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Health & Safety Executive
HM Nuclear Installations Inspectorate

Heysham 2 and Torness Nuclear Power Stations

The findings of NII's assessment of British Energy's periodic safety review

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HEYSHAM 2 & TORNESS
NUCLEAR POWER STATIONS

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PREFACE

Under a condition attached to the nuclear site licence, Periodic Safety Reviews (PSRs) are required to be carried out by the licensee of a nuclear power plant. The reviews are complementary to the day-to-day regulatory controls which are applied to nuclear power stations. They provide the opportunity to undertake a comprehensive study of the safety of the plant, taking into account aspects such as its operational history, ageing factors which could lead to a deterioration in safety, and the advances in safety standards since the time of construction or the previous review. From this, the safety of future operation of the plant can be evaluated.

The reviews are submitted to the Health and Safety Executive's Nuclear Installations Inspectorate (NII) for consideration and assessment to evaluate whether an adequate level of safety has been achieved. The PSRs for the advanced gas-cooled reactors (AGRs) have been completed to an agreed programme and will be repeated at 10 year intervals. The outcome of the first of the AGR PSRs, for the Hinkley Point 'B' and Hunterston 'B' nuclear power stations, was reported by NII in 1997 (Reference 1). This was followed by the PSRs for Dungeness ‘B’ in 1998 (Reference 2) and Heysham 1 and Hartlepool in 1999 (Reference 3).

This is the final report of the first cycle of AGR PSRs. It summarises the outcome of the PSRs for the Heysham 2 and Torness nuclear power stations, which have been carried out by the licensees, British Energy Generation Limited (BEGL) for Heysham 2 and British Energy Generation (UK) Limited (BEG(UK)L) for Torness. It supplements our initial report which was issued as a technical annex to a press statement in July 2000 (Reference 4). It describes the current position and background to NII's assessment and our conclusions on the acceptability of continued operation of these stations.

In general, we are satisfied that the licensee has completed a detailed scrutiny of the safety of the nuclear power stations. Improvements to the plant which the licensee had initiated in advance of the review have enhanced the safety of the stations, bringing the design closer to current standards. The overall outcome of the licensee's reviews, together with the programmes of additional modifications and inspections which have been put in place, provide confidence in the ability of these stations to continue to operate safely.

Nevertheless, we have also identified the need for some further work and programmes for this have been agreed with the licensees, which they intend to complete by April 2002. Subject to the completion of this work, and continuing satisfactory results from the routine monitoring and demonstrations of safety required under the nuclear site licensing arrangements, we are confident that the Heysham 2 and Torness nuclear power stations can continue to operate safely at least until the end of 2009, at which time a further periodic safety review will be required.

INTRODUCTION

1. The second generation of gas-cooled reactors built in the UK were the Advanced Gas-cooled Reactors (AGRs). Fifteen reactors were built including the prototype which commenced operation at Windscale in 1962 and was closed down in 1981. At Heysham 2 and Torness commercial operation of the reactors began in 1988. These stations were then owned by the Central Electricity Generation Board and the South of Scotland Electricity Board respectively.

2. Each station is currently operated by a different licensee: Heysham 2 is operated by British Energy Generation Limited (formerly Nuclear Electric Limited); Torness is operated by British Energy Generation (UK) Limited (formerly Scottish Nuclear Limited). Heysham 2 and Torness have traditionally been treated as “sister” stations. Although their basic design is the same, there were some differences in the detailed design and there have been some design changes throughout the period of operation. However for all practical purposes, in many areas the two stations can be considered to be identical. There has been close collaboration between the two licensees in the production of the Periodic Safety Reviews (PSRs). Therefore, in view of the similarities and the joint work undertaken, this report covers both power stations.

3. Considerable experience was gained in conducting PSRs during the earlier Long Term Safety Reviews (LTSRs) of the Magnox stations. The generic issues which were identified as a result of those reviews were taken into account in advance of the PSRs for the older AGR stations. This resulted in the licensees developing and implementing a programme of improvements to upgrade the safety of their plants in response both to changes in design standards and safety criteria, and to developments in safety technology and analytical techniques. This programme was known as the AGR Safety Review and Enhancement Programme (ASREP). In contrast to the older AGRs, Heysham 2 and Torness were not required to enhance plant provision in respect of the key issues arising from ASREP. The key ASREP issues included such items as fire protection, diverse tripping, diverse shutdown, diversity of post trip cooling, and the provision of an alternative indication centre. The Heysham 2 and Torness plants were already closer to current standards in each of these areas.

4. An initial report summarising the NII assessment findings for the Heysham 2 and Torness PSRs was issued as a technical annex to a press statement in July 2000 (Reference 4). That report gave our overall conclusions on the acceptability of continued operation for a further 10 years. This report provides a more detailed discussion of our main findings. In the meantime, some of the work identified has been completed, further information has been submitted for our consideration, and programmes of ongoing work proposed which the licensees intend to complete in 2002.

5. For background information, details of the legislation and licensing system used for the regulation of UK nuclear power plants is given in Annex A.

OBJECTIVES OF THE PERIODIC SAFETY REVIEW

6. Prior to any new nuclear installation being authorised to operate, the licensee must have a valid safety case, which is essentially a written demonstration that the intended operation of the plant will be adequately safe. The safety case therefore needs to confirm that all credible hazards have been identified, appropriate standards have been set and met, adequate safety features are in place, all significant assumptions have been identified, verified and validated, and that all instructions, limits and conditions required to maintain operations within specified margins for safety have been identified.

7. As an installation matures, modifications are made to the plant, ageing effects take place, some components may become obsolete and need replacing and plant operating instructions may be changed as a result of experience. During all this time the safety case must remain valid. The PSR process is designed to ensure that a thorough and comprehensive review is made of the safety case at regular intervals throughout a nuclear power station's life. The reviews have become a well established feature in the licensing requirements for nuclear plant, and are intended to be more wide ranging than a restatement of the safety case. They complement the normal day-to-day operational monitoring of safety, which is further underpinned by thorough inspections and assessment of the condition of the plant during normal maintenance and testing as well as during the planned periodic reactor shutdowns.

8. The objectives of the PSRs are:

- to review the total current safety case for the station and confirm that it is adequate;
- to compare against current standards for new plant, evaluate any deficiencies and implement any reasonably practicable improvements to enhance plant safety;
- to identify any ageing process which may limit the life of the plant;
- to revalidate the safety case until the next PSR, subject to the outcome of routine monitoring by the licensee and regulation by NII.

9. In reviewing the total current safety case, which is the first objective, we expect the licensee to reaffirm the validity of the original safety case, reflecting on factors such as:

- the original safety standards to which the plant was built;
- the various engineering improvements introduced during the operational lifetime which have enhanced safety;

- the numerous safety assessments undertaken during the station's life.

10. The second objective, to compare against current standards for new plant, is not straightforward. Advances in scientific and engineering knowledge, coupled with experience during operation of all types of plant, generally contribute to improvements in safety standards and practices. In many cases, this will be beneficial to existing plant. For example, advances in scientific knowledge may be used to provide greater confidence in the continued safe operation of a plant. We therefore require the review to address all relevant advances in safety standards and practices. Any significant shortcomings should be identified, and any improvements which are found to be reasonably practicable should be introduced.

