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ANL/NSE-24/28

Zero Power Reactor Database (ZPRD) Development Plan

Nuclear Science and Engineering Division

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Zero Power Reactor Database (ZPRD) Development Plan

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EXECUTIVE SUMMARY

Past sodium-cooled fast reactors (SFR) were built with an active experimental program in place to support the design and development work. Most of the experimental facilities in the United States that were important for SFR design were shutdown in the 1980s and 1990s. Reactor licensing and construction requires any reactor design to be verified against existing reactor facilities or experimental measurements. With the absence of those experimental facilities, modern SFR projects must rely on historical measurements to demonstrate that the engineering modeling software and data being used for the new reactor design work are reliable. There has been a considerable push in the last 6 years by both DOE and commercial companies to obtain historical experimental measurements that are relevant for SFRs, in particular those with features that are important for the new reactor designs of interest.

The zero power reactor experiments carried out at Argonne National Laboratory's critical facilities (ZPR-3, ZPR-6, ZPR-9, and ZPPR) from the 1950s to the 1980s are some of the best reactor physics experiments on SFR technology that are available today. Of particular interest today are the ZPPR-15 measurements done at the ZPPR facility for the Integral Fast Reactor project in the 1980s as they are in line with most commercial and DOE interests today. In the past 10 years, the measurements done on ZPPR-15 have been processed into both Monte Carlo (MCNP) and deterministic models (MC^2-3 and DIF3D) useable for validating the engineering modeling software for key parts of the SFR design work. To achieve this, a detailed model description must be created for the experiment and the experimental measurement that the engineering modeling software is to reproduce. Then, an assessment of the uncertainty on the measured quantity which considers all of the sources of uncertainty in defining the model must be obtained and documented. The models created for ZPPR-15 provide the best validation basis available today for neutronics modeling software. Reference 2 is a good resource to understand how these models were built and how the uncertainties on the measured quantities were derived.

The intention of the Zero Power Reactor Database (ZPRD), hosted at frdb.ne.anl.gov, is to make available the experimental measurements and models that have been constructed to-date. Though ZPPR-15 measurements are the primary data requested for validation needs, other measurements on ZPPR, ZPR-6, and ZPR-9 in support of the Clinch River Breeder Reactor (CRBR) and Fast Test Reactor (FFTF) should also be considered important for future software validation needs. In this manuscript, the details of available measurements on ZPR-3, ZPR-6, ZPR-9, and ZPPR facilities are summarized, and a general organization of the web interface is displayed. Many of the documents associated with the measurements are export controlled information so access to the database will also have to be controlled.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 Introduction

Argonne National Laboratory (ANL) operated four split-table critical experiment facilities, ZPR-3, ZPR-6, ZPR-9 and ZPPR, between 1955 and 1990. ZPR is the abbreviation for Zero Power Reactor, and ZPPR was the abbreviation for Zero Power Plutonium Reactor which was changed to Zero Power Physics Reactor in the 1980s due to negative views on Plutonium breeding and proliferation concerns. ZPR-3, ZPR-6, ZPR-9 and ZPPR were four reactors in a series of zero power reactors (or lower power reactors) designed at Argonne in the 1950s and 1960s. For detailed information on these experimental facilities a good starting point are references [1,2].

The first ANL split-table critical experiment facility, ZPR-3 or ZPR-III, was constructed at Argonne's facilities in southeast Idaho. These facilities were frequently referred to as Argonne National Laboratory-West or ANL-W until they became part of Idaho National Laboratory in October 2005. The first ZPR-3 assembly program began in 1955, and the last ZPR-3 critical assembly program ended in 1970.

ZPR-6 or ZPR-VI, the second Argonne split-table facility, was constructed in the early 1960s in Building 315 at the Argonne National Laboratory site in Illinois. ZPR-6 operated from 1963 until 1982. Until the formation of Idaho National Laboratory, the Argonne site in Illinois was often referred to as Argonne National Laboratory-East or ANL-E. After the formation of Idaho National Laboratory, the ANL-E designation became meaningless.

