GENERAL ATOMICS

U.S. Nuclear Regulatory Commission
Attn: Mr. J. Ibarra
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18 February 2002

Subject: Plans for GT-MHR Pre-application Interactions

Reference: NRC Project No. 716

Dear Mr. J. Ibarra:

As discussed at our December kickoff meeting, please find attached the document, *U.S. Pre-Application Licensing Plan for the Gas Turbine – Modular Helium Reactor (GT-MHR).* The document outlines the scope and general schedule General Atomics proposes for pre-application interactions and review by NRC staff. As indicated in our earlier discussion, we will welcome any comments or suggestions you have on the plan and will consider them for inclusion in a final draft. We would appreciate receiving any comments you have on the plan in writing by April 5.

It should be understood that while the schedules described in the plan reflect General Atomics' best estimate at the time, they are based on resource assumptions that are not in all cases in place. Perhaps most immediately, we have assumed DOE support for NRC costs in interactions on issues generic to gas-cooled reactors. In addition, the scheduled completion of GT-MHR safety analyses anticipates industry-government cost sharing. Changes in the resources available would impact the schedule.

Should you have any questions on this letter or the attachment, please feel free to contact L.aurence Parme at 858 443-2518.

Sincerely,

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Enclosures: (1)
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U.S. Pre-Application Licensing Plan

for the

Gas Turbine - Modular Helium Reactor (GT-MHR)

Issued by:

General Atomics

DOE Contract No. DE-AC03-01SF22343

February, 2001

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Acronyms and Abbreviations

AOO	Anticipated Operational Occurrence
CFR	Code of Federal Regulations
COL	Combined Construction & Provisional Operating License
DBE	Design Basis Event
EIS	Environmental Impact Statement
EPBE	Emergency Planning Basis Event
GT-MHR	Gas Turbine - Modular Helium Reactor
HTGR	High Temperature Gas-Cooled Reactor
LBE	Licensing Basis Event
LWR	Light Water Reactor
MHTGR	Modular High-Temperature Gas-Cooled Reactor
NUREG	Nuclear Regulatory Document
PAG	Protective Action Guideline
PRA	Probabilistic Risk Assessment
SAR	Safety Analysis Report
SER	Safety Evaluation Report
SSC	Systems, structures, and Components

Definitions

COL: Combined construction and provisional operating license as defined in 10CFR52

Licensing Basis Events (LBE): The collection of off-normal or accident events used to demonstrate that the design meets its top-level regulatory criteria. Collectively, licensing basis events are postulated and analyzed in probabilistic risk assessments to demonstrate compliance with top-level regulatory criteria. LBEs encompass the following three event categories:

1. Anticipated Operational Occurrences (AOOs): Events anticipated to occur once or more in the life of the plant and are realistically analyzed in the Safety Analysis Report to demonstrate compliance with 10CFR50 Appendix I dose limits.
2. Design Basis Events (DBEs): Events not anticipated to occur in the life of the plant but are postulated and conservatively analyzed in the Safety Analysis Report to demonstrate plant and site compliance with 10CFR50.34 dose limits.
3. Emergency Planning Basis Events (EPBEs): Events of lower frequency than design basis events. These events are not expected to occur in the lifetime of a population of plants EPBEs are postulated and realistically analyzed in the Safety Analysis Report to demonstrate compliance with Protective Action Guidelines, EPA 520/1-75-001 dose limits and, together with the other LBEs, with the NRC Safety Goals.

Safety Related: A set of systems, structures, and components (SSC) chosen as available and capable of performing required functions to meet 10CFR50.34 doses for all Design Basis Events

TLRC: Top-level regulatory criteria

1. Introduction

The safety goal underlying all design and licensing activities for the Gas Turbine - Modular Helium Reactor (GT-MHR) is as follows:

> *Operation of the plant, including mishaps, will not restrict the normal day-to-day activities of the surrounding public. Risks from any mishaps will be less than those occurring at commonly accepted industrial activities.*

To achieve safe, economical power production consistent with this goal, the design of the GT-MHR relies on a fundamentally new approach to safety. Radionuclide releases are controlled through retention of radionuclides within the fuel itself, assuring safety with minimal reliance on active design features or operator actions. Because the design minimizes the need to rely on active design features and operator actions, the safety case rests on first principles (laws of physics) and on the integrity of passive design features. The reliability needs thereby imposed on secondary barriers, such as the helium pressure boundary or reactor building, become less urgent.

