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PHYSICAL SECURITY FOR THE GALENA 4S NUCLEAR POWER GENERATION FACILITY

Prepared for the City of Galena, Alaska

PHYSICAL SECURITY

I EXECUTIVE SUMMARY

Physical security at nuclear facilities is an important licensing and design consideration, especially in light of heightened concerns over terrorist activities following the events of September 11, 2001. This paper presents physical security information concerning the Toshiba 4S (Super Safe, Small, and Simple) Liquid Metal Reactor (LMR). It is part of a series of white papers commissioned by Galena that discuss important aspects of deploying a 10 MWe Toshiba 4S Nuclear reactor based Power Facility (4S NPF) in Galena. These papers are intended to open lines of communication with various stakeholders and the U.S. Nuclear Regulatory Commission (NRC) regarding the Galena 4S NPF project.

This paper is not intended to present a proposed physical security system for a 4S NPF, but is an informational paper that (1) sets forth general NRC physical security requirements for nuclear power plants, (2) describes the inherently protective design and security features of the 4S technology and discusses why the physical security system for a 4S NPF does not, as a result, need to be as extensive as that for a classical nuclear power plant (even an advanced reactor design) which has inherent security requirements beyond those of a 4S facility, (3) provides a conceptual overview of physical security for a 4S NPF, and (4) identifies and discusses security staffing issues that would need to be resolved in licensing a 4S NPF in Galena.

As explained in the following sections, the small, protective design of the 4S NPF allows for vastly reduced plant hardware and security staffing, while at the same time providing adequate protection against radiological sabotage and theft of nuclear materials as required by NRC regulations. As shown in this paper, the inherently protective safety and security features of the 4S technology greatly simplify and reduce site security requirements.

II BACKGROUND

A. The City of Galena

The City of Galena, Alaska (Galena) is a small community (pop. 700) located in west-central Alaska, along the banks of the Yukon River. The closest communities to Galena (within 100 air miles or less) are Koyukuk (pop. 100) approximately 30 miles to the west, Nulato (pop. 330), approximately 40 miles to the west, Kaltag (pop. 230), approximately 60 miles to the west, Ruby (pop. 190) approximately 50 miles to the east, and Huslia (pop. 300), approximately 70 miles to the northeast. The nearest major population center is Fairbanks (pop. 30,500), 270 miles to the east.[1]

[1] U.S. Census Bureau, 2000 Census data, available online at http://www.census.gov/popest/cities/tables/SUB-EST2004-04-02.csv.

Galena has no roads linking it to the rest of the state. A former United States Air Force base, now known as the Edward J. Pitka Sr. (PAGA) airport, is located 1.5 miles west of the city. The main runway of the airport (runway 7-25) is 7,254 feet long, and is capable of handling heavy transport type air traffic. The airport is the primary access point into and out of the Galena area, and operates year-round. The Yukon River serves as the major heavy transportation resource during the unfrozen summer months. Galena serves as an educational and cultural center for the region. There are many public use and commercial buildings in the area of the airport and the city itself including schools, workshops, and municipal buildings. Homes are predominately located around the "New Town" area, 1.5 miles east of the airport.

B. The Galena Power Supply

Galena has no connection to an outside power grid. The city currently depends on diesel generators for its electric power supply. Galena experiences long, severe winters (winter low temperatures may reach –50°C (-60°F) or below and temperatures below -40°C (-40°F) are common). The lack of low cost year-round heavy transport into Galena requires the city to maintain large diesel fuel tanks in order to meet energy demand. The escalating price of fuel and the associated costs of fuel transportation, storage, and financing make the cost of electricity prohibitively high to Galena residents. These economic issues, coupled with environmental pollution concerns, make it prudent for Galena to explore alternative ways to meet its energy needs.[2]

C. The Galena 4S Project

In 2004, Galena received presentations from Toshiba Corporation (Toshiba) on a "Super-Safe, Small and Simple" (4S) Nuclear Based Power Generation Facility. The 4S reactor was developed jointly by Toshiba and the Central Research Institute of Electric Power Industry (CRIEPI) of Japan.[3] Following those presentations, Galena secured the preparation of a U.S. Department of Energy (DOE) sponsored study on ways to meet Galena's power requirements.[4] The study included analyses of the thermal and electric load profiles for Galena, technologies available to meet those loads (the technologies evaluated in detail were enhanced diesel power, coal, and a 4S NPF, which were determined to be the only viable alternatives), the environmental and regulatory issues associated with each of these technologies, and the overall economics of each energy option. The DOE study concluded that the 4S NPF is the best economic and environmental choice for Galena.

On December 14, 2004, the Galena City Council passed a resolution calling for the deployment of a 4S NPF in the community. The resolution stated, among other things,

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[2] Adams Atomic Engines, Inc., Atomic Insights, "Nuclear Power for Galena, Alaska" (March 2005), available online at http://www.atomicinsights.com/AI_03-20-05print.html.

[3] See, e.g., http://www.uaf.edu/aetdl/Presentations.htm.

[4] Robert E. Chaney et al., "Galena Electric Power- A Situational Analysis" (DE- AM26-99FT40575) (December 2004). Science Applications International Corporation (SAIC) coordinated the study, in which the University of Alaska and Idaho National Engineering and Environmental Laboratory participated.

that: "It is in the public interest to pursue the siting of a Toshiba 4S nuclear battery in Galena." The council further directed the City Manager to "establish a process and timeline leading to evaluations, industrial partners, and financial and contractual arrangements necessary to bring the economic and environmental benefits of the 4S to Galena."

Since the passing of the resolution, Galena has been investigating the regulatory and economic feasibility of locating a 10 MWe 4S NPF in Galena. In parallel, Toshiba has been developing a preliminary design document (PSID) to submit to the U.S. Nuclear Regulatory Commission (NRC) for its review.[5]

In order to move the siting evaluation process forward and open lines of communication with various stakeholders and the NRC, Galena has commissioned a set of white papers that discuss important aspects of the small nuclear power facility project including a General Overview, Nuclear Liability and Insurance, Emergency Planning, Physical Security, Decommissioning, Containment, and Seismic Isolation. This paper is part of the white paper series.

D. Features of the 4S Reactor

The 4S design introduces a small liquid metal nuclear reactor to the commercial power industry in the United States. Liquid metal reactors (LMRs) have been operated successfully worldwide and have been used in the United States at test facilities, with over 300 reactor years of operational experience. The small, advanced design of the 4S has several important operational and safety advantages, particularly for remote location deployment, when compared to the large light-water commercial nuclear power plants currently operating in the United States. The peak thermal output of the 10 MWe 4S reactor is approximately 30MW thermal (MWt), which is a small fraction of the power output of a standard sized commercial reactor. Important features of the design of the 4S include:

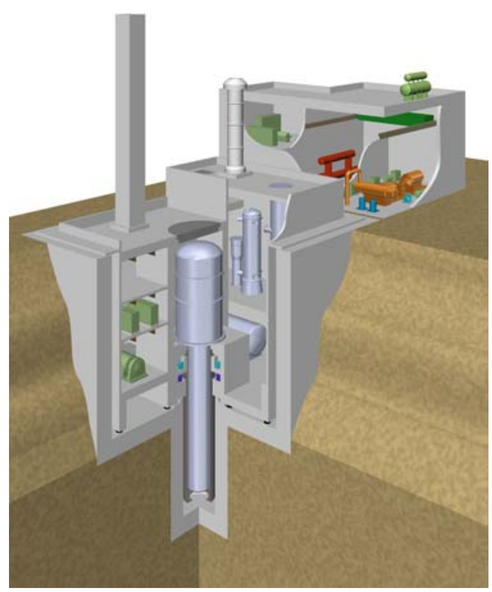
- Modular construction, which will reduce costs and construction time
- Nuclear systems that are embedded below grade, resulting in safety and security benefits
- Liquid sodium coolant, which does not react with core internals or piping
- Sodium coolant that is not highly pressurized, which minimizes stresses on the plant systems
- Passive safety systems that do not depend on emergency power to function
- Negative reactivity temperature coefficients, including coolant void reactivity, that cause the reaction rate in the core to slow down as temperatures rise
- Air-cooled reactor vessel, steam generator and condenser, so that no coolant water or intake structures are required
- 30-year core life, which avoids the need to refuel, eliminates fuel storage, and minimizes fuel handling concerns

[5] "Galena Project Officials Gear Up for Pre-Application Activities," Inside NRC, February 6, 2006.

- Capability of load following without mechanical operation of reactor control system
- Ease of decommissioning by containment of all radioactive materials within the reactor module throughout the life of the plant.

These unique features are among those that provide the 4S reactor system with significant benefits in operational capability, physical security, and protection of public safety. Many of the systems that increase cost, raise safety concerns, and pose potential security hazards at current plants (such as use of numerous mechanical pumps and valves, the need for a spent fuel pool, and the reliance upon high and low pressure water injection systems) have been eliminated in the design of the 4S. While the 4S reactor system does raise some new issues, such as the need to deal with highly reactive liquid sodium and potential accident scenarios involving sodium-water interaction, these issues have been addressed in the 4S system design and in past LMR facilities. On balance, the licensing of a 4S NPF should be a relatively straightforward process, provided that good communications are maintained between all parties involved and there is a timely flow of complete and accurate technical information.

With respect to physical security, the small size of the 4S NPF and its many inherently protective features greatly enhance plant security and would facilitate plant licensing. The figure to the right is a 3D rendition of the 4S power generation facility. It depicts the reactor building (lower left), which is below grade, and the turbine generator building (upper right). To put the small size of this facility in perspective, the overall dimensions of the below ground <u>and</u> above ground structures are approximately 190 feet long and 90 feet wide, and can be accommodated in less than ½ acre of land.



