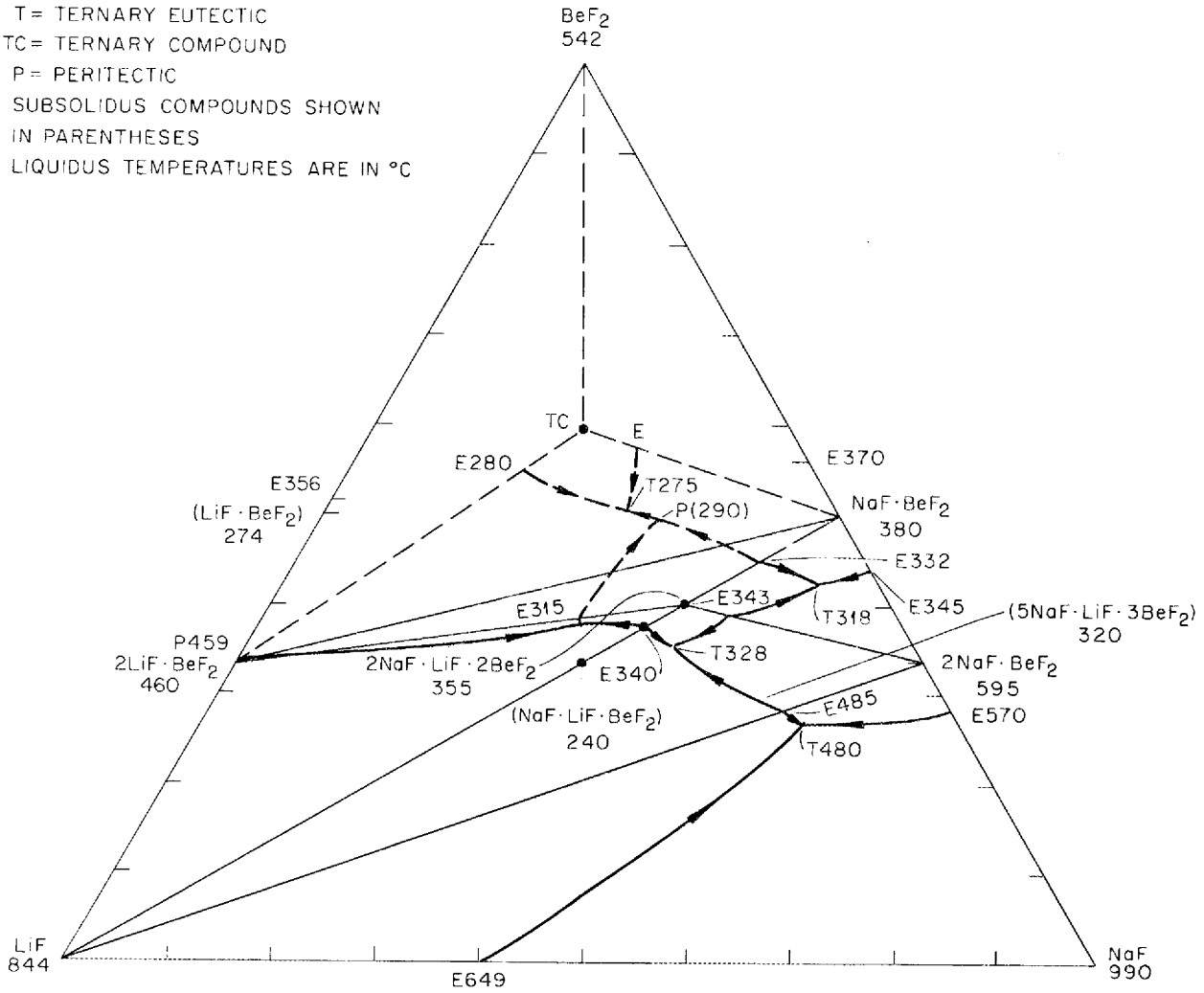


The System NaF-LiF-RbF.

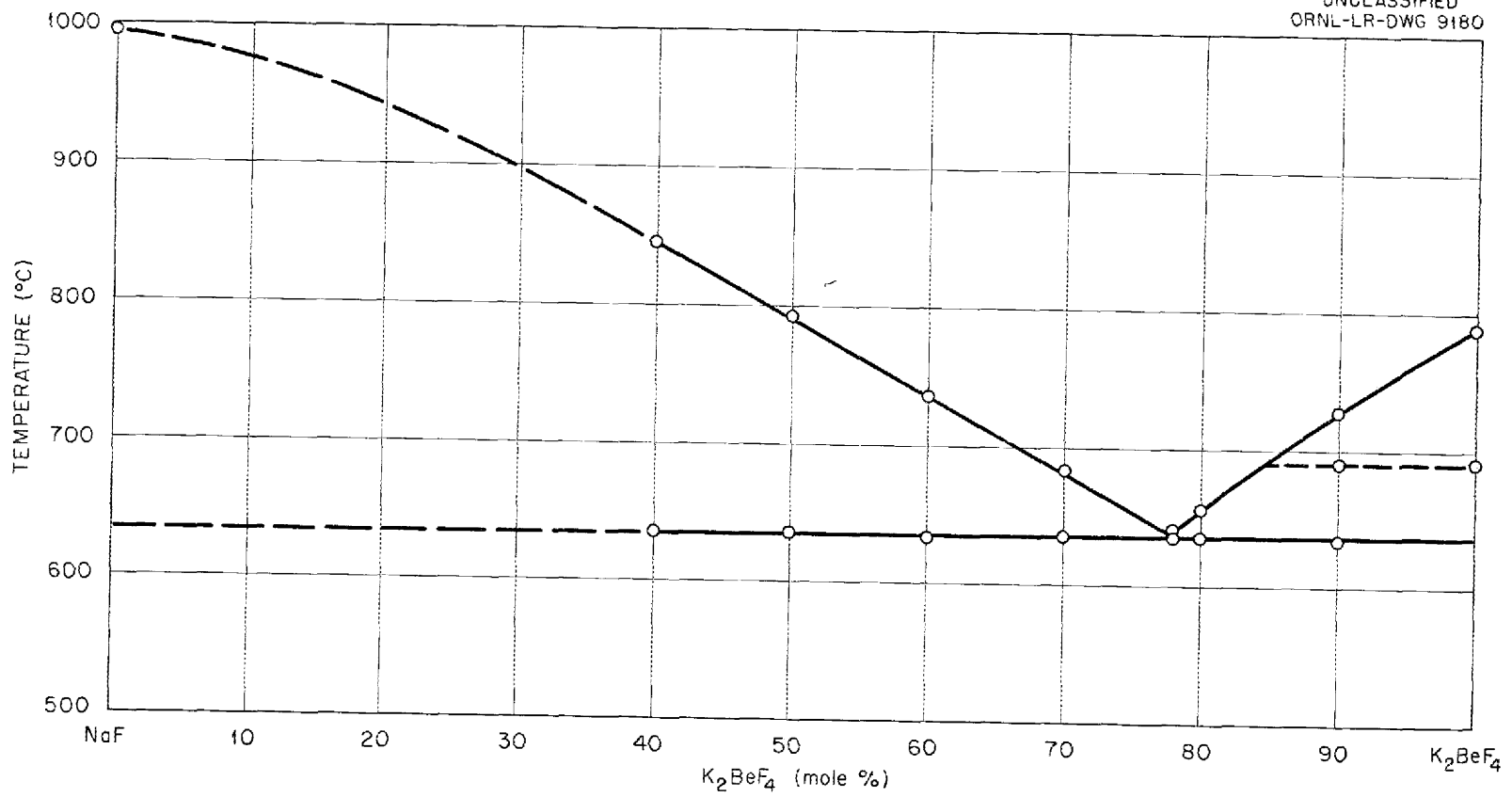


Compatibility Triangles in the System NaF-KF-BeF<sub>2</sub>.

E = EUTECTIC  
T = TERNARY EUTECTIC  
TC = TERNARY COMPOUND  
P = PERITECTIC  
SUBSOLIDUS COMPOUNDS SHOWN  
IN PARENTHESES  
LIQUIDUS TEMPERATURES ARE IN °C

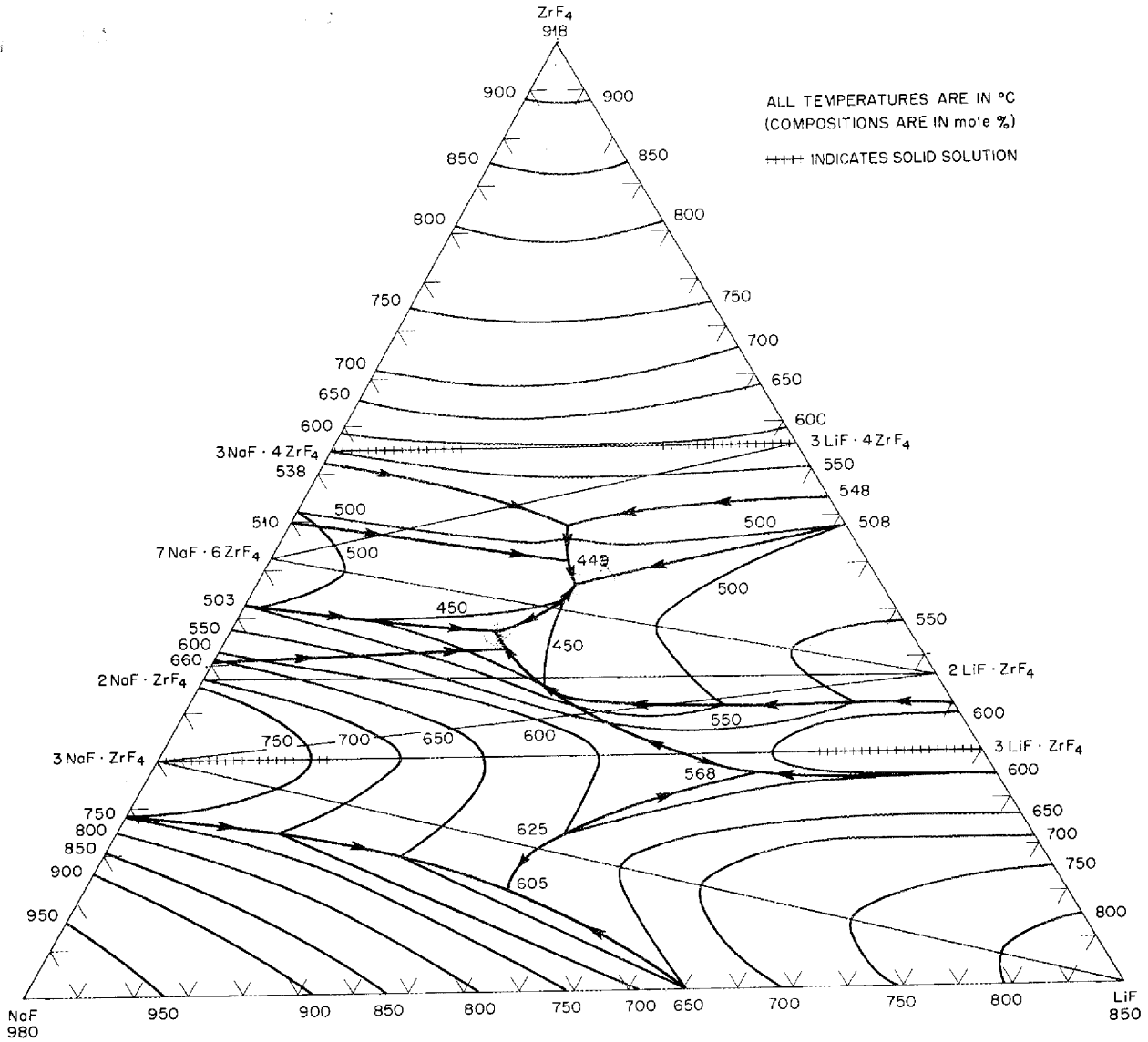


The System LiF-NaF-BeF<sub>2</sub>.



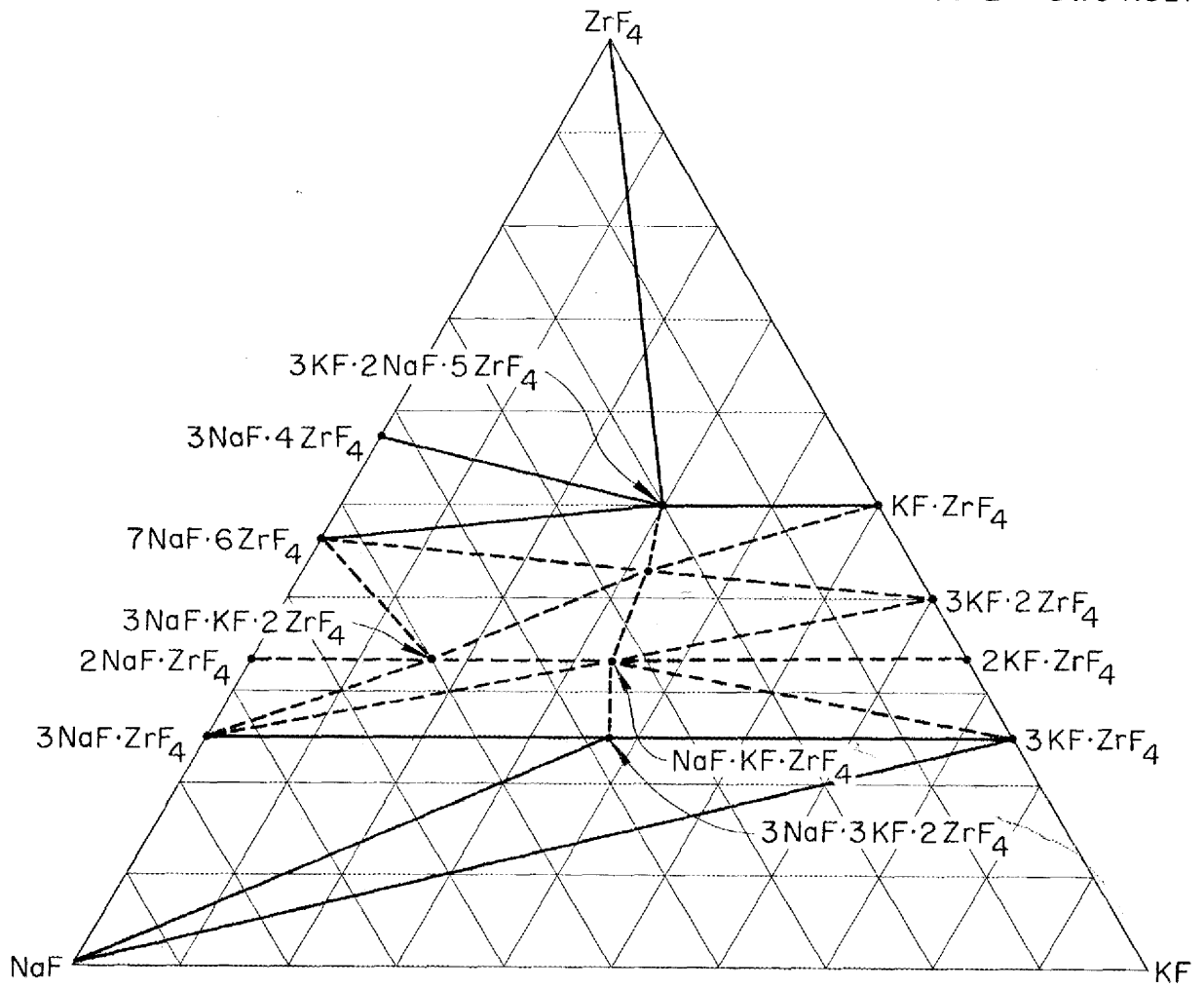
The Join NaF-K<sub>2</sub>BeF<sub>4</sub>.