The third Argonne critical experiment facility, ZPR-9 or ZPR-IX, was constructed in Building 315 at ANL-E in parallel with or shortly after completion of ZPR-6. ZPR-9 operated from 1964 until 1981. The reactor cells, or rooms, housing the ZPR-6 and ZPR-9 machines were located on opposite sides of a common workroom and vault, and the same staff operated both facilities. ZPR-6 and ZPR-9 used the same inventory of materials for critical experiments.

ZPPR, the fourth and largest of Argonne's critical experiment facilities, was constructed at ANL-W in the late 1960s. The first ZPPR critical experiment program began in 1969. The last ZPPR critical experiment program ended in 1990.

Critical experiment facilities are operated for various purposes. Some critical experiments are designed to provide basic nuclear data in a particular energy range or for particular materials. Some critical experiment facilities were intended primarily to provide data to support the criticality safety of production operations at the site where the critical experiment facility was located. The critical experiment facilities at Oak Ridge National Laboratory and Rocky Flats, for example, primarily supported operations with fissionable material at those sites.

Argonne's four critical experiment facilities were originally designed to support the development of sodium cooled fast reactors (LMFRs, LMFBRs or LMRs). The experiments conducted at Argonne's ZPR/ZPPR facilities ranged from basic fast reactor physics measurements to very detailed simulations of specific reactor designs and various configuration possibilities. The ZPR/ZPPR measurements provided data to support the designs of EBR-II, Fast Flux Test Facility (FFTF), Southwest Experimental Fast Oxide Reactor (SEFOR) and the Clinch River Breeder Reactor (CRBR) among others. Because all of the machines were flexible, there are several instances where the ZPR/ZPPR machines were used to model fast reactors not considering sodium coolant (gas cooled, nuclear rockets, etc…).

Because there are no operating critical experiment facilities that can support present day fast reactor design, some of the accumulated ZPR/ZPPR data is deemed vital to support present day reactor design efforts. In this report, the types of information available from legacy ZPR and ZPPR data and its potential uses are discussed with regards to commercial entities. As the intention of the present project is to create an outward facing database for commercial and non-commercial collaborators, the basic layout details of the web interface are proposed here and their implementation will be the focus of the coming year(s) work.

2 Available ZPR and ZPPR Data and Potential Uses

Each ZPR/ZPPR experimental machine had its own program and thus own experiments. In many cases, the same types of experiments were done such as sodium void worth or foil reaction rate measurements. Table 2.1 provides a list of the experiments that might be of interest to industrial users and a symbol that will be used in the follow on tables for each machine to indicate what experimental measurements are available.

Given Table 2.1, the assemblies in ZPR-3 that have been processed are listed in Table 2.2. As seen, a short description of the purpose of each assembly is given. For ZPR-6, ZPR-9, and ZPPR there is an available reference that summarizes the assemblies [1]. For ZPR-3 there is no such document and thus investigative work is required just to determine what the purpose of the assembly was and what experiments were available. Included in Table 2.2 is an indication of how many MCNP models [3] exist today for each assembly. As seen, there is typically only a single MCNP model indicating that the reference critical configuration of the assembly was modeled. While there may be hundreds of individual loadings, unless special experiments were conducted, there is little validation purpose to modeling all of the loadings. It is noteworthy to point out that this table does not list the number of MC^2+DIF3D models [4-6] available. This is primarily because there are relatively few DIF3D models available for most of the ZPRD assemblies. In the case of ZPR-3, there are none.

From the list of experiments that were done in each ZPR-3 assembly, it should be clear that a single MCNP input will not cover all of those experiments. For sodium void worth or simulated control rod worths, these require at least one loading per measurement. Similarly, for the Doppler sample worth, this will be a separate loading from the reference critical configuration. In the case of ZPR-3/48, two MCNP models are present for two reference critical configurations. As seen, there are several other experiments done on this assembly, all of which correspond to more loadings which have not been processed. At present most of the ZPR-3 loading details are available, but the details on the experiments beyond those processed are unknown. The experiments were carried out as the available documentation indicates that, but the specific experimental measurement might not be available or might be converted to a form that is not easy to match with today's modeling and simulation capabilities. The reader should refer to reference [2] for further details on modeling experimental measurements in the ZPR and ZPPR machines.