The reactor building (also referred to as the Nuclear Island) houses the reactor module (lowest left corner of figure), the steam generator (slightly higher and to the right of the reactor module), and other vital safety equipment. As can be seen in the figure, the lower part of the reactor module (containing the reactor core) is located in its own below grade silo-like reinforced concrete structure. The heavy reinforced concrete cap like structure on the top of the reactor module encloses the reactor assembly and core and provides the only access to the nuclear fuel, which is placed within the reactor module. Heavy lifting equipment is required to remove the cap and gain access the nuclear fuel.

The major components enclosing the reactor assembly and core are the reactor vessel, the containment guard vessel, and the guard vessel closure head (the heavily reinforced concrete cap on top of the reactor module). The containment guard vessel surrounds the reactor vessel and ensures that the core will not be uncovered and core cooling can be accomplished even if the reactor vessel leaks. The reactor vessel is the container and support for the reactor core, the primary radioactive sodium coolant, and the primary sodium intermediate heat exchanger structures. The reactor core is designed to have negative reactivity temperature coefficients, including coolant void reactivity, meaning that the nuclear reactivity of the fuel decreases as the reactor heats up, such that nuclear reactions in the core would cease for beyond design basis events that would raise the temperature of the core, such as loss of coolant flow without scram or loss of heat sink without scram.

The primary heat transport system (PHTS) through which the radioactive sodium coolant flows is wholly contained within the sealed reactor vessel. The radioactive sodium heated by the reactor core enters and flows through two intermediate heat exchangers (IHX), located within the reactor vessel, where it is cooled as it heats non-radioactive sodium that circulates through the intermediate heat transport system (ITHS). All radioactive materials in the 4S are limited to the PHTS and the fuel, both of which are wholly contained within the reactor vessel. No radioactive materials are ever removed from 4S reactor vessel throughout its 30-year life.

The ITHS transports heat from the primary system to the steam generator (SG) where it produces steam that drives convention steam turbine equipment. The IHTS is comprised of a piped loop thermally coupled to the primary system by the IHXs located in the reactor vessel and to the SG located in the SG compartment. The sodium that is circulated through the IHTS to transfer the heat from the primary system to the SG system is non-radioactive. The non-radioactive IHTS sodium entering the shell side of the SG heats the water on the tube side to produce steam, which drives a steam turbine located within the turbine generator building. The steam is cooled by the main condenser, which is also located with the turbine generator building. The condensed water is re-circulated through the SG system to repeat the process.

The 4S reactor shutdown heat removal systems consist of main condenser cooling, an intermediate reactor cooling auxiliary system (IRACS) for the SG, and the safety related reactor vessel auxiliary cooling system (RVACS) which removes heat directly from the reactor. The RVACS is a passive safety related system that transports heat to the atmosphere by natural circulation of air. It functions continuously with its heat transport rate governed by the reactor vessel temperature. During an event involving loss of ability to remove heat via the main condenser or the IRACS, the resultant higher primary sodium temperatures will raise the reactor vessel temperature and cause the RVACS to respond automatically with a corresponding increase in heat removal rate sufficient to maintain cooling of the 4S.

The above features of the 4S design and related features of the design are discussed at greater detail in the overview white paper[6] prepared as part of this series of white papers.

[6] Overview of Galena's Proposed Approach to Licensing a 4S Reactor-Based Power Generation Facility (Overview White Paper).

E. White Paper Objectives

The “white papers” in this series are part of an effort underwritten by the State of Alaska to provide “expert legal and technical analysis for [a] proposed mini-nuclear plant” at Galena. The objectives of the papers are threefold: (1) to discuss some of the more important issues that will need to be addressed by the NRC in its consideration of applications for an early site permit (ESP) and a combined construction/operating license (COL) for a 4S NPF located in Galena; (2) to identify approaches for handling issues to ensure that the overall cost of operating a 4S NPF in Galena is competitive with alternative electric power generation methods; and (3) to increase the awareness of government officials and the general public regarding the process for obtaining authorization from the NRC to construct and operate a 4S NPF in Galena.

Ultimately, Galena must determine if proceeding with the licensing and construction of a 4S NPF is economically justified. These papers are intended to assist the City in making that determination.

III RELEVANT LAW

A. Overview of Applicable, Rules, Regulations, and Guidance

1. NRC Rules and Regulations Governing Nuclear Plant Security

The NRC provides licensees with requirements that, if met, will result in adequate protection of workers, the public, and the environment. The NRC sets the rules that licensed users of radioactive materials must follow which are promulgated in Title 10 of the Code of Federal Regulations (10 CFR).

The security program for a nuclear power plant encompasses all of the elements associated with site physical security, access authorization, and fitness for duty. Physical security and access authorization requirements for nuclear power plants are contained in Part 73, "Physical Protection of Plants and Materials," of Title 10 of the Code of Federal Regulations (10CFR). Part 73 contains some 30 separate substantive regulations and seven substantive appendixes, of which 21 regulations and four appendixes apply to nuclear power reactors in general and will need to be evaluated and addressed in the development of the physical protection systems and program for the Galena 4S NPF. Key provisions of Part 73 concerning nuclear power plant security include the following:

- 10 C.F.R. § 73.1, which defines the generic design basis threat (DBT) against which nuclear facilities are to be protected (discussed further in Section III.B below);
- 10 C.F.R. § 73.55, which sets forth physical protection requirements for nuclear power plants to protect against the DBT (discussed further in Section III.C below); and
- 10 C.F.R. § 73.56, which sets forth the personnel access authorization requirements for nuclear power plants, including background investigations and psychological assessments for employees granted "unescorted access" at a nuclear power plant.

Fitness for duty requirements are contained in 10CFR Part 26, "Fitness for Duty Programs." The objective of such programs are to provide reasonable assurance that nuclear power plant personnel will perform their tasks in reliable and trustworthy manner and are not under the influence of any substance or suffer from any mental or physical impairment which in any way adversely affects their ability to safely and competently perform their duties.

Following the events of September 11, 2001, the NRC issued security orders that supplemented and in some cases modified the security requirements contained in Part 73, including the DBT against which nuclear power plants must be protected, and the fitness for duty requirements contained in Part 26, particularly as they relate to security guards. Further, the NRC has issued a proposed rule that would update the DBT for nuclear power plants following the events of September 11 (discussed in Section III.B below).

2. Regulatory Guidance Documents

Nuclear power generation facilities must be built to satisfy NRC and other regulations as specified in applicable Code of Federal Regulations, such as Part 73 and Part 26 of the CFR. In addition, the NRC issues various "guidance" documents that do not constitute regulatory requirements but provide information and guidance on how its regulatory requirements may be met. Foremost among these are Regulatory Guides which describe methods to implement specific parts of the Commission's regulations, techniques used by the staff to evaluate specific problems or postulated accidents, and data needed by the staff in its review of applications for permits or licenses. They provide applicants and licensees with methods acceptable to the staff for demonstrating compliance with NRC requirements. Other guidance documents include Standard Review Plans developed to guide the staff in evaluating license applications as well as industry guidance documents endorsed by the NRC, such as documents developed by the Nuclear Energy Institute (NEI), a nuclear industry trade association.

Regulatory guidance documents concerning physical protection at nuclear power plants that would be applicable in developing the physical protection systems and program for the Galena 4S NPF include the following:

a. Regulatory Guide 5.7: Entry/Exit Control for Protected Areas, Vital Areas, and Material Access Areas.

b. Regulatory Guide 5.12: General Use of Locks in the Protection and Control of Facilities and Special Nuclear Materials.

c. Regulatory Guide 5.43: Plant Security Force Duties.

d. Regulatory Guide 5.44: Perimeter Intrusion Alarm Systems.

e. Regulatory Guide 5.65: Vital Area Access Control, Protection of Physical Security Equipment, and Key and Lock Controls.

f. Regulatory Guide 5.68: Protection Against Malevolent Use of Vehicles at Nuclear Power Plants.

g. NUREG – 0800; Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, Section 13.6: Physical Security.

h. NEI 03-12: Security Plan, Training and Qualification Plan, and Safeguards Contingency Plan (endorsed by the NRC).

3. Codes and Standards

In addition to regulations and regulatory guidance documents, there are specific codes and standards to which adherence may be required in order to meet regulatory requirements and good engineering practices. Some of the codes and standards that would be applicable to developing the physical protection systems and program for the Galena 4S NPF include the following:

a. Underwriters Laboratories, Standard UL437, Key Locks.

b. Underwriters Laboratories, Standard UL752, Bullet-Resisting Equipment.

c. Institute of Electrical and Electronics Engineers, IEEE Standard 566: Recommended Practice for Design of Display and Control Facilities for Nuclear Power Generating Stations.

d. Federal Specification (Interim), W-A-00450B (GSA-FSS): Alarm Systems, Interior, Security, Components For.

B. Design Basis Threat for Nuclear Power Plants

The NRC's requirements for physical security at nuclear power plants and other nuclear facilities set forth in 10 C.F.R. Part 73 are built around the "design basis threat" (DBT) defined in 10 C.F.R. § 73.1. The DBT specifies threats (e.g., number of attackers, weapons, etc.) for "acts of radiological sabotage"[7] and for the "theft and diversion formula qualities of strategic of special nuclear material"[8] against which nuclear facilities are to be defended.