11. Another essential element of the review is that we require all structures, systems, or components susceptible to ageing or wear-out to be examined, and failure mechanisms, together with any life-limiting features, identified. These various factors then have to be evaluated, particularly for aspects which may eventually result in unacceptably reduced levels of safety, and ultimately dictate the safe working life of the power station.

12. Finally, we expect the PSRs to confirm that the safety case will remain valid until the time of the next review, which is normally set at ten years. As we have stated above, the PSRs complement the normal operational monitoring of safety, which is also regulated by NII. Therefore, although the PSRs may conclude that the safety case is adequate for another ten years, this will be dependent upon continuing satisfactory results from routine inspections. Should any safety related factor emerge in the interim period which may throw doubt upon the continuing validity of the safety case, we would require the licensee to resolve the matter to our satisfaction.

WORKING ARRANGEMENTS

British Energy Generation (UK) Ltd (BEG(UK)L) and British Energy Generation Ltd (BEGL)

13. The licensees are responsible for carrying out and reporting on the Heysham 2 and Torness PSRs. These PSRs comprised 44 separate Topic Reports, plus a Summary Report, with supporting references, which were submitted for NII's consideration. The Summary Report brought together the wide range of subjects addressed in the Topic Reports, and concluded that subject to satisfactory completion of identified potential improvements, satisfactory safety cases had been demonstrated which supported continued operation of the Heysham 2 and Torness reactors up to the end of 2009.

14. The reports were produced by station and headquarters staff, assisted in a number of cases by licensees' contractors. All the reports were peer reviewed by other staff from the licensees' organisations before being submitted to the NII.

NII

15. Assessment of the licensees' PSRs involved a team of about 20 NII inspectors, whose number and composition varied with time.

16. The inspectors used the *NII's Safety Assessment Principles*

(Reference 5) as the standard against which to judge the safety of the reactors. Although the principles are intended primarily for use on new plant, differences between the original standards to which the reactors were built and the current safety standards are taken into account when applying the principles. In particular, the principle that all risks must be shown to be either negligible or "As Low As Reasonably Practicable (ALARP)" is very relevant to the assessment. The age of the plant and projected life are important factors which were considered when making judgments on the reasonable practicability of making improvements.

DESCRIPTION OF PLANT

17. Heysham 2 and Torness nuclear power stations began commercial electricity production in 1988. Heysham 2 power station is situated on the Lancashire coast to the south of Morecambe and near the port of Heysham (see Figure 1) and Torness power station is situated on the coast to the south east of the Forth estuary approximately 5 miles east of Dunbar (see Figure 2). Each station consists of two 1700 MW(th) advanced gas-cooled reactors. A cross section of a reactor showing the more important features is given in Figure 3. The fuel is in the form of hollow pellets of uranium dioxide stacked in thin walled stainless steel tubes, with small external ribs to aid heat transfer to the coolant gas, referred to as fuel pins. These fuel pins form part of a fuel element which comprises 36 such pins mounted vertically within a cylindrical outer graphite sleeve and supported by stainless steel grids. The fuel elements are mounted into a vertical stack of eight which are held together by a central tie bar running through the middle of the fuel elements, to form a fuel stringer. The graphite core into which the fuel stringers are loaded contains 332 fuel channels and 89 control rod channels. The reactor core is a massive graphite construction comprising layers of interlocking graphite bricks which act as the moderator for the reactor. It is surrounded by a large domed cylinder, fabricated from carbon manganese steel, known as the gas baffle, which serves as a barrier to separate the gas which cools the graphite, from the hot gas from the fuel channels which is being passed to the boilers.

18. The reactor cores are each housed within large pre-stressed concrete pressure vessels, cast around a 13mm thick carbon steel liner. The liner is designed as a gas-tight membrane and it is welded to the steel tubes which penetrate the pressure vessel. The liner and concrete temperatures are kept within acceptable limits by a combination of insulation on the gas side of the liner and a pressure vessel cooling water (PVCW) system on the concrete side. The concrete of the pressure vessel, which is approximately 5.5m thick, also serves as a biological shield which reduces radiation emissions. The reactor cores are cooled by forced circulation of pressurised carbon dioxide gas which flows through the core and ensures that the fuel channels and the graphite core are maintained at the required temperatures. The carbon dioxide coolant gas is circulated by eight electrically driven gas circulators per reactor. The boilers are a 'once through' design incorporated within the concrete pressure vessel. Steam from the boilers of each reactor drives one of two turbine generator units each producing a net electrical power output of approximately 670 MW.

SUMMARY OF NII's FINDINGS

19. Our principal comments on the PSRs of the Heysham 2 and Torness nuclear power stations are discussed under the following main headings:

- Review of Operating Experience
- Reactor Safety Systems
- Reactor Pressure Boundary
- Reactor Internals
- Human Factors
- Operating Rules
- Natural and Other Hazards
- Fuel Handling and Cranes
- Waste and Spent Fuel Management
- Ageing
- Radiation Doses
- Station Safety Case

Review of Operating Experience

20. The Heysham 2 and Torness reactors have operated within the existing framework of legislation since their design phase. Aspects such as plant modifications, in-service deterioration, up-dated fault analyses, advances in safety standards, and new data on physical phenomena relevant to safety, have been addressed on a regular basis throughout the station's life by the licensees and have been reported to NII.

21. It was recognised during the assessment of the earlier Magnox nuclear reactor LTSRs, that many of the generic issues (Reference 6) identified were also applicable to the AGRs. As a result, a programme of plant improvements was put in place for the older AGRs, this was known as the AGR Safety Review and Enhancement Programme (ASREP). The key issues addressed were: diverse guardline, diverse shut-down, improved fire-protection, increased diversity of post-trip cooling, and provision of an alternative indication centre. The early consideration of these issues was of great benefit to the PSRs of the older AGRs. However, for Heysham 2 and Torness it was not necessary to consider the ASREP programme, as these newest stations have been designed against more modern standards which made provision for the issues identified in the ASREP programme.

22. An event occurred in December 1997 when all 4 grid supplies to Heysham 2 were lost in high winds. The strong winds blowing off the sea caused salt to be deposited on the National Grid Company’s 400kV substation which resulted in flashovers on the insulators. Grid supplies were re-established, but shortly afterwards another disruption on the grid caused a further loss of all 4 grid supplies and then only one station supply was re-established. Another loss of grid event occurred at Heysham 2 in December 1998, again caused by a flashover due to salt deposits on the transmission system insulators as a result of high winds. Although the station’s automatic diverse standby supplies worked well, the licensees have conducted investigations to see what can be done to minimise potential disruption from future loss of grid events. As a result, the licensees have introduced improved response and training procedures to re-establish supplies with the minimum of delay and retain the ability to withstand further grid disruption.

23. At Heysham 2, several minor leaks of treated water from the pressure vessel cooling water (PVCW) system have occurred. But in March 1997 a large leak was identified with a much greater leak rate than those previously known. Throughout the period of high leakage a temporary modification to the PVCW system was undertaken to increase the make up flow rates. The leak was repaired using a sealing compound and at all times the PVCW system maintained an acceptable level of cooling. Corrosion monitoring has shown that no significant corrosion has occurred to date.

24. In 1992 at Heysham 2, during a periodic shutdown on a reactor, one of the four Reactor Vessel Relief Valves (RVRVs) was found to lift at a pressure below the limit stated in the Operating Rules. The valve had previously been incorrectly set. The valve was subsequently reset correctly. At Torness in 1992, during a check on the RVRV pressure settings an apparent downwards drift in the set pressure was observed. The pressure settings are important to the safety case which require the RVRVs not to lift early. The testing and setting procedures have now been changed.