Modular gas-cooled reactor design is different from previous reactor designs. Heat removal from the core is ensured through use of high-temperature materials in the core (all refractory core) and geometry conducive to conduction and radiation, as well as large heat capacity and low power density. Core melt due to loss of cooling is not physically possible. Fuel integrity does not rely on the presence of the helium coolant. The GT-MHR design couples the passive safety of modular gas-cooled reactors with a high efficiency Brayton cycle power conversion system, so that it is both safe and highly efficient.

In the existing U.S. reactors, loss of coolant is the most important challenge to control of radionuclide release. To ensure that loss of coolant, which could lead to core melt, does not occur, heat is removed using engineered systems that supply and circulate liquid coolant through the core and deposit heat to an ultimate heat sink. Coolant is required, and the coolant systems require a source of motive force for circulation. Overall reactor safety is based on the principle of defense-in-depth, reflected in the use of multiple barriers to radionuclide release, as well as in redundancy and diversity in engineered systems that perform safety functions.

U.S. licensing for commercial reactors is built on 40 years of accumulated construction and operation experience in light water reactors. The task of this licensing plan is to establish licensing methods that recognize the differences in modular gas-cooled reactor technology while assuring that the GT-MHR safety meets or surpasses the degree of safety required of existing U.S. commercial power reactors.

This plan identifies licensing-related activities, administrative processes, organizational responsibilities, and the schedule supporting U.S. Nuclear Regulatory Commission (NRC) pre-application interactions aimed at a potential, future review and approval of the GT-MHR for U.S. commercial operation.

1.1 Objective

The objective of this plan is to assure that necessary pre-application licensing activities are identified, planned and executed to facilitate a future application for the NRC to issue a

Combined Construction and Provisional Operating License (COL) for a first module, and Design Certification for the GT-MHR plant.

The pre-application interactions are intended to be responsive to the NRC Advanced Reactor Policy guidance. In particular, they are intended to provide "the earliest possible interaction of applicants, vendors, other government agencies and the NRC to provide the most effective regulation for advanced reactors, and to provide all interested parties, including the public, with a timely, independent assessment of the safety characteristics of advanced reactor designs."

1.2 Background

In the mid 1980s, General Atomics with support from other vendors, architect engineers, national laboratories, and utilities under DOE funding developed the conceptual design of the Modular High-Temperature Gas-Cooled Reactor (MHTGR), as a promising advanced reactor for potential commercialization. Several years of pre-application interactions with the NRC culminated in the submittal of licensing approach and assessment documents including a "pre-application SAR" (*Preliminary Safety Information Document*) and a probabilistic risk assessment (PRA).

In the early 1990s, the DOE program shifted focus from the steam cycle MHTGR to the more economic, direct Brayton cycle of the GT-MHR. Most recently, the GT-MHR development has focused on its application for the disposition of weapons-grade plutonium (WPu) in the Russian Federation. This cooperative effort between the DOE and Minatom has been led by General Atomics and OKBM, respectively. As preliminary design nears completion, General Atomics, supported by a group of interested utilities, is exploring the parallel re-introduction into the U.S. of a uranium version of the GT-MHR for commercial power production.

1.3 Scope and Schedule

This plan addresses pre-application licensing activities that will ultimately support an application and the issuance of a COL and Design Certification of the GT-MHR and rulemaking by the NRC. This pre-application review will build on the Fort St Vrain HTGR license and more directly, the MHTGR pre-application review and recent NRC reviews of other modular gas reactors. In doing so, we anticipate using the NRC's 1989 draft PSER as a point of departure for identifying issues still to be resolved.

The GT-MHR pre-application activities are grouped into four elements: programmatic and process topics, licensing approach, technology development, and design assessment. The activities in each of these elements are aimed at the identification of GT-MHR unique features and long-lead time topics that can be addressed prior to an application. The activities in each category will be organized to most efficiently flow into the NRC's established review vehicles (e.g., the Safety Analysis Report [SAR]). This plan does not include activities primarily related to permitting a power plant site.