The DBT requirements are in the process of being amended to take into account the experience gained since the events of September 11, 2001.[9] On February 25, 2002, the NRC issued an Order requiring nuclear plants to take steps to enhance security at nuclear power plants.[10] On April 29, 2003, the NRC issued an Order requiring nuclear power plants to revise their physical security plans, security personnel training and qualification plans, and safeguards contingency plan to implement requirements beyond those set forth in 10 C.F.R. § 73.1.[11] Additionally, in the recently enacted Energy Policy Act (EPA) of 2005, Congress directed the NRC to revise its DBT and identified 12 factors related to

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[7] Id. The regulations define radiological sabotage to mean "any deliberate act directed against a plant or transport in which an activity licensed pursuant to the regulations in this chapter is conducted, or against a component of such a plant or transport which could directly or indirectly endanger the public health and safety by exposure to radiation." 10 C.F.R. § 73.2

[8] Id. The regulations define "strategic special nuclear material" to mean " uranium-235 (contained in uranium enriched to 20 percent or more in the U-235 isotope), uranium-233, or plutonium." Formula quantity is defined to be strategic special nuclear material "in any combination in a quantity of 5,000 grams or more computed by the formula, grams (grams contained in U-235) + 2.5 (grams U-233 + grams plutonium)."

[9] See "Design Basis Threat," Proposed Rule, 70 Fed. Reg. 67,380 (Nov. 7, 2005) (Proposed DBT Rule).

[10] See Order Modifying Licenses (Effective Immediately) (Feb. 25, 2002).

[11] See Issuance of Order Requiring Compliance with Revised Design Basis Threat for Operating Power Reactors: Order Modifying Licenses (Effective Immediately) (Apr. 29, 2003)**;** see also Proposed DBT Rule at 67,381.

plant security for the NRC to consider in amending its DBT requirements.[12] On November 2, 2005, the NRC initiated a rulemaking to incorporate the supplemental DBT requirements prescribed by its Order of April 29, 2003, and to consider the 12 factors set forth in the EPA.

The detailed threat characteristics of the DBT constitute "safeguards information" and are not available to the public. Thus, in defining the DBT in its regulation, the NRC has sought to provide a "level of detail that reflects all major features of the DBTs, yet avoids compromising licensee security by not publishing the specific tactical and operational capabilities of the DBT adversaries."[13] Specific details comprising the DBT (e.g., number of attackers, specific weapons, ammunition, etc) are set forth in "adversary characteristics documents" (ACDs) not publicly available.[14] The technical bases for the ACDs are derived largely from intelligence information.[15]

The DBT, as set forth in 10 C.F.R. § 73.1, requires nuclear plants to be protected against acts of radiological sabotage. The new rule proposed by the NRC, which incorporates the supplemental DBT requirements prescribed by the NRC's April 29, 2003, DBT Orders, would expand the DBT definition in several significant respects, namely to address more aggressive actions conducted by more capable attackers.[16]

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[12] Those factors include (1) the events of September 11, 2001; (2) an assessment of physical, cyber, biochemical, and other terrorist threats; (3) the potential for attack on facilities by multiple coordinated teams or a large number of individuals; (4) the potential for assistance in an attack from several persons employed at the facility; (5) the potential for suicide attacks; (6) the potential for water-based and air-based threats; (7) the potential use of explosive devices of considerable size and other modern weaponry; (8) the potential for attacks by persons with a sophisticated knowledge of facility operations; (9) the potential for fires, especially fires of long duration; (10) the potential for attacks on spent fuel shipments by multiple coordinated teams of a large number of individuals; (11) the adequacy of planning to protect the public health and safety at and around nuclear facilities, as appropriate, in the event of a terrorist attack against a nuclear facility; and (12) the potential for theft and diversion of nuclear materials from such facilities. Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594, § 170E.b(1)-(12) (Aug. 8, 2005). The pending NRC rulemaking on redefining the DBT explicitly takes into account some of these factors.

[13] Proposed DBT Rule at 67.382.

[14] Id. at 67,380.

[15] Id.

[16] The proposed rule would amend 10 C.F.R. § 73.1 to require nuclear power plants to be protected by acts of radiological sabotage by

> (i) A determined violent external assault, attack by stealth, or deceptive actions, including diversionary actions, by an adversary force capable of operating as one or more teams, attacking from one or more entry points, with the following attributes, assistance and equipment:
>
> (A) Well-trained (including military training and skills) and dedicated individuals, willing to kill or be killed, with sufficient knowledge to identify specific equipment or locations necessary for a successful attack,
>
> (B) Active (e.g., facilitate entrance and exit, disable alarms and communications, participate in violent attack) or passive (e.g., provide information), or both, knowledgeable inside assistance,
>
> (C) Suitable weapons, including hand-held automatic weapons, equipped with silencers and having effective long range accuracy,

While neither the NRC's existing nor proposed DBT includes airborne attacks by a terrorist on a nuclear facility, the NRC is considering as part of the ongoing rulemaking process whether airborne attacks should be included in the DBT. [17] In its Statement of Considerations on the proposed DBT rule, the Commission states that, even though airborne attacks are not currently part of the DBT, it has "required existing nuclear power plant licensees to develop and implement strategies to mitigate potential consequences in the unlikely event of an [airborne] attack, including an aircraft crash into a nuclear power plant."[18] The Commission goes on to note that "[f]or new nuclear power plants, the opportunity exists to develop designs that provide for enhanced protection against potential [airborne] threats."[19] The proposed DBT also incorporates attacks by "an adversary force capable of operating as one or more teams and attacking from one or more entry points,"[20] but because the number of attackers comprising the DBT is safeguards information, the DBT rule does not spell out what that number is. The Commission has stated, however, that the "DBT is based upon review and analysis of actual demonstrated adversary characteristics in a range of terrorist attacks, and a determination as to the attacks against which a private security force could reasonably be expected to defend."[21]

The Commission has previously addressed the extent to which private security forces at nuclear power plants can reasonably be expected to defend against certain attacks directed at nuclear facilities. The Commission's regulations expressly provide that licensees of nuclear power plants cannot be expected to defend against attacks directed at a nuclear facility "by an enemy of the United States, whether a foreign government or other person."[22] In a similar vein, following the events of September 11, 2001, the

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> (D) Hand-carried equipment, including incapacitating against and explosives for use as tools of entry or for otherwise destroying reactor, facility, transporter, or container integrity or features of the safeguards systems, and
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> (E) Land and water vehicles, which could be used for transporting personnel and their hand-carried equipment to the proximity of vital areas, and
>
> (ii) An internal threat, and
>
> (iii) A land vehicle bomb assault, which may be coordinated with an external assault, and
>
> (iv) A waterborne vehicle bomb assault, which may be coordinated with an external assault.

Proposed DBT Rule, 70 Fed. Reg. at 67,383-84. The proposed rule defines the DBT against which protection is to be provided to prevent theft or diversion of formula quantities of strategic nuclear material to be identical to that for radiological sabotage. Id.

[17] Airborne attacks are one of the factors that the 2005 EPA calls on the NRC to consider in amending its DBT and rulemaking petitions have been filed with the NRC requesting amendment of the DBT to include airborne attacks.

[18] Proposed DBT Rule, 70 Fed. Reg. at 67,385.

[19] Id.

[20] Id. at 67,383.

[21] Id. at 67,385.

[22] 10 C.F.R. § 50.13. In the Statement of Considerations accompanying 10 C.F.R. § 50.13, the NRC wrote: "The protection of the United States against hostile enemy acts is a responsibility of the nation's defense

Commission rejected a petition requesting the NRC to establish a no-fly zone within 10 nautical miles of the Indian Point nuclear power plant and to require the licensee to deploy defenses and security systems sufficient to protect and defend the no-fly zone. In rejecting the petition, the Commission made clear that:

> There are limits to what can be expected from a private guard force, even assisted by local law enforcement. Even if it is determined that nuclear power plants should be defended against aircraft attack, the NRC cannot expect licensees to acquire and operate antiaircraft weaponry. Protection against this type of threat may be provided by other means within the federal government.[23]

Furthermore, just recently the Commission has reaffirmed in proposed amendments to 10 C,F.R Part 52 of its regulations (Licenses, Certifications, and Approvals for Nuclear Power Plants) the continuing validity of 10 C.F.R. § 50.13 following the events of September 11, 2001. In the proposed amendments for Part 52, the Commission has proposed to include a provision "essentially identical" to 10 C.F.R. § 50.13 that licensees for combined licenses to construct and operate a nuclear facility "need not provide design features or other measures for protection of nuclear power plants against attacks by enemies of the United States."[24] As stated in the Statement of Considerations for the proposed rule, the "Commission is simply making it clear that its longstanding determination [that licensees need not defend against attacks from enemies of the state] applies to applications under Part 52 just as it applies to applications under part 50."[25]

In sum, the NRC has established a comprehensive DBT for nuclear power plants, which requires extensive physical security systems and forces (discussed below). This DBT is designed to identify the types of terrorist attacks that are the most extensive in private industry. There are, however, limits on the level of attacks against which a private security force at a nuclear power plant – or any other critical infrastructure – can be

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establishment and of the various agencies having internal security functions. . . . One factor underlying the Commission's practice in this connection has been a recognition that reactor design features to protect against the full range of the modern arsenal of weapons are simply not practicable and that the defense and internal security capabilities of this country constitute, of necessity, the basic 'safeguards' as respects possible hostile acts by an enemy of the United States." Exclusion of Attacks and Destructive Acts by Enemies of the U.S. in Issuance of Facility Licenses, 32 Fed. Reg. 13445 (1967).

[23] Entergy Nuclear Operations (Indian Point, Units 1, 2, and 3), DD-02-6, 56 N.R.C. 296, 310 (2002).

[24] See "Licenses, Certifications, and Approvals for Nuclear Power Plants," Proposed Rule, 71 Fed. Reg. 12,782, 12,788 (Mar, 13, 2006).