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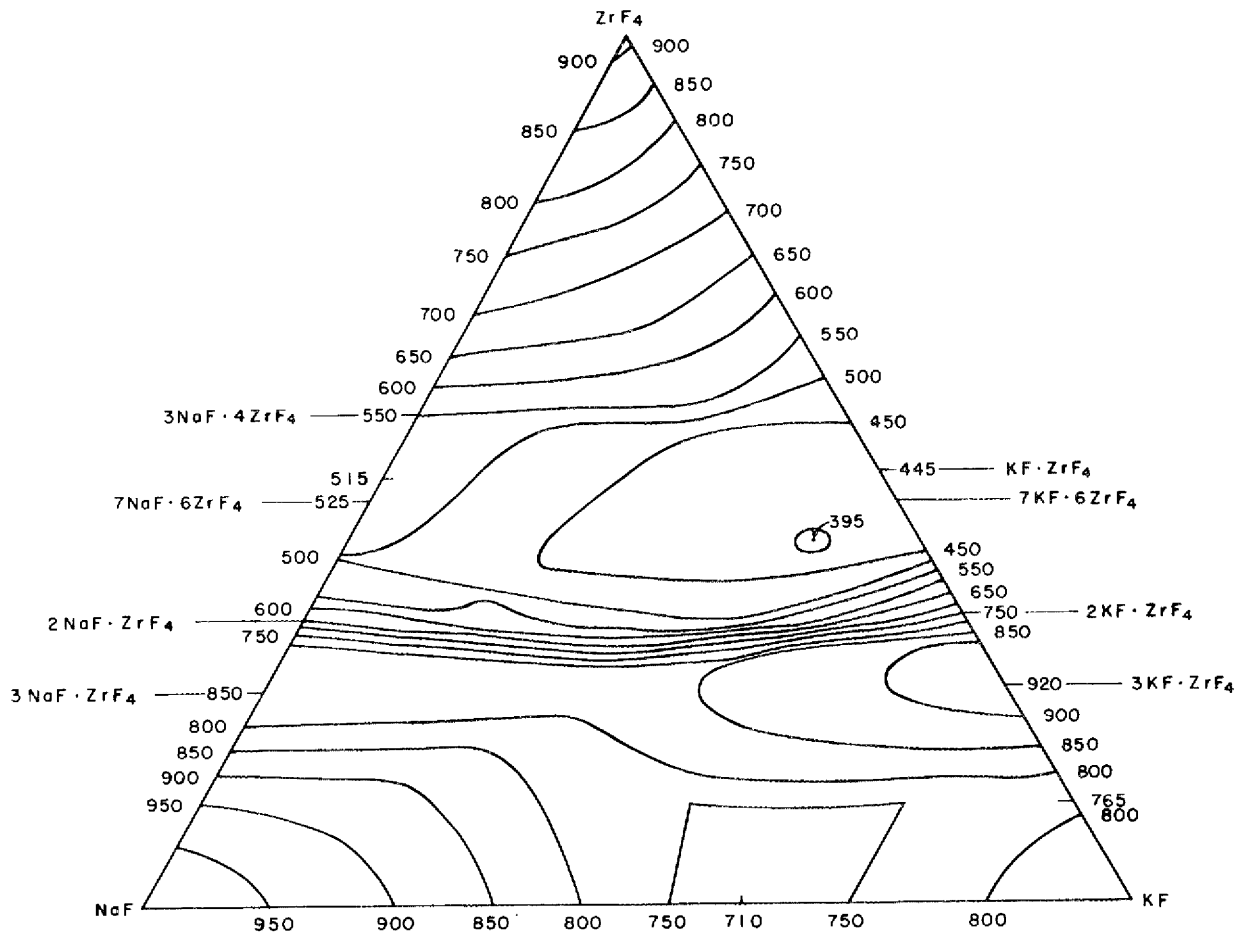
The System NaF-LiF-ZrF<sub>4</sub>.

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Compatibility Triangles in the System NaF-KF-ZrF<sub>4</sub>.

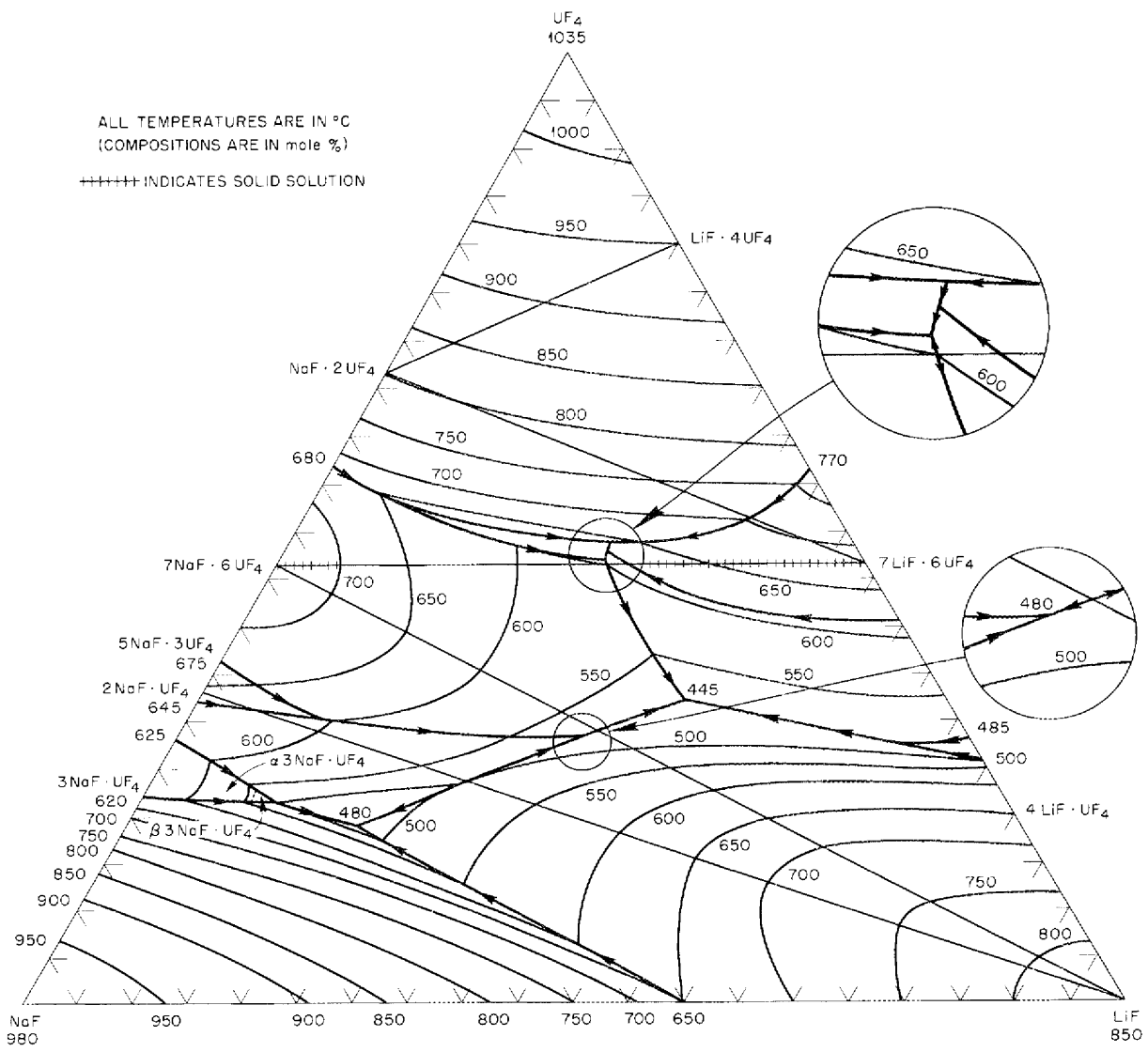
PHOTO 25043



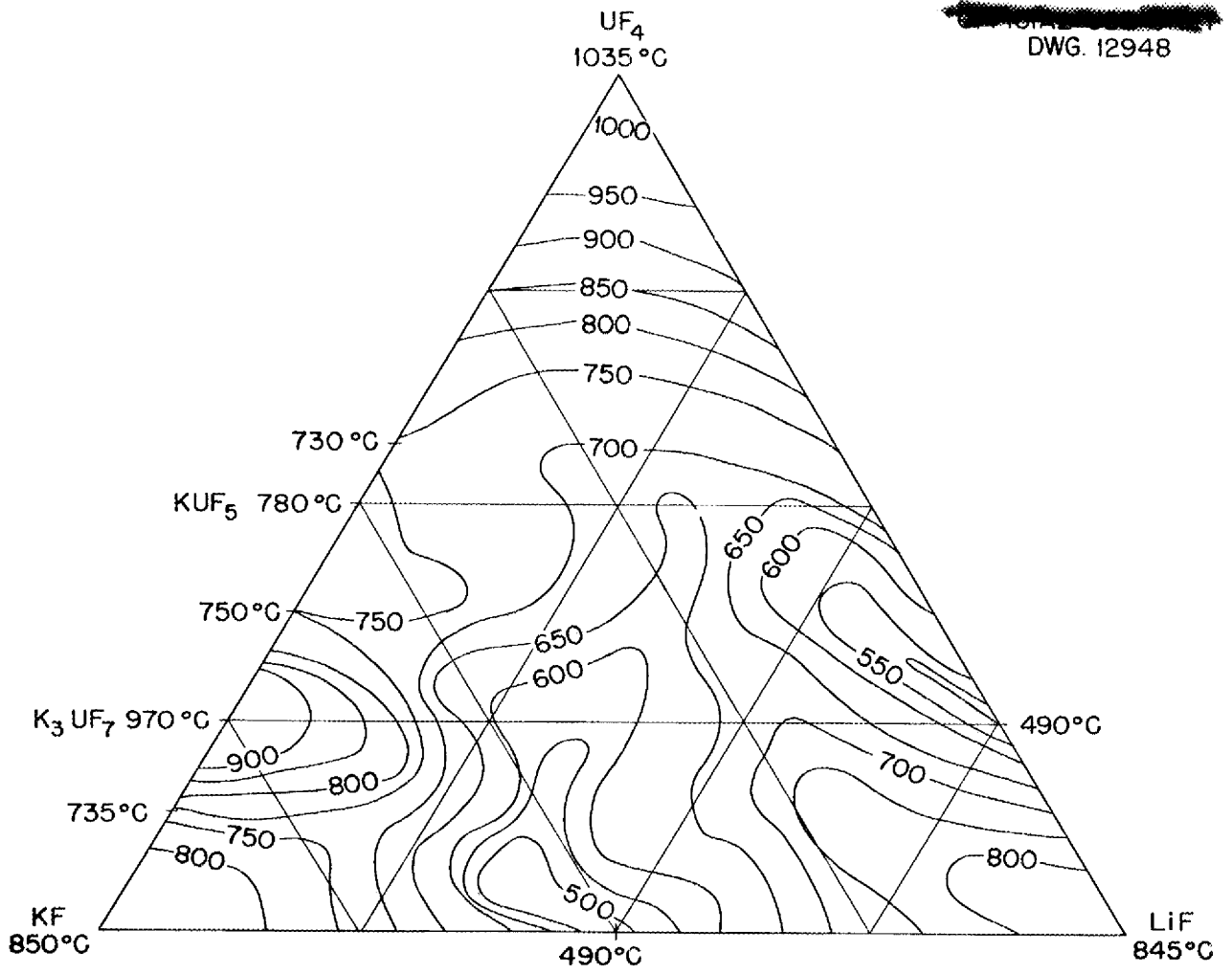
Liquidus Temperature (°C) in the NaF-KF-ZrF<sub>4</sub> System.





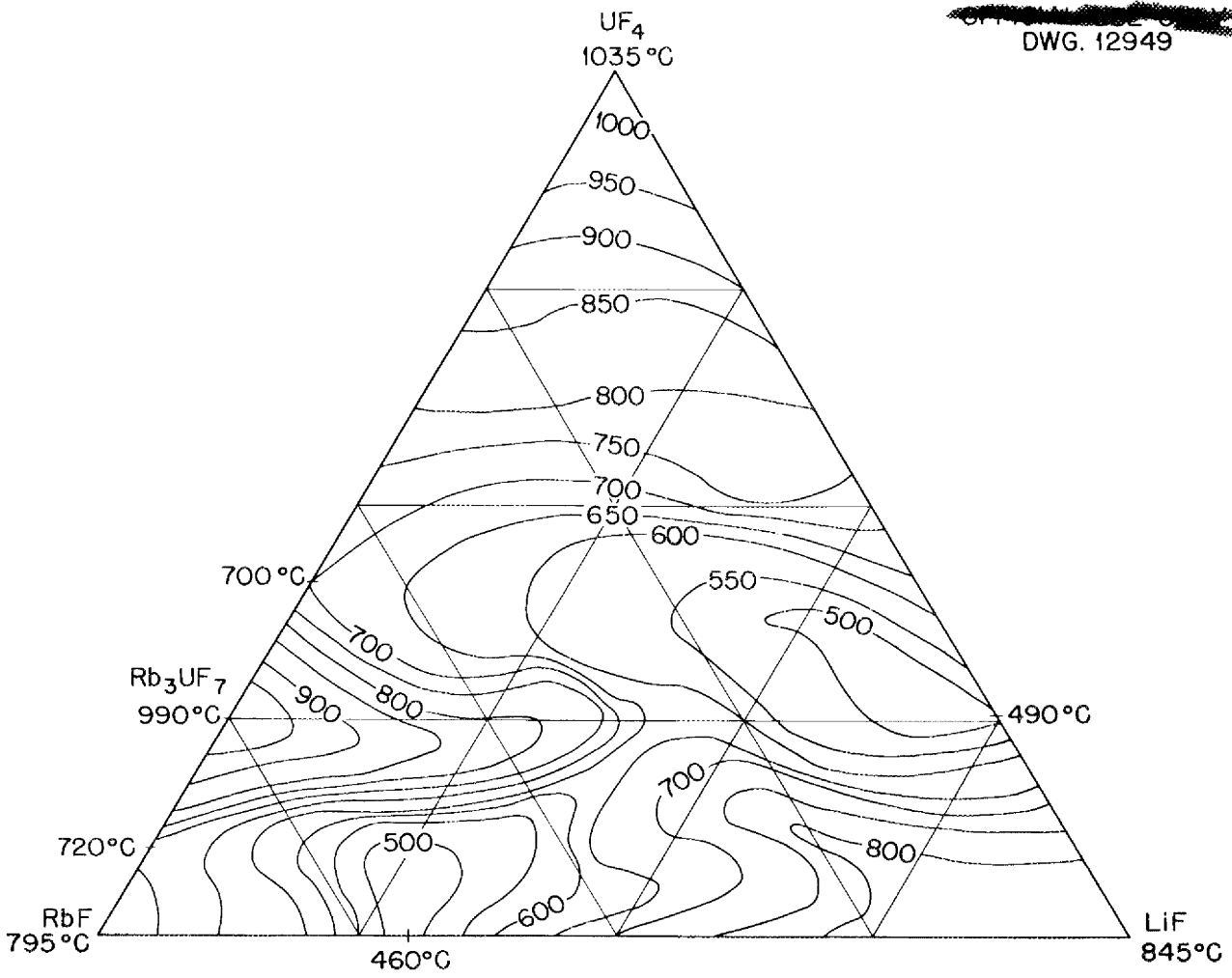


The System NaF-LiF-UF<sub>4</sub>.

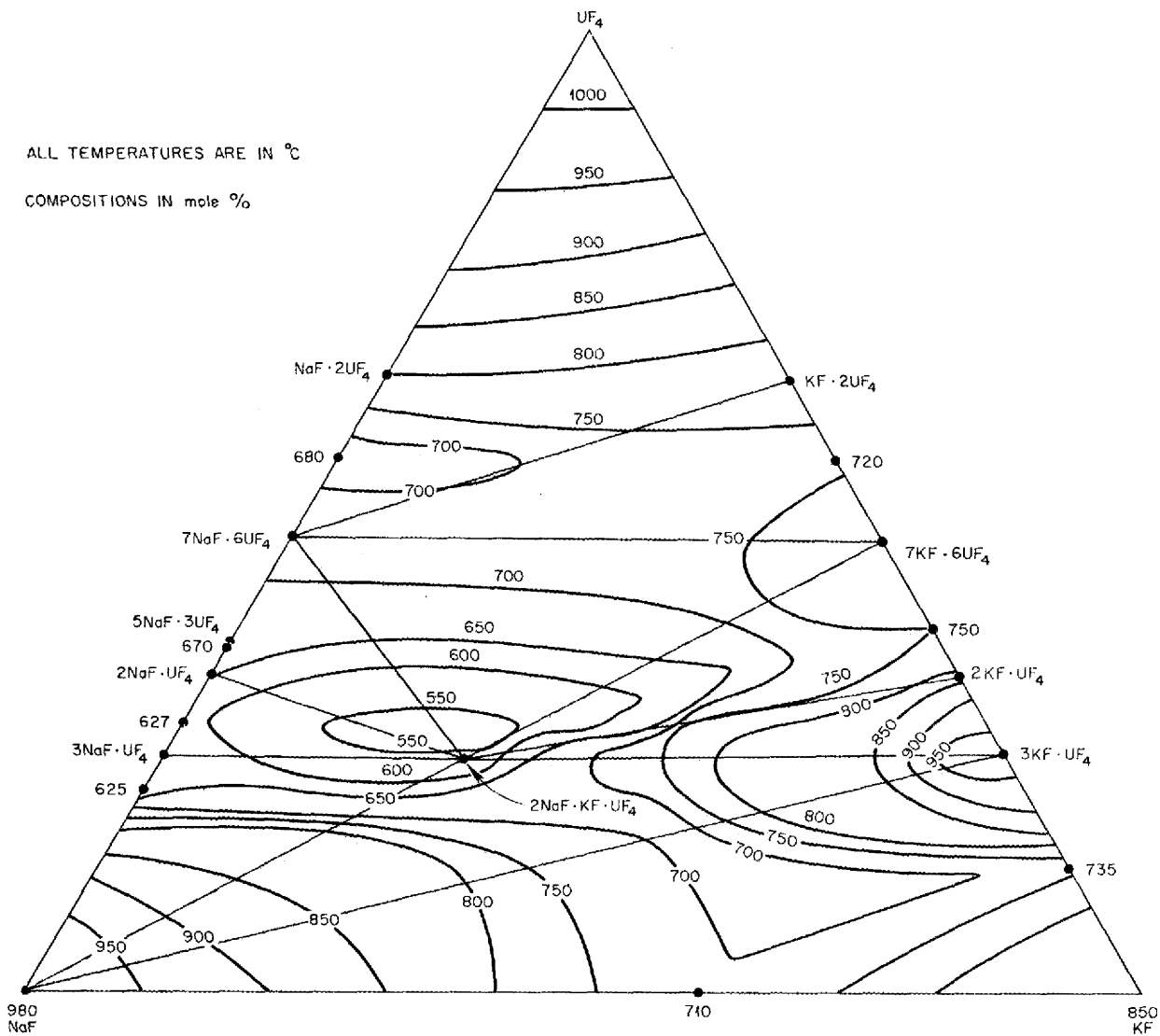


The System KF-LiF-UF<sub>4</sub>.