The list of assemblies for ZPR-6 and a brief description of their purpose is provided in Table 2.3. As seen, only 10 total assembly programs are available. The shading applied to the first four assemblies is to indicate that the loading records are not available, and thus models cannot be created. ZPR-6/8 is also shaded as it was never built, and thus there is no experimental data available for it. Most of the remaining assemblies have been processed and only include the reference critical configuration. Models for ZPR-6/5 can be created, but there is likely little interest in carbide fuel forms today. Except for ZPR-6/7 there is only a single MCNP model for the reference critical configuration. For ZPR-6/7, many sodium void worth and simulated control rod experiments were modeled. Based upon past experience, the various reports will have published experimental results for the experiments listed in Table 2.3 and thus if models are not already available, it is possible to create them.

Table 2.1. List of Experiments carried out in ZPR-3, ZPR-6, ZPR-9, and ZPPR

Symbol	Experimental Measurment
B	Radial bowing – plate rearrangements and bowing oscillators
BR	Breeding ratio (derived from foil measurements)
B0	^{10}B reaction rate measurements
C	Criticality
CA	Calandria – measurements of various parameters in a pin zone created in a ZPR/ZPPR core for comparison with a corresponding plate configuration
CR	Control rod worth – measurements of the reactivity worth of simulated control rods
D	Doppler sample worth – Doppler reactivity worth of various types of samples
F	Reaction rate measurements using small foils and occasionally in-core fission chambers
G	Gamma flux measurement with thermoluminescent dosimeters (TLDs)
E	Axial expansion
ES	Eigenvalue separation
I	Importance measured via ^{252}Ca source traverse
K	Kinetics parameter measurements
L6	^{6}Li reaction rates (measured in ZPPR-13)
LV	Lithium void worth (measured in ZPPR-20)
NC	Noise coherence measurements
NN	Neutron noise measurements
NS	Neutron spectrum measured with proton recoil spectrometer
P0	^{240}Pu – A zone with high ^{240}Pu content was created in several assemblies. Various measurements were made in the high ^{240}Pu zone.
RW	Reflector worth – The space reactor assemblies simulated reflector control of a space reactor. A few other assemblies measured room return by changing the reflector.
SC	Sodium capture
SD	Spatial decoupling
SH	Shield measurements – A simulated shield was built in several assemblies. Reaction rates, gamma flux and other prameters were measured in the shield zone.
SM	Sodium manometer – The reactivity worth of a sodium manometer was measured.
SV	Sodium void worth – The reactivity worth of sodium voiding was measured in many assemblies. Measurements sometimes included sodium voiding in pin zones created with calandria.
SW	Subassembly worth – The reactivity worth of a simulated subassembly (a small array of core drawers) was measured.

Note that in many cases the experimental measurements may require deterministic methodologies as Monte Carlo cannot obtain a solution with realistic computational effort, and the user is referred to reference [2] for more details.

The list of assemblies for ZPR-9 and a brief description of their purpose is provided in Table 2.4. For ZPR-9 there were 36 assemblies and as was done for ZPR-6, the assemblies where no loading records are available, or those which were not built, are shaded to indicate that no models can be built. More than half of the assemblies with loading data have already been processed with a major focus again on the critical reference configuration (note that ZPR-9/1 through ZPR-9/9 all have just the critical reference evaluated). The exception is the GCFR series of assemblies ZPR-9/28 through ZPR-9/30. In these cases there are 3 critical reference configurations and additional models of some of the other experiments. Because these are for a gas cooled fast reactor, that aspect likely has low interest to commercial companies today. ZPR-9/26 and ZPR-9/27 are likely the most valuable ones today with ZPR-9/32 being of some interest. However, without loading records for ZPR-9/26 and ZPR-9/27, the ZPR-9 machine has little to offer for sodium cooled fast reactors today.