[25] Id. Consistent with 10 C.F.R. § 50.13, the proposed rule, 10 C.F.R. § 50.10, provides that "Neither an applicant for a license to manufacture, construct, and operate a utilization facility under this part, nor for an amendment to this license, or an applicant for an early site permit, a standard design certification, or standard design approval under this part, or for an amendment to the standard design certification or approval, is required to provide for design features or other measures for the specific purpose of protection against the effects of—(a) Attacks and destructive acts, including sabotage, directed against the facility by an enemy of the United States, whether a foreign government or other person; or (b) Use or deployment of weapons incident to U.S. defense activities. Id. at 12,890 (emphasis added).

expected to defend, and at which point the defense against such attacks becomes a government responsibility.

C. NRC Security Requirements Applicable to Nuclear Power Plants

The specific security requirements applicable to nuclear power plants are set forth in 10 C.F.R. § 73.55, "Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage." 10 C.F.R. § 73.55(a) requires the establishment of an onsite physical protection system to "designed to protect against the design basis threat of radiological sabotage as stated in § 73.1(a)" so as to provide "high assurance" that licensed activities are neither inimical to the common defense and security and nor pose undue risk to the public health and safety. In order to meet these general objectives, the onsite physical protection system and security organization must meet the applicable requirements set forth in paragraphs (b) through (h) of the regulation. Briefly, these are as follows:

- Paragraph (b) of 10 C.F.R. § 73.55, "Physical Security Organization," requires the establishment of a security organization to protect the facility against radiological sabotage, including armed guards who must meet extensive physical, mental fitness, and weapons training requirements specified in Appendix B to 10 C.F.R. Part 73.
- Paragraph (c) of 10 C.F.R. § 73.55, "Physical barriers," requires all vital equipment be located "within a vital area, which in turn shall be located within a protected area such that access to vital equipment requires passage through at least two physical barriers of sufficient strength to meet the performance requirements" of 10 C.F.R. § 73.55(a).[26]
- Paragraph (d) of 10 C.F.R. § 73.55, "Access Requirements," requires that access to the protected area is to be strictly controlled.
- Paragraph (e) of 10 C.F.R. § 73.55, "Detection aids," requires two continuously manned alarm stations, a central alarm station which is to be located on site within the protected area and a second alarm station which does not need to be on site.
- Paragraph (f) of 10 C.F.R. § 73.55, "Communication requirements," requires each on-duty guard to be capable of continuous communication with each continuously manned alarm station.
- Paragraph (g) of 10 C.F.R. § 73.55, "Testing and maintenance," requires regular testing and maintenance of all security equipment as well as annual audits of the overall security program.

[26] 10 C.F.R. § 73.55(c) (emphasis added). Requirements prescribed for these barriers include an isolation zones adjacent to the physical barrier at the perimeter of the protected area, illumination of the isolation zones and all exterior areas within the protected area, monitoring and detection capability to assure detection of attempted penetration of the barrier and enable timely response by the security organization, and appropriate vehicle control measures. Id.

- Paragraph (h) of 10 C.F.R. § 73.55, "Response requirement," requires the licensee to develop and maintain a formal Safeguards Contingency Plan in accordance with 10 C.F.R. Part 73, Appendix C which is a detailed plan by which a licensee is to respond to threats of radiological sabotage.[27] In addition, 10 C.F.R. § 73.55(h)(3) specifies the number of on duty guards that need to be "immediately available" to respond to a threat, and requires licensees to establish and document liaisons with local law enforcement authorities who can be summoned for assistance in the event of an attack.[28]

Thus, nuclear power plants are required under10 C.F.R. § 73.55(b)-(h) to institute stringent physical protection and security provisions to protect against acts of radiological sabotage, which have been further augmented and enhanced by NRC security orders issued since the events of September 11, 2001. However, 10 C.F.R. § 73.55(a) does authorize the NRC to allow an applicant or licensee to provide measures different than those specified in paragraphs (b) through (h) of the regulation if the applicant or licensee demonstrates that the proposed alternative measures meet the general performance objectives and requirements prescribed by 10 C.F.R. § 73.55(a) and provide protection against radiological sabotage equivalent to the measures provided by paragraphs (b) through (h) of the regulation.[29]

IV ANALYSIS

A. General Plant Security Concepts

The physical security program at a nuclear power plant is implemented by the plant's Security and Safeguards (S&S) program. The program provides protection for both the facility and the nuclear materials it contains so as to ensure adequate protection of the public health and safety and the environment. The basic required safety functions at a nuclear power plant are those necessary to shut down the reactor, maintain core cooling, remove decay heat, and control radionuclide release to limits below that specified in 10 C.F.R. Part 100. Those safety functions must be protected against adverse external threats and sabotage initiated events.

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[27] A Safeguards Contingency Plan is to identify a predetermined set of threats to the facility, the actions that will be undertaken to respond to the identified threats, the means for implementing the response actions, and those responsible for implementing the response actions. See 10 C.F.R. Part 73, Appendix C.

[28] 10 C.F.R. § 73.55(h)(2) & (h)(3) (emphasis added). The regulation requires that "nominally" ten guards shall be available to respond immediately to a threat, unless specifically required otherwise by the Commission, and that this number "may not be reduced to less" than five guards. 10 C.F.R. § 73.55(h)(3). This requirement is discussed further in Section IV.E infra.

[29] Further, an applicant or a licensee may seek an exemption from the requirements of 10 C.F.R. § 73.55(b)-(h) under 10 C.F.R. § 73.5, which authorizes the Commission to grant an exemption from the requirements if 10 C.F.R. Part 73 upon determining that the exemption is "authorized by law and will not endanger life or property or the common defense and security, and [is] otherwise in the public interest." Whether the NRC might allow fewer guards to be employed at the Galena 4S NPF than that required by 10 C.F.R. § 73.55(h)(3), either under the authority of 10 C.F.R. § 73.55(a) or by exemption under 10 C.F.R. § 73.5, is discussed in Section IV.E infra.

The main objectives of the S&S program are: (1) to protect against attack and sabotage of the plant that could cause a release of dangerous levels of radioactivity into the surrounding environment, and (2) to guard against the theft and diversion of nuclear materials from the plant that could be used to cause harm elsewhere. As discussed below, the 4S facility design incorporates multiple features that minimize the risk that terrorists will succeed in sabotaging the plant or illicitly diverting nuclear materials.

In light of the events of September 11, S&S activities have taken on a heightened level of importance at nuclear power plants. For that reason, and in keeping with global security concerns, the DBT will need to be rigorously considered in the design and licensing of a 4S NPF in Galena. The details of the S&S program to address plant security will be included in a plant Safeguards & Security Plan, Vital Area Analysis, and Facility Specific Threat Policy Statement. These documents will describe the physically secure areas of the facility and the barriers and controls provided to limit access; the intrusion detection devices; and the provisions for responding to intrusions, including the defined threat and the respondent force available at the site to defeat the postulated threat. Because of their detailed information concerning protection against potential threats, these documents will be considered SAFEGUARDS information, as required by Title 10 of Code of Federal Regulations Part 73.21, and, accordingly, would not be made available to the public.

B. 4S Design Features that Enhance Security

The 4S design incorporates numerous protective features that enhance plant security and minimize the risks from terrorist activities. Those design features include:

- No periodic refueling
- No fuel handling (except initial core load and final removal)
- No Fuel Pool
- Reactor and other nuclear systems embedded below grade and encased in concrete
- Removal of concrete cap that is necessary to obtain access to nuclear fuel requires heavy equipment not on site
- Proliferation resistant fuel that cannot be easily converted
- A reactor vessel that is welded shut without mechanical fasteners
- Liquid sodium coolant that is too dangerous to handle without special tools not found in the plant. Sodium must be handled in order to reach reactor fuel and internals.
- If liquid sodium is allowed to cool, it solidifies and solders the fuel and the internals to the reactor vessel creating a solid monolith
- Negative reactivity temperature coefficients, including coolant void reactivity, that cause the reaction rate in the core to slow down as temperatures rise
- Passive, natural circulation heat removal systems to cool the reactor core.
- Other passive, automatic safe shutdown design features

The design of the 4S precludes, as a practical matter, terrorist diversion of nuclear materials. The fuel is never removed and is maintained within the reactor core for the entire 30-year design life of the plant. Thus, no periodic handling of fuel is required over the life of the plant. Since the reactor does not require periodic refueling, there is no need for a spent fuel storage pool, which is considered by many to be vulnerable to sabotage or attack.

Because there are no fuel handling or other intrusive activities planned during the 30-year lifetime of the core, the reactor vessel and components can be more effectively sealed and protected from intrusion. The 4S reactor vessel will be installed underground beneath a large, heavy, reinforced concrete cap that deters unauthorized removal of the fuel from the core. The design only allows access to the fuel by removing this heavy reinforced concrete cap, which requires a heavy-duty crane. Once construction is completed, no such crane will be located at the Galena site. Absent a heavy-duty crane capable of lifting and removing the cap, the cap would need to be broken and removed in pieces. This would be a cumbersome, time consuming process and no group of terrorists could accomplish it without detection long before they could breach the vessel. Moreover, breaching the highly radioactive reactor vessel in this manner would require shielding and special tools.

The reactor vessel itself is welded shut and sealed within a guard vessel, requiring intruders would not only to access the guard vessel, but also to cut into the top of the reactor core. The reactor coolant is highly radioactive liquid sodium, cannot be drained by equipment available at the site, and, even if it could be drained, would be subject to high-energy sodium-air reactions. The properties of the coolant present a formidable barrier to would-be intruders, as the sodium has to be drained in order to open the reactor vessel and obtain access to the fuel.

The temperature of the sodium coolant needs to be above ~100 Degrees Centigrade to stay in the liquid phase. If the reactor shuts down and cools, as would happen in the case of a major security breach, the sodium will freeze solid. The freezing of the sodium results in the effective soldering of the entire reactor core into a solid monolith. Thus, even if a way is obtained ahead of time to drain the sodium safely, the reactor and its sodium loops will have to be maintained at temperatures that facilitate sodium removal but which are too elevated for easy handling.