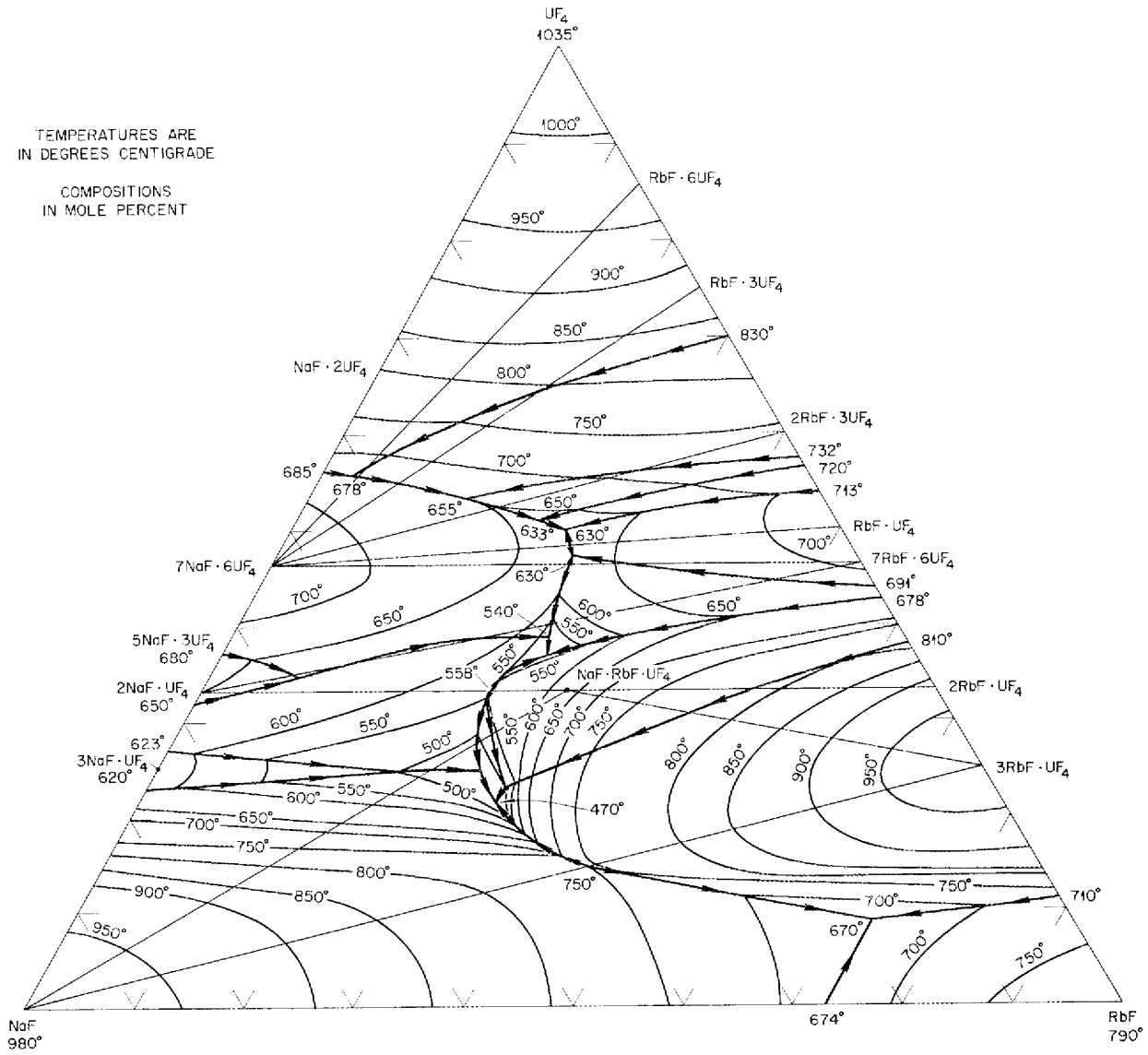
~~CONFIDENTIAL~~  
DWG. 12949



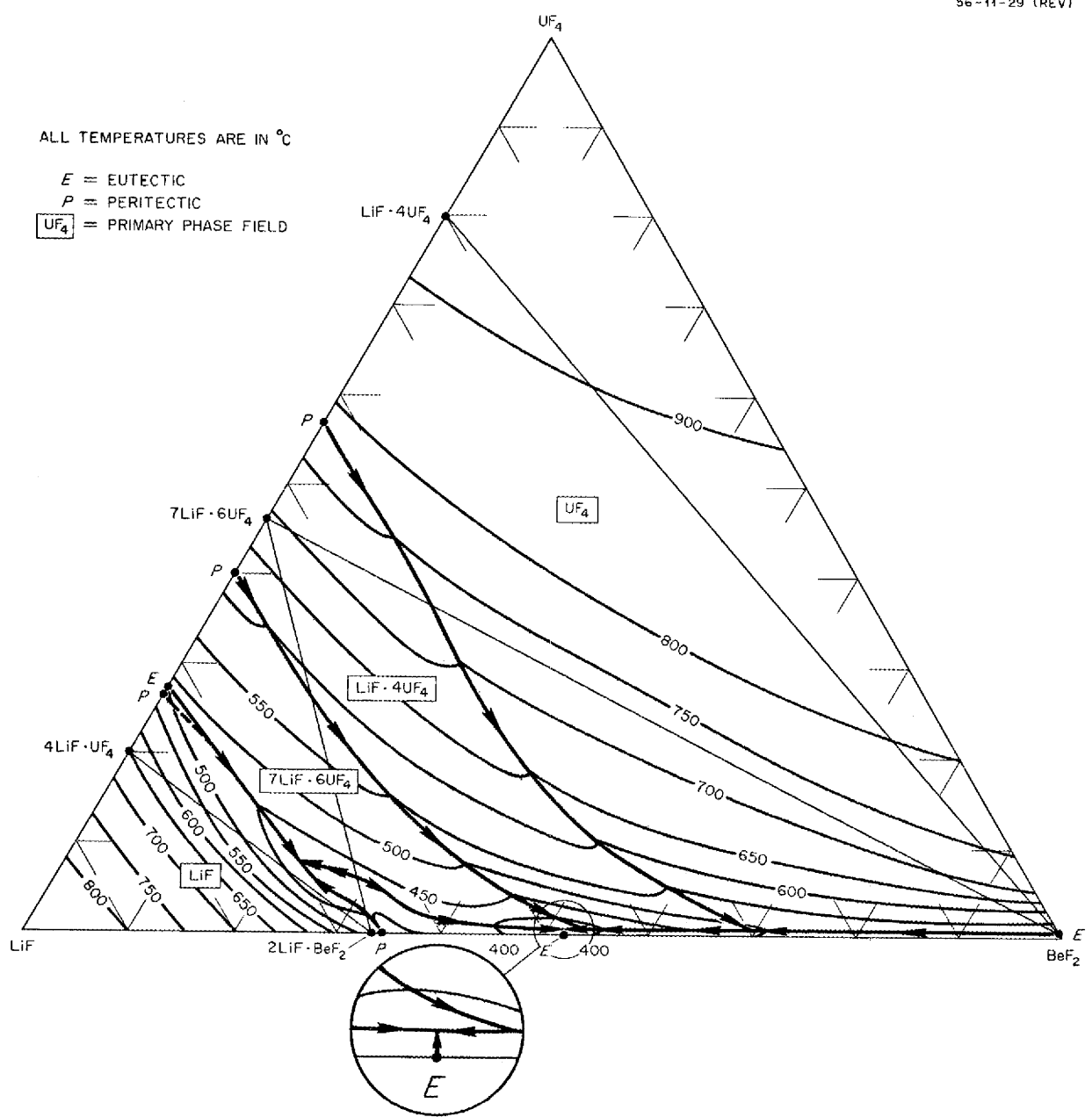
The System RbF-LiF-UF<sub>4</sub>.



The System NaF-KF-UF<sub>4</sub>; Liquidus Temperatures and Compatibility Triangles.

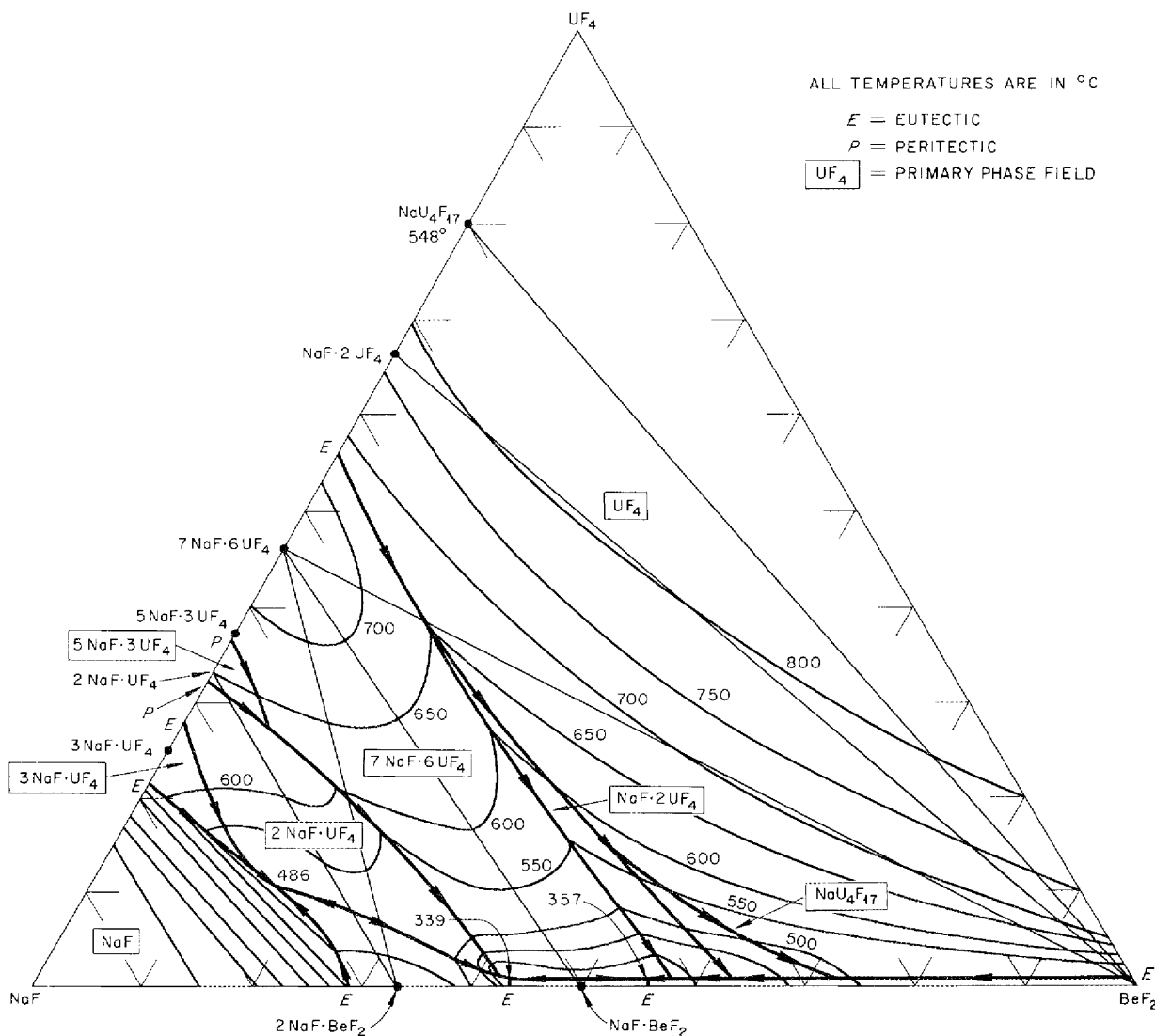


The System NaF-RbF-UF<sub>4</sub>.



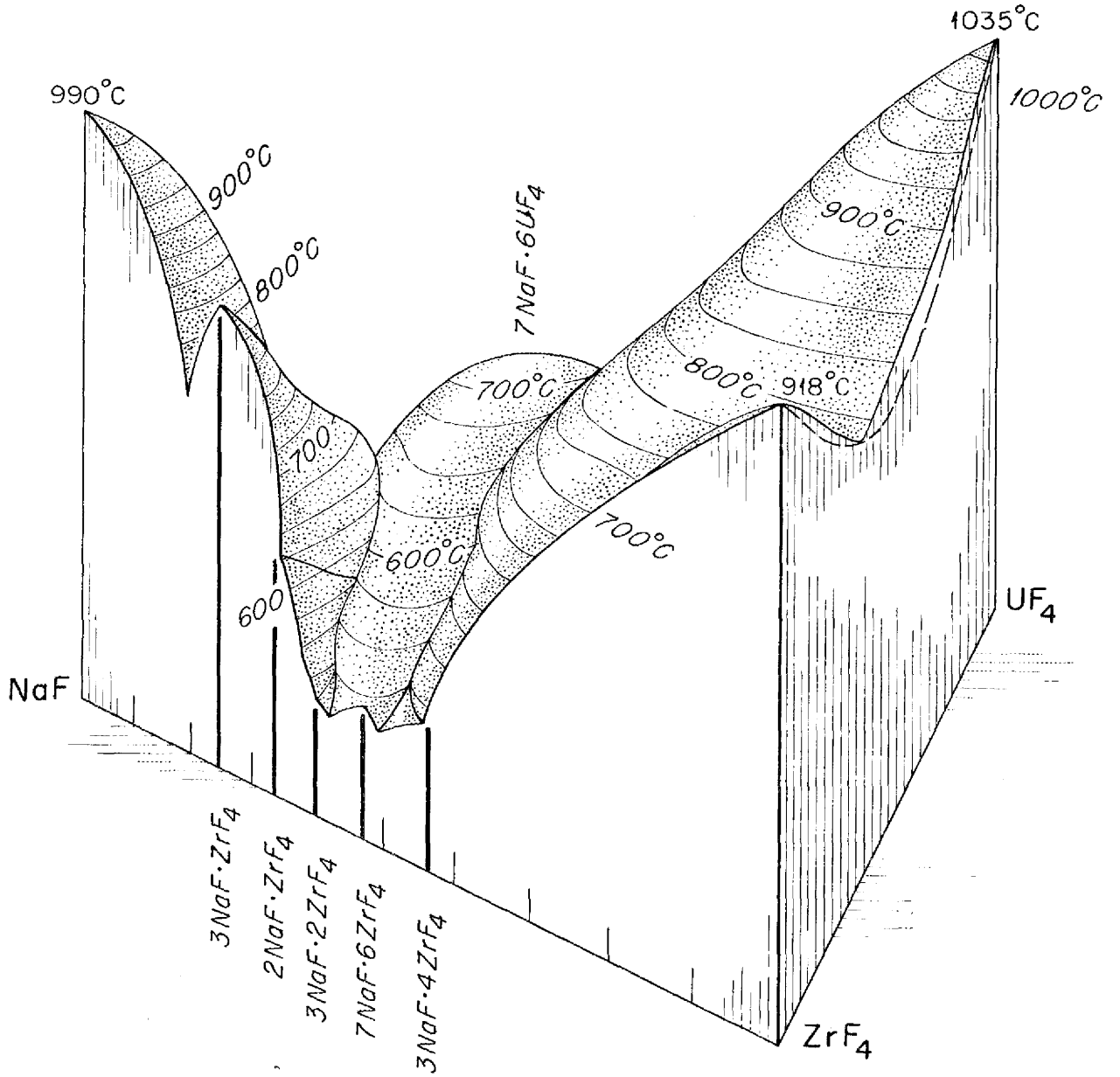
The System LiF-BeF<sub>2</sub>-UF<sub>4</sub>.