The list of assemblies for ZPPR and a brief description of their purpose is provided in Table 2.5. As seen, there were 21 assembly programs completed and the loading records for ZPPR-1 are the only ones not available. This is because the medium upon which the ZPPR-1 records were stored was deemed “not scannable.” Many of the models built are focused on reference critical configurations except for ZPPR-15. This is primarily as ZPPR-15 was exclusively focused on validation of sodium cooled, metal fueled fast reactors. Many of the ZPPR-15 experiments have been modeled with MCNP or MC^2-3 & DIF3D. Given the heavy focus of current industry partners on the ZPPR-15 data, making these models available is the initial focus of the ZPRD web interface. While ZPPR-15 stands out as the most valuable for present industry interest, there is still some potential interest in the various CRBR mockups or even the Jupiter series.

With the available ZPRD assemblies detailed and the available experiments listed, some discussion on the usefulness of that data is appropriate. Without an experimental program available to build mockup facilities, one has to rely more on models and simulation. Fortunately today’s computing capabilities are so far beyond that available in the 1970s or 1980s that one can rely more upon them than was done in the past. Given that MCNP or deterministic models both rely upon cross section data and its processing, it should be clear that having experimentally measured data consistent with the reactor design of interest that can be used as part of the validation basis for the modeling and simulation codes is vital for this approach to work. This is in essence what the ZPRD is focused on providing. While ZPPR-15 is of particular interest for most commercial reactor designs, several of the other ZPRD assemblies have features which can be supportive in software validation.

At present, MCNP (and the cross section libraries it has available) do very well calculating the criticality of the ZPPR-15 assemblies. The availability of a significant number of highly precise criticality measurements with low uncertainties has clear implications on criticality predictions. For routine reactor design and safety analysis, precise measurements of criticality are only important if the experiment of interest matches the safety analysis model. A more important consideration for reactor design is the control rod worth as this impacts the allowable excess reactivity at the beginning of a cycle and thus the cycle length, etc… Safety analysis would be concerned with inaccuracies in the reactivity coefficients due to cross section data problems or simple modeling problems. As an example, an uncertainty in the delayed neutron fraction β for Pu dominated fueled systems can be rather restrictive for reactor design and thus having a measurement that confirms the reliability of the modeling and simulation codes can be quite useful. Thus beyond just the criticality measurements that ZPRD assemblies provide, the various experiments carried out in ZPRD assemblies can be valuable as a validation basis for the modeling and software codes.

Looking at the list of experiments done in ZPRD assemblies in Table 2.1, one can easily identify criticality (C), the control rod worth (CR), and the kinetics (K) as important measurements. Criticality measurements are of course standard and one can find CR measurements in many ZPRD assemblies. In contrast there are only a few kinetics measurements listed in the tables and only the ZPR-9/32 one has potential to be of interest to current industry users. The importance (I) measurements are similar to the kinetics measurements and would be similarly valuable with regard to software validation. The Pu-240 configurations (P0) pose as non-fresh fuel environments for a variety of measurements and thus can be useful.

The foil reaction rate measurements (F), and foil breeding ratio (BR) measurements, can be considered valuable for validation of fuel cycle modeling as they provide confidence in the spatial reaction rate distribution for key isotopes. However, they are typically intended to be used as relative reaction rates as the neutron flux level delivered (power) to the foils is not measured or is difficult to work out. Thus they have limited context for validation of fuel depletion and only infer that the spatial distribution of the reaction rates given a steady state power are being calculated correctly. In that regard they are still valuable validation for modeling software as small errors in those reaction rates, over a large time interval, can lead to large errors in the fuel depletion.

The sodium void worth measurements (SV), sodium manometer (SM), and sodium capture (SC) are obviously very important measurements for a sodium cooled fast reactor. However, the intention of reactor design is to make large voided regions not possible as part of operations. Thus the idea that one needs to correctly calculate large sodium void worths is not easy to support. However, doing sodium density measurements are valuable as this is a key part of reactor safety. Thus the small sodium void worth measurements can be considered useful in this regime. The sodium manometer was a measurement of a conceptual idea for a fast reactor assembly that during a low of flow accident would introduce a large void near the reactor periphery to increase leakage and drive the system sub-critical. Because of how they were done, one can just consider these to be small sodium void worth measurements although their location in radial blanket regions of ZPPR-15 does impact their relevance. The sodium capture measurements are similar to foil measurements in terms of their use.