The nuclear elements that fuel the reactor are also unattractive to potential theft since they are proliferation resistant. (Also, each fuel assembly weighs approximately 350 kilograms or almost 800 lbs). The 4S fuel cannot be used to produce a nuclear weapon without undergoing significant isotopic enrichment, which is an extremely costly and technologically challenging process.[30] If the 4S nuclear fuel were to fall into the wrong hands, it could not be easily converted or enriched to weapons-grade fuel.

[30] The 4S is fueled by Uranium and Plutonium. These two elements can contain a variety of different isotopes, but only two isotopes are of primary concern for non-proliferation: Uranium-235 and Plutonium-239. The Uranium in the 4S is approximately 10% U-235, which classifies it as Low Enriched Uranium (LEU). The Plutonium in the 4S has a moderate proportion of Pu-239, but contains over 27% Pu-240. In contrast, the manufacture of nuclear weapons requires either (1) Highly Enriched Uranium consisting of 93% or more U-235, or (2) Plutonium metal with a very high proportion of Pu-239 and less than 7% Pu-240. Golay, Michael W. "On Social Acceptance of Nuclear Power," Rice University, August 2001. It

Inherent design features of the 4S also make it extremely unlikely if not impossible for saboteurs to cause a radiological release from the plant. Again, the lack of a spent fuel pool and the inaccessibility of the fuel within the 4S reactor eliminate any readily available sources of nuclear materials to use as a dirty bomb.

To cause a radioactive release, saboteurs would need to either cause a malfunction of the reactor or affect a direct breach of the containment guard and reactor vessels. The wholly passive design features of the 4S, however, preclude saboteurs from causing a reactor malfunction that could cause a release of radioactivity into the environment. The 4S reactor has a negative reactivity temperature coefficient – including coolant void reactivity. This means that, as the reactor heats up, the nuclear reactivity of the nuclear fuel decreases, such that nuclear reactivity of the core would shut down with loss of coolant flow or other loss of heat removal capability. Likewise a loss of electrical power would cause the reflectors controlling reactivity (described in the overview white paper) to fall to the bottom of the core, reducing or eliminating nuclear reactivity of the core and effectively scramming the reactor. Further, the passive safety related reactor vessel auxiliary cooling system (RVACS) would maintain cooling of the reactor core by natural circulation of air.

Even if saboteurs seized the plant controls, they could not overcome the passive design features of the 4S and affect a plant meltdown. Operation of the 4S reactor is automatic and requires no human intervention. The function of the control room and the role of the plant operator(s) is to monitor – not to control – reactor operations. While an operator can direct shutdown of the 4S reactor by insertion of the main control rod into the core, an operator cannot overcome the inherent negative reactivity of the 4S and other features of its design that precludes meltdown of the reactor fuel. Those features are inherent in the physical design of the plant and cannot be altered by physical control of the plant.

The hardened underground placement of the 4S protects against a radioactive release caused by saboteurs utilizing explosives to breach the containment guard and reactor vessels. The containment guard and reactor vessels are located in their own below grade silo-like structure that precludes direct application of explosive charges to their sides. Rather, access to the reactor fuel can only be obtained through the heavily reinforced concrete cap to the 4S reactor, which requires a heavy-duty crane to remove. The heavily reinforced concrete cap protects against saboteurs causing a radioactive release by applying explosives to the cap.

Likewise, the heavily reinforced concrete cap, the reinforced concrete walls of the reactor building, and installation of the reactor building underground provides protection against direct attacks, such, as for example, a missile or air attack. The below-grade 4S reactor building is in effect a hardened bunker that protects against the release of radioactivity into the environment.

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should also be noted, that as with any nuclear power reactor, the Uranium and Plutonium present in the 4S would be subject to normal IAEA safeguards as set forth in the Treaty on the Non-Proliferation of Nuclear Weapons IAEA INFCIRC/153 – "The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons" June 1972

In short, the 4S facility does not include many of the potential vulnerabilities of typical nuclear power plants. Further, the many passive and protective safety design features of the 4S affirmatively protect the facility against terrorist attack. Therefore, protection from threats that need to be considered by existing nuclear plants or other planned large reactors are eliminated, greatly reduced, and/or simplified in the case of the 4S by virtue of its design features. The many inherent design features of the 4S NPF that protect against terrorist attacks minimize the need for armed security guard forces at the site.

C. Plant Layout (as related to Physical Security)

A conceptual layout for the Galena 4S NPF is shown in Figure 4.1 below. As described above, transportation into and out of Galena is limited to aircraft and Yukon river traffic during the summer. These facts are relevant for physical security because (1) the relative inaccessibility of the site reduces the likelihood of saboteur activity while increasing the likelihood that such activity will be detected, and (2) they need to be considered in developing potential threat scenarios and protection and response requirements that will vary for different months of the year.

Figure 4.1 shows the outer boundary fence for the site enclosing the Owner Controlled Area as well as the inner security barrier, through which access would be strictly controlled, enclosing the Protected Area. The Nuclear Island would be located within the Protected Area (this includes the nuclear reactor, steam generator and all vital equipment) and would be located underground. Other plant facilities located within the Protected Area would include the Turbine Island, or turbine building, diesel generator, switchgear, control center and the security facilities. Facilities located outside the Protected Area but within the Owner Controlled Area would include the administration facility, warehouses, training facilities etc. Brief descriptions are as follows:

- As discussed, the Nuclear Island would be located below grade and would include the nuclear reactor, steam generator and other vital equipment.
- The Turbine Island would house the systems and equipment that make up the plant steam power systems. Included would be a steam turbine, the main/auxiliary steam and feed water/condensate systems, cooling and heat rejection systems, and other associated services and equipment.
- The diesel generator facility would house the non-1E emergency diesel generators. The diesel generators would be placed in service in the event of a loss of power to provide power for minimal services necessary for safety and emergency as well as to avoid equipment damage.
- The other facility within the security fence would house the switchgear, plant control center, plant security, and training rooms.
- The plant control center would include the technical support center, computer room and communications, and would serve to control, monitor and display most plant operations including manual initiation of plant shut down. The facility would be safety grade based on the NRC recommendation as

documented in the PRISM SER (discussed in Section D below). Habitability systems would be installed to ensure occupancy following an accident. Safety grade cabling/cable trays would be routed in separate cable trays and external routed cables would be routed in safety grade duct banks.

- The plant security facility would be the primary control point for access of equipment and personnel through the security barrier. Command and Control of the response forces would be coordinated from this facility. The facility would be designed to incorporate the safeguards & security requirements encompassed within rules and regulations identified in Section 3, above.
- The facilities within the Protected Area enclosed by the security barrier would be hardened structures designed to meet seismic category II requirements.
- The facilities located outside the security barrier would be conventional construction.