Pre-application activities commence in 2001 and are phased to coincide with the technology and design progress. The duration and timing of activities within the pre-application phase is likely to require adjustment dependent upon resources and developments in the various areas. However, a rough duration of approximately 2 years is planned with staggered, parallel interactions on topics in each of the four elements. The pre-application interactions culminate in the submission of a draft SAR in 2003 and the

NRC issuance of a statement on the licensability of the design. Table 1 summarizes pre-application schedule with each of the planned elements and tentative dates. In addition, the earliest potential schedule for a future application is also depicted

Table 1. Overview Summary of GT-MHR Interaction Schedule

Milestone	Date
Pre-application Phase	
Opening meeting	December, 2001
Programmatic and process topics	March – April, 2002
Licensing approach	April – May, 2002
Technology topics - Fuel - Graphite - Metals - Core physics (if required)	May – Sept, 2002
Design Assessment	July – Dec, 2002
Submit draft SAR	March, 2003
NRC licensability statement	December, 2003
Future Application Phase	
Submission of SAR - Combined license (COL) application - Design Certification application	July, 2004
Combined License issued for 1st module	June, 2007
Design Certification of GT-MHR issued	TBD

2. Pre-Application Phase

During the pre-application phase, efforts will be concentrated on implementing early interaction with the NRC and at the same time preparing for subsequent application for design certification and COL. The GT-MHR Program will develop submittals to the NRC that will support an affirmative statement of licensability for the GT-MHR and also lay the groundwork for expeditious review following formal application.

2.1 Programmatic and Process Topics

The programmatic and process topics will include subjects on how the pre-application review will be conducted, financial and legal process issues, the SAR outline, and the application process, and the use of modular HTGR experience.

Early in the pre-application phase, agreement will be reached on how the pre-application phase is to be conducted. It is envisioned that interactions will generally be at the working level. Participants will include the NRC staff, the vendor design and technology team (GA, OKBM, and others), the utility group, and DOE. The vendor team will make presentations on the agreed-on topics followed by give-and-take questions and comments. The vendor team will then submit a summary or letter or report documenting the positions or information discussed. To the extent practical this will be done in a format consistent with later inclusion in the draft SAR. For example, the licensing approach presentation would be written as the draft SAR Chapter 3 and the graphite technology and reactor core presentations as Chapter 4. After submittal, the vendor team would answer any requests for additional information and amend the draft chapters. In this way, as the pre-application topics are discussed, the final draft SAR submittal will be prepared in a format that is consistent with the required documentation in the application phase. The relationship between the meeting topics and SAR chapters is illustrated in Figure 1.