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56-11-30 (REV)



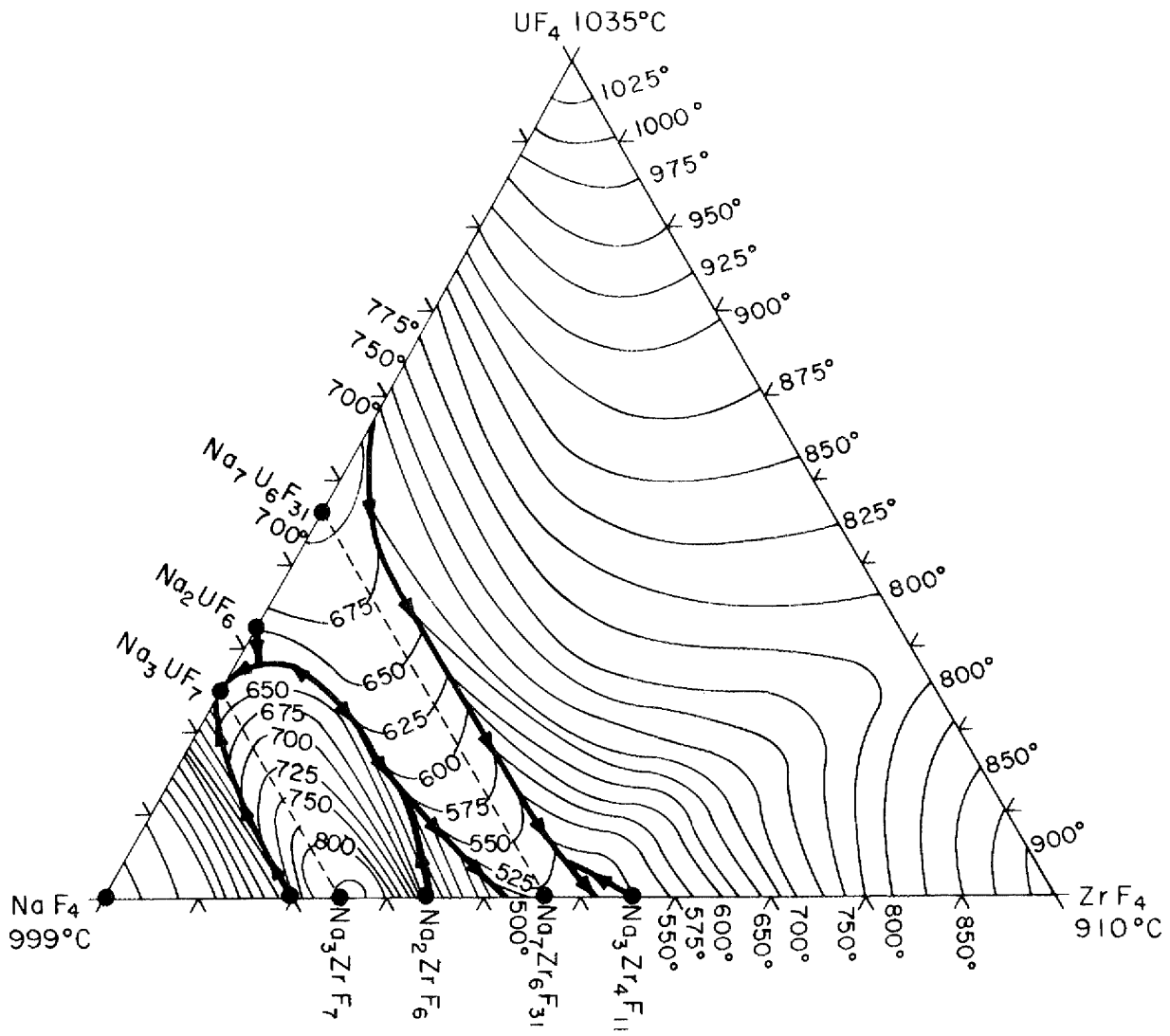
The System NaF-BeF<sub>2</sub>-UF<sub>4</sub>.



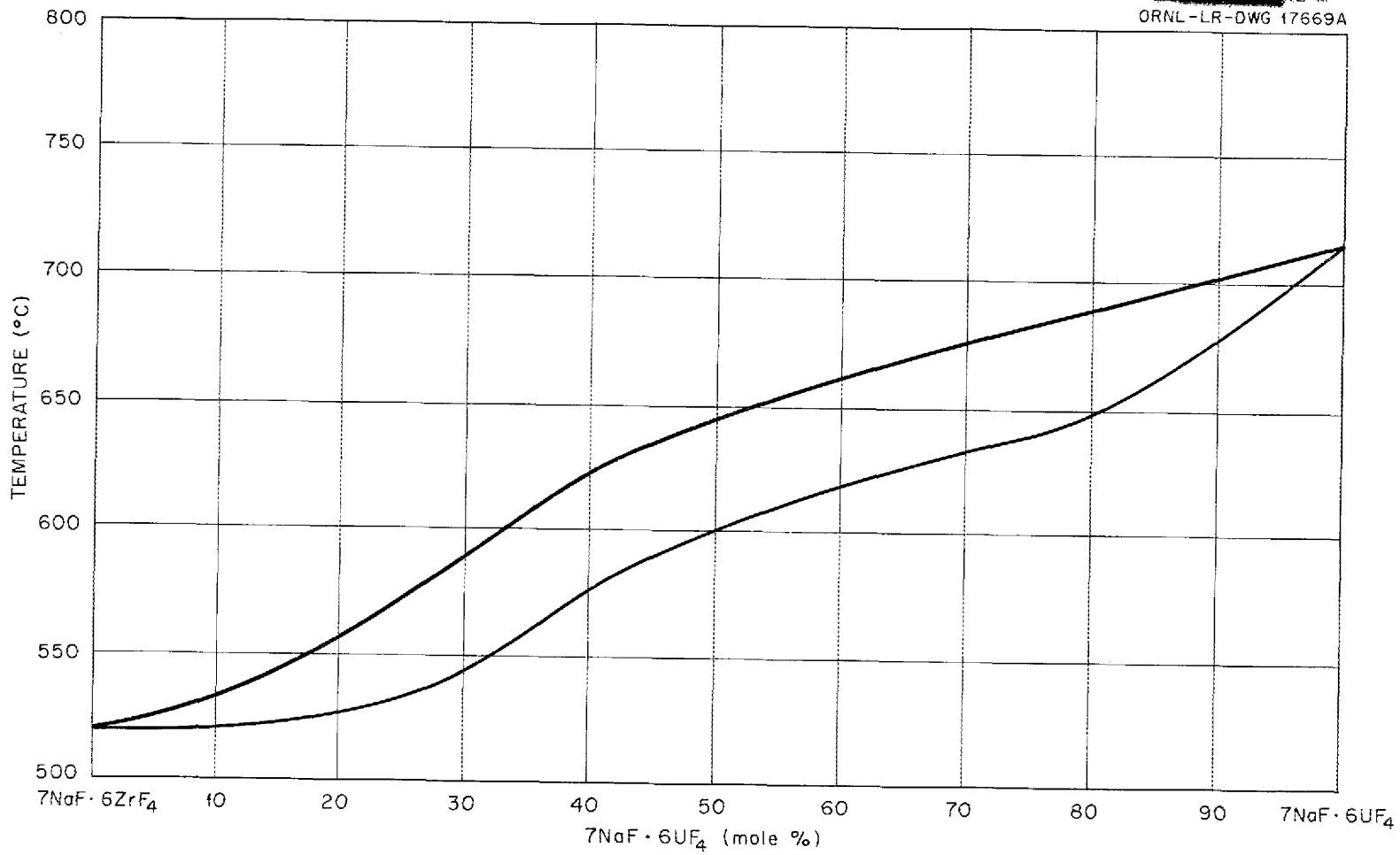


The System NaF-ZrF<sub>4</sub>-UF<sub>4</sub>.

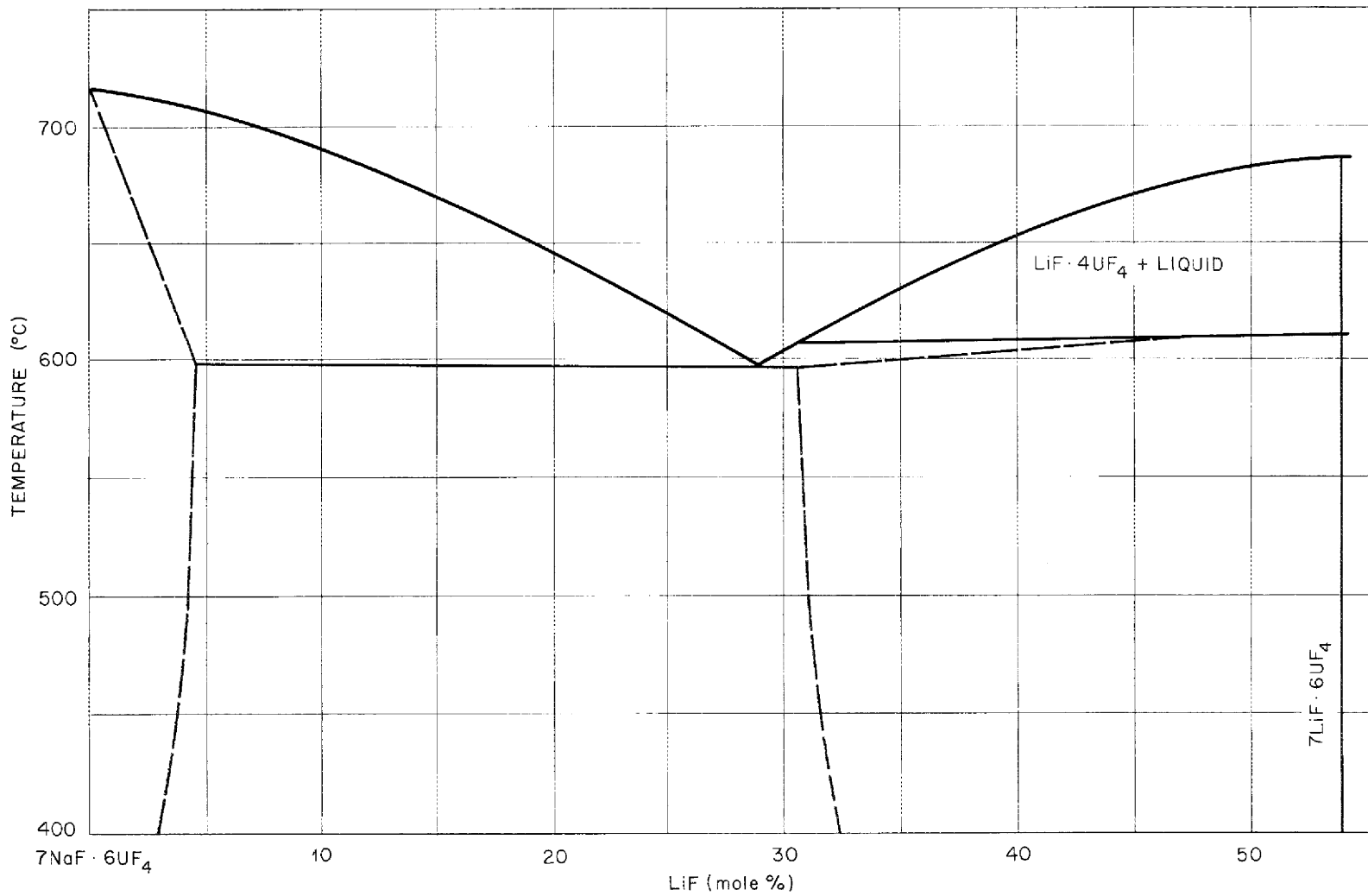
PHOTO 22349



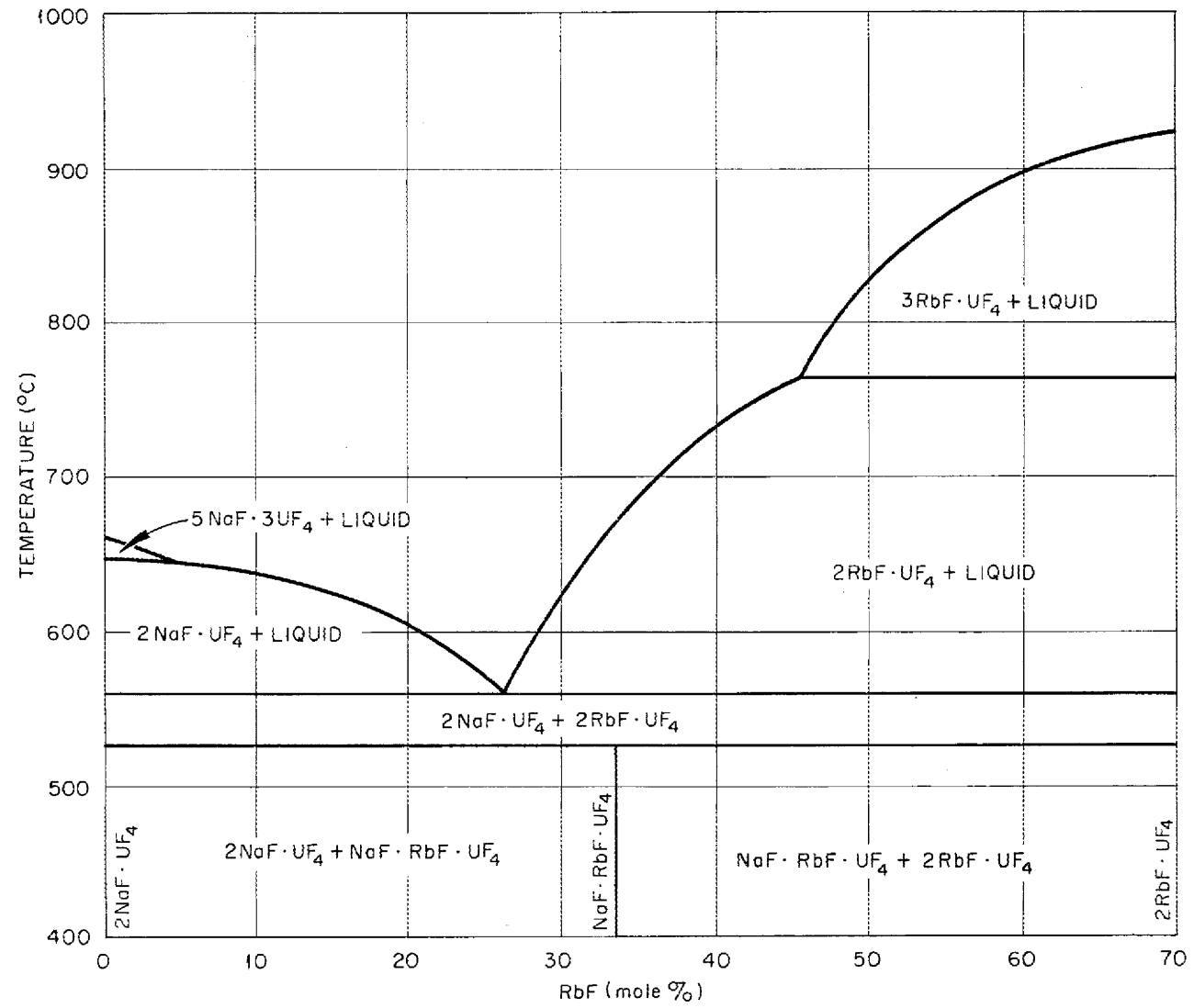
Liquidus Temperatures in the System NaF-ZrF<sub>4</sub>-UF<sub>4</sub>.