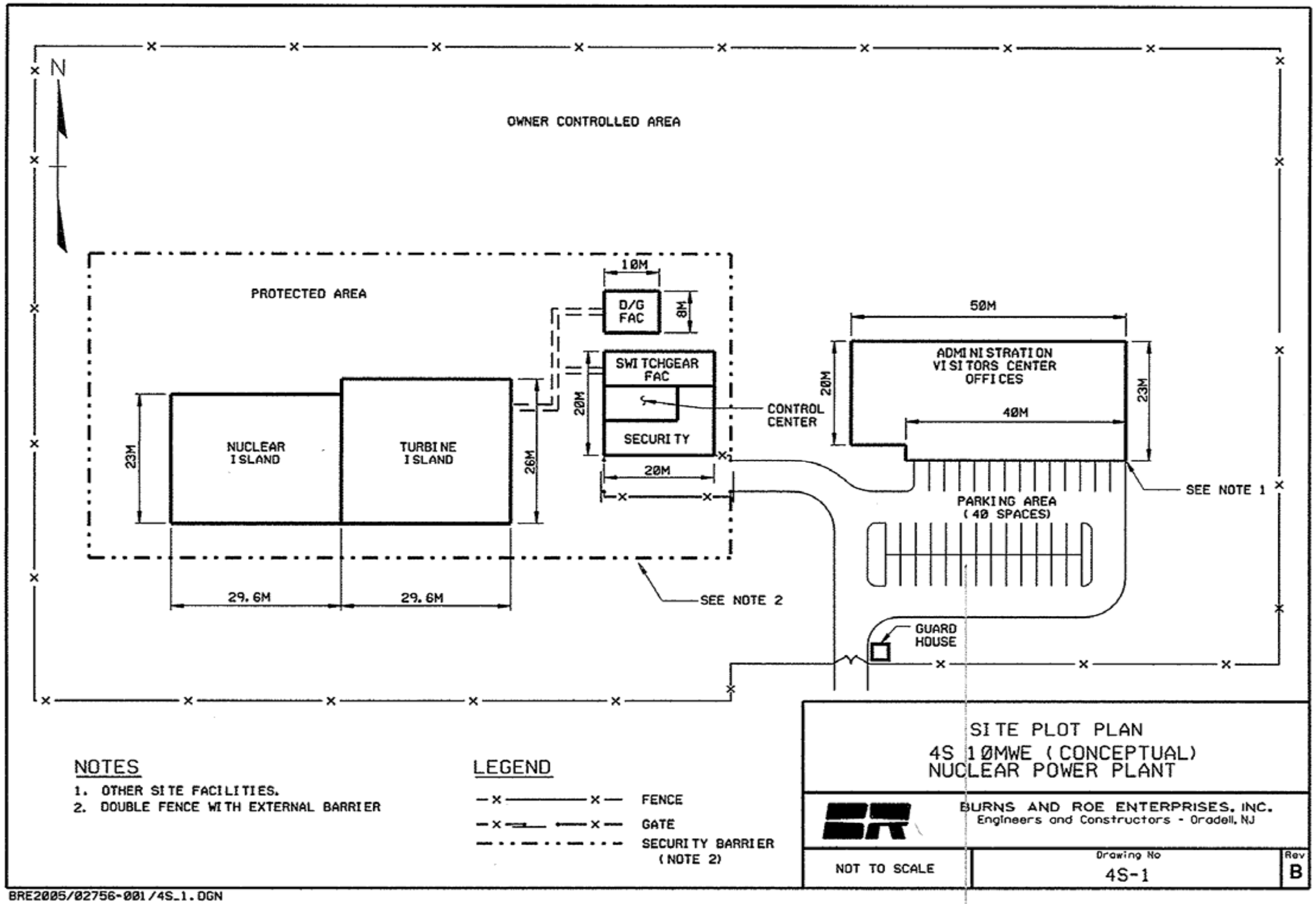

FIGURE 4.1 CONCEPTUAL PLANT LAYOUT

D. 4S and PRISM Comparison

The NRC has previously reviewed the Preliminary Safety Information Document (PSID) of an advanced reactor design, the Power Reactor Innovative Small Module (PRISM), which uses a modular, pool-type, liquid-sodium cooled reactor of a similar design to the 4S Reactor. Since the NRC has already reviewed the PSID for the PRISM, it is appropriate for this paper to discuss the security issues identified by the NRC during its review of the PRISM that are relevant to the 4S and to describe how the 4S Physical Security System addresses those issues.

The Department of Energy (DOE) submitted the PSID for PRISM to NRC for pre-application review in November 1986. In September 1989 the NRC published a draft Safety Evaluation Report (SER) documenting its preliminary review of the PRISM PSID.[31] Among other issues raised in its Draft SER, the NRC identified 10 issues related to physical security of the PRISM. DOE filed an amended PSID in early 1990 addressing issues raised by the NRC in its preliminary review, including the 10 security related issues.[32] The NRC reviewed the amended PSID and published its final SER on the PRISM PSID in February 1994.[33]

Most of the ten security issues raised by the NRC were related specifically to the PRISM site or design and are not applicable to the Galena 4S NPF. Three of the issues, however, are sufficiently related to security at the proposed Galena 4S NPF to warrant discussion here. These are the (1) location of the control room, (2) location of the sodium-water reaction pressure relief system, and (3) plant protection against potential insider sabotage.

In the original PRISM PSID, the control room was located outside of the Nuclear Island Protected Area because it was determined not to involve any safety related functions, or contain any safety related equipment, due to the inherently passive design features protecting the PRISM (e.g., reactor shutdown due to negative reactivity). The NRC in its draft SER took issue with the location of the control room outside of the Protected Area because it viewed the operators as an important source of knowledge concerning the plant status, design and behavior which could prove extremely valuable in understanding, responding to, and recovering from and accident situation caused by terrorist attack.[34] Accordingly, in its amended PRISM PSID, DOE relocated control room within the Protected Area, and designated it as a Category II, tornado hardened structure.[35]

In the conceptual plant layout for the Galena 4S NPF, all facility control operations are controlled from a control center located within the Protected area inside the security

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[31] Preapplication Safety Evaluation Report for the Power Reactor Innovative Small Module (PRISM) Liquid-Metal Reactor, Draft Report, NUREG-1368 (Sept. 1989).

[32] Amended DOE PRISM PSID at G.4.14-1 to G.4.14-11.

[33] Preapplication Safety Evaluation Report for the Power Reactor Innovative Small Module (PRISM) Liquid-Metal Reactor, Final Report, NUREG-1368 (Feb. 1994) (Final PRISM SER, NUREG-1368).

[34] Amended DOE PRISM PSID at G.4.14-1 & G.4.14-2.

[35] Id. at G.4.14-8.

barrier. The control center would house the plant operators, technical support center, computer room, and communications equipment. It would serve to control, monitor and display most plant operations including manual initiation of plant shut down. The facility would be safety grade based on the NRC recommendation documented in PRISM SER. Safety grade cabling/cable trays would be routed in separate cable trays that are physically separated from each other and externally routed cables would be routed in safety grade duct banks.

In the PRISM, the sodium-water reaction pressure relief system (SWRPRS) consists of two rupture discs connected in series between the shell side of the steam generator and the reaction products separation tank (RPST). The rupture discs, and the line leading from the steam generator to the RPST, protect the intermediate heat exchanger (IHX) tubes from potential over pressurization in the Intermediate Heat Transport System (IHTS) piping that would result from a sodium water reaction due to a postulated steam generator tube leak. In the original PRISM PSIS, the SWRPRS was located within the steam generator building, which was outside the high security Protected Area boundary. Because the NRC considered the SWPRS as being important to maintaining primary system and containment integrity, the NRC requested additional justification to support the location of the SWRPRS outside of the Protected Area.[36] In the amended PRISM PSID, a special protective area was established around the SWRPS providing for controlled access and other security measures.[37] In its final SER, the NRC found this arrangement generally acceptable.[38]

In the 4S design, the sodium water reaction pressure relief system would located within the Nuclear Island, which is both within the Protected Areas as well as below grade. Thus, in the 4S design, the level of protection for this system is the same as that for the 4S Nuclear Island generally which is more stringent than that provided for the PRISM SWRPS, as the system is within the Protected Area of the 4S.

In its draft SER for the PRISM, the NRC observed that the design of the PRISM for protection against insider sabotage threat had not been addressed.[39] In its amended application, DOE responded that insider assistance "would not be sufficient to overcome the design features" of the PRISM because its design "prevents individual control over reactor operations" which are controlled by plant design features "inaccessible to an individual."[40] In its final SER, the NRC concluded that the "passive safety features of the PRISM design provides advantages in protection against insiders and outsiders as compared to a current-generation LWR" and that the insider sabotage threat had been sufficiently addressed for the pre-application stage."[41] As discussed above, the 4S design

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[36] Id. at G.4.14-1 & G.4.14-2.

[37] Id. at G.4.14-9 & G.4.14-10.

[38] Final PRISM SER, NUREG-1368 at 13-8.

[39] Amended DOE PRISM PSID at G.4.14-2.

[40] Id. at G.4.14-8.

[41] Final PRISM SER, NUREG-1368 at 13-9 & 13-10.

similarly prevents individual control over reactor operations such that neither an insider nor an outsider can sabotage the 4S through operation of the reactor controls.

E. Physical Security for the Galena 4S Power Plant

In accordance with NRC requirements, physical security for the Galena 4S NPF would encompass a comprehensive, integrated protective strategy that would include, among other features, physical protection, surveillance, access control, threat response and neutralization, and training. The actual S&S plan developed for the site (except for access authorization and fitness for duty provisions that would be addressed in Chapter 13 of the Final Safety Analysis Report) would be submitted to the NRC in a stand alone document that would be withheld from public disclosure in accordance with the provisions of 10 CFR 73.21. What follows is a general description of the physical security system proposed for the Galena 4S facility that would satisfy the NRC requirements.

Three security areas would be designated to provide physical security for the Galena 4S facility. These areas would be:

- An Owner-Controlled Area, which would be the area contiguous to the Protected Area, with limited security control. The perimeter of this area would be marked by signs or other means to ensure that persons entering the area are aware that they are on private property. Patrol roads would facilitate locating and removing persons from this area.
- A Protected Area, within the Owner-Controlled Area, that would be enclosed by a security barrier established in accordance with 10 C.F.R. 73.55(c) through which access would strictly controlled in accordance with 10 C.F.R. 73.55(d). An isolation zone would maintained on both sides of the barrier in accordance with 10 C.F.R. 73.55(c)(3) with sufficient illumination for monitoring and observation at night as required by 10 C.F.R. 73.55(c)(5). In accordance with 10 C.F.R. 73.55(c)(3), employee and visitor parking areas would be located outside the outer isolation zone.
- Vital Areas would be located within the Protected Area. Vital equipment and facilities would be isolated from non-vital equipment and facilities to the maximum extent practical. Additionally, vital areas would be further protected by building walls, roofs, and floors that would constitute a second physical barrier in accordance with 10 C.F.R. 73.55(c)(1). The second physical barrier enclosing vital equipment would be capable of both deterring intrusion by unauthorized persons and providing resistance to physical penetration. Further, most, if not all, vital equipment would be located below grade, which would provide additional resistance to penetration from external threats such as aircrafts or missiles.

Security measures would be incorporated into the Galena 4S facility to protect the Protected Area and Vital Areas in accordance with the NRC requirements discussed above in Section III. These would include, as a minimum, a perimeter security barrier enclosing the Protected Area and all Vital Areas, intrusion-detection systems, closed-circuit television assessment systems, lighting systems adequate for effective surveillance, patrol roads, methods to resist forced entry, and an access control system to control access to the Protected Area and Vital Areas of the plant. In addition, a continuously manned central alarm station would be maintained within the Protected Area in accordance with 10 C.F.R. 73.55(e). A second continuously manned alarm station would also be established in accordance with 10 C.F.R. 73.55(e), which could be located at the Galena Police Station.

A physical security organization would be established to protect the facility from radiological sabotage in accordance with 10 C.F.R. 73.55(b). Security guards and watchmen would be trained and outfitted as prescribed by 10 C.F.R. 73.55(b) and be provided with communications equipment in accordance with 10 C.F.R. 73.55(f) to enable their continuous communication with the manned alarm stations.

A Safeguards Contingency Plan would be developed in accordance with 10 C.F.R. 73.55(h) for the Galena 4S facility that would identify potential threats to the facility, the necessary actions to respond to those threats, the means of implementing the response actions, and those responsible for implementing the response actions. Further, liaisons would be established and documented with Local Law Enforcement Agencies (LLEAs) who could be summoned for assistance in the event of an attack. These would include the local Galena police as well as, potentially, emergency response forces from Elmendorf and Eielson air force bases, located near Anchorage and Fairbanks respectively.