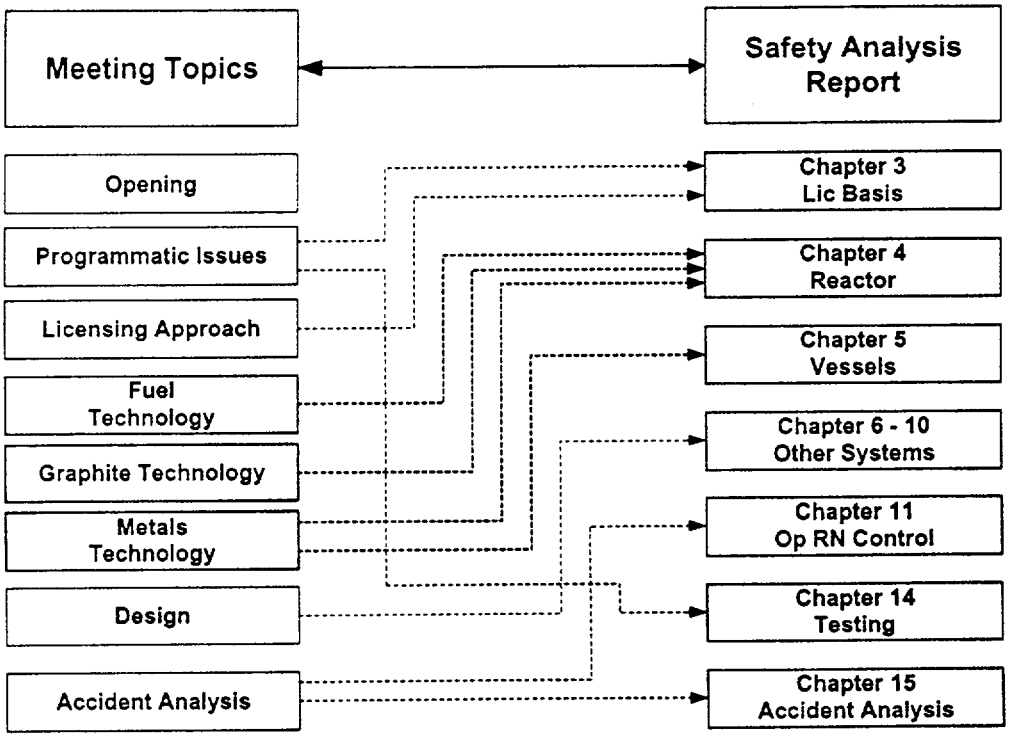

Figure 1. Meeting topics support structure of SAR.

In addition to meetings with the NRC staff, it is anticipated that there will be briefings with NRC Commissioners and the Advisory Committee on Reactor Safeguards (ACRS) on policy and technical topics.

A number of legal and financial process issues also need to be addressed in pre-application involving the modular nature of the GT-MHR plant and the changing utility regulatory environment. It is anticipated that these efforts will take advantage of progress made on these issues by Exelon and the NRC as part of the recent Pebble Bed Modular Reactor (PBMR) discussions. These issues include:

- Fuel cycle impacts in 10 CFR 51
- Requirements on annual fees in 10 CFR 171
- Number of licenses in 10 CFR 50.75
- Financial protection requirements in 10 CFR 140
- Operator staffing requirements in 10 CFR 50.54(m)
- Decommisssioning funding requirements in 10 CFR 50.75(e)
- Minimum decommissioning costs in 10 CFR 50.75
- Financial qualifications in 10 CFR 50.33

Another important procedural task is to provide high-level review and comment on the possible application phase to follow. This should include NRC comment on the proposed schedule, use of design, technology development, and operation of the WPu GT-MHR in the Russian Federation, the relationship between design certification and COL applications, and definition of major interactions required between the NRC and the GT-MHR Program.

2.2 Licensing Approach

Topics addressed in the area of licensing approach will include selection of risk-informed GT-MHR licensing bases and review of existing regulations and guidance for GT-MHR applicability.

There has been substantial dialogue on advanced reactor licensing for non-LWRs and the use of PRA methods for the selection of licensing bases for modular gas-cooled reactors, beginning with the MHTGR and continuing with the recent NRC review of the PBMR. The vendor team will take advantage of those reviews. The GT-MHR pre-application emphasis on this program element will be less on the process philosophy and more on implementation of the approach. The licensing approach will consist of a comparison of the risk-informed licensing bases with existing regulatory regulations and guidance.

The GT-MHR licensing bases will include top level regulatory criteria, licensing basis events, regulatory design criteria, safety equipment classification, and special treatment of safety-classified equipment.

An item-by-item review of the existing regulations and guidance will categorize regulations according to whether a given regulation applies, partially applies, or does not apply and GT-MHR regulation/ guidance required.

These topics will be documented in SAR chapters 1 to 3.

2.3 GT-MHR Technology Development and Confirmation

Technology supporting the GT-MHR design centers on confirming or qualifying various materials and equipment. It will be necessary, for example, to select a graphite supplier, and to confirm the adequacy of a reestablished fuel manufacturing capability in the U.S. In addition, GT-MHR fuel will be specified to higher standards than previously required of

licensed HTGRs. The technology activities submitted for NRC review will include those required to demonstrate that the licensing bases have been met. Relevant research conducted by the NRC, DOE, U.S. industry, and foreign countries will be identified.

Technology was discussed at considerable length for the MHTGR and it is anticipated that the GT-MHR review would build on this background, focussing on areas where requirements differ or the approach to confirming the adequacy of these materials or equipment have changed since the 1980s. Specific issues (e.g., fuel, graphite) will be discussed in near-term meetings and technology planning will be submitted for NRC review.

