1.30 Safe Operation and Maintenance of Research Reactor

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ABSTRACT

The first Thai Research Reactor (TRR-1) was established in 1961 at the Office of Atomic Energy for Peace (OAEP), Bangkok. The reactor was light water moderated and cooled, using HEU plate-type with U_3O_8- Al fuel meat and swimming pool type. The reactor went first critical on October 27,1962 and had been licensed to operate at 1 MW (thermal). On June 30, 1975 the reactor was shutdown for modification and the core and control system was disassemble and replaced by that of TRIGA Mark III type while the pool cooling system, irradiation facilities and other were kept. Thus the name "TRR-1/M1" has been designed due to this modification the fuel has been changed from HEU plate type to Uranium Zirconium Hydride (UZrH) Low Enrichment Uranium (LEU) which include 4 Fuel Follower Control Rods and 1 Air Follower Control Rod. The TRR-1/M1 went critical on November 7, 1977 and the purpose of the operation are training, isotope production and research. Nowaday the TRR-1/M1 has been operated with core loading No.12 which released power of 1,056 MWD. (as of October 1998). The TRR-1/M1 has been operated at the power of 1.2 MW, three days a week with 34 hours per week, Shut-down on Monday for weekly maintenance and Tuesday for special experiment. The everage energy released is about 40.8 MW-hour per week. Every year,The TRR-1/M1 is shut-down about 2 months between Febuary to March for yearly maintenance.

1. PREAMBER

1.1 This document has reference to WARRANTIES and constitutes the specifications on Safety Limits and Limiting Safety System Settings, Specifications on Limiting Conditions of Operation and Code of Practice in respect of paragraph 1 (a) and 1 (b) thereof. These Specifications and Code of Practice apply to the operation and use of the Reactor specified in Special Condition 1 and its ancillary systems only.

1.2 Design information and other descriptions of The Reactor, its components and ancillary systems are included in this document in so far as to provide the "Bases" to support the selection and significance of the Safety and Operation Limits Specifications. Such description and "Bases" are for information purposes only and are not part of the WARRANTIES.

2. GENERAL DESIGN

The reactor core will be located in a reactor pool structure which also serves as a part of the composite radiation shield. Core cooling will be provided by natural circulation of pool water which is in turn cooled and purified in external coolant circuits. The pool water conductivity will be maintained at 2 micro- mho /cm or lower to ensure its purity and the pool water level at 6 meters or more above the top of the reactor core to ensure adequate vertical shielding.

The reactor will be operated in three modes, steady state, pulsing and square wave. Reactor power levels in the steady-state and square wave modes will range up to and include 2000 kW (thermal). Pulsed mode operation will take place by step reactivity insertions with the reactor initially at a power level less than 1 kW. The maximum step reactivity insertion will be 2.1 k/k ($ 3.00) which will produce a peak reactor power of approximately 2000 MW (thermal). A summary of principal design parameters for the reactor is given in Table 2-1.

TABLE 2-1
PRINCIPAL DESIGN PARAMETERS

Reactor Type	TRIGA Mark III
Maximum Steady-State Power Level	2,000 kW (thermal)
Maximum Pules	2.1 % k/k ($ 3.00)[a]
Fuel Element Design	
Fuel-moderator material	U-$ZrH_{1.6}$ [b]
Uranium content	8.5 wt.- %
Uranium enrichment	20 % U-235
Shape	Cylindrical
length of fuel	38 cm (15 in) overall
Diameter of fuel	3.63 cm (1.43 in) O.D.
Cladding material	Type 304 SS
Cladding thickness	0.051 cm (0.020 in)
Number of Fuel Elements	100
Excess Reactivity, max	6.3 % k/k (cold,clean) (a)
Number of Control Rods	
Safety transient	1
Regulating	1
Shim	2
Safety	1
Total reactivity Worth of Rods	10.12 % k/k (a)
Reactor Cooling	Natural convection of pool water

(a) Reactivity: $ 1 = 0.7 % δk/k
(b) The nominal H/Zr Ratio is 1.60 , and the maximum value is 1.65

3. SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

3.1 SAFETY LIMIT-FUEL ELEMENT TEMPERATURE

Specifications.
The temperature in a "standard" TRIGA fuel element shall not exceed 1000 °C under any conditions of operation.