The gamma flux measurements (G) are similarly important to the foil measurements as these are the best data available to validate modeling of the gamma flux distribution. Other important measurements include Doppler sample worth (D), radial bowing (B), and axial expansion (E) measurements. These provide validation for those specific features of a fast reactor, but they inherently require deterministic codes as the reactivity worths are typically less than 1 pcm. The neutron spectrum measurements (NS) are somewhat valuable only because the original measured details (thousands of channels) are not available and the experimental data is provided, by today's standards, in a coarse multi-group structure.

From here, the importance of the experimental measurements as validation data is significantly reduced. The Li-6 and lithium void worth measurements were obviously specific issues for those reactor programs and are not of value for sodium cooled fast reactors. The subassembly worth measurements (SW) are clearly specific to a given subassembly and reactor design and might not be relevant today. The shield measurements (SH) typically involved special configurations of a given reactor concept to introduce a sodium pool or other core external components of interest for measurements. These configurations are valuable but, other than criticality, they can be very difficult for any modeling code to actually obtain good predictions in those ex-core regions and their importance is design specific. While the B-10 reaction rate measurements (B0) are useful, the control rod measurements are much more consistent with the desired modeling goal. The calandria measurements (CA) were done but it is not clear what value they would add to MCNP or a deterministic modeling code unless they contained fuel that is very consistent with the industry interest.

The eigenvalue separation (ES) and spatial decoupling measurements (SD) are important for reactor power stability, but most fast reactors being considered today are very far away from the regime where this aspect would be important. Moreover, most modeling and simulation codes today do not actually obtain the higher eigenvalues/eigenfunctions and thus there may not be a modeling code to validate. Similarly, the noise coherence measurements (NC) and neutron noise measurements (NN) have to do with calculating the true power of the reactor system by understanding the correlation of the detector information from a given reactor. While this is valuable information, modeling and simulation codes cannot be validated against this data. These measurements would also likely be part of regular operations for any new reactor today.

Because most of the ZPRD assemblies were reviewed for relevance as part of the recent VTR design process, most of the measurements of interest to industry focus on sodium cooled fast reactors have been identified. Both MCNP and MC^2+DIF3D models were constructed for those measurements. The ZPPR-15 was of course the primary assembly program of interest although ZPPR-17A was also chosen because of its radial bowing measurement.

Table 2.2. ZPR-3 Critical Assembly Programs (1955 – 1970).

Assem.	Purpose	MCNP Models	Experiments Available/Processed
6	Simulated slab, cylinder, and sphere	1	[C]
11	Benchmark physics – HEU/DU – depleted uranium reflector	1	[C]
12	Benchmark physics – HEU/DU/graphite – depleted uranium blanket	1	[C]
23	Benchmark physics – HEU/Al – depleted uranium reflector	1	[C]
41	Benchmark physics – HEU/DU/Al/steel – depleted uranium reflector	1	[C]
48	Benchmark physics – Pu/DU/graphite/sodium – DU blanket	2	[C][CR][D][F][NS][SV]
53	Benchmark physics – Pu/DU/graphite core – DU reflector	1	[C][D]
54	Benchmark physics – Pu-DU/graphite core – iron reflector	1	[C]
56	Support FFTF design	1	[C]
58	Benchmark physics – Pu/graphite core – depleted uranium reflector	1	[C][NS]
59	Benchmark physics – Pu/graphite core – lead reflector	1	[C]

Table 2.3. ZPR-6 Critical Assembly Programs (1963 – 1982).

Ass.	Purpose	MCNP Models	Experiments Available
1	*Test of the ZPR-6 facility, experimental techniques and equipment*		
2	*Physics benchmark for a sodium-cooled UC core, H/D ≈ 1*		
3	*Physics benchmark for a sodium-cooled UC core, H/D ≈ 1/3*		
4Z	*Cylindrical zoned UC core with sodium cooling*		
5	Clean, cylindrical UC benchmark assembly similar to ZPR-6/4Z		[C][F][SV]
6A	Large uranium oxide physics assembly – part of the Demonstration Reactor Benchmark Criticals Program	1	[C][D][F] [NS][SV]
7	Large plutonium oxide physics assembly – part of the Demonstration Reactor Benchmark Criticals Program – plutonium-fueled counterpart of ZPR-6/6A	29	[C][CA][CR][D] [F][NS][P0][SV]
8	*Planned but never built because of changing program priorities*		
9	All uranium core with 9% effective enrichment – ANL equivalent of the Los Alamos National Laboratory (LANL) Big Ten assembly (10% enriched uranium)	1	[C][F]
10	Plutonium/carbon/stainless steel benchmark assembly – part of the Diagnostic Cores Program	1	[C]

Table 2.4. ZPR-9 Critical Experiment Programs (1964 – 1981).