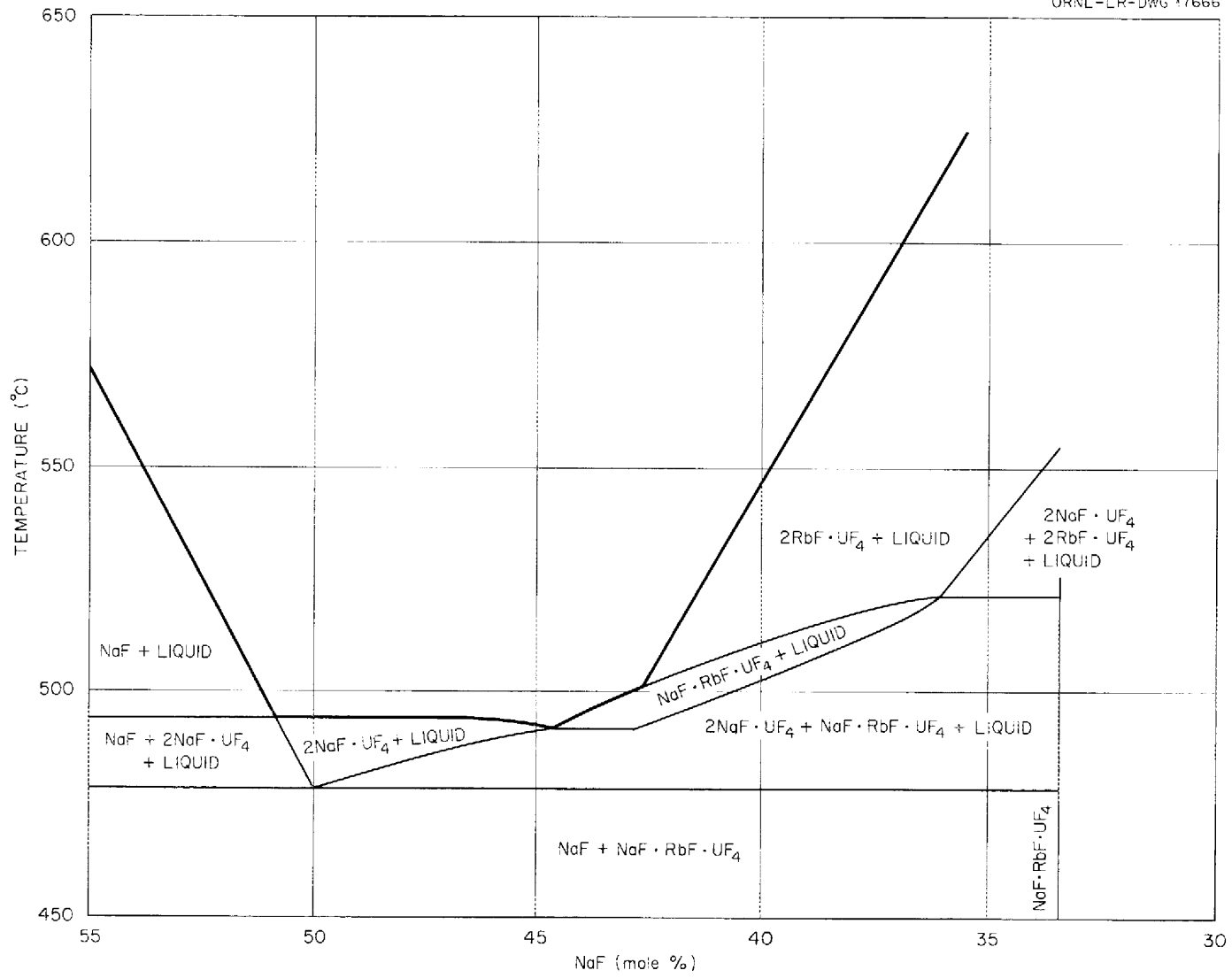
The System  $7\text{NaF} \cdot 6\text{ZrF}_4 - 7\text{NaF} \cdot 6\text{UF}_4$ .

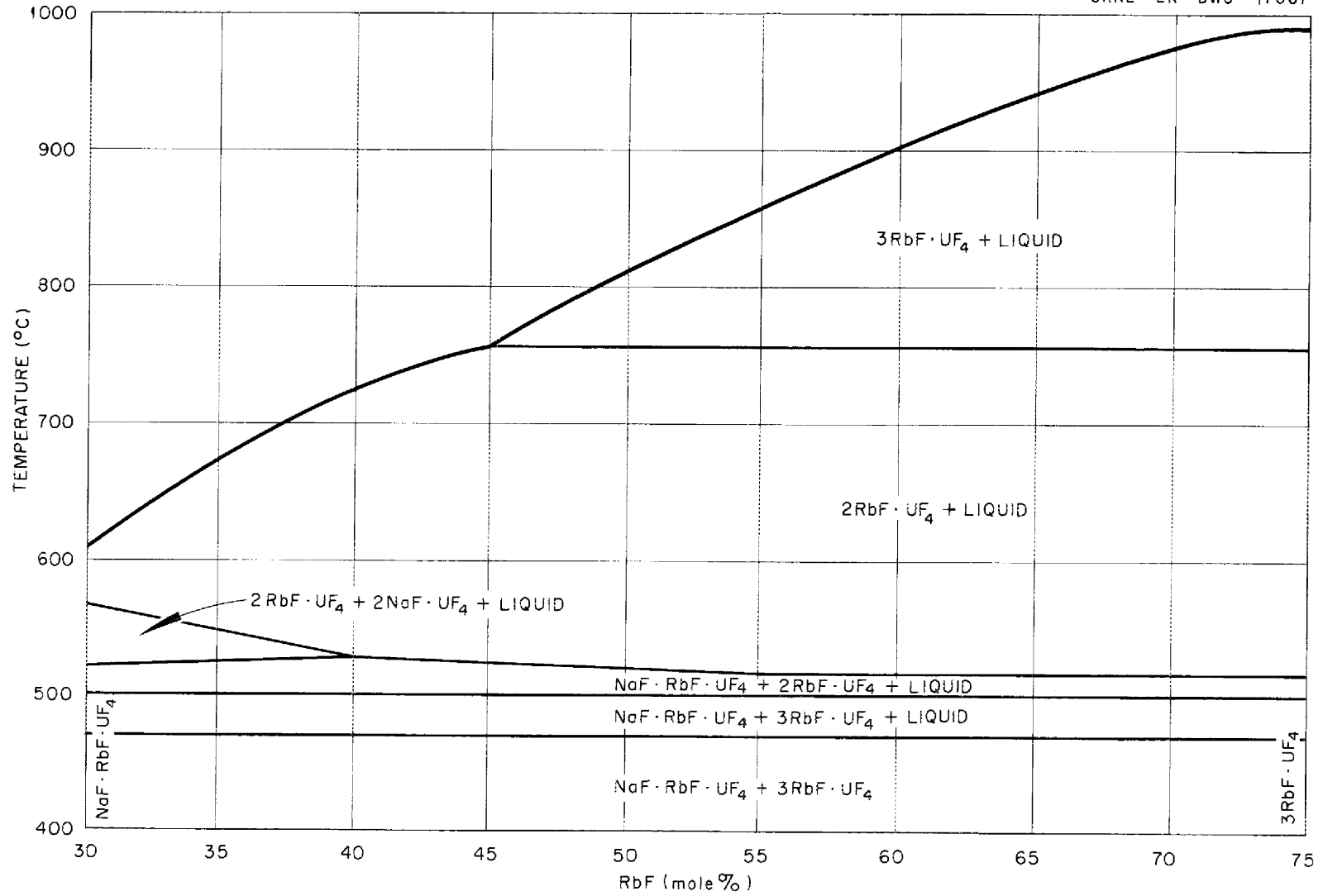


The Join  $7\text{NaF} \cdot 6\text{UF}_4 - 7\text{LiF} \cdot 6\text{UF}_4$ .

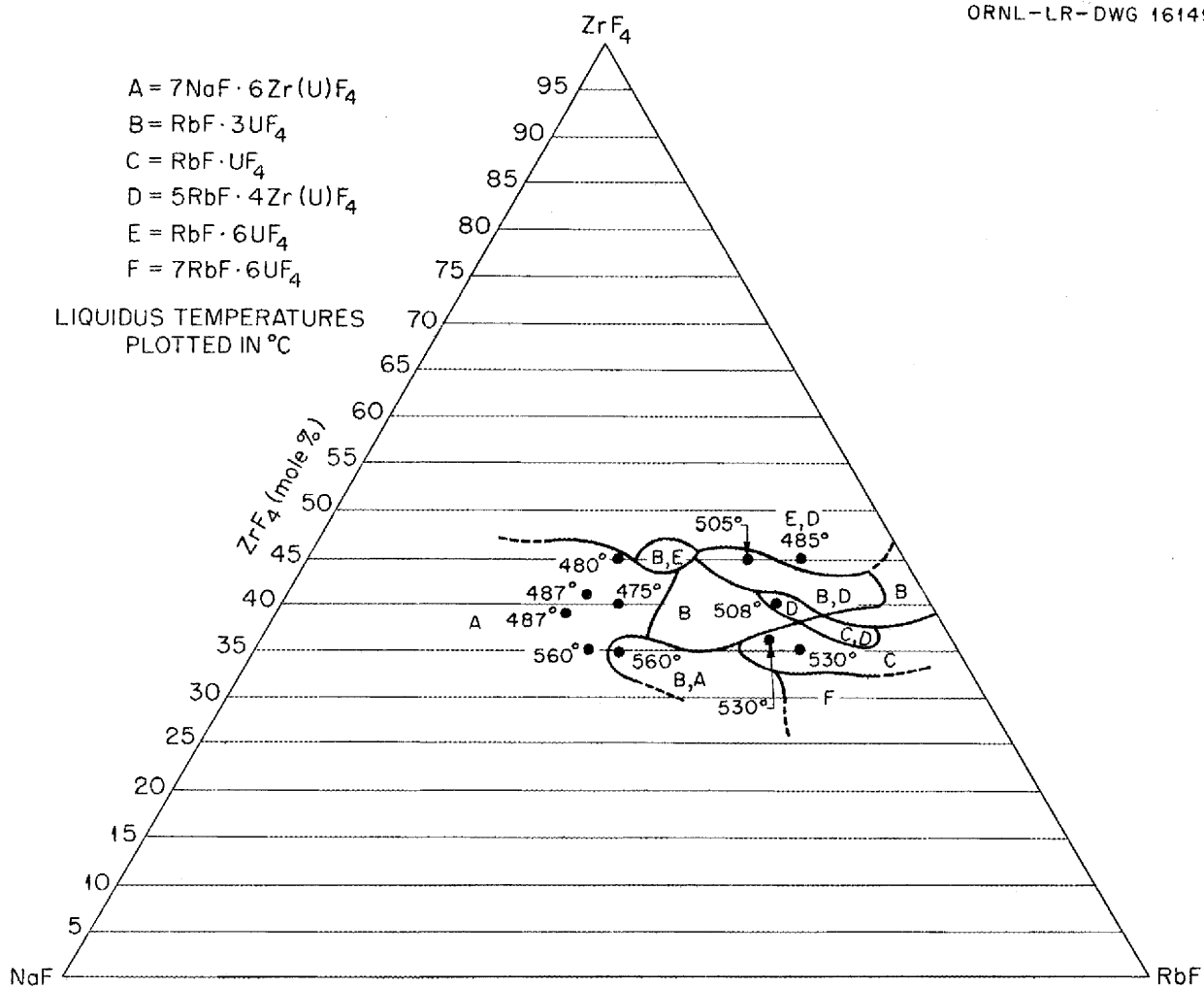


The Join  $2\text{NaF}\cdot\text{UF}_4$ - $2\text{RbF}\cdot\text{UF}_4$ .