Basis.
The important parameter for a reactor exclusively fueled by TRIGA fuel element is the fuel element temperature. This parameter is well suited as a single specification for both steady-state and pulse mode operation especially since it can be measured.

The limiting effect of fuel temperature is the out gassing of hydrogen from U-ZrH x fuel-moderator mixture and the subsequent stress produced in the fuel element clad material. The strength of the clad as a function of temperature can thus set the upper limit on the fuel temperature.

The safety limit for the TRIGA fuel element is based on data which gives a strong indication that the clad will not be ruptured if fuel temperature are never greater than in the range of 1200 °C to 1250 °C, provided that the clad temperature is less than about 500 °C. The fuel manufacturer Thus set a conservative safety limit for fuel temperature of its standard element at 1150 °C when the fuel clad is water cooled. At this safety limit temperature of 1150 °C, the hydrogen pressure is about a factor of 4 lower than would be necessary for clad failure. (Ref. 1/3-27).

In order to increase the safety margin and in observance of fuel temperature limit specified by USNRC for reactors using the same type of TRIGA fuel element (e.g. Facility License No. R- 100 dated May 14, 1971 and License No. R-76, Safety Amendment No. 7 dated June 26, 1975) (2), the Thai Reactor Safety Committee (RSC) (3) further lower the fuel element temperature limit in case of the Thai Research Reactor (TRR-1/M1) to 1000 °C.

3.2 LIMITING SAFETY SYSTEM SETTINGS

Specifications.
The limiting safety system settings for fuel temperature shall be 650 °C as measured in the instrumented-standard fuel element located in the central region of the core.

Basis.
This specification applies to scram settings of measured fuel element temperature.

In the event that the measured fuel element temperaturc reaches or exceeds the limiting safety system setting, a reactor scram shall be initiated to prevent the fuel temperature safety limit from being reached. The limiting safety system settings of 650 °C is specified by the manufacturer of the fuel element. (Ref. 1/3-83)

4. LIMITING CONDITIONS FOR OPERATION

4.1 STEADY STATE OPERATION

Specifications.
The reactor power level shall not exceed 2.2 MW (2200kW) under any condition of operation. The normal steady state operating power level of the reactor shall be 2 MW maximum. However , for purposes of testing and calibration, the reactor may be operated at higher power levels not to exceed 2.2 MW during the testing period.

Basis.
These specifications apply to energy generated in the reactor during steady state operation with the objective of assuring that the fuel temperature safety limit will not be exceeded during steady state operation.

The safety system settings for reactor power level shall be 2.2 MW (thermal) as specified by the reactor manufacturer. The action of the safety system shall be the initiation of a reactor scram in the event that the power level limit of 2.2 MW exceeded, thus precluding prolonged operation above this power level. Ref.1/3-83).

Secon 3.2 of the manufaturer Safety Analysis Report for Standard TRIGA Mark III indicated that scram setting of power level at 2.2 MW should limit the maximum fuel temperature to below 600 °C, thus providing a safety margin of atleast 400 °C below the fuel temperature safety limit specified for this reactor. (Ref.1/3-54 & 3-56)

4.2 REACTIVITY LIMITATIONS

Specifications.
The reactor shall not be operated unless the shutdown margin provided by scrammable control element relative to the cold xenon-free critical condition shall be 0.50 dollars or greater with :

a. the highest worth non-secured experiment in its most reactive state, and
b. the transient control element fully with-drawn.

Basis.