25. In 1992 a failed fuel pin was detected at Heysham 2 in a fuel assembly which was part of the intitial charge. The current off-load pressurised refuelling (OPR) and the low power on-load refuelling (LPR) safety cases do not cover the handling of failed fuel. At the time of the failure of the fuel pin the safety case did not cover the transfer of the failed fuel from the reactor to the decay store. A specific justification was presented which supported the discharge of the fuel assembly and its storage in the decay store.

26. At Heysham 2 there has been one instance of a Reactor Seawater (RSW) System pump discharge valve failing to open during routine testing, due to a retaining ring becoming detached. In an earlier incident the same valve failed to open due to a hydraulic cylinder problem. This cylinder was identified as source of recurring problems. In addition some damage to the valves has been observed due to erosion of the seat and wear/corrosion of the shafts. Consequently all these pump discharge valves are being replaced on a rolling programme.

27. At Torness, there have been several reported events associated with the main coolant gas pypass plant isolation valves failing to operate on demand. Recent maintenance and testing indicates that reliability has been improved, but for any future similar failures, a simple operator recovery action has been implemented which will free the locked spindle, allowing it to close. No such failures have been reported at Heysham 2.

28 At Heysham 2 four of the eight gas circulators showed anomalous behaviour between November 1992 and June 1994. In a certain position of the inlet guide vanes (IGVs), shaft vibration appeared, coupled with a fall in motor current and circulator pressure differential. The four circulators were exchanged during the reactor outage in June 1994. After about a year’s operation a further gas circulator (No. 10) started to exhibit anomalous behaviour, and in 1997 this was also exchanged. Monthly monitoring has confirmed that anomalous behaviour has not returned since June 1994, apart from circulator No 10. Inspection of the five removed gas circulators has not positively identified the cause of the anomalous

behaviour, though it is judged that the cause is due to deposit build up on the impeller side plate inlet radius. The sixteen gas circulators currently installed at Heysham 2 are demonstrating acceptable performance with no indications of anomalous behaviour. At Torness increased vibration levels coupled with a drop in motor current have been observed on one circulator. But, as these observations are associated with IGV settings above those used for full reactor load, this anomalous behaviour was not considered to be important for normal operation. However, for depressurisation fault conditions the effect of anomalous gas circulator behaviour has been addressed in the safety case.

29. The licensee is required to maintain a record of incidents and this has been considered as part of the safety review. Although technical problems and minor incidents have occurred during operation to date, we are satisfied that the licensee has taken appropriate action by making changes to procedures and modifications to plant. While a satisfactory operational record is not in itself sufficient justification for concluding that these reactors can continue to be safely operated until the end of 2009, it is a good indicator and has been used by the licensees to justify some of the plant reliability and performance data.

30. The radiation doses to workers have been regularly monitored and controlled well within statutory limits. In addition, radiation levels at the perimeter of the licensed site are regularly monitored in order to confirm that doses to the public remain below statutory limits. The results are discussed in paragraphs 103 to 104.

31. Overall, the review of operating experience has shown that the reactors have been safely operated, and that radiation doses to workers have been well controlled. This helps to provide confidence that the station can continue to be safely operated.

Reactor Safety Systems

(i) ***General***

32. The principal components of the reactor safety systems are the reactor trip, reactor shutdown, post trip cooling and essential electrical systems. The condition of the reactor is monitored by instrumentation feeding into the safety circuit guardlines which detect abnormal or fault conditions in the reactor and initiate automatic shutdown and post trip cooling. Fault studies are undertaken to predict the conditions which may challenge plant safety and these allow appropriate system trip levels to be set. The reliability of the protection systems has been kept under review and, where appropriate, obsolete instrumentation has been replaced by modern equivalents. We report below firstly on the fault studies which have been considered and then on the associated protection systems.

(ii) ***Fault studies and safety analysis***

33. Fault studies are required to prove that the reactors stay in a safe state, even when a wide range of credible fault conditions is considered. These were included in the original design studies and the PSRs have provided an opportunity for a thorough review. The schedule of credible faults has been updated and fault transient analyses have been undertaken which confirm that the reactor protection systems have

adequate capability to ensure that the reactors can always be shut down when necessary and maintained in a safe state.

34. Heysham 2 and Torness had a probabilistic safety assessment (PSA) as part of the original safety case. It was called the Fault Sequence Probability Analysis (FSPA). However, the licensees have carried out a new (PSA) as part of the PSRs. This has involved calculation of the frequencies of all fault sequences, together with their potential consequences. The PSA has shown that overall the Heysham 2 and Torness design has proved robust in both plant segregation and redundancy and in the design of the man machine interfaces. The results of the PSA have confirmed the value of the plant improvements which are being implemented as part of the plant enhancement programme. We have concluded that the PSA is to a good standard and its results are acceptable.

(iii) ***Reactor shutdown systems***

35. The primary reactor shutdown system at both Heysham 2 and Torness uses boronated steel control rods to shutdown and maintain the reactor in a sub-critical condition when required. The Primary Shutdown (PSD) system is 'fail safe' in that failure of any essential supporting system will cause the rods to fall into the core under gravity. The secondary shutdown (SSD) system provides 'defence in depth' for the essential safety functions of reactor shutdown and holdown which are normally delivered by the PSD. The SSD injects nitrogen into the core and has been designed to satisfy shutdown and holdown requirements for all frequent faults even if the PSD fails. A manually initiated tertiary shutdown system based on injection of boron beads supplements the SSD system and allows the reactor to be depressurised.

36. The main and diverse guardlines monitor a number of reactor parameters and, where reasonably practicable, diverse parameter measurements are provided when higher protection integrity is required by the safety case. The main guardline system is implemented using 'Laddic' logic modules which have no moving parts and are 'fail safe' upon loss of electrical supplies. The diverse guardline system is relay based and is also 'fail safe' on loss of supplies. In addition to the main and diverse guardlines, a 'shutdown' guardline system (auxiliary guardline) is provided which protects the reactor when shutdown. The auxiliary guardline provides protection against unexpected rises in core reactivity. Based on current testing and experience, we are confident that the operational performance will continue to be adequate and that this can be expected to continue at least for the period until the next PSR is due.

(iv) ***Post trip cooling***

37. AGRs have an important safety feature in that cooling of the pressurised reactor can be maintained after shutdown by natural circulation of the carbon dioxide coolant gas, provided a supply of water to the main boilers is maintained to act as a heat sink. As a result of the follow up work from the Hinkley Point B PSR, the licensees have agreed to carry out further analysis of the concrete pressure vessels, to cover loss of Pressure Vessel Cooling Water in prolonged abnormal post trip cooling

conditions. This will provide additional confidence in the ability of the pressure boundary to remain intact under all conditions.

38. The cooling systems include a main boiler feed water supply, an emergency boiler feed supply and a separate decay heat boiler feed water system. These have had no significant operational problems. However, when comparing the systems against current standards, the licensees have identified a potential need for additional diversity in the boiler feed water systems to improve the protection against certain low probability fault scenarios. They are currently implementing modifications which will further reduce the likelihood of cooling failure during fault scenarios. NII supports these improvements and has agreed timescales for their implementation to further underpin the long-term safety case.