Assem.	Purpose	MCNP Models	Experiments Available
1 –9	Physics properties of nuclear reactor cores with uranium-tungsten (U-W) fuel for nuclear rocket engines	9	[C]
10	*Skipped*		
11 –18	*Small, cylindrical zoned assemblies with UC fuel*		
19	*Small, cylindrical zoned assemblies with uranium oxide fuel*		
20	*Zoned assembly with central test zone*		
21-23	*Small, cylindrical zoned assemblies with uranium oxide fuel*		
24-25	*Small, cylindrical zoned assemblies with null-reactivity compositions (k_∞ = 1.0) in the central test zone*		
26-27	*Design and engineering mockups of the Fast Test Reactor (FTR). FTR was the initial name for FFTF during the design phase.*		
28-30	Design and safety evaluation studies of the Gas-Cooled Fast Reactor (GCFR)	6	[C][CA][CR][D][F][K][NS]
31	Plutonium carbide benchmark assembly for the Advanced Fuels Program	1	[C][CR][D][F][SV]
32	Safety-related experiments for sodium-cooled Pu/U oxide cores – simulated severe core meltdown configurations - HCDA		[C][CR][F][K][SV]
33	Design support for the Safety Test Facility (STF) All-Converter Assembly		[C][CR][D][F]
34	Uranium/iron benchmark – part of the Diagnostic Cores Program	1	[C][CR][K][F]
35	Had a central zone based on ZPR-6/6A in the center of the ZPR-9/34 configuration		[C]
36	All uranium core with 9% enrichment – same as ZPR-6/9	1	[C][F]

Table 2.5. ZPPR Critical Assembly Programs (1969 – 1990).

Assem.	Purpose	MCNP Models	Experiments Available
1	*Design support for the Fast Test Reactor (FTR) – later FFTF*		
2	Demonstration Reactor Benchmark Criticals Program – Physics benchmark and engineering mockups	14	[C][CR][D][G] [NN][NS][SV]
3	Demonstration Reactor Benchmark Criticals Program – Physics benchmark and engineering mockups		[C][CA][CR][D] [F][G][I][NS][SV]
4	Demonstration Reactor Benchmark Criticals Program – Physics benchmark and engineering mockups		[BR][C][CA][CR] [D][F][G][I][P0][SV]
5	Clinch River Breeder Reactor (CRBR) engineering mockup – severe accidents - HCDA		[C][CA][CR] [D][F][I][SV]
6	CRBR engineering mockup		[C][CA][CR][F][G][NS]
7	CRBR engineering mockup		[C][CA][CR][D][F][G][I][SV]
8	Thorium cycle study in a CRBR configuration		[C][CR][D][F][G][I][NS][SV][SW]
9	Jupiter series benchmark for a conventional oxide-fueled LMFBR		[C][CR][D][F][G][I][NC][NS][SV]
10	Jupiter series benchmark for a conventional oxide-fueled LMFBR		[C][CR][F][G][I][SV]
11	CRBR engineering mockup		[C][CA][CR][D][F][G][I][NS][SV]
12	Clean physics core to study CRBR fuel properties	11	[C][CA][F][NS][SV]
13	Jupiter series – large radially heterogeneous core		[C][CA][CR][D][E][F][G][I][NC] [SD][SV][B0][L6][P0]
14	Small LMR with BeO reflector control		[C][CR][F][G]
15	Metal-fueled Integral Fast Reactor (IFR) physics benchmark	86	[C][CR][D][E][F][G][NC] [NS][SD][SM][SV][B0]
16	SP-100 space power reactor mockup		[C][CR][F][G][K][NS][RW]
17	Jupiter series benchmarks for an oxide-fueled LMFBR	5	[B][C][CR][E][F][G][SD][SV]
18	Jupiter series benchmarks for an oxide-fueled LMFBR		[C][CR][ES][F][G][SC][SD]
19	Jupiter series benchmarks for an oxide-fueled LMFBR		[C][CR][ES][F][SD][SV]
20	SP-100 space power reactor mockup	4	[C][F][CR][G][LV][NN][SH]
21	Criticality studies for the IFR fuel cycle	6	[C]