These specifications apply to the reactivity condition of the reactor and the reactivity worth of control elements and experiments. They apply for all modes of operation with the objective of assuring that the reactor can be shutdown either manually when required, or by actions of the safety systems to prevent the fuel temperature safety limit from being exceeded.

The value of the shutdown margin given in the specifications assures that the reactor can be shutdown from any operating condition even if the transient control rod should remain in the fully withdrawn position.

4.3 PULSE MODE OPERATION

Specifications.

The maximum reactivity inserted during pulse mode operation shall be $ 3.00 (2.1 % δk/k).

Basis.

This specification applies to the peak power level of reactor as a result of a step insertion of reactivity with the objective of assuring that the fuel temperature safety limit will not be exceeded during pulsing.

In the pulse mode of operation the step insertion of $ 3.00 should result in a reactor peak power of about 2000 MW with prompt reactor period of 2.8 mSec, and a consequent energy release of 26 MW-sec and associated peak fuel temperatures below 650 °C Limiting the maximum reactivity step insertion to $ 3.00 thus provides a safety margin of atleast 350 °C below the fuel temperature safety limit specified for this reactor. Data of pulse tests on the Advanced TRIGA Prototype Reactor reveal that an associated peak fuel temperatures of approximately 1050 °C would require a step reactivity insertion of $ 5 (3.5 % δk/k) which is far above the value given in this specification. (Ref. 1/3-54 & 3-57).

4.4 CONTROL AND SAFETY SYSTEM

4.4.1 Reactor Control System

Specifications.

The reactor shall not be operated in the specified mode of operation unless the measuring channels listed in Table 4-1 are operable.

TABLE 4-1 MINIMUM MEASURING CHANNELS

Measuring Channel	Min. No. Operable	Specified Mode S.S.	Specified Mode Pulse
Fuel Element Temperature	1	X	X
Linear Power Level	1	X	
Log Power Level	1	X	

Basis

The specifications apply to the information which must be available to the reactor operator during the reactor operation with the objective of providing sufficient information to the operator to assure safe operation of the reactor.

Fuel temperature displayed at the control console gives continuous information on this parameter which has a specified safety limit.

The specifications on reactor power level indication are included since the power level is related to the fuel temperature.

4.4.2 Reactor Safety System

Specifications.

The reactor shall not be operated unless test performed the safety channels during the "Start-up Checkout" described in Table 4-2 indicate that the requirements on the minimum number of operable channels in the specified mode of operation are met.

TABLE 4-2 MINIMUM REACTOR SAFETY CHANNELS

Safety channel		Number Operable in Specified Mode S.S.	Pulse
Fuel Temperature	Scram if exceeds 650°C	1	1
Power Level	Scram if exceeds 2.2 MW (except for tests under 4.1)*	1	-
Manual Scram	Scram when activated	1	1
Wide Range (Log)	a. Prevent initiation of a pulse above 1 kW.	-	1
	b. Prevent control element withdrawal when neutron source count is < 2cps.	1	-
HV Monitor	Scram on loss of high voltage to pwr channels.	1	1
Pulse Mode Switch	Prevent withdrawal of standard contr. & regl. elements in pulse mode.	-	1
Transient Rod Control	Prevent application of air unless fully inserted	1	-

* Power level scram setting for testing shall not exceed 2.4 Mw

Basis

These Specifications apply to the reactor safety system with the objective of specifying the minimum number of safety system channels that must be operable for safe operation.

The fuel temperature and power level scrams provided protection to assure that the reactor can be shutdown before the safety limit on the fuel element temperature is reached.

The manual scram allows the operator to shutdown the reactor when required and serves as a backup against an unsafe or abnormal condition in the reactor system.

The interlock to prevent startup of the reactor when neutron count is less than 2 cps assures that sufficient neutrons are available for startup and that the wide range measuring channel is operable.

In the event of failure of the power supply for the safety chambers, the high voltage monitor prevents operation of the reactor without adequate instrumentation.