(v) ***Electrical supplies***

39. The PSRs include an assessment of the electrical supply and distribution systems that are essential for reactor safety at each station. The objective of this is to show that sufficient electrical supplies can be made available under all credible fault conditions. Loss of external supplies to the stations would cause the reactors to trip and alternative station supplies would then be required. The stations are provided with batteries which can cope with short-term electrical power demands. These are supported by diesel generators which are capable of producing sufficient electrical power to maintain adequate forced cooling of the shutdown reactors. The licensees have identified worthwhile improvements to the maintenance practices at the stations including reviews of the status of load schedules, the frequency of auto-checks of gas circulator variable frequency converters, and the status of safety documentation.

(vi) ***Safety related instrumentation***

40. Operational experience of the safety related instrumentation at Heysham 2 and Torness has been satisfactory. The instrumentation continues to meet its original functional requirements and in this respect supports the case for continued operation. Throughout the life of the station, the licensees have introduced more modern components when replacements were required due to obsolescence or ageing, and modifications have been made to introduce additional instrumentation where this has been shown to be beneficial. Some of these improvements are ongoing and we will continue to monitor progress.

41. The licensees have confirmed that the majority of essential alarms are hard wired to the Central Control Room (CCR) alarm fascia panels, but for Torness a few are processed via microprocessor based alarm modules. We are not satisfied that the reliability requirements of the microprocessor based alarm modules can be adequately demonstrated. We therefore require an alternative strategy. In view of the difficulty in demonstrating reliability claims, BEG(UK)L has agreed to implement improvements by installing hard wiring to these units. This work is currently ongoing and we will monitor progress.

42. The licensees presented proposals to address the question of whether computer systems would

handle the transition through the millennium ("Year 2000") and associated dates. A significant programme of work was carried out and the event passed without incident.

Reactor Pressure Boundary

(i) ***General***

43. It is important that the licensees' review of the safety case demonstrates high integrity of the reactor pressure boundary. At Heysham 2 and Torness the key components of the pressure boundary are the pre-stressed concrete pressure vessel (PCPV), the PCPV steel liner, the penetrations through the PCPV and thermal insulation attached to the liner. Other pressure boundary components include the pipework associated with external carbon dioxide (CO_2) gas systems, PCPV standpipes and the fuelling machine when connected to the reactor.

44. BEGL has presented a robust case for the PCPV by reference to conservatisms in the original design, quality checks prior to full operation, the quality and performance of thermal insulation on the vessel's inner surfaces, tolerance to a variety of degradation mechanisms, detectability of significant leaks, the redundancy and maintainability of the pre-stress tendons and the ability to monitor and adjust the level of pre-stress in the tendons during the operational life of the station. The safety case to confirm continued integrity of the other key components of the pressure boundary is made by demonstrating acceptable quality in the original design and construction, the original proof pressure test, compliance with current standards, in-service inspection and, in many cases, the ability to withstand failures of components in the boundary.

45. The PSRs address the safety cases for the key components which make up the reactor pressure boundary. The summary report describes how these components interact with each other and presents a satisfactory overall safety case for the reactor pressure boundary. Our findings on the reviews of each of these parts are summarised below under the relevant headings.

(ii) ***Reactor pressure vessel and foundations***

46. We have to remain satisfied that structural failure of a PCPV at Heysham 2 or Torness is so unlikely that it can be deemed incredible. The integrity of the PCPV has to be demonstrated across a range of credible faults.

47. To ensure safety, it is important that the pressure vessel is operated at all times within agreed limits as required by the safety case. The pressure vessel operating history at Heysham 2 and Torness has been examined by the licensees and, as expected from the results of our own regular inspection checks, it has confirmed that nothing of significance has occurred, which might jeopardise continued safe operation.

48. An important element of the vessel safety case involves evaluation of the current safety margins in the light of the large margins in the original design which were demonstrated by means of stress analyses and scale model tests. Current analyses of the vessels, together with consideration of operational history, routine monitoring and inspection programmes and time dependent changes, have

demonstrated that the vessels satisfy current standards for normal operation and fault conditions.

49. From the PSRs of earlier AGRs we required further analysis to demonstrate pressure boundary integrity in the event of loss of pressure vessel cooling with coincident loss of forced circulation of the primary coolant. This work is currently ongoing on other AGRs and it is expected to demonstrate continued pressure boundary integrity for this low probability fault. As a result of this requirement, the licensees have agreed to present further analysis for Heysham 2 and Torness and to clarify the safety role of the pressure vessel cooling system. The analysis will adopt current analytical techniques and appropriate material properties.

50. As required by pressure vessel regulations, a proof-pressure test was conducted at the time of construction. This test subjected the vessel to a higher pressure and thus higher stresses than would ever be expected during reactor operations. Additionally, many strain gauge measurements were taken during commissioning to demonstrate satisfactory behaviour. We have reviewed these results and, taken with the comprehensive inspection of the pressure vessels undertaken at the time of construction, we are satisfied as to the quality of the original build.

51. In-service inspection and monitoring of the vessels has continued throughout their lives. The methods used have included routine visual examinations, concrete sampling, ongoing strain gauge measurements, leakage checks (for both carbon dioxide and water), routine tendon inspections and pre-stress checks. None of these has revealed evidence of any significant deterioration, thereby providing further confidence in the continuing integrity of the reactor vessels.

52. Finally, the PCPV foundations must continue to provide adequate support throughout reactor life. Deterioration of foundations would become manifest through reactor building cracking or PCPV tilt, both of which are regularly monitored and have given no evidence for concern.

53. Overall, we are satisfied that there is a robust safety case for the PCPVs, which demonstrates that the structures retain large design margins to cope with design basis accidents. The vessels are subject to adequate programmes of regular inspection and maintenance. However, we will continue to monitor the work programme and the analysis of the new fault condition noted in paragraph 49, to underpin our judgment that the case for the PCPVs supports continued operation until at least the next PSR due at the end of 2009.

iii) *Liner, penetrations and insulation*

54. The liner safety case has been examined. The original design was conservative and supported by proof pressure tests. The liner and penetrations were designed and constructed effectively to modern standards which are based on experience with earlier AGRs.

55. The liner is generally loaded in compression and has been shown to be capable of withstanding predicted loads in the event of design basis over-pressurisation faults. We judge that the levels of liner leakage which can be tolerated would be detected by

routine monitoring of vessel pressure and coolant make-up and that this would lead to appropriate mitigating actions being taken by the operators. Routine monitoring of liner temperatures provides ongoing trend information and a method of detecting any significant local temperature changes. Overall we accept the licensees' conclusion that major failure of the liner is unlikely, however we shall keep factors such as temperature monitoring and material properties under review during future operation.

56. The PCPV has penetrations for fuel and control rod standpipes, gas circulators, personnel access, boiler feed, steam pipes, electrical and instrumentation connections. The original design of these penetrations is such that any credible failure is claimed to be tolerable. Thus, compared to earlier AGRs, the penetrations safety case is enhanced by this consequences of failure argument. We are satisfied that the penetrations have been adequately considered in the Periodic Safety Review, that no significant issues have been identified, and that these plant items should continue to perform adequately at least until the next PSR is due.

57. In order to improve confidence in the ability of the pressure boundary to remain intact under all conditions, the licensees have agreed to carry out further work in addition to the consequences of failure argument presented for the major penetrations. This will include the demonstration that all potential coolant gas leakage paths, including the small bore pipework, have been considered and do not threaten the long term post-trip cooling safety case. This work is currently ongoing and we will continue to monitor it.