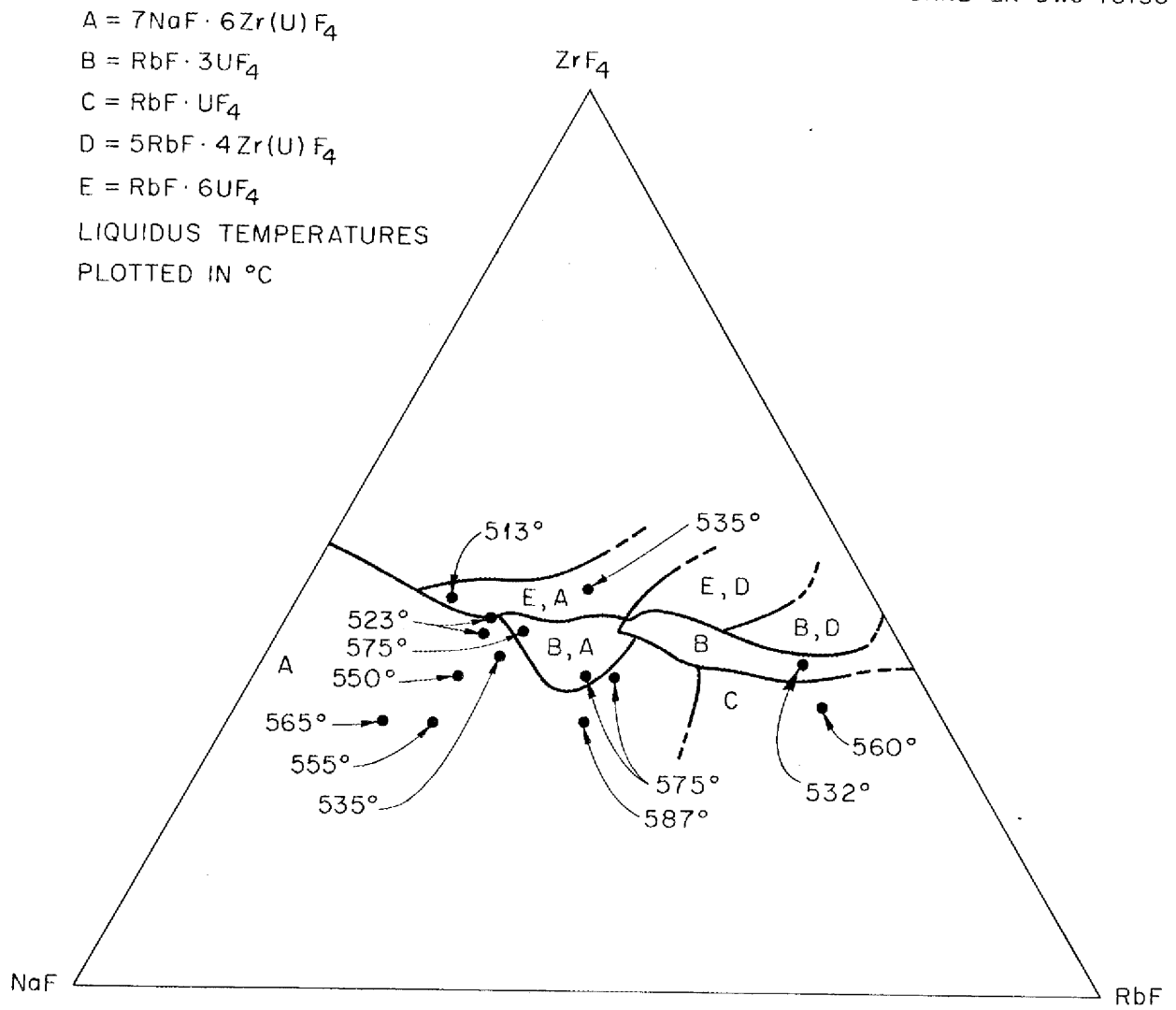


The Join NaF · RbF · UF<sub>4</sub> - 3RbF · UF<sub>4</sub>



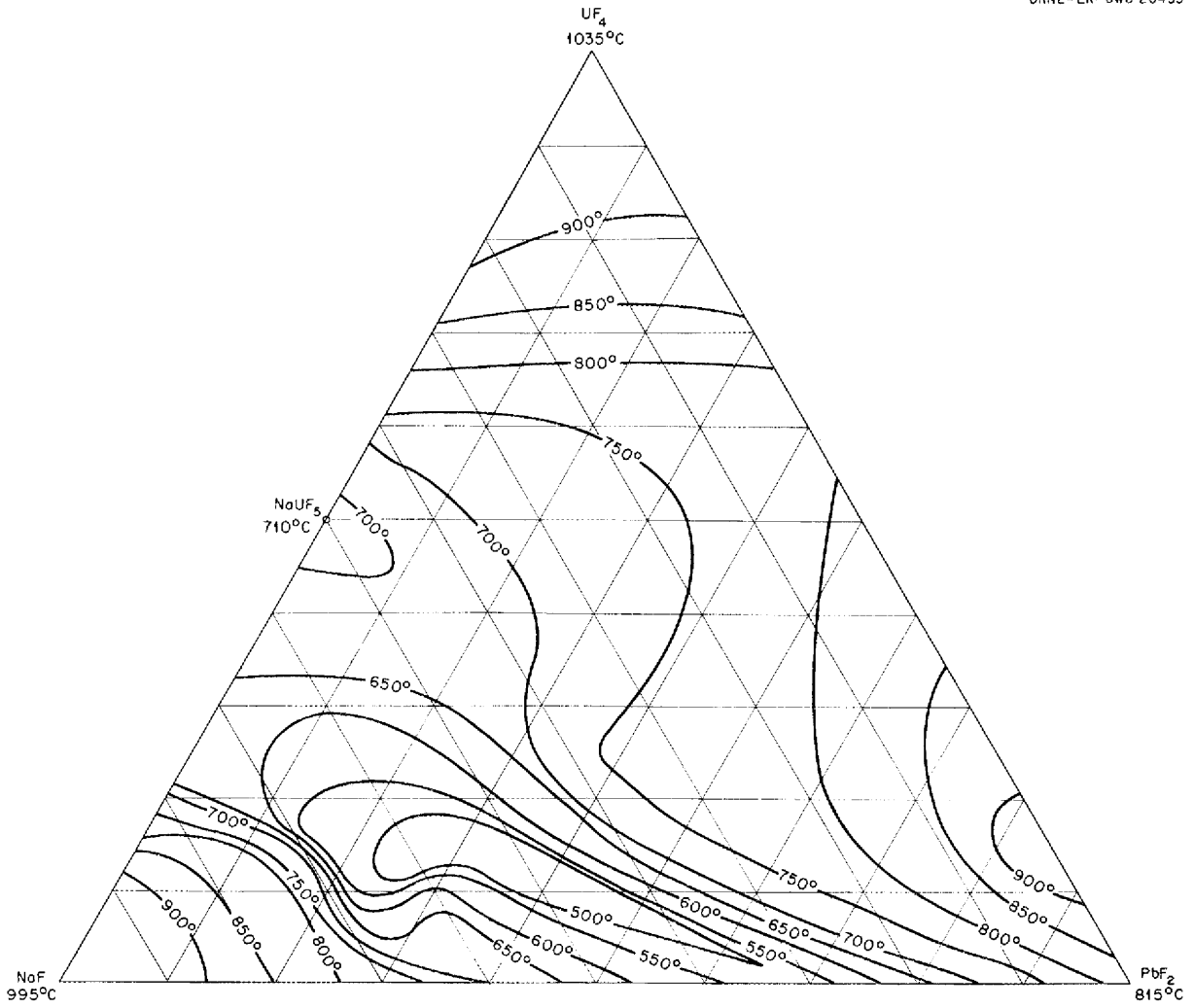
Primary and Secondary Uranium-Containing Phases in the System NaF-RbF-ZrF<sub>4</sub>-UF<sub>4</sub> with 4 Mole % UF<sub>4</sub>.





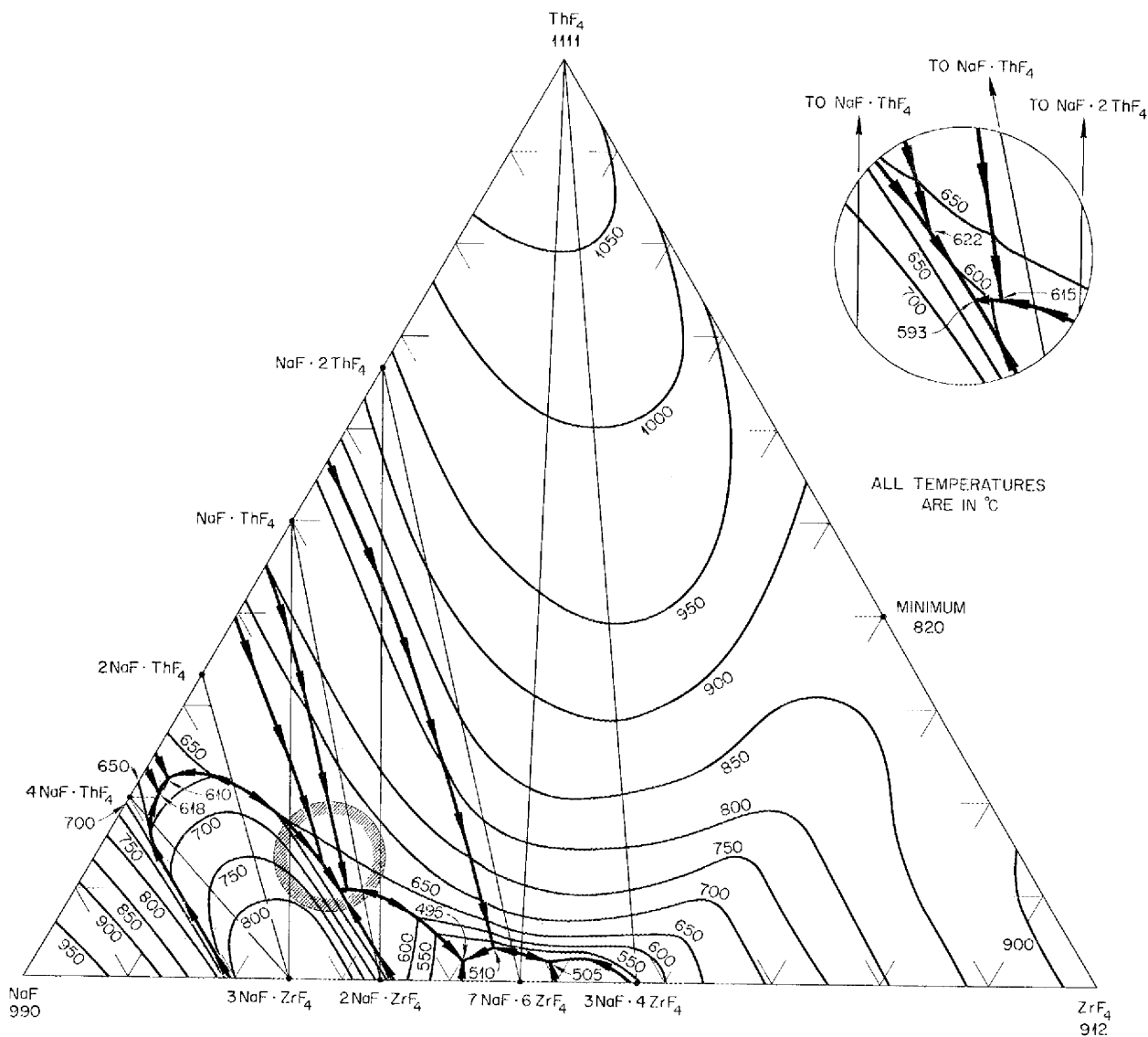
Primary and Secondary Uranium-Containing Phases in the System NaF-RbF-ZrF<sub>4</sub>-UF<sub>4</sub> with 7 Mole % UF<sub>4</sub>.

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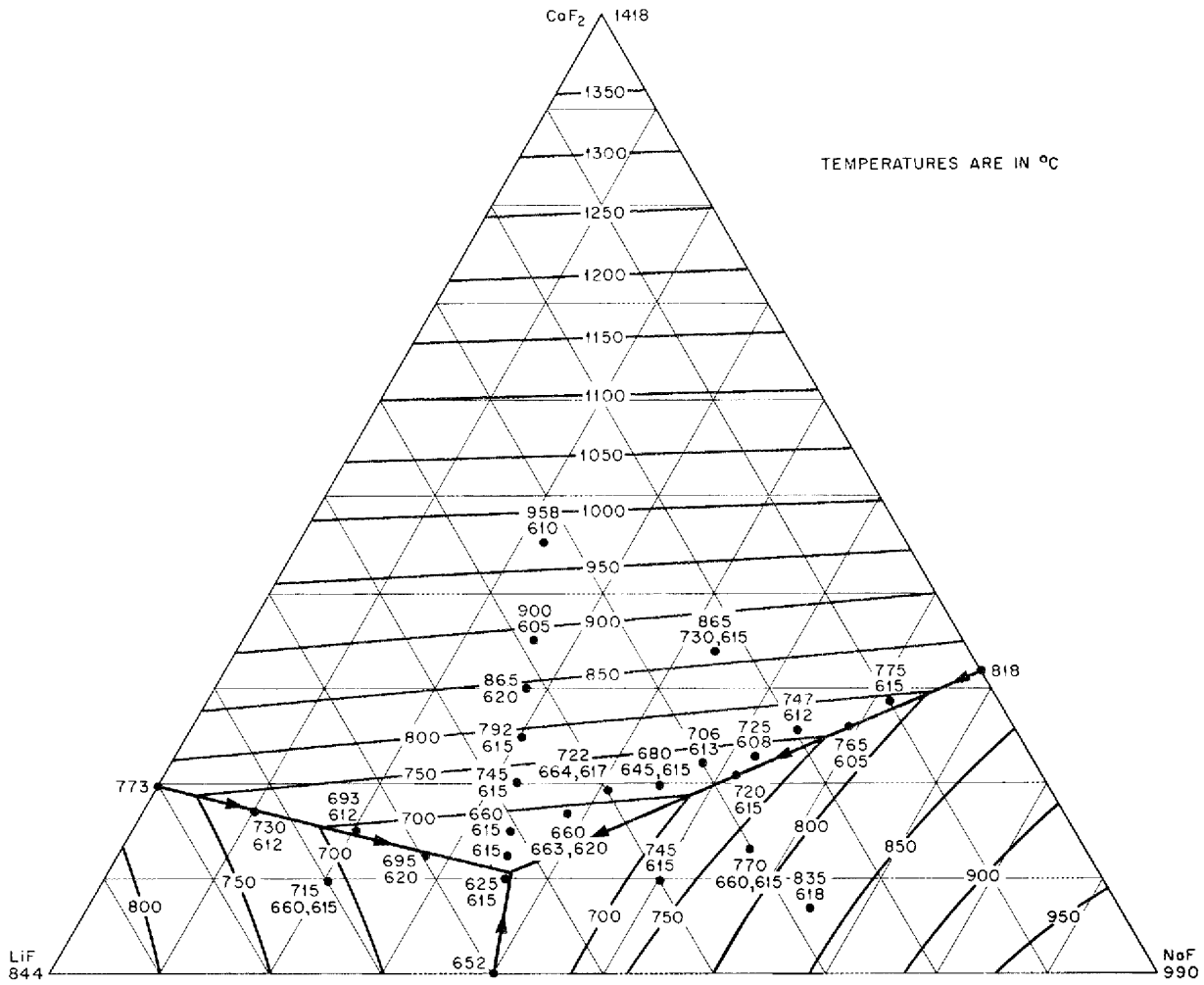
The System NaF-PbF<sub>2</sub>-UF<sub>4</sub>.

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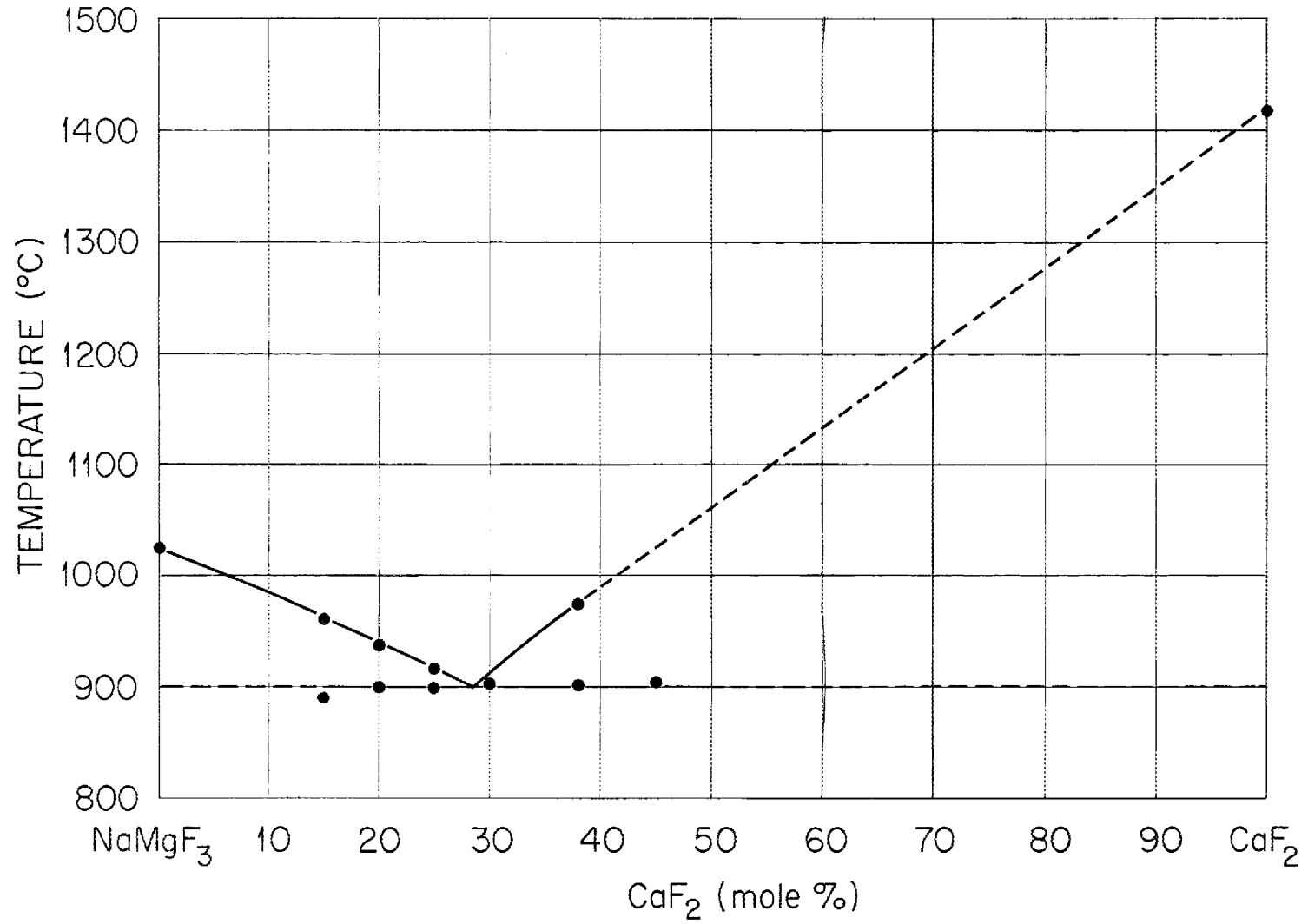
The System NaF-ZrF<sub>4</sub>-ThF<sub>4</sub>.