The interlock to prevent initiation of pulse above 1 kW in to assure that the magnitude of the pulse will not cause the fuel element temperature safety limit to be exceeded.

The interlock to prevent withdwawal of the standard or regulating control elements in the pulse mode is to prevent the reactor from being pulse while on a positive period.

4.5 RADIATION MONITORING SYSTEM

Specifications

The reactor shall not be operated unless the radiation monitoring channels listed in Table 4-3 are operable. Each channel shall have a readout in the reactor control room and be capable of sounding and audible alarms which can be heard in the control room.

For periods of time for maintenance to the radiation monitoring channels, the intent of this specification will be satisfied if they are substituted with portable gamma sensitive in struments having their own alarms or which shall be kept under visual observation.

TABLE 4-3 MINIMUM MONITORING CHANNELS

Channel	Function	Number
Bridge Area Radiation Monitor	Monitor radiati on level on the reactor bridge	1
Beam Area Radiation Monitor	Monitor radiation level in the beam room	1

Basis

The specifications apply to the radiation monitoring information which must be available to the reactor during reactor operation with the objective of assuring radiation safety to personnel within the reactor gas-tight area.

The radiation monitors provide information to operating personnel of any impending or existing danger from radiation so that there will be sufficient time to evacuate the facility and take the necessary steps to prevent the spread of radioactivity to the surroundings.

5. CODE OF PRACTICE

5.1 ADMINISTRATIVE CONTROL AND DELEGATION OF AUTHORITY

a. The reactor and its ancillary system shall be under the administrative control of the Director of Reactor Operations Division (DRO). The DRO shall be responsible to the Secretary General (SG) of the Office of Atomic Energy for Peace (OAEP) for the safe operation and maintenance of the reactor and associated equipment. The DRO shall be responsible for assuring that all operations are conducted in a safe manner and within the limits specified in section 3 and 4 of this document, in compliance with the safety requirements established by the Reactor Safety Committee (RSC), and with the health physics regulations established by the Health Physics Division (HPD) in so far as the regulation are applicable to radiation safety in the operations of the reactor and associated equipment.

b. The DRO shall have the power to authorize, in writing , a qualified reactor engineer and/or a senior reactor operator to carry out on behalf of himself certain specific administrative control functions required pursuant to para.(a) above. The intent of para. (a) shall be satisfied when the requirements are fulfilled by the DRO and/or the authorized person, or persons, acting on his order. However, such authorization does not relieve the DRO from his administrative control responsibility vested in him under para. (a).

c. The SG shall , at his discretion in the event that DRO is not able to perform his administrative control functions, designate a senior reactor engineer to temporary serve as an Acting DRO for a specified period of time. During such period of time, the Acting DRO shall have the authority and responsibility normally vested in the DRO in accordance with para. (a) above and thereby the DRO is temporarily relieved of his administrative control responsibility under para. (a).

5.2 EXTERNAL REVIEW

In order to obtained an unbiassed judgement on matters related to nuclear safety in the operation and use of the reactor facility, the Thai Atomic Energy Commission for Peace (Thai AEC) may appoint a Reactor Safety Committee (RSC) to review, evaluate, and make recommendations in respect of safety standards and procedures associated with the operation and use of the facility.

The composition, scope and authority of the RSC is briefly described in Ref. [3] which is not a part of the WARRANTIES.

However, in so far as the Reactor is concerned, the Code of Practice requires the followings:

a. The Reacotr Operations Division shall prepare and submit documents classified and listed here under for review, evaluation and approval by the RSC.