58. The licensees have carried out a detailed review of the liner, penetrations and insulation to demonstrate that they will continue to be capable of protecting the PCPV from exposure to excessive temperatures which could affect its long term integrity. The licensees will review a number of detailed design issues against modern standards as part of their own PSR follow up work. NII has assessed the liner safety case and we are satisfied that the liner has been maintained at low temperatures and there is no evidence of corrosion due to the presence of water. The licensees have demonstrated that if failure of insulation were to occur, it would be limited, tolerable, and identifiable by the programmes of regular inspection which are in place. We are therefore satisfied that the PCPV liner and insulation has been demonstrated to be fit for continued service at least until the next PSR due at the end of 2009.

(iv) ***External gas circuits***

59. There are only a limited number of external gas circuits associated with the primary pressure boundary. They comprise the safety relief valve pipework, gas bypass pipework, and primary coolant blowdown and filling lines. The potential risk of rapid reactor depressurisation through failure of these circuits is protected against by features of the original design. The pipework is subject to routine inspections. The licensees have demonstrated the integrity of the external gas circuits, subject to the development and completion of the seismic safety case.

(v) ***Standpipes***

60. The licensees have undertaken a detailed review of the reactor pressure vessel standpipes. The operational history has been examined and we are satisfied that no incidents have occurred which prejudice continued safe operation.

61. The safety case provides confidence that total failure of standpipes can be discounted and no unacceptable degradation has been identified which could lead to failure of a standpipe. Even if this should occur, the consequences of failure would not pose a significant threat because there is a secondary restraint load path to prevent complete ejection. We are satisfied that the licensees have demonstrated that the standpipes are fit for continued service.

(vi) ***Pressure vessel cooling water (PVCW) system***

62. The PVCW system at each station comprises two independent circuits to control concrete temperatures during normal operation. The adequacy of this function is monitored by operational checks of the liner temperatures and alarms when the PVCW system fails. Additionally, each reactor is monitored for any leakage from the system which could affect the integrity of the vessel or the liner. There have been a number of PVCW leaks which have required action to locate and seal them. The licensees have shown that the design of the plant is adequate when compared to the requirements of current standards and design codes. We are therefore satisfied that the PVCW system is capable of controlling vessel temperatures during normal operation. For fault conditions however, as discussed in paragrah 49, the licensees have agreed to carry out further analysis of the Pre-stressed Concrete Pressure Vessel and liner to clarify the safety role of the PVCW system for the new potentially bounding fault.

Reactor Internals

(i) ***General***

63. The graphite reactor cores and elements of the associated steel support structures are examples of components susceptible to changes induced by ageing mechanisms such as oxidation, corrosion, erosion and irradiation induced embrittlement. They are also components which cannot be renewed should they become affected to an unacceptable degree. Routine monitoring, inspection, testing and regular safety assessment of these components are consequently of great importance in demonstrating their continuing fitness for purpose.

(ii) ***Graphite core***

64. The graphite of the AGR reactor cores is of a very high quality. However, it is slowly oxidised by the coolant gas during reactor operation and its structural strength is therefore gradually reduced with time. Neutron irradiation also affects graphite and induces slow changes in the physical dimensions of graphite components, their strength, elastic properties, thermal expansion and thermal conductivity. In order to predict these changes, graphite specimens were tested in experimental reactors at the design stage. Additionally, measurements are routinely made on small samples removed from channels of the reactor cores by a remote trepanning technique during periodic

shutdowns, and channel profiles are periodically checked for distortion using a remote controlled measuring device.

65. Following the earlier PSRs of the other AGRs, we asked that the licensees put in place more comprehensive programmes of measurement and sampling to provide additional confidence in the future capability of all AGR cores. We have reviewed these programmes and accept that they address the relevant chemical and physical properties. We are satisfied that the results of the measurements made to date and the supporting theoretical studies show that the graphite cores will remain fit for purpose. The licensees are developing new trepanning equipment to improve the reliability of the sampling process. We will ensure that the cores will be appropriately monitored during the operating period covered by these PSRs using our regulatory powers under the Licence if necessary.

(iii) ***Steel structures (core support, core restraint, guide tubes)***

66. The internal steel structures of an AGR are subject to ageing processes, for example neutron irradiation which can cause embrittlement. Other age related degradation processes include fatigue, fretting and creep. The licensees review the effect of these by assessment and by undertaking routine inspection of safety related components during the periodic shutdowns of each reactor. However, a major difficulty in this monitoring process is that AGRs were not designed to allow easy access for internal inspection and therefore only limited in-service inspection has been possible. The licensees have introduced a Component Life Assessment programme to calculate creep-fatigue damage accumulation in reactor internal components resulting from all significant plant operations.

67. We are satisfied, on the basis of the presently available operational experience and research data, that ageing degradation of the internal steel structures is not expected to be life limiting at Heysham 2 and Torness. However, experience has shown that unexpected changes can arise and therefore more frequent and detailed monitoring of specific components may eventually become necessary as the plant ages. Operation until the end of 2009 is therefore dependent upon the continuing satisfactory feedback from the routine inspection programmes.

68. The core restraint and core support structures are two particularly important components. The core restraint structure sits inside the gas baffle cylinder. It surrounds the reactor core and is essential for maintaining the core geometry. The core is supported by the diagrid which is a circular grillage structure. A mat of core support plates rests on the diagrid. The design is such that irradiation doses to critical components are generally low so that irradiation embrittlement is not expected to be significant. Periodic visual inspections of the core restraint and support structures have shown no evidence of deterioration. The safety case reviews undertaken during the PSRs have demonstrated that these structures are safe for continued operation.

(iv) Gas baffle assembly

69. The gas baffle assembly can be divided into three regions: the diagrid support skirt, the cylinder, and the torispherical dome. A high degree of integrity is required from the gas baffle assembly to ensure that the reactor coolant flow maintains the fuel elements, graphite core and primary circuit components within specified temperatures for all plant operating conditions and hazards. An essential part of the safety case is that any degradation and ageing mechanisms are understood and demonstrated to be acceptable. Degradation mechanisms have been considered, including irradiation, strain ageing and corrosion. Their effects are judged to be small. The only potential degradation mechanism of consequence is fatigue due to the operating cycles to which the components are subject. The fatigue damage of a number of critical components is continuously monitored and updated in the licensees' Component Life Assessment programme. Results indicate no cause for concern with performance meeting expectations. We will continue to monitor this work as part of our normal regulatory business during continued operation.

(v) ***Boiler internals***

70. Routine inspections of accessible boiler internal components have indicated that they generally remain in good condition. The licensees are continuing to monitor creep and fatigue damage of boiler components during plant operation using the Component Life Assessment work programme.

71. The boilers were designed taking account of the main potential failure modes and included design against a seismic event. The licensees' Component Life Assessment Programme shows that the boilers will be capable of operating to the end of the PSR operating period (end December 2009) without any of their action level limits being reached. Our assessment of the licensees' PSRs indicate that comparison with current standards reveal no significant shortfalls. On the basis of the safety case and PSR documentation, we are satisfied that the plant is safe for continued operation.