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ORNL-LR-DWG 12779



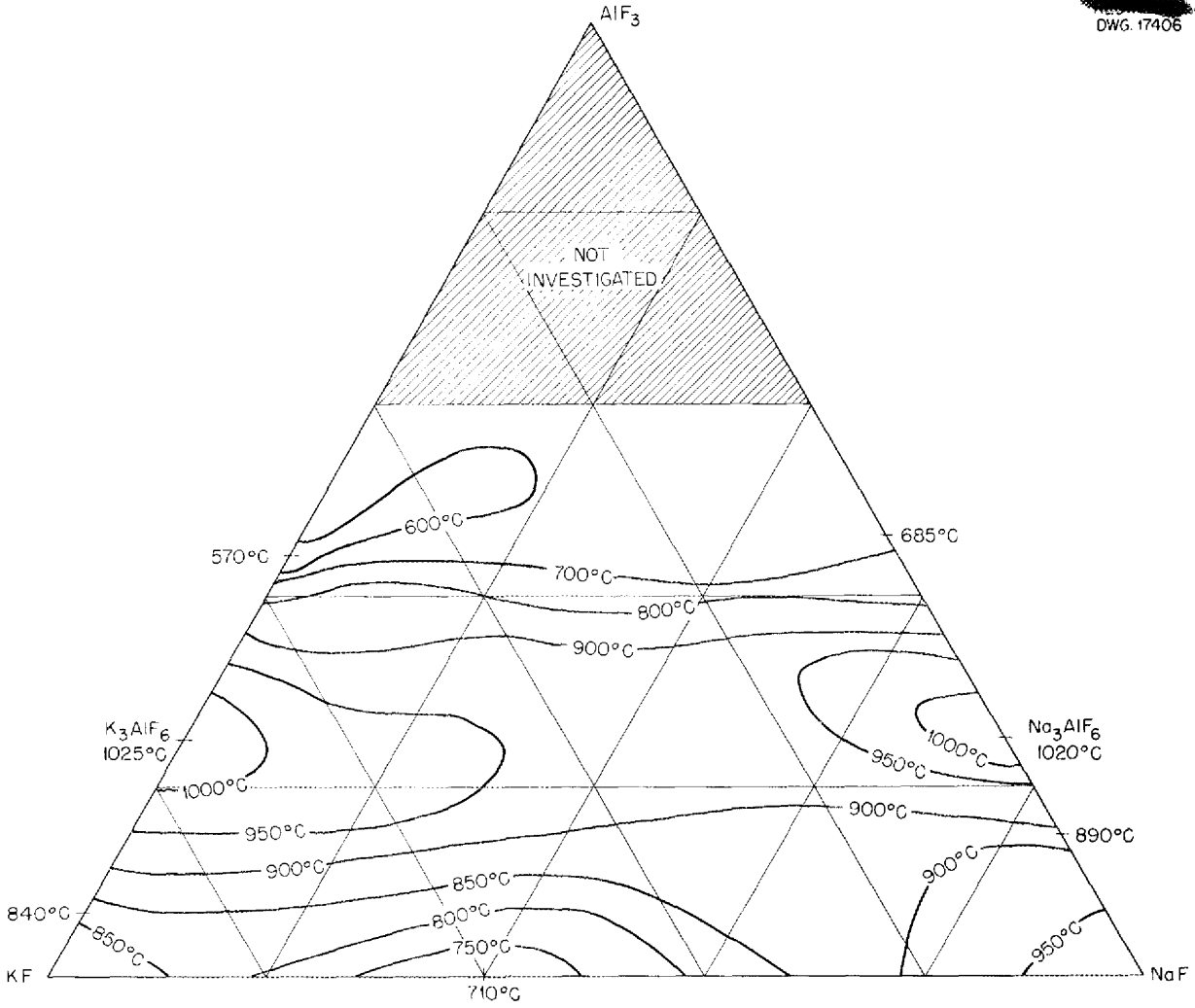
The System LiF-NaF-CaF<sub>2</sub>.

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ORNL-LR-DWG 12780



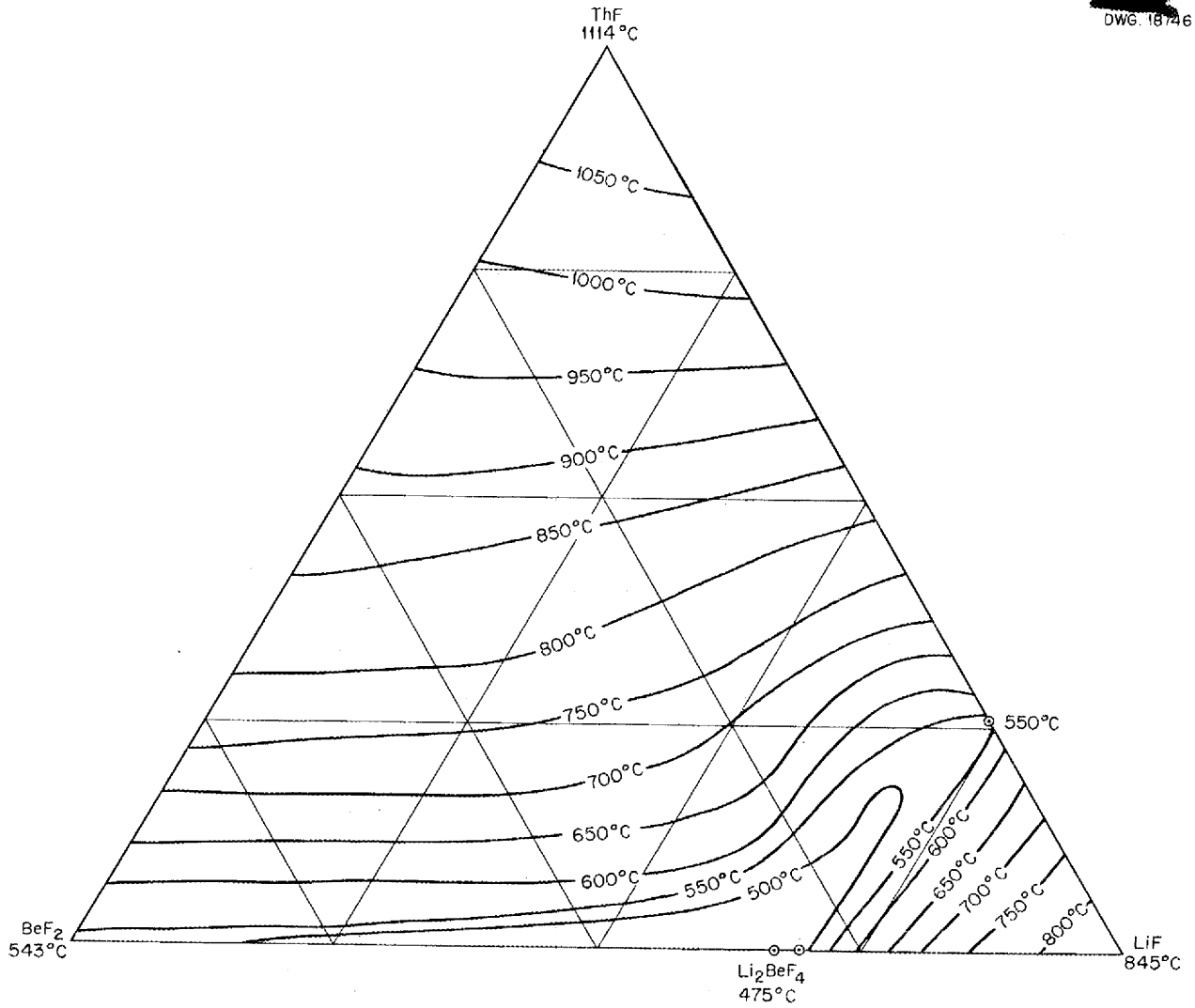
The System NaMgF<sub>3</sub>-CaF<sub>2</sub>.

DWG. 17406



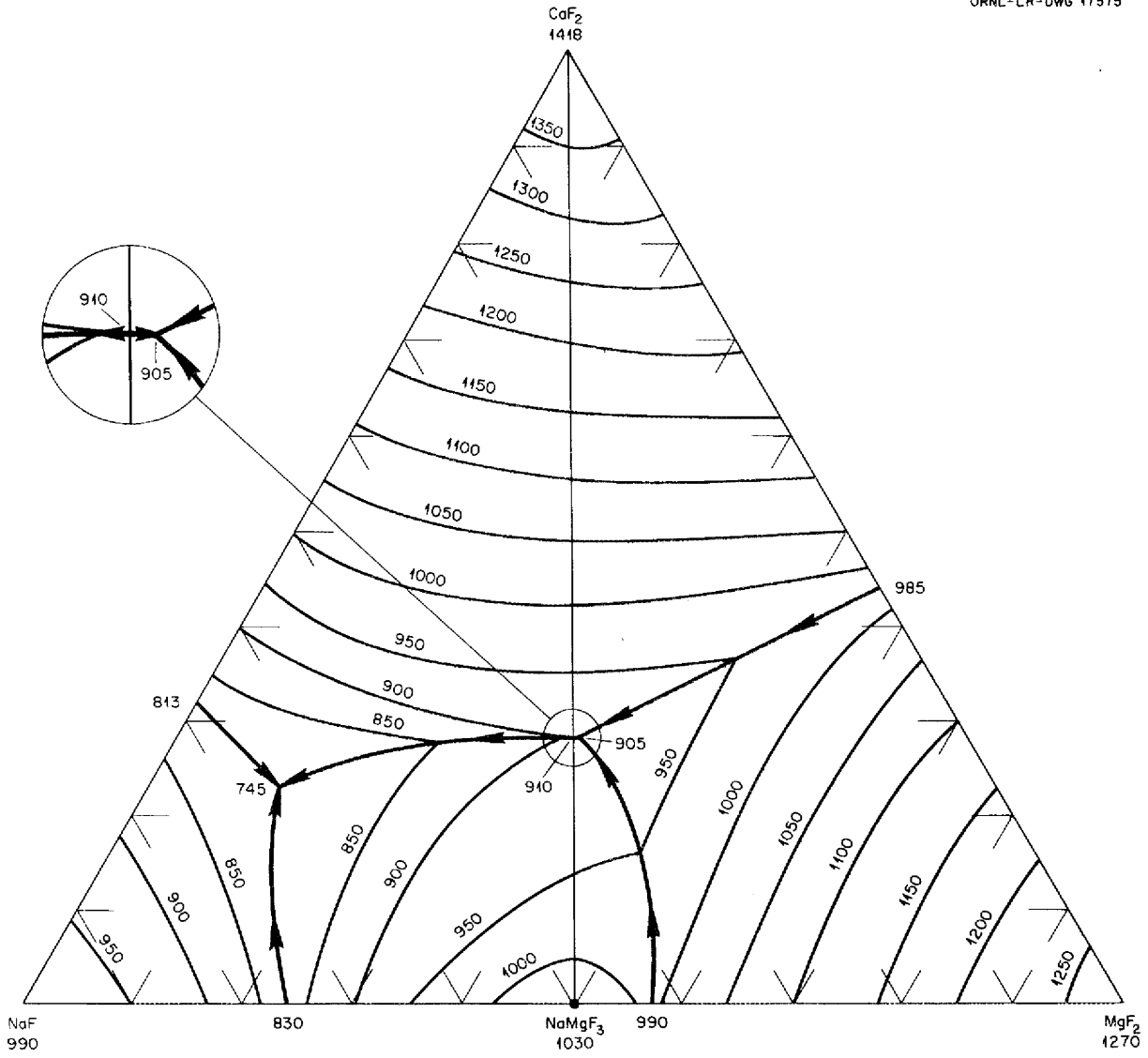
The System KF-NaF-AlF<sub>3</sub>.

DWG. 18746



The System BeF<sub>2</sub>-LiF-ThF<sub>4</sub>

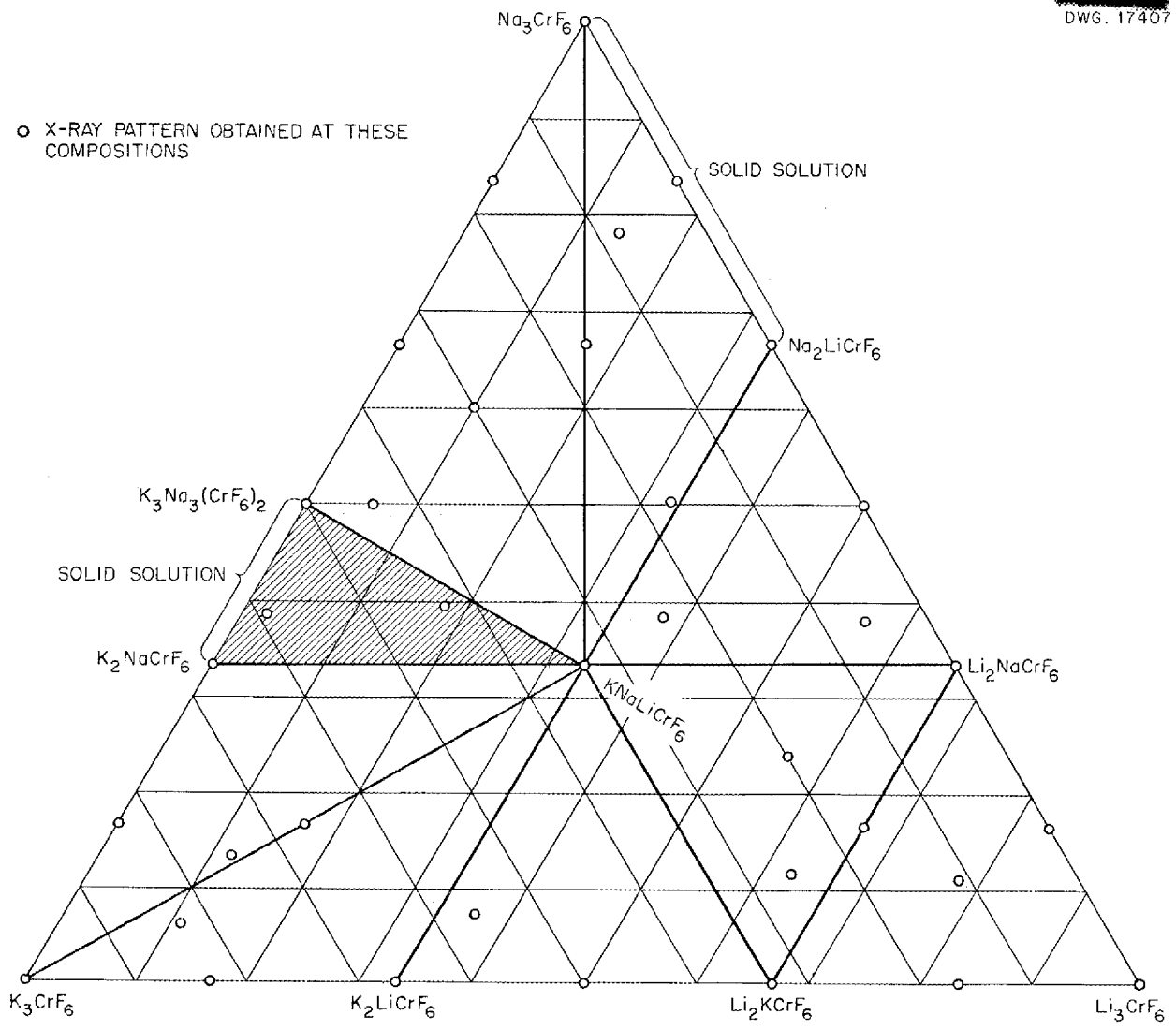
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ORNL-LR-DWG 17575



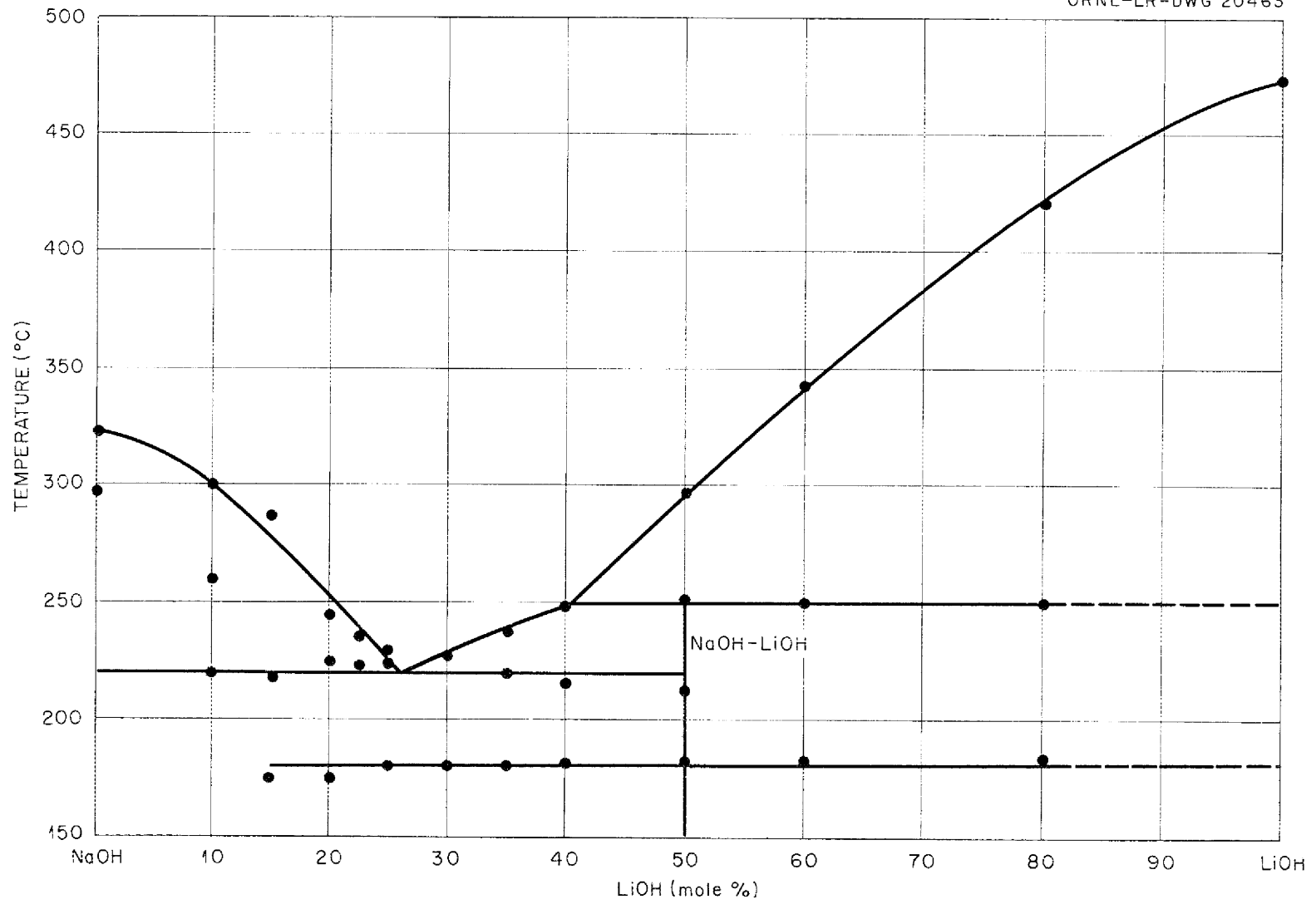
The System NaF-MgF<sub>2</sub>-CaF<sub>2</sub>.