TABLE 5.1 CLASSIFICATION OF DOCUMENTS REQUIRING APPROVAL OF THE RSC

1. Specifications on Safety Limits , Safety System Setting Limits and Limiting Conditions of Operation, including request to amend any such specifications in a manner that would make the specification become less conservative
2. Standard Operating Procedures (SOP) on operationg of the reactor in any mode of operation.
3. Standard Operation Procedures (SOP) for performing of reactor critical experiment and any operation which involves core change, movement of fuel element into or out of the reactor core and control element removal and replacement (including core diagram which serves as core loading certificate),and for performing reactor experiments with the objective of verifying or determining reactor parameters.

b. The Reactor Operations Division hall submit a request to perform an experiment classified as "Special Experiment" as listed here under for review and recommendations by the RSC.

TABLE 5.2 LIST OF EXPERIMENTS CLASSIFIED AS SPECIAL EXPERIMENTS

1. An individual experiment which is not secured and whose reactivity worth can be determined or estimated to be greater than $ 1.00
2. Irradiation of any material containing fissible element in any form when the <u>fissile content</u> can be determined or estimated to be greater than the following limits:
   2.1 For irradiation in central thimble : 0.5 mg
   2.2 For in-core irradiation or irradiation in the reactor pool, with the exception of central thimble : 2.0 mg
   2.3 For irradiation in a beam tube , thermal column for pneumatic facility whose irradiation chamber is not located in the reactor core : 50.00 mg.

3. Irradiation of any explosive material such as gunpowder, dynamite or TNT) of the quantity greater than 5.00 mg.

4. Any Experiment not covered by (1) , (2) and (3) above but that the DRO , RSC or the Director (or Chief) of the Health Physics Division subsequently designates as special experiment.

* Exemption In the event that an experiment classified as special experiment has been approved by the RSC and provided that such an experiment can be verified to be non-hazardous limits and safe conditions for performing such an experiment has been established from The said result, subsequent performings of the experiment within the established safety limits and safe conditions do not require the approval of the RSC.

c. When the RSC is in term of office :
(1) Any document requiring approval of the RSC pursuant to para . (a) above shall become effective only when it is endorsed by the DRO in accordance with conditions established by the RSC in its approval of the document, and
(2) Any special experiment under para. (b) above can be carried out following the authorization of the DRO in accordance with conditions established by the RSC in its approval of the experiment request.

d. Within the period of time during which the RSC is not in term of office: The Secretary General of the OAEP may, at his discretion, authorize a person who is <u>not attached</u> to the Reactor Operations Division to consider the documents, or request to perform special experiments, requiring RSC approval under para. (a) or (b) above to temporarily fulfill the requirements for external review. The authorized person shall have the power to exercise his judgement and, at his discretion, to give an "interim approval" in lieu of the normal RSC approval and thereby the DRO is authorized to proceed to endorse the document or to authorize the experiment request in the manner prescribed in para. (c) above.

Such "interim approval" shall be submitted for consideration of the new RSC within a reasonable time following the commencement of the RSC term of office. The decision of the RSC on the interim approval shall rule from the time the RSC makes the decision but it shall <u>not</u> have any effects on any operations or any experiments which has been proceeded before the moment of decision.

5.3 APPOINTMENT OF REACTOR OPERATING PERSONNEL

a. The Secretary General of the OAEP shall, with the recommendation of the Director of Reactor Operation Division, qualify and appoint appropriately trained personnel to serve in the following capacities, listed in the order of seniority:

1. Reactor supervisor
2. Reactor senior operator
3. Reactor operator
4. Reactor operator-trainee

b. An up-to-date list of the appointment under para. (a) above shall be maintained by the Reactor Operations Division, and a copy of which may be made available upon request to the Insurer or its authorized representative.

5.4 APPOINTMENT OF HEALTH PHYSICS OFFICERS

a. An up-to-date list of qualified health physicists who may be made available to perform health physics duties required in the operation and maintenance of this reactor and associated equipment shall be prepared by the Director (or Chief) of the Health Physics Division. A copy of the list shall be distributed to the Reactor Operations Division, and may also be made available upon request to the Insurer or its authorized representative.