Human Factors

72. A significant element of the PSRs reflects the importance of operator performance in nuclear power plant operations. Many assumptions have been made in the PSRs in respect of the operators' ability to respond appropriately to plant disturbances. This means that factors affecting operator performance must be identified, and claimed operator actions demonstrated to be feasible and properly supported.

73. The licensees have considered the role of the operator during both normal operation and credible fault conditions. Detailed task analyses have been undertaken to confirm that operating staff would be able to meet the demands placed on them within the time which is available. The licensees have carried out a thorough review of this area and we support the recommendations which the licensees have identified. Other aspects of human factors, such as operator training, are subject to continuing reviews.

74. An important development in recent years, and a facet of the safety case studies which supports the PSR

programmes, has been the development of strategies to help operators deal with more remote fault conditions known as beyond design basis accidents. Under this initiative, "Symptom-Based Emergency Response Guidelines" have been developed to assist the operators in their decision-making processes.

75. We intend to carry out an assessment of the licensees' human factors safety review during the operating period of this PSR. In the meantime however, our continuing site inspection activities undertaken through normal regulatory business have concluded that the current framework of operating, maintenance and emergency procedures required to support the safety case, is satisfactory.

Operating Rules

76. Conditions attached to the site licence require the power station to be operated in accordance with Operating Rules, Operating Instructions and a Plant Maintenance Schedule, which are systematically reviewed and updated by the licensees. As part of this safety review process, operating rules and maintenance activities have been examined in the light of the updated safety case, and appropriate changes and revisions have been identified, which will be addressed through normal regulatory activities.

Natural and other hazards

(i) ***General***

77. Modern safety standards require that reactor plant be adequately protected against the effects of both externally generated hazards and those which may arise from on-site operations. External hazards include earthquakes, flooding and aircraft crashes, while on-site hazards include the effects of fire and releases of steam from the secondary circuit. It must be shown that the reactors can be shut down and subsequently maintained in a safe state should they be subjected to the effects of any foreseeable hazard.

78. Hazards were considered in the original design of the Heysham 2 and Torness reactors. The PSR included a comprehensive review of both internal and external hazards and this has resulted in a number of safety improvements which are currently being implemented on both stations.

(ii) ***Resistance to earthquakes***

79 Although historical records show that earthquakes of significant magnitude are rare events in the UK, modern nuclear power stations have to be safeguarded against them because they may pose a challenge to all parts of the plant's protection systems at the same time. Current safety criteria require a nuclear plant to be designed such that in the event of a specific earthquake, known as the design basis earthquake, the reactor can be safely shut down and the necessary safety related structures and equipment maintained in a safe condition. The design basis earthquake for modern plant is defined as the earthquake which is expected to be exceeded once in 10,000 years.

80. The Heysham 2 and Torness power stations were originally designed to withstand seismic loads, however, the seismic event was defined in a different manner than currently specified in modern standards. As part of the PSR process, the licensees reviewed the original design against modern

standards. Dialogue on the scope and extent of the modern standards review continues and this may lead to some further improvements being identified. The review of the differences between the original design and modern standards will continue and we will closely monitor the licensees' progress with this work. In the meantime, we are satisfied that the plant may continue to operate.

81. For the other AGR power stations, which were not initially designed to withstand earthquakes, the strategy adopted for the seismic case has been to demonstrate, where reasonably practicable, the availability of at least two lines of plant protection for frequent seismic events and a single, robust, line of protection for infrequent events. An earthquake which is expected to occur once in a thousand years is deemed to be frequent. The infrequent earthquake is defined as that which would not be expected to occur more than once in 10,000 years. The original design basis for Heysham 2 and Torness provided for a single line of defence for earthquakes, a second line of protection was not within the original design. The licensees are developing a strategy to determine the extent of the assessment and modifications required to provide a reasonably practicable second line of protection for frequent earthquakes. This may lead to a program of improvements which will need to be implemented at both stations. This ongoing work arising from the PSR and from our assessment is being addressed as part of the agreed PSR follow-up programme.

82. Two possible shortcomings of the original seismic design of the stations have been identified by our assessment of the PSR. These are the need to address the reasonable practicability of seismic qualification of the secondary shutdown systems and the seismic qualification of the small bore piping, failure of which could allow a slow depressurisation of the reactors after a seismic event. We require the licensees to provide a seismic qualification case for these pipes and for the shutdown systems for infrequent earthquakes where it is reasonably practicable.

83. We consider that the rigorous approach adopted by the licensees to the PSR process in assessing plant and identifying improvements for both frequent and infrequent earthquakes, will, when complete, provide a high level of confidence in the ability of the reactors to survive a significant earthquake. In the interim, the original seismic design of these reactors has satisfied us that continued operation of these reactors is acceptable.

(iii) *Steam and gas release*

84. Major failure of any of the steam or gas pipework located outside the pressure vessel could provide a potential source of damage to surrounding safety structures and equipment. As part of the PSRs, we required assurance that such an event is unlikely and that if it did occur, no unacceptable consequences would arise.

85. The safety case for steam release hazards is a recent one and meets the modern standard. The stations were designed for both frequent and infrequent hot gas release hazards. The licensees have conducted a thorough review of the safety case as part of their PSR process. On the basis of the safety case and PSR documentation, we are satisfied that the plant is safe for continued operation. Further

operation will be supported by inspections at appropriate intervals to confirm continuing plant integrity.

(iv) ***Fire***

86. A fire can result in damage to safety related equipment, thereby preventing it from performing its safety function. In a modern nuclear power station, fire compartments are established which are separated by appropriately rated fire resistant barriers that segregate redundant and/or diverse safety related equipment. This is referred to as the Fire Containment Approach. In addition to this, and as part of the defence in depth approach to managing fire risk, detection and extinguishing systems are installed which conform to the best available current standards. Heysham 2 and Torness stations have adopted this modern and preferred approach.

87. The studies undertaken in preparation for the PSRs by the licensees resulted in a number of plant modifications being identified which should further reduce the risk of fire compromising nuclear safety. A number of these modifications have already been implemented and the balance will be completed as part of the licensees PSR follow up work. Our assessment concludes that provisions for managing fire risk meet modern standards and that the PSR has involved a thorough review. We are satisfied that the plant may continue to operate.

(v) ***Other hazards***

88. Other hazards examined as part of the PSR include aircraft crash, flooding and wind loading. The potential for an aircraft crash on the reactors has been reviewed using current data. It was found that this does not present a significant risk, because a light aircraft crash would not seriously threaten reactor integrity and the probability of a heavy aircraft crash on to a reactor is low enough to be discounted.

89. The risks from flooding by extreme sea or rainwater events were considered as part of the work undertaken in the PSRs. The protection was considered adequate.

90. An assessment of the wind hazard identified a requirement to give further consideration to the effects of dominant openings in large structures subjected to high winds. Further assessment work in this area has been commissioned by the licensees aimed at confirming the capability of essential safety related structures and plant to withstand extreme wind loads. This will be completed as part of their programme of PSR follow up work targeted for completion early 2002. We will continue to monitor the licensees assessment of the wind hazard. In the meantime we are satisfied that the plant may continue to operate.

Fuel Handling and Cranes

(i) ***Refuelling equipment***

91. At both Heysham 2 and Torness, refuelling is carried out at low power, or off-load on a pressurised reactor. Safety cases for these operations, which are carried out using a large and complex refuelling machine, were reviewed by the licensees as part of the PSR.