The GT-MHR technology program, as it relates to licensability, will address fuel and fission products, graphite, and metals. The planning for each area will comprehensively define base technology requirements meeting identified needs.

2.4 Design Assessment

The third element of review is the GT-MHR design and its compliance with the top-level criteria. Design assessment consists of three related elements: briefings on GT-MHR design, followed by briefings and submission of safety analyses, specifically a draft PRA and SAR.

The review of GT-MHR design will focus on aspects of the design different from the previously reviewed MHTGR but provide sufficient background to place these differences in context. This focus on differences will include the enlarged (600 MW) annular core, the larger and higher temperature vessel system, and the gas turbine centered power conversion system. Since coupling the reactor directly to power conversion machinery affects the plants operation and operating modes, key operating characteristics will also be covered.

A level-3 Probabilistic Risk Assessment (PRA) is the first and central constituent to understanding safety and developing the SAR. The PRA will provide the following:

- a systematic characterization of GT-MHR safety,
- uncertainty analyses associated with the deterministic accidents reported in the SAR,
- a context for addressing limiting, hypothesized accidents outside the design basis,
- justification of the emergency planning approach.

The PRA also provides a basis for determining licensing bases used in the SAR, including the risk-informed selection of licensing basis events and safety classification. The approach provides licensing bases general consistent with the existing NRC licensing framework but appropriate to the unique characteristics of gas-cooled modular reactors. This approach was previously and successfully utilized by General Atomics with the MHTGR pre-application review and has more recently been proposed for use by Exelon Generation with the PBMR. The selection of GT-MHR Licensing Basis Events and safety classification would also be presented.

With the PRA providing an overall characterization of safety and licensing bases, we will prepare a draft SAR based on the completed Russian preliminary design but with certain designed commercial GT-MHR features (e.g., uranium-fueled core).

Both safety documents (PRA and the SAR) would make use of the 1980s MHTGR submittals as a starting point. The content and format of this documentation should be

agreed upon but we envision following as closely as possible the earlier format based on Regulatory Guide 1.70 but modified to address the safety criteria and design features developed for the GT-MHR.

Because the draft SAR is based on a preliminary design, it will not be as detailed as the final SAR submitted as part of an application, but attention will be given to design features and characteristics that govern safety performance. Significant design basis events will be analyzed. The PRA will be provided separately but in conjunction with the draft SAR.

It is expected that as a result of briefings on the GT-MHR, topics of interest to NRC will require special briefings or informal submittals. These will be scheduled in a timely manner prior to submittal of the draft SAR.

2.5 Pre-application Phase Schedule

The pre-application phase begins in late 2001 and concludes with NRC issuance of a statement of licensability for the GT-MHR. This licensability statement is described in Section 2.6

The schedule is contingent on resource availability driven by funding from a variety of industry and governmental sources. Consequently it is subject to some uncertainty. Nevertheless, a near-term schedule and meeting goals are listed in Table 2.

Table 2. Proposed Near-term Meeting Schedule

Date	Subject	Goals
December 01	Introductory Meeting - generic issues in licensing and gas-cooled reactor technology	• Introduce GT-MHR design concept. • Obtain NRC comment on and agreement with licensing plan. • Establish meeting schedule.
Mar - Apr 02	Programmatic Issues	• Obtain NRC comments on programmatic issues.
Apr - May 02	Licensing Approach – regulatory criteria, licensing basis events	• Obtain NRC agreement on top-level regulatory criteria. • Present methods for selecting licensing basis events. • Obtain NRC agreement on licensing approach.
May - Sept 02	Technology Development – containment philosophy, fuel, graphite qualification, use of foreign technology	• Familiarize NRC with GT-MHR technology. • Obtain comments on technology approaches • Obtain NRC comments on use of foreign technology.
Jul - Dec 02	Design Assessment	• Obtain NRC agreement with SAR outline.