5.5 ASSIGNMENT OF REACTOR OPERATING DUTIES AND AUTHORIZATION TO OPERATE THE REACTOR

a. No individuals but that who is qualified and oppointed as a reactor supervisor or operator pursuant to sub-section 5.3 and whose name is in the current list of appointment specified in para. (b) thereunder shall be allowed:

(1) to manipulate the reactor control system in order to startup the reactor to operate it in any mode of operation, or
(2) to load or unload a fuel element into or out of the reactor core, or to move a fuel element within the reactor core or within the reactor pool.

b. A reactor operator-trainee shall be allow to perform an operation specified in para. (a) above only under direct supervision of the shift supervisor on duty.

However, the DRO may allow a reactor operator - trainee to perform routine operating duties, such as during steady state operation ,under direct supervision of a reactor operator who is in change of the operation at that time.

c. In the event that there is a requirement to manipulate the rector control system for purpose other than starting-up or operating the reactor, such as in the service and maintenance of the reactor system, the DRO may allow a qualified technician to manipulate the control system as a part of the required job procedures. Such job ,however , shall be carried out under the direct supervision of a reactor supervisor or a rector engineer designate by the DRO to supervise the job. Similarly, movement of a fresh or irradiated fuel element outside of the reactor pool may be carried out by an individual or a group of individuals assigned to handle a fuel transfer operation. such fuel transfer, however, shall be carried out under the direct supervision of a staff member designate by the DRO.

d. The reactor shall not be operated in any mode unless the operation is authorized by the DRO. Normally the "Reactor operations Weekly Schedule "which is endorsed by the DRO shall serve as the authorization for the operations which are listed in the schedule. Should there be a requirement for an un-schedule, operation ,the DRO may authorize the un-schedule operation by signing his approval in the reactor Log Book (described under Sub-Section 5.7)

e. The Reactor Shall be operated in "Shifts" , with each shift having a duration of not over 8 hours. (For example, a 24-hour continuous operation will be arrange into 3 or more shift).

   A group of qualified personnel, defined as "Duty Crew" shall be assigned for each shift to operate the reactor and to fulfill health physics and experimental or other operational requirements.

   The "Duty Crew" shall be composed of a minimum of one Reactor shift Supervisor, one reactor operator or operator-trainee and one health physics officer.

   The DRO, with the cooperation of the Health Physics Division, shall be responsible for naming individuals qualified under Sub-Section 5.3 or Sub-Section 5.4 , as the case may be , to shift duties.

   In the event that more than one reactor supervisor, or reactor operators, or health physicists are assigned to the same shift, the operational order (or any other documents serving the same purpose, such as the Reactor Operations Weekly Schedule) shall be adequately clear in respect of the area of assignment or area of responsibility of each individual assigned. In any event, the name of the reactor supervisor who is in-charge of the shift and that of the operator, or operator-trainee, who is assigned as the "reactor control operator" for the particular period of time shall be duly recorded in the Reactor Log Book (specified under Sub-Section 5.7).

Interim Assignment

In order that the General Atomic Company (GA) may fulfill its obligations under the "Agreement" of 16 September 1975 with the OAEP [4], GA personnel who are assigned to assist the OAEP pursuant to "Article 10-Testing" and 10 "Appendix A-1, Services" of the aforementioned

"Agreement" shall, for the intent of this Sub-Section 5.5, have the authority equivalent to that of the Reactor Supervisor under Sub-Section 5.3

The authorization for GA personnel to act as the reactor supervisor shall be in effect from the day that the individual reports for work at the OAEP Throughout the period of time required to complete the checkout, startup and nuclear calibration testing of the Completed reactor as described in "Article 10" of the "Agreement" and until the OAEP signs its acceptance of the completed Reactor pursuant to "Article 6-Inspection and Acceptance" of the "Agreement"

Throughout the period of time during which GA personnel are authorized as the reactor supervisors, either the Deputy Secretary General of the OAEP (as the Manager of the Reactor Conversion and Installation Project and Chairman of the OAEP Reactor Acceptance Committee), or the DRO (of OAEP), or any of the GA reactor supervisors shall, in the interest of safety to personnel or to equipment, have the power to halt, or to cause to halt, any operation involved in the carrying out of the "Testing" at any time, pending consultation between the senior personnel of the OAEP and of GA.