92 The licensees have identified a number of improvements associated with maintenance and testing documentation, safety documentation

and the need for some minor plant modifications. The most significant of these improvements have already been carried out and the balance of work will be completed as part of the licensees' programme of PSR follow up work due for completion by early 2002. The safety performance of the refuelling machine, and the refuelling process, has been adequate and our assessment of the PSR has judged that the safety case for fuel handling continues to be satisfactory. We are satisfied that refuelling operations can be safely carried out throughout the operating period of this PSR subject to satisfactory results from routine inspections.

(ii) ***Cranes***

93. There is a small number of cranes and other lifting equipment at Heysham 2 and Torness whose failure may pose a dropped load hazard which could be significant to nuclear safety. There is a much larger number of cranes and other lifting equipment which could pose a dropped load hazard of lower nuclear safety significance. Within the PSR, the licensees have completed a comprehensive review of all lifting equipment to identify, categorise and assess each item. This was a considerable extension of the original safety case, and represents best practice. Our assessment has determined that a formal safety case is now required for some of the medium category lifting equipment. The licensees are developing this safety case, and it is due to be completed later this year. It is not expected that this new safety case will necessitate any significant modifications.

94 Following our assessment of the licensees' review of the lifting equipment, we have concluded that, in the specific cases of the fuelling machine support structure and charge hall crane, further justification of the structural elements to modern standards is required. The licensees have agreed to carry out this further work and it will be completed as part of the programme of PSR follow up work. The fuelling machine and charge hall crane have been proof tested and have operated satisfactorily for a considerable number of years. No obvious degradation mechanisms exist for the structural elements, and we are satisfied that, in the interim, the plant is safe for continued operation.

Waste and Spent Fuel Management

95. Radioactive wastes from Heysham 2 and Torness are handled in various ways according to the type and level of radioactivity involved. Solid non-combustible waste with low levels of radioactivity is stored temporarily prior to eventual disposal to the British Nuclear Fuels plc site at Drigg in Cumbria. Solid combustible low level waste can be incinerated in purpose-built facilities and liquid wastes are treated before authorised discharge (see para 104). Waste with intermediate levels of radioactivity is stored on site.

96. We have examined the safety documentation prepared by the licensees for the existing radioactive waste storage facilities and note that, for Torness wet sludge wastes, current arisings indicate there will be capacity shortfalls before the next PSR in 2009. In addition to the PSR documentation, the Licensees have provided further information to clarify the waste management strategies for some waste streams, including spent catalyst.

97. As a result of our assessment of the Torness PSR, we require further justification of the arrangements for management of solid LLW and desiccant. The licensee has set up a separate project to deal with this activity. In the short term, NII requires the presentation of a plan setting out the waste handling options available, the advantages and disadvantages of each option, and BEG(UK)L's intended course of action. Since completion of their PSR, BEG(UK)L has provided further clarification and justification of its policies to discharge this action and agreed to provide a programme for the longer term waste management strategy. Overall we are confident that the licensees are seeking to maintain a satisfactory waste management strategy.

Ageing

98. As part of these PSRs, the licensees have undertaken systematic reviews of the processes for the management of age related degradation of all nuclear safety related components at Heysham 2 and Torness. This has included reviewing the adequacy of the current maintenance, inspection and test regimes. We have examined these submissions and generally find the arrangements satisfactory to support operation at least until the end of 2009. Ageing mechanisms for the reactor internals, in particular the cores, require careful consideration due to their exposure to high levels of radiation. As described in the above section on 'Reactor Internals', these mechanisms have been evaluated in the PSRs and continue to be regularly monitored through inspection and sampling programmes.

99. Overall, we are confident that the licensees will continue to keep the process of ageing under close scrutiny. NII will continue to monitor the position as part of our routine regulatory inspections.

Radiation doses

(i) ***General***

100. Annual statutory dose limits for exposure to ionising radiation arising from sources other than medical and natural background are set at levels which ensure that the risk of harm to any person receiving such doses is low. The current annual statutory dose limit for classified workers is 20 mSv and that for the public is set 20 times lower at 1 mSv. For comparison, the average dose received in a year from radiation of natural origin in the UK is 2.2 mSv (Reference 7), though in some parts of the country it can exceed 5 mSv. There is a further statutory duty on employers to restrict the exposure of workers and other persons to ionising radiation, so far as is reasonably practicable. Advisory bodies such as the International Commission on Radiological Protection (ICRP), and the National Radiological Protection Board (NRPB), monitor and research national and international information on radiation on a continuing basis, and issue advice about keeping doses as low as reasonably achievable. They also issue updated recommendations on maximum doses from time to time, as additional or new information comes to light.

101. The most recent recommendations of the ICRP were published in 1990 (Reference 8). The NRPB gave its advice on the application of the ICRP's recommendations to the UK (Reference 9). These effectively recommended a reduction of the

annual dose limit for classified workers from 50 mSv to 20 mSv, and that for members of the public, from 5 mSv to 1 mSv. These recommended limits were incorporated into NII's Safety Assessment Principles (Reference 5). The revised Euratom Basic Safety Standards Directive incorporating the new limits was adopted in May 1996, with a lead-in period for their implementation. HSE revised the Ionising Radiations Regulations 1985 to bring the Directive into effect in January 2000. The new Ionising Radiation Regulations, 1999 specify the statutory dose limits that have legal force in the UK.

(ii) ***Doses to on-site workers***

102. Individual radiation doses to classified workers at Heysham 2 and Torness continue to be controlled to levels averaging around 0.2 mSv per year. This is well below the current statutory limit and the limit recommended by the ICRP. One particular contribution to radiation exposure arises from maintenance operations and, as the reactor plant ages, the need for more maintenance and inspection may increase the radiation exposure of station staff. We will require longer term plant operations to take any potential for additional radiation dose into account and show that it is acceptable.

(iii) ***Doses to the public***

103. In order to assess the exposure of members of the public to direct radiation from the site, the licensees monitor radiation levels at the perimeter of Heysham 2 and Torness sites. The licensees have reported that the results continue to show that the contributions from these stations to radiation dose rates at the site perimeter fence are very low. They have concluded that no member of the public is likely to receive an annual dose from direct radiation from the Heysham 2 and Torness site which exceeds the statutory limit of 1 mSv. [It should be noted that members of the public in the vicinity of Heysham site could also receive a small radiation dose from the Heysham 1 station. It is anticipated that this will be no higher than that from Heysham 2]. The Heysham 2 and Torness nuclear sites are included in the NII's 5 year rolling programme (Reference 10) to check independently the dose rates, and the associated exposure of members of the public reported by licensees. To date, the results from our independent checks in the vicinity of the Heysham 2 and Torness power stations are in broad agreement with the licensees' results and confirm that their monitoring and assessment of doses to the public are acceptable.

104. Under the terms of their discharge authorisations, the licensees measure liquid and gaseous discharges and monitor the environment in the vicinity of the sites on a regular basis. The environment agencies check the results of these monitoring programmes. These monitoring programmes confirm that the radiation exposure of members of the general public arising from authorised discharges of gaseous and liquid radioactive waste remains very low.

Station Safety Case

105. The PSR process represents a considerable investment on the part of the licensees to review the safety of Heysham 2 and Torness. The level of safety has been enhanced by implementing plant modifications, carrying out supporting studies and reviewing operating procedures.