The above provisions for security at the Galena 4S facility would include the elements necessary to satisfy NRC requirements. Significantly, however, the number and size of plant vital areas containing vital safety equipment and components requiring protection would be much smaller from that of a typical nuclear power plant (NPP). As a small 10 MW facility, the "footprint" for the Galena 4S NPF would be less than 19% of that of a typical 1000 MWe NPP. Accordingly, the amount of security equipment and the number of security personnel required to protect the Galena 4S NPF would be significantly less than those required for a typical NPP.

Most importantly, the small size of the Galena 4S complex, the reduced number of vital areas requiring protection, and the small size of the plant operating staff[42] would allow for a vastly smaller security force in general, and a smaller response force in particular since there is less area to protect. Additionally, the simplicity of the area needing protection would reduce the response scenarios and security force required to neutralize any threats (e.g., no intake structure, no fuel pool or other on-site storage of spent nuclear

[42] the number of personnel on site at any given time would be very small. Therefore, personnel processing would be greatly reduced and this would translate into a significant reduction in the size of the access control station (located within the security building) and the guardhouse. Also, since most of the work force would be on the non-radioactive turbine side, the need for health physicists and the supporting infrastructure would be minimal.

fuel), as would the reduced vulnerability of the Galena 4S NPF due to its many other protective design features.

Following the events of September 11, a typical NPP site today has a security force well in excess of 100 people.[43] The exact compliment of the Galena 4S security force would be dependent on the specific security threats posed to the facility and detailed analysis of adequate response to those threats in accordance with NRC requirements. However, it is clear that the size of the security contingent on site would be significantly less than that needed for a typical NPP. In addition, credit could be taken for supplementary response forces provided by LLEAs including, potentially, emergency response forces from Elmendorf and Eielson air force bases.

F. Security Staffing for the Galena 4S Power Plant

The security force would constitute the major staffing requirement for the Galena 4S NPF, and hence a major part of the facility's operating cost. Preliminary estimates provided by Toshiba in the spring of 2004 estimated that the number of security guards for a 4S NPF would be 23 out of a total plant operating staff of 43.[44] (This estimate was based on assuming three shifts of five guards each, multiplied by 1.5 to account for time off and annual leave.[45]) In estimates provided for the DOE December 15, 2004 study, Toshiba conservatively estimated – based on "current practices at large nuclear power plants in suburban areas of the lower 48 states and Japan" – that a "security guard force of 34 would be required," but that, because of the inherently protective design features of the 4S described above, far fewer guards may in fact be needed.[46] While noting that "a detailed risk assessment" would be needed to determine the "level" of security force required, the DOE study went on to state that "[w]ith remote monitoring from the City/State law enforcement offices, only one guard may be necessary on-site at all times;" this estimate would result in a total security force of four guards.[47] Therefore, the DOE study used an upper bound estimate of 34 and a lower bound estimate of 4 for the number of security personnel that would be required for a 4S NPF at Galena. The DOE Study estimated the total number of additional plant staff required to operate the Galena 4S NPF to be eight.[48]

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[43] After Sept. 11, the nuclear energy industry substantially enhanced security at nuclear plants. Security forces at nuclear plants were increased by one-third to approximately 8000 officers at 103 plants located at 64 NPP sites.

[44] See Electronic Mail from Yoshiaki Sakashita to Douglas Rosinski (May 17, 2004) (Sakashita E-mail); see also Toshiba Presentation, *4S Current Status – 4S: Super Safe, Small & Simple* to the 2004 Alaska Rural Energy Confernce, Talkeetna, Alaska (April 27-29, 2004). In other presentations, Toshiba has estimated total plant staff for 4S to be 35 without any separate estimate provided for the required number of security force personnel. See Toshiba Presentation, *4S Current Status – 4S: Super Safe, Small & Simple* (2004).

[45] Sakashita E-mail.

[46] DOE Study at 37. Applying the same assumptions as used in the Sakashita E-mail, a total guard force of 34 would translate to 3 shifts of 7 to 8 guards.

[47] Id; see also DOE Study at 69-70.

[48] DOE Study at 70, Figure 6.7.

It follows from the above discussion that the number of security personnel required to protect the 4S NPF would likely be the most significant factor in plant operating costs. Accordingly, the level of required security staffing should be explored early in the licensing process with the NRC in order to identify the factors that would be relevant, and the steps that could be taken, to minimize the size of the plant security force while still providing effective protection for the facility. For example, features might be added to the plant's physical design that could reduce the number of required security personnel or, as suggested by the DOE Study, appropriate arrangements might be made with LLEAs that could avoid the necessity of having a large on-site guard force.

The NRC regulations directly address the number of security guards required for a nuclear facility. As set forth in 10 C.F.R. 73.55(h)(3), the total number of guards and armed, trained, personnel that are to be "immediately available" to respond to a threat shall nominally be ten (10), unless specifically required otherwise on a case by case basis by the Commission; however, this number may not be reduced to less than five (5) guards." Using the same assumptions as set forth in the Sakashita E-mail, the continuous presence of a nominal force of 10 armed guards at the site all times to respond immediately to a threat would translate into a total armed force of approximately 46, and the presence at all times of a minimum armed force of 5 would result in a total armed force of approximately 23. In addition, the requirement for two continuously manned alarm stations required under 10 C.F.R. 73.55(e) would translate into an additional nine security personnel being required for the Galena 4S NPF (assuming both alarm stations were on site).

In the case of the PRISM, DOE proposed an on-site armed response force less than the nominal force of 10 based on a "vulnerability analysis" to the DBT performed for the proposed PRISM design.[49] In its draft SER, the NRC commented that "[r]esponse time for local law enforcement authorities must be considered before recommended reductions from the nominal force of 10 specified in 10 CFR 73.55 would be considered acceptable," to which DOE replied that no credit for LLEA support was taken in determining the size of the PRISM on-site armed response force.[50] In the Final SER, the NRC deferred consideration of acceptability of the proposed response force size until the licensing of an actual facility under 10 C.F.R. Part 52, reasoning that the size of the onsite response force "must be based on the site and plant design" and therefore could not be assessed at the "pre-application stage."[51]

While the ultimate size of the security guard force for the Galena 4S NPF cannot be determined at this early stage of the project, there are several actions that Galena can take to start defining the size of security force that would be required for the facility. First, the key to determining the actual number of armed security guards that would be required for the Galena facility would be to assess the vulnerability of the 4S to potential sabotage.

[49] Amended DOE PRISM PSID at G.4.18-8; see also Final PRISM SER, NUREG-1368 at 13-9.

[50] Amended DOE PRISM PSID at G.4.18-2 & G.4.14-8.

[51] Final PRISM SER, NUREG-1368 at 13-9.

While the final vulnerability assessment for the Galena 4S NPF would need to await completion of the detailed design and plant layout, generic vulnerability assessments of the 4S can be done at this time. A generic vulnerability assessment of the PRISM was done as part of PRSIM PSID that was filed with the NRC, and presumably Toshiba is performing a such a generic vulnerability assessment as part of the 4S PSID that it is currently preparing to be filed with the NRC. Galena should confirm that a generic vulnerability assessment is being done for the 4S, and, if not, plan an appropriate course of action to ensure that such an assessment is performed early on in the project.

Second, Galena should discuss with the NRC Staff the circumstances under which Galena would be allowed to reduce the number of onsite armed guards to less than the nominal ten or minimum five required by 10 C.F.R. 73.55(h). The protective design features of the 4S discussed in Section IV.B above reflect that the likelihood that saboteurs could effectuate a radiological release even if they were to obtain temporary control of the facility would be minimal or non-existent. Indeed, the suggestion contained in the DOE study that one armed guard, with monitoring by City/State law enforcement offices, might be sufficient to guard the facility necessarily assumes that saboteurs, operating within the parameters of the DBT, would not be able to effect a radiological release even if they were to gain temporary control of the facility. While a detailed vulnerability assessment would be necessary to establish the extent to which the protective design features of the 4S could withstand saboteurs, Galena should explore with the NRC Staff the issues that would need to be addressed and the showings that would have to be made to justify a reduction in the required security force for the site based on the protective design features of the 4S.

Third, Galena should preliminarily assess the LLEA support that might be provided by City and State law enforcement as well as armed response support potentially available from nearby federal military facilities, such as Elmendorf and Eielson air force bases. The number of required on-site armed force responders might be reduced by the training and equipping of City police personnel, who could respond to a saboteur incident at the 4S NPF on short notice. Also, one of the continuously manned alarm stations required for the 4S NPF under 10 C.F.R. 73.55(e) might be a continuously manned City emergency center outside of the plant. With respect to armed responder support from State LLEAs and federal military facilities, the issue would be whether such responders could reach the facility in a timely manner in order to prevent saboteurs, operating within the parameters of the DBT, from causing a radiological release at the facility.

Fourth, Galena should also assess and explore with the NRC Staff other plant staffing that would be required for the Galena 4S NPF[52] and the extent to which such staffing might also perform necessary security functions. For example, given the limited role of

[52] Current NRC regulation, 10 C.F.R. § 50.54(m)(2), would require a minimum operating staff of four persons for the 4S NPF, but in the context of its review the PRISM PSID, the Staff accepted in principle decreased operator staffing from that specified in 10 C.F.R. § 50.54(m)(2) if the applicant could demonstrate, among other things, that smaller operating crews could respond effectively to a worst case array of power maneuvers, refueling and maintenance activities, and accident conditions. See NUREG-1368 at 13-6.

plant operators for the 4S, the continuously manned central alarm station required under 10 C.F.R. 73.55(e) might be located in the control room and manned by a plant operator.