5.6 EXPERIMENT AUTHORIZATION

a. Any experiment shall not be carried out with or within the reactor, or with or within any experimental facilities without prior authorization of the DRO.

   For the intent of this Sub-Section, an "Irradiation" is a class of experiment and, consequently, an irradiation facility whose irradiation chamber is located in neutron flux field or gamma field which is produced by the reactor is an experimental facility.

   "Experiment Request Forms" appropriate to different classes of experiments shall be provided by the Reactor Operations Division (ROD) for use in the request for, and review of, the experiment. Following prescribed procedures and in the event that the experiment is approved by the DRO, the request form bearing an approval mark and signature of the DRO shall serve as the authorization to conduct the experiment.

b. In the cases of a request for a special experiment requiring an external review pursuant to para.(b) of Sub-Section 5.2, the DRO should proceed according to the procedures described thereunder. In principle however, the DRO shall have the ultimate power to stipulate experiment limits and conditions, or to disapprove the experimentl before or after presenting the experiment request for an external review.

5.7 OPERAT ION RECORDS AND FUEL REORDS

a. Reactor Log Book

Operating records of the reactor shall be maintained by the Reactor Operations Division in the Reactor Log Books. The current Log Book shall be kept within the reactor control room at all time when the reactor is not secured and the reactor shift supervisor is required to review the record of the latest previous operation before initiating the first startup or first pulsing of the reactor in his shift. The current Log Book may be taken out of the Control room only by the DRO authorization when the reactor is secured, such as for the verification of fuel inventory record or for other administrative control purposes; however, unless under an emergency or alert condition, the Log Book should not be taken out of the Reactor Building.

A finished log book shall be kept in a safe place for a period of not less than 10 years.

In the event that the current Log Book or a finished log book which is less than 10 years old is lost or damaged to the extent that a recorded information is lost, the DRO is required to report the lost or damage to the SG as soon as possible within 48 hours from the time the lost or damage is discovered.

The recording in the Log Book shall include, but not be limited to, the followings

(1) the current core loading certificate (or its certified copy), which should be securely fastened to an appropriate page in the Log Book;

(2) name of the shift supervisor on duty, and name of the operator or operator-trainee who is being assigned to manipulate the reactor control system (usually referred to as the "reactor control operator")

(3) mode of operation and parameters or data which are important to operation in the specified mode, such as the reactivity inserted and time of initiation of the pulse (for pulse mode); startup time, power level and time reach power, positions of control rods (for steady state operation); readings of radiation monitoring channels; etc.;

(4) records of fuel movements within, into or out of, the reactor pool, including name of the authorized staff member who is in-charge of the fuel movement;

(5) any parameters or data which are needed in the calculation of fuel burn-up, or for the preparation of fuel element history, or for the verification of fuel inventory.

(6) significant information on in-core experiment and its reactivity effect on the reactor, such as sample identification, time of loading or unloading and change in control rod position if any; in the event that specific data sheets are available for a certain experiment, they may be used instead of the Log Book recording provided that a copy of the completed data sheets are securely attached to the Log Book.

(7) occurrences of failure of a component of the reactor system and, in particular, of the instrumentation or control system, and brief summary of the remedial actions and time when the rectification is completed.

(8) occurrences of any abnormal incident within the reactor gas-tight area, such as high radiation level alarm or rupture of irradiated specimen container causing contamination of a reactor part or the floor.

and (9) any event or incident that the shift supervisor or the control operator (or Log Book keeper) considers worthy of recording in the Log Book.

b. Fuel Records

Fuel Records shall be maintained, using appropriate forms, record cards, data sheets and procedures that may be established by the DRO, in the following manners:

(1) that fulfills established "Safeguards" requirements, with particular reference to the "Safeguards Agreement" between Thailand and the International Atomic Energy Agency [5];

(2) that the location of any fuel element under safeguards may be identified when required;

(3) that fuel burn-up may be appropriately calculated;

and (4) that the fuel inventory may be properly maintained and verified.