These activities can increase the complexity of the documentation which form the station safety cases. The licensees have therefore agreed that, as part of the output from the PSRs, the stations will provide formal review procedures for updating their operational safety cases. This will reflect current plant configuration, will be readily accessible to the operators, and will be regularly updated.

CONCLUSIONS

106. We conclude that the licensees have conducted a wide ranging and comprehensive Periodic Safety Review of the Heysham 2 and Torness AGR power stations. The programmes of PSR follow up work involving modifications, procedural changes, inspections and further analysis will reinforce the safety case for longer term operation.

107. Nevertheless, as a result of our assessment of these PSRs, we have identified some further areas where we require additional improvements in the licensees safety cases. A programme of actions has been agreed which includes additional analysis, inspection and modifications. Responses to some of these requirements have already been received from the licensees and these are being assessed. The licensees have given NII a commitment to complete the remaining work by April 2002. The NII requirements for follow-up work are summarised in Annex B. We require the licensees to report on all ongoing work at regular progress meetings and at the start-up meetings during 3-yearly periodic shutdowns.

108. Provided that the agreed programmes of further analyses, improvements and inspections referred to in paragraphs 106 and 107 give satisfactory results, NII expect the Heysham 2 and Torness AGR stations to be able to operate safely until the end of 2009 when the next Periodic Safety Review will be required. Our conclusion is of course subject to the continuing satisfactory results from inspections and justifications of safe operation which are required under the current licensing arrangements.

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ANNEX A

Statutory Position for Regulation of UK Nuclear Power Plant

Legislation

1. The main legislation governing the safety of nuclear installations is the Health and Safety at Work etc. Act 1974 and associated relevant statutory provisions of the Nuclear Installations Act 1965 (refs. A1 and A2). Under these Acts, no site may be used for the installation or operation of any commercial nuclear installation unless a nuclear site licence has been granted to a corporate body by HSE, and is for the time being in force. NII is that part of HSE responsible for administering this licensing function.

2. The Health and Safety at Work etc. Act 1974 places a general duty on employers to ensure, so far as is reasonably practicable, the health, safety and welfare of all their employees and also to conduct their undertaking in such a way as to ensure, so far as is reasonably practicable, that people not in their employment who may be affected thereby are not exposed to risks to their health and safety. The radiological protection requirements for the workforce and the public are covered by the Ionising Radiations Regulations 1999 (Reference A3) made under the Health and Safety at Work etc. Act 1974.

3. The Nuclear Installations Act places an absolute duty upon the licensee to ensure that no injury to persons or damage to property is caused from ionising radiation arising from the site. Furthermore, the licensee is responsible under the Act for the safe design and operation of its plant and to ensure the health and safety of its employees and the public.

4. It is the duty of NII to see that appropriate safety standards are developed, achieved and maintained by the licensee, to seek to ensure that the necessary safety precautions are taken and to monitor and regulate the safety of the plant by means of its powers under the licence and relevant regulations.

Licensing System

5. The legislation empowers NII, on behalf of HSE, to issue the licence for a nuclear power station and to attach appropriate conditions in the interests of safety. The Heysham 2 and Torness site licences have 36 standard conditions attached to them concerning the safety of the plants' operation, maintenance and inspection requirements. One of the conditions attached to the site licence relates to periodic reviews and reassessment of safety, which is the subject of this report.

A1. *Health and Safety at Work etc. Act 1974*, Ch. 37, HMSO, ISBN 0 10 54 3774 3.

A2. *Nuclear Installations Act 1965 (as amended), Ch. 57,* HMSO, ISBN 0 10 850216 3.

A3. *The Ionising Radiations Regulations 1999* (SI 1999 No.3232), The Stationery Office, ISBN 0 11 085614 7.

ANNEX B

NII Requirements for Follow-up Work

BEGL and BEG(UK)L (the licensees) have reported their periodic safety reviews (PSRs) for operation of Heysham 2 & Torness up to 20 years to the end of 2009, at which time further PSRs will be required. The PSRs are reported in a series of 44 topic reports covering a number of safety-related subjects together with an overall summary report.

NII's assessment has examined these PSR submissions and many have been found to be acceptable. However, other submissions or the recommendations arising from them, contain shortfalls and we have identified additional requirements for further work which apply to both stations unless otherwise stated.

A current summary of the main requirements for the on-gong work is provided below. The licensees are committed to completing the remaining work by April 2002. All the follow-up work will be progressed to a satisfactory conclusion as part of NII's normal regulatory duties conducted under the site licensing arrangements.

Licensee's Plant Improvement Programmes

The licensees have identified areas where further safety analyses, modifications or changes in procedures may be required and these are listed in their Auditable Record of Issues Arising (ARIA). The licensees began implementing this programme of improvements in 1999 and, while currently ongoing, much work has been completed. We have agreed this programme with the licensees such that the balance of work outstanding will be completed as part of their own PSR process by April 2002.

Post Trip Cooling

BEG(UK)L and BEGL are to clarify the safety function of the pressure vessel cooling system (PVCS) in post trip cooling of the PCPV.

Reactor Safety Circuits

For Torness, BEG(UK)L is to justify the use of additional equipment to support reactor control interlocks which are purely computer based.

Control and Instrumentation

For Torness, BEG(UK)L is to develop an alternative strategy for supporting the reliability of the microprocessor based essential alarms to meet the programmable electronic systems (PES) guidelines.

Reactor Pressure Boundary

BEG(UK)L and BEGL are to demonstrate that all potential CO_2 leakage paths have been considered and that the leakage rate used for the seismic case does not undermine the long-term post-trip cooling safety case.

Natural and Other Hazards

BEG(UK)L and BEGL are to ensure that systems for secondary shutdown, pressure support and post trip cooling will be seismically qualified for the frequent seismic event where reasonably practicable.

In order to enhance the seismic qualification case for reactor shutdown, BEG(UK)L and BEGL are to provide further justification of the claimed seismic reliability of the primary shutdown system for the more onerous infrequent seismic event. Alternatively, BEG(UK)L and BEGL are to uprate the seismic qualification case for the secondary shutdown system to withstand the infrequent event.

BEG(UK)L and BEGL are to demonstrate that the original seismic analyses which support the design of the stations are robust when compared to modern standards.

BEG(UK)L and BEGL are to demonstrate that the standards used in the original seismic design of the stations are robust when compared to modern standards.

For Heysham 2 BEGL is to update the system used to control modifications at the station, so that it becomes capable of ensuring that the seismic safety case is not undermined. The process will need to ensure that suitably qualified and experienced personnel (SQEP) are available to fulfill this requirement.

Fuel Handling and Cranes

BEG(UK)L and BEGL are to review the capability of the Fuelling Machine, to reassess the design margins for normal and seismic loads, and confirm their adequacy against modern standards.

BEG(UK)L and BEGL are to review the capability of the Charge Hall Crane (CHC) against modern standards including the consideration of weighing the CHC and checking this against the seismic loading case.

BEG(UK)L and BEGL are to develop the safety case for lower category lifting equipment.

Radioactive Waste and Spent Fuel Management

For Torness, BEG(UK)L is to clarify the strategy for disposal routes and storage of radioactive waste arisings

Station Safety Case

BEG(UK)L and BEGL are to provide a review of the Civil Engineering safety case for all safety related buildings and structures.

BEG(UK)L and BEGL are to review the safety case accessibility and visibility and the effect of the PSA findings on the deterministic case in the Periodic Safety Review Topic Reports.

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