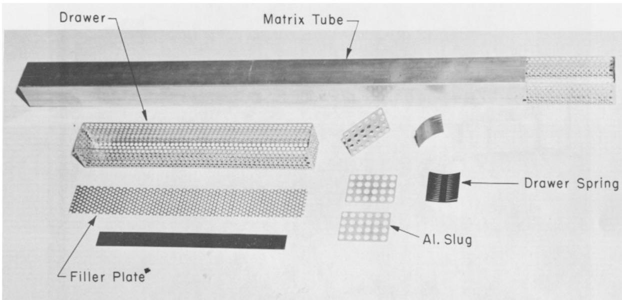
3 Web Interface Conceptual Design

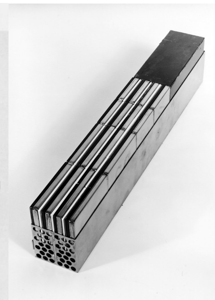
Given descriptions of the set of assemblies and experiments available in ZPR and ZPPR machines, a rough layout of the web interface needs to be defined. Figure 1 shows a rough layout of the head page of ZPRD. The intention of this page is to describe what a ZPRD experimental machine looked like and how the experiment was constructed. The four machines that we have data for are all listed and should be links to the next level of head pages for each machine.

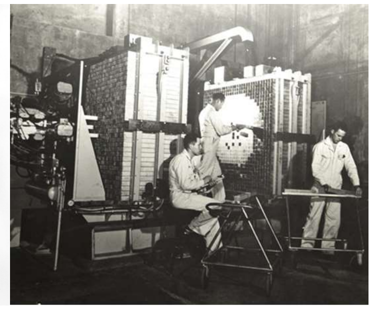
Figure 2 shows an example of the head page for ZPPR. More details on the ZPPR experimental machine would be presented here. The table is intended to give a top level description of each assembly program along with the number of available MCNP and MC^2+DIF3D inputs/outputs. Because the table includes a list of available experiments performed in each assembly, another table is needed to describe the shorthand notation (i.e. [C] is criticality). The links should go to the head page of each ZPPR assembly loading.

Figure 3 shows an example of the ZPPR-15 head page. This page should have a listing of all of the loadings that were processed into MCNP models. Each loading should have a purpose description. For the cases where it is a reactivity worth, the associated critical or subcritical reference loading should be identified. The intention of the pictures is to only to show the basic layout and size of a given loading. Pictures of the spatial fast flux distribution might be useful if they show how the loading changes alter the fast flux profile (should be obtainable for each loading). The links for each loading should provide access to a MCNP tarball of the inputs and outputs from whatever ENDF options were tested. For the MC^2+DIF3D part it will be a link to a tarball so it might be best to make both of them links to tarball.

The most difficult part of constructing the above web page is determining the ZPR-TM references that are appropriate for each assembly program in ZPR. Most of the recent ZPR database work done to build the repository was focused on collecting the files and reports in a fashion that should make the above construction a tolerable process to setup.







Basic description of ZPR and ZPPR and the experimental purpose of the machine.

Basic description of plates and components used to create a loading for a reactor.

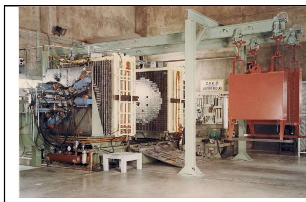
	**ZPR-3**
	**ZPR-6**
	**ZPR-9**
	**ZPPR**

Figure 1. Example ZPRD Head Page Setup in the Repository

Detailed description of ZPPR and the experimental purpose of the machine. When it operated, where it was located, details on its dimensions and any peculiarities on measurement equipment or its capabilities. Pictures of ZPPR machine and components would be nice beyond the normal.