Fifth, Galena might seek independent expert review of appropriate security measures (e.g., security equipment, procedures, arrangements, response forces and tactics) for a 4S NPF to be located at Galena taking into consideration the inherently protective safety and security features of the 4S design and arrangement. One such expert group is the "Proliferation Resistance and Physical Protection (PR&PP) Group" that is funded by jointly by DOE and the National Nuclear Security Administration (NNSA). The mission of the PR&PP expert group is to develop a systematic method to evaluate and compare proliferation resistance and physical protection of Generic IV nuclear energy systems. The NRC is an observer of the expert group, and review by this expert group would provide a solid foundation on which to establish appropriate security force requirements, as well as other appropriate security measures, for the Galena 4S NPF.

The licensee for the Galena 4S NPF would need to request authorization from the NRC, either under 10 C.F.R. § 73.55(a) or 10 C.F.R. § 73.5, in order to reduce the number of armed responders "immediately available" on-site to respond to a threat to less than the minimum prescribed by 10 C.F.R. 73.55(h)(3).[53] Under 10 C.F.R. § 73.55(a), the NRC may authorize a licensee to provide measures different than those specified in paragraphs 10 C.F.R. § 73.55 (b)-(h) if the licensee demonstrates that the proposed alternative measures meet the general performance objectives and requirements prescribed by 10 C.F.R. § 73.55(a) and provide protection against radiological sabotage equivalent to the measures provided by paragraphs (b) through (h) of the regulation. Alternatively, under 10 C.F.R. § 73.5, the NRC may formally grant nuclear power plant licensees an exemption to the requirements contained in 10 C.F.R. Part 73 upon determining that the requested exemption is "authorized by law and will not endanger life or property or the common defense and security, and [is] otherwise in the public interest."[54]

In either case, the key to obtaining NRC permission to maintain fewer than five armed guards on site at all times would be to show via the vulnerability assessment that the protective design features of the 4S allow for a reduced number of armed guards to protect against the DBT. Demonstrating the sufficiency of a reduced number of guards to protect against the DBT would establish that the general performance objectives and requirements prescribed by 10 C.F.R. § 73.55(a), requiring nuclear plants to be protected against the DBT, would be met. Similarly, such a vulnerability assessment would

[53] Similarly, an exemption would be required to the extent Galena sought to reduce the operating staff for the 4S NPF below the minimum staff of four required under 10 C.F.R. § 50.54(m)(2).

[54] Unlike the requirements of 10 C.F.R. § 50.12 for granting an exemption under 10 C.F.R Part 50, 10 C.F.R. § 73.5 neither specifies nor requires a showing of special circumstances for the granting of an exemption under 10 C.F.R. Part 73. The granting of an exemption to reduce the operating staff for the 4S NPF below that required under 10 C.F.R. § 50.54(m)(2) would, however, require an exemption under 10 C.F.R. § 50.12, which in addition to establishing no "undue to risk to public health and safety" would require a showing that "special circumstances are present" which warrant the granting of the exemption. 10 C.F.R. § 50.12(a)(2)(i)-(vi) specify the special circumstances or justifications for which an exemption from 10 C.F.R. Part 50 requirements may be granted.

establish that neither the public health and safety nor the common defense and security would be endangered by granting an exemption to the requirements of 10 C.F.R.§ 73.55(h).

Further, such a demonstration would enable Galena to satisfy the special circumstances requirements of 10 C.F.R. § 50.12(a)(2), if such were required, which would provide additional support for the granting of an exemption. 10 C.F.R.§ 50.12(a)(2)(ii) authorizes an exemption where no undue risk to public health and safety is otherwise presented upon showing that application of the regulation "is not necessary to achieve the underlying purpose of the rule." A vulnerability assessment demonstrating the sufficiency of less than five armed guards to protect against the DBT would establish that application of 10 C.F.R.§ 73.55(h) "is not necessary to achieve the underlying purpose of the rule."[55]

10 C.F.R. § 50.12(a)(2)(iii) authorizes an exemption where no undue risk to public health and safety is otherwise presented based upon a showing that compliance with the regulation would result in undue hardship to the licensee, <u>or</u> costs significantly in excess of those contemplated when the regulation was adopted, <u>or</u> significantly in excess of those incurred by others similarly situated. Here, a vulnerability assessment demonstrating the sufficiency of less than five armed guards to protect against the DBT would enable a showing that complying with the requirements of 10 C.F.R.§ 73.55(h) would result in undue financial hardship. Compliance with 10 C.F.R.§ 73.55(h) could significantly increase the cost of power generated by the Galena 4S NPF, particularly in comparison to a typical commercial nuclear power facility that generates and sells on the order of 1,000 MWe, two order of magnitude greater than the power to be generated by Galena 4S NPF.

In sum, the inherently protective design and security features of the 4S should enable the licensee of the Galena 4S NPF to reduce the number of security force personnel below that specified by NRC regulation.

V CONCLUSIONS

This paper describes the inherently safe design features of the 4S NPF and security enhancements incorporated into the 4S design. These features make the 4S NPF an unattractive target either for sabotage or theft and diversion of nuclear materials. The many inherently protective features of the 4S would justify adding a fifth "S" for "SECURE" to the description of the facility.

The many protective features of the 4S as a practical matter make it very unlikely that a terrorist attack aimed the plant's nuclear materials would be successful. The fuel is never removed from the core and is maintained within the sealed reactor vessel, along with the highly radioactive sodium coolant, for the entire 30-year design life of the plant. Access to the fuel can be obtained only by using a heavy-duty crane to remove the large, heavy,

[55] A similar showing would have to be made with respect to plant operators, i.e., that a change in the number or function of plant operators from that prescribed by 10 C.F.R. § 50.54(m) would not present an undue risk to public health and safety and that the application of those provisions of 10 C.F.R. § 50.54(m) for which an exemption is sought "is not necessary to achieve the underlying purpose of the rule

reinforced concrete cap to the reactor vessel. Additionally, the reactor vessel and the enclosing containment guard vessel are located in their own underground silo-like structure, which further protects against unauthorized access to the 4S nuclear fuel.

Further, the nuclear fuel of the 4S reactor is designed to be proliferation resistant. The 4S fuel cannot be used to produce a nuclear weapon without undergoing significant isotopic enrichment, which is an extremely costly and technologically challenging process. If the 4S nuclear fuel were to fall into the wrong hands, it could not be easily converted or enriched to a weapons-grade material.

The many protective features of the 4S likewise preclude, as a practical matter, radiological sabotage of the plant. The lack of any spent fuel pool and the protection of the reactor core located within the sealed reactor vessel preclude any direct saboteur access to nuclear materials. The installation of the reactor vessel, with its heavy reinforced concrete cap, and the containment guard vessel in their own underground silo bunker protect against explosives and missile attacks. Furthermore, the wholly passive design features of the 4S – such as negative temperature and coolant void reactivity and passive cooling of the reactor – preclude saboteurs from causing a reactor malfunction that could cause a radiological release, even assuming their seizure of the control room.

Because of the many protective features of the 4S, along with its small size, small number of vital areas, and simple plant layout, the amount of security equipment and the number of security personnel required to protect the Galena 4S NPF would be significantly less than that for a typical NPP. There are no fuel pools or other on-site spent fuel storage facilities, vital areas are minimized (and below grade), and breaching the core is not credible. As a result, security forces needed on site would be greatly reduced from those required for currently operating NPPs (which number well in excess of 100).

The precise number of security personnel required for the Galena 4S NPF would be determined by a vulnerability assessment based on the DBT, the protective features of the 4S, and LLEA support that may be provided by City and State law enforcement as well as potentially nearby federal military facilities. An exemption pursuant to 10 C.F.R. 50.12 from the NRC requirements would be needed to implement a reduced security force for the facility to the extent that fewer than five armed guards were immediately available on site to respond to a security threat. There would appear to be good grounds for seeking such an exemption.

VI RECOMMENDATIONS

Galena should take appropriate actions to ensure that security considerations are incorporated early in the design and licensing process for the Galena 4S NPF. Such early integration would allow for efficient and cost effective implementation of required security systems as well as potentially significantly reducing plant operating costs by, for example, making changes to the facility's layout or design that could reduce the number of required security personnel over the life of the facility. Including security early in plant licensing and design would also demonstrate a commitment to public health and safety and the protection of the plant personnel. It also would allow for efficient interface, development, and compatibility of the Safeguards & Security and Emergency Plans

In particular, Galena should take immediate steps towards determining the level of security force that would be required to protect the Galena 4S NPF against the DBT. In this respect, Galena should (1) confirm that Toshiba has performed a generic vulnerability assessment for the 4S NPF, and if not plan an appropriate course of action to ensure that such an assessment is performed early on in the project; (2) initiate discussions with the NRC Staff to explore the justifications that would be required by the Staff to reduce plant security forces based on the protective design features of the 4S; (3) assess the LLEA support that might be provided by City and State law enforcement as well as armed response support potentially available from nearby federal military facilities, such as Elmendorf and Eielson air force bases; (4) assess and explore with the NRC Staff other plant staffing that would be required for the Galena 4S NPF and the extent to which such staffing might also perform security functions; and (5) seek independent review of appropriate security measures for the Galena 4S NPF from an expert group such as the "Proliferation Resistance and Physical Protection (PR&PP) Group" that is funded by jointly by DOE and NNSA.

Based on the above steps, Galena should be able to determine early in the project the required level of security and other plant staffing which would be major contributors to plant lifetime operating costs. Based on these assessments, Galena would be in a position to seek exemptions to the NRC regulations governing plant staffing, as well as potentially other exceptions to NRC security requirements, based on the small size of the 4S NPF and its many inherently protective design and security features.