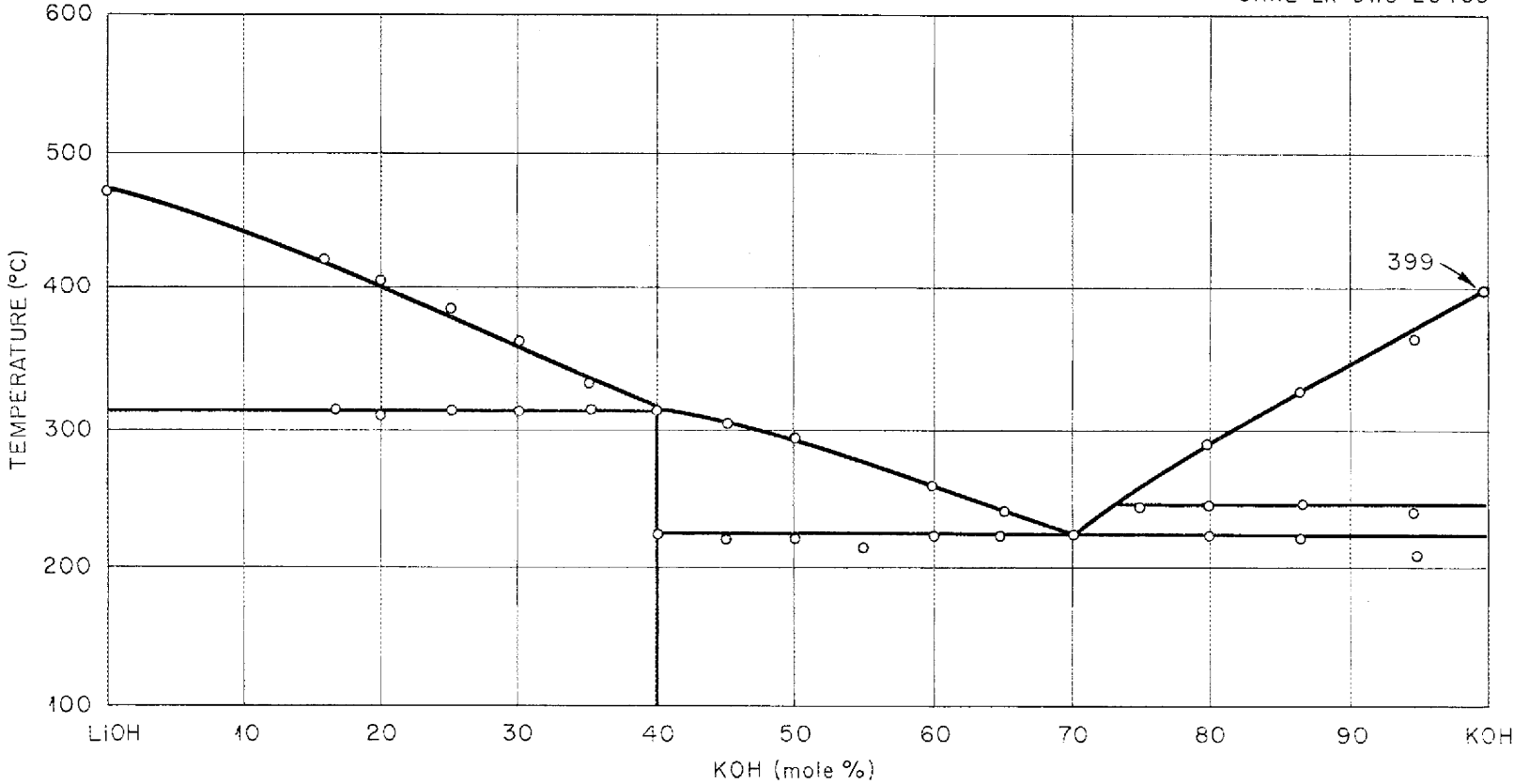
DWG. 17407



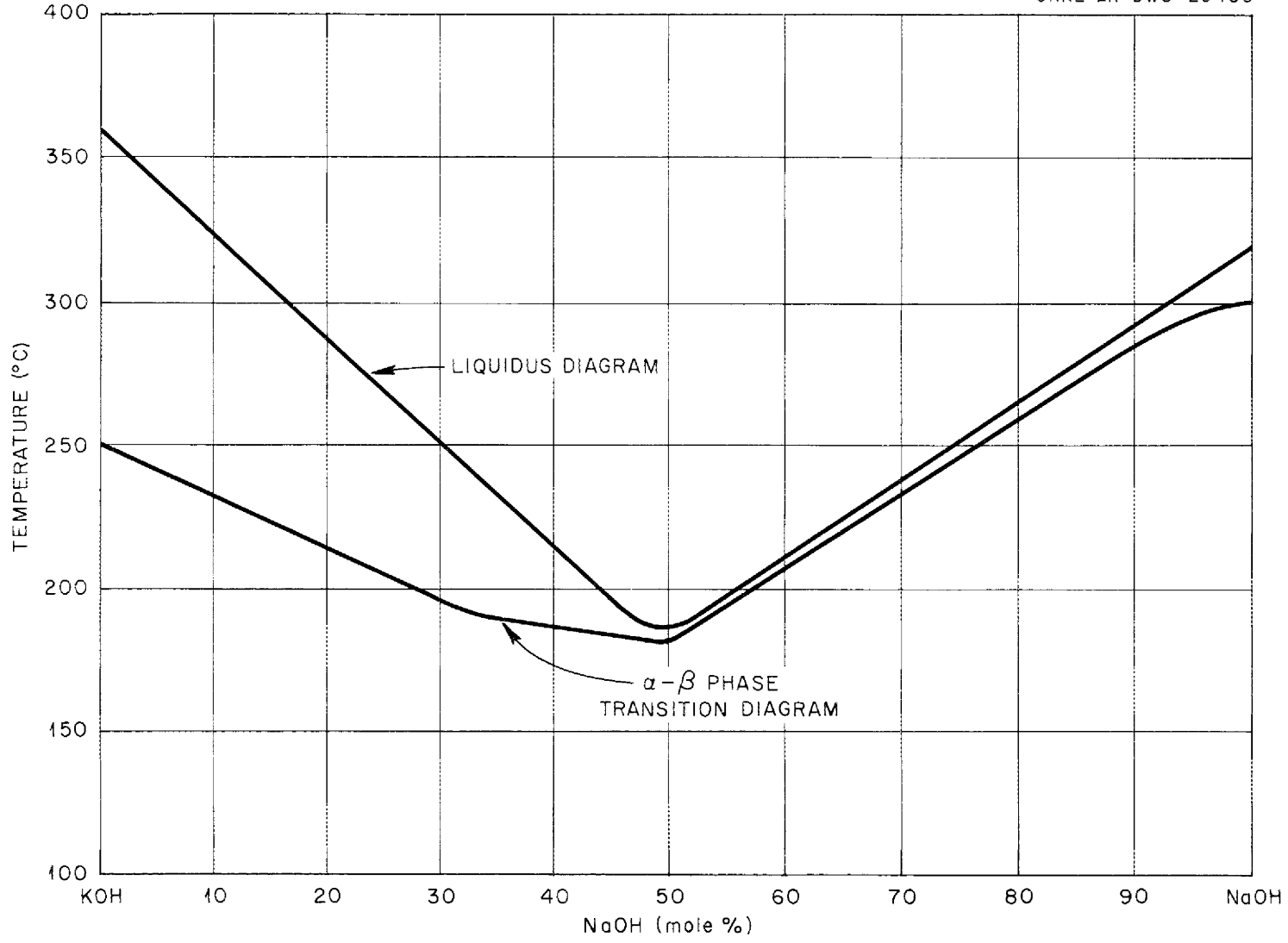
The System  $\text{K}_3\text{CrF}_6$ - $\text{Li}_3\text{CrF}_6$ - $\text{Na}_3\text{CrF}_6$ .



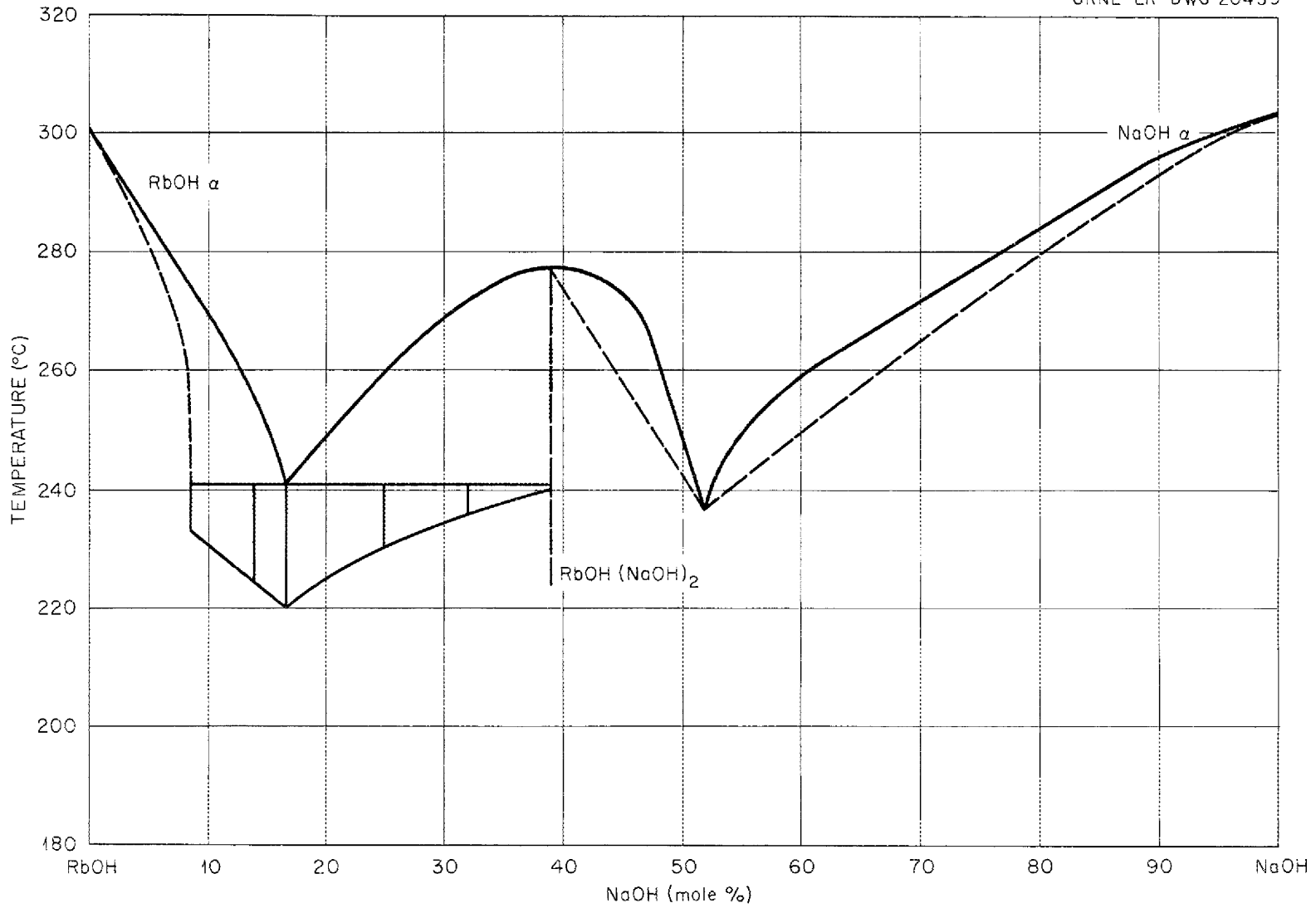
The System NaOH-LiOH.



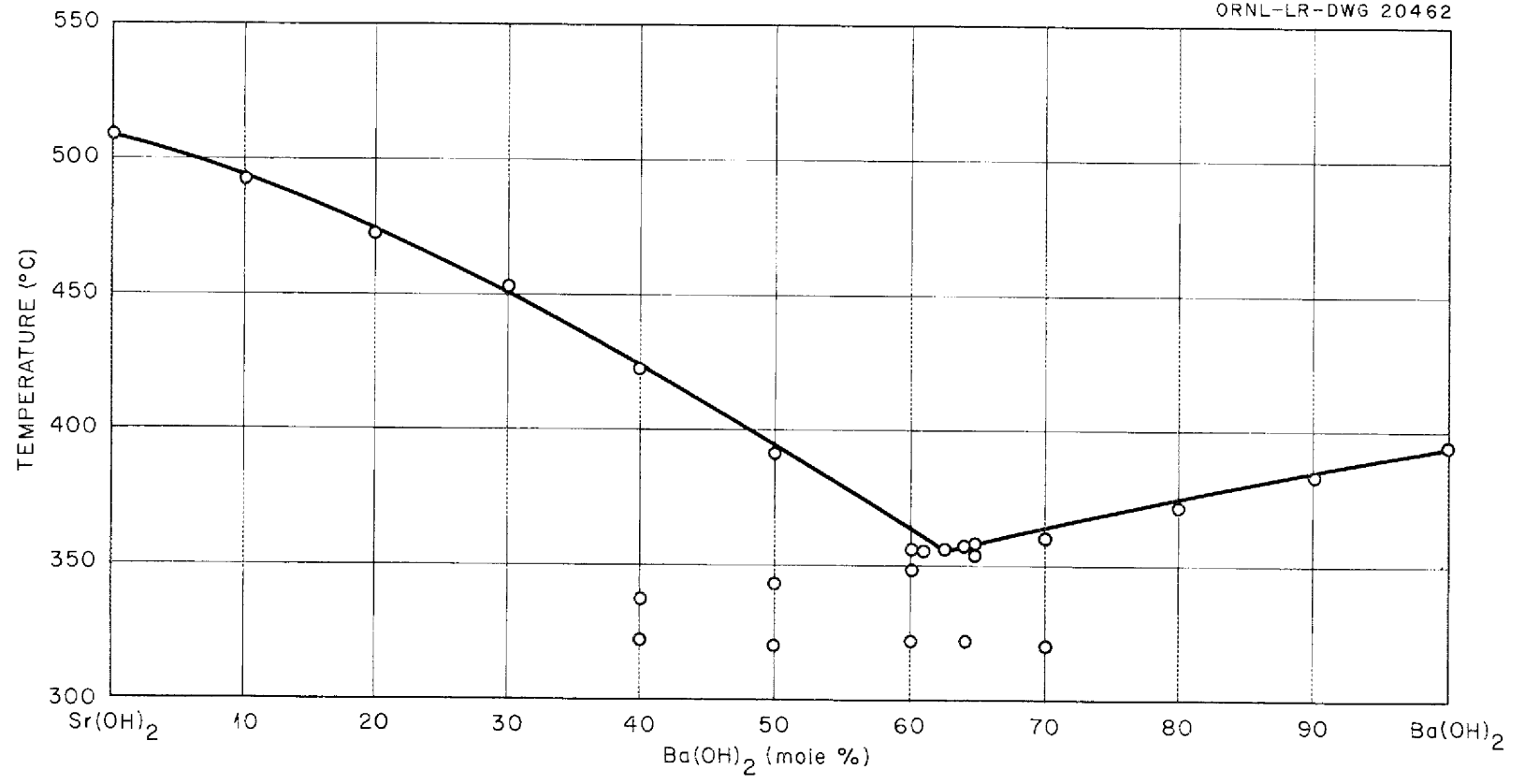
The System LiOH-KOH.



The System KOH-NaOH.



The System RbOH-NaOH.



The System Sr(OH)<sub>2</sub>-Ba(OH)<sub>2</sub>.