Table that lists experiments that were done (i.e. definitions of [C] in table below).

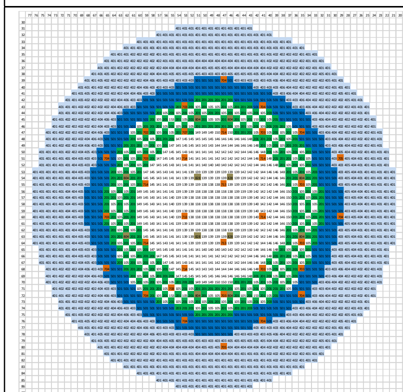
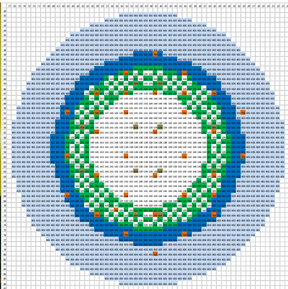
	ZPPR-1			
	…			
	**ZPPR-15**	Metal-fueled Integral Fast Reactor (IFR) physics benchmark	86 available MCNP loadings. Xx available MC^2-3+DIF3D models	[C][CR][D][E][F][G][NC][NS][SD] [SM][SV][B0]
	…			

Figure 2. Example ZPPR Head Page Setup in the Repository

Detailed description of ZPPR-15 and the experiments available. Dates of activity. Links to relevant logbooks, loading records, ZPR-TM, hot constant memos, and all other top level reports for this assembly. Link for summary reports, if they exist, for ZPPR-15. Links to ICSBEP and IRPHRP are also advisable unless we create new summary documents of past work.

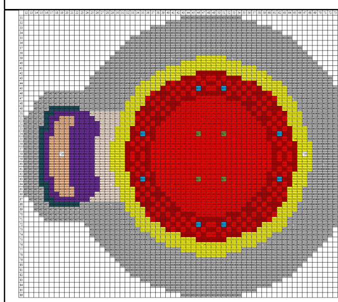
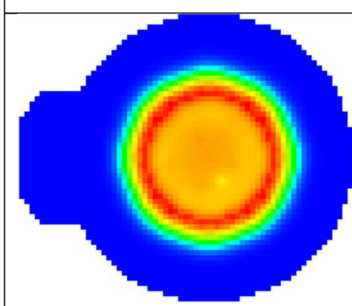
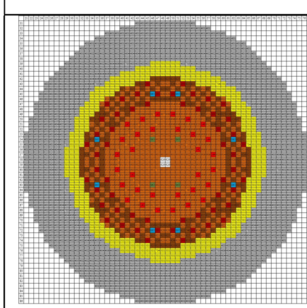
	Loading 10		
	**…**		
	**Loading 40**	Critical Reference Configuration ZPPR-15A	**MCNP** **MC^2-3+DIF3D**
	**…**	Foil measurement	

Figure 3. Example ZPPR-15 Head Page Setup in the Repository

4 Conclusion

This report is focused on the setup of the web page and the data to be included. Most of the work done on ZPRD has been focused on collecting the data into a repository. Given the 20+ years of building models and doing analysis work on ZPR and ZPPR machines, this action was essentially the comprehensive review of the previous work and identification of relevant inputs, outputs, and reports. While ZPPR-15 is considered the most important aspect today, all of the past work on ZPR and ZPPR was collected.

The expected commercial companies would prefer not to have to use resources to redo model construction for a ZPR or ZPPR experiment. Further they prefer not to have to redo the analysis if it has already been done and documented. Finally, they prefer the pedigree of the data be readily available. In that regard, the main focus of the web page design is to present these details. As the web page layout figures imply, a summary of the type of experiments that were done for each ZPRD assembly will be provided. The reports that detail the experimental measurements and any reports that detail modern comparison of calculation to experiment will be provided. The reports that list the plate details and all relevant documents that were used to source uncertainty information will also be made available. The ZPPR-15 assembly is presently the most desired by industry and thus the initial web page layout will focus on getting it available to the end user. From there, the other available ZPRD models, source reports, and reports detailing the analysis work will be added in the coming years.

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