2.6 NRC Licensability Statement

At the conclusion of the pre-application phase, a definitive NRC statement regarding the licensability of the GT-MHR is sought. This statement, in the form of a letter, will help provide a clear path and method for licensing a GT-MHR design. Conditioned on the

preliminary stage of the GT-MHR design and ongoing technology development, the overall licensability statement should reach conclusions on the following questions:

1. Is the GT-MHR design concept licensable?
2. Are the top-level regulatory criteria acceptable and can they remain valid through design certification?
3. Is the methodology for proceeding from top-level regulatory criteria through risk assessments and other safety analysis to the deterministic licensing bases acceptable and can it remain valid through design certification?
4. Is the approach for emergency planning acceptable?
5. Is the proposed approach to obtaining a combined license for the first module and design certification for subsequent modules acceptable.
6. Is technology planning adequate for the license of a first GT-MHR and subsequent design certification?

3. Application Phase

While an application is beyond the scope of this report, a discussion of the general approach envisioned for an application one of the objectives of the pre-application phase.

Pre-application phase accomplishments form the foundation for a future application. The objective of the application phase is to obtain NRC issuance of a COL for the first GT-MHR module and, in parallel, seek Design Certification for follow-on modules, along with required rulemaking. Compliance of the design with applicable criteria and regulations will be demonstrated by the GT-MHR applicant through formal licensing documents describing the GT-MHR and its safety features supporting NRC review of the design. These include updated versions of the GT-MHR Safety Analysis Report and PRA submitted as drafts during the pre-application phase.

For the purposes of this plan, it is assumed that application for a COL would refer to a site previously permitted through the Early Site Permitting (ESP) process of 10 CFR Part 52. Discussion of the ESP is also outside the scope of this plan. It is also assumed that the application period will be guided by the existing NRC policies and regulations. On that basis, the following steps are proposed:

- SAR – Two Safety Analysis Reports will be prepared. One will be site-specific for a first module on a pre-approved site and aimed at a combined license. The other, while describing an identical plant will be for a generic site and aimed at Design Certification.
- Review and Questions - Subsequent to docketing of the SARs by the NRC, detailed review of the applications will commence. NRC normally makes requests for further details or clarification of the design. Timely responses to these questions will be submitted to NRC as amendments to the SARs.

  The independent but parallel or near parallel reviews for a COL and Design Certification are anticipated to be synergistic, reducing the overall effort required for the two applications.

- Safety Evaluation Report - NRC review and technical acceptance of the design will be documented in its Safety Evaluation Report (SER). Upon resolution of major open issues, the final SER will be issued. It is anticipated that confirmatory testing of key safety features specified for the first module may form the basis for a subsequent decision on Design Certification
- ACRS Review - The formal design application will be referred to the ACRS for review and issuance of a letter report to the Commission on the acceptability of the GT-MHR.
- Rulemaking - The additional rulemaking process provided by 10 CFR 50, Appendix O, Section 7 will be pursued, including the establishment of a formal licensing board and adjudicatory proceedings.

The design submitted for review Design Certification will include all safety systems, structures and components. Other systems and structures will be described functionally and evaluated for interfaces. Utility and site specific parameters and requirements will be enveloped and reflected in the overall standard design.

Activities and milestones are tentatively scheduled as shown in Figure 2 at the end of Section 4.

4. Overall Schedule

Licensing activities commence in 2001 and conclude with issue of Design Certification and any required rulemaking. Completion of a first module and Design Certification is scheduled to support a commercial GT-MHR market by the beginning of the next decade (ie., approximately 2010).

Figure 2, on the following page, displays the overall licensing schedule. The "regulatory" bars display the major elements of this plan. Other bars display critical program milestones. The milestone dates for the events in the application phase should be considered tentative.

The figure also shows the linkage between international GT-MHR project development and the licensing activities described in this plan. Submittal of major safety analyses (SAR and probabilistic risk assessment) is tied to completion of preliminary design, for draft documentation in pre-application review, and final design for documentation submitted at the time of application. Furthermore, application for a COL is linked to a commercial order for the first module. Application for Design Certification is contingent only on completion of final design. Issue of the certification is assumed for planning purposes to be granted after startup and testing of the first module. The results of constructing and operating this first module could be used to provide further confidence in the safe, economic and reliable performance of the standard design.