5.8 AUTHORIZATION TO SHUTDOWN THE REACTOR UNDER ABNORMAL CIRCUMSTANCES.

a. Shutting down the reactor is a normal step in reactor operations and thus provisions for "normal" or "scheduled" shutdown are governed by the requirements of Sub-Section 5.3 and 5.5. To be more specific, a scheduled. shutdown under routine circumstances is to be carried out only by the shift supervisor or the control operator.

   The above statement notwithstanding, any of the following staff members shall have the authority to shutdown the reactor under abnormal circumstances when there is an adequate evidence that such action is required for the interest of safety or security:

   1. The DRO or any staff member whose name is on the current list of appointment under para.(b) of Sub-Section 5.3.

   2. The Director (or Chief) of the Health Physics Division, or a staff member temporarily appointed as Acting Director (or Chief) of the HPD, or the health physics officer on duty.

   3. Any OAEP security officer holding an appointment at post level 4 or above (according to the Post Classification System).

b. Provided that the unscheduled shutdown for reasons of safety or security is willfully initiated by a human being (i.e. not by a device which is a normal part of the reactor safety system), such shutdown shall be referred to as an "Emergency Shutdown".

   The reason, real or imagined, for the initiation of an emergency shutdown shall be subsequently recorded in the reactor Log Book.

5.9 PHYSICAL PPOTECTION OF VITAL AREAS

The space within the reactor gas-tight enclosure, normally referred to as "Reactor Gas-tight Area" or, simply, "Reactor Area", is classified by the OAEP as a "Vital Area".

In order to apply Appropriate physical protection measures within the vital areas and, at the same time, recognizing that certain degree of flexibility is desirable to encourage full use of the reactor, the following code of practice shall be applied to the reactor area.

a. Dangerous objects or materials, such as fire arms, any form of explosive devices, explosive materials, are normally not allowed in the reactor area.

Any individual seeking to bring such dangerous object or material into the reactor area for a bona fide purpose, such as for, or in connection with forensic investigations, or for neutron radiography work, shall contact the DRO for proper advice and possible authorization before attempting to bring such object or material into the reactor area.

b. Any persons or packages may be searched for concealed dangerous object or material before being allowed access to the reactor area.

c. The DRO, the reactor shift - supervisor on duty and OAEP senior security officers shall have the power to enforce appropriate actions for the physical protection of the reactor area, including the search before entrance, prevention of access, confiscation of object or material not allowed into the reactor area, escorting an individual into or out of the protected area, subdueing the intruder or violator, and to order other OAEP staff members to assist in such actions.

6. REFERENCES

1. Standard TRIGA Mark III - Safety Analysis Report (Prepared for the Office of Atomic Energy for Peace, Thailand). General Atomic Publication No. E-117-547, November 1975. (Numbers following stroke indicate page number).

2. Appendix A to Facility License No. R-100, Technical specification for Torrey Pines TPIGA Mark III Reactor, May 14, 1971; and -

   Appendix A to Facility License No. R-76, Technical Specifications and Bases for the Washington State University Modified TRIGA Reactor USNRC Docket No. 50-27, (Change No. 4), June 26, 1975.

3. See ANNEX 1 - Reactor Safety Committee, (attached).

4. Agreement for the Purchase and Sale of Components of the 2000 kW/Pulsing TRIGA Mark III Reactor and Services in Assembly, Conversion and Installation, between the Office of Atomic Energy for Peace Bangkok, Thailand and the General Atomic Company, San Diego, California, USA., as made on 16 September 1975.