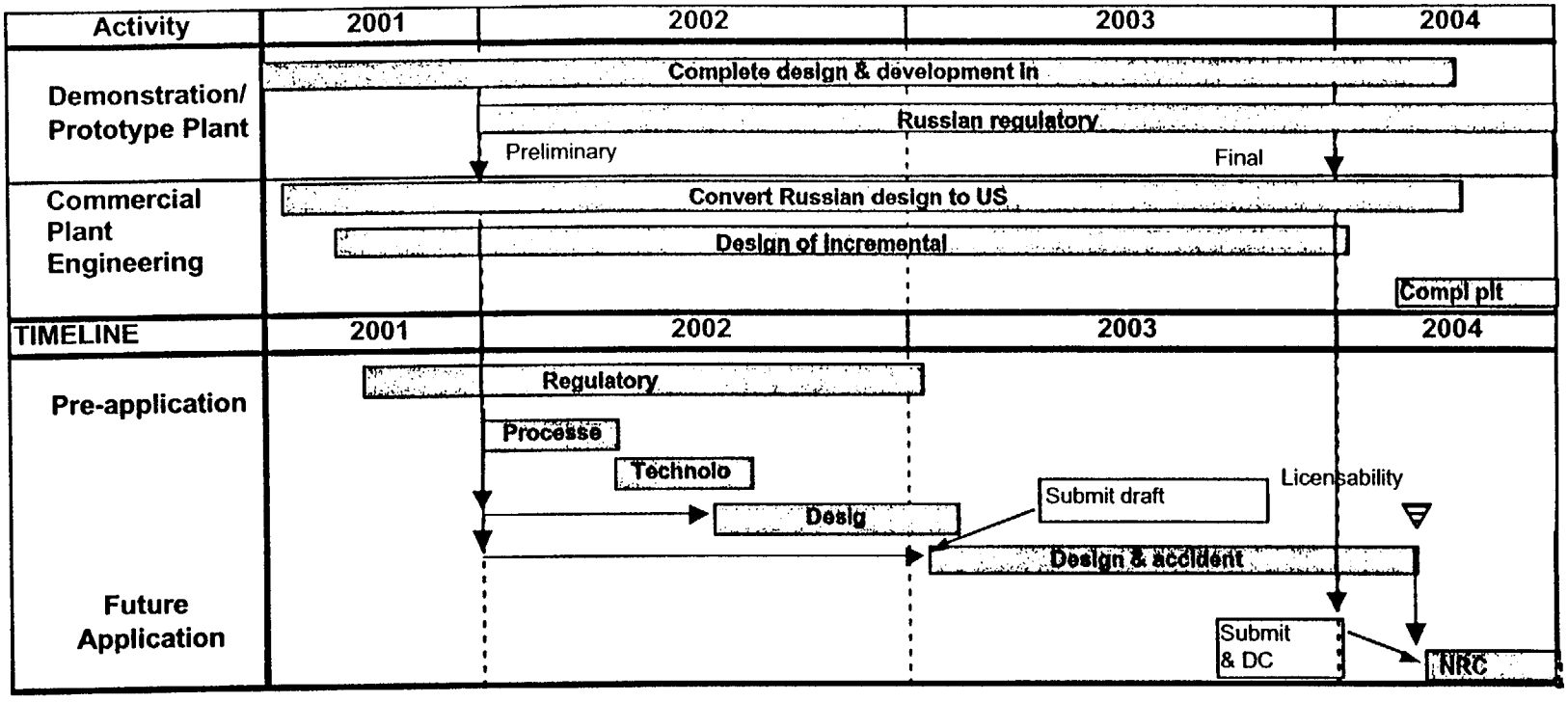

Figure 2. Overall Schedule

5. References

1. Policy for Regulation of Advanced Nuclear Power Plants, (Draft). Nuclear Regulatory Commission. March 1983.

2. Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition), Regulatory Guide 1.70, Rev. 3. November 1978.

3. Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition), NUREG-0800, Nuclear Regulatory Commission. July 1981.

4. Statement on Standardization of Nuclear Power Plants, 43FR38954, Nuclear Regulatory Commission. August, 1978.