CONNECTICUT YANKEE ATOMIC POWER COMPANY

HADDAM NECK PLANT
362 INJUN HOLLOW ROAD • EAST HAMPTON, CT 06424-3099

December 21, 2006

Docket No. 50-213
CY-06 -152

Re: 10 CFR 50.71(e)

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Haddam Neck Plant
Decommissioning Updated Final Safety Analysis Report

The purpose of this letter is for Connecticut Yankee Atomic Power Company (CYAPCO) to submit a revision to the Haddam Neck Plant Decommissioning Updated Final Safety Analysis Report (UFSAR) as required by 10 CFR 50.71(e). This revision is provided in Attachment 1. This revision contains replacements pages, with insert instructions, for the Decommissioning UFSAR submitted on July 28, 2005[(1)]

Pursuant to 10 CFR 50.71(e)(2)(i), this revision accurately presents changes completed since our previous submittal that are necessary to reflect information and analyses associated with changing plant conditions during the final phase of decommissioning at the Haddam Neck Plant (HNP) site. As the plant completes site remediation and final status surveys, the UFSAR will be updated in accordance with 10 CFR 50.71(e)(4).

As stipulated in 10 CFR 50.71(e)(2)(ii): "This submittal shall include an identification of changes made under the provisions of Section 50.59, but not previously submitted to the Commission." Accordingly, the 50.59 evaluations for the FSAR changes in this submittal have been included with the 10 CFR 50.59 annual report for the HNP which was submitted on January 19, 2006[(2)] pursuant to 10 CFR 50.59(b).

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(1) W. Norton (CYAPCO) letter to the U. S. Nuclear Regulatory Commission, "Decommissioning Updated Final Safety Analysis Report," dated July 28, 2005.

(2) G. P. van Noordennen (CYAPCO) letter to the U. S. Nuclear Regulatory Commission, "10 CFR 50.59 Summary Report," dated January 19, 2006.

A053
NMSS01

If the NRC should have any questions, please contact me at (860) 267-3938.

Sincerely,

G. van Noordennen — 12-21-06

Gerry van Noordennen — Date
Director of Nuclear Safety and Regulatory Affairs

Attachment

cc: S. J. Collins, NRC Region I Administrator
T. B. Smith, NRC Project Manager, Haddam Neck Plant
Dr. E. L. Wilds, Jr., Director, CT DEP Monitoring and Radiation Division

Attachment 1

Haddam Neck Plant

Updated Final Safety Analysis Report

Replacement Pages with Insert Instructions

December 2006

HADDAM NECK PLANT
FINAL SAFETY ANALYSIS REPORT
December 2006 Update
Insert Instructions – Page 1 of 1

Please revise your controlled copy per instruction below:

Remove Page Number(s)	Effective Date	Insert Page Number(s)	Effective Date	Justification
List of Effective Pages, Pages EP-1 through EP-6	July 2005	List of Effective Pages, Pages EP-1 through EP-4	December 2006	Admin. change
All Chapters	July 2005	Chapter 1, Table of Contents, Page 1-i	December 2006	LBDCR #58

Connecticut Yankee

DECOMMISSIONING UPDATED FINAL SAFETY ANALYSIS REPORT

HADDAM NECK PLANT UFSAR

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Page, Table or Figure	Chapter 10	Revision Date
Page 10-i		July 2002

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Page 11-i		September 2006
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Page 11.2-1 through 11.2-2		September 2006
Page 11.4-1		September 2006
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Page 11.4-3		February 2005
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Page 13-i		July 2005
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Page 15-i		September 2006
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CHAPTER 1

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CHAPTER 1

INTRODUCTION AND GENERAL DESCRIPTION OF SITE

1.1 INTRODUCTION

In December of 1996, Connecticut Yankee Atomic Power Company (CYAPCO) certified to the NRC of the permanent cessation of operations of the Haddam Neck Plant (HNP) and that all of the fuel assemblies have been permanently removed from the reactor vessel and placed in the Spent Fuel Pool (Reference 1.1-1). Following the cessation of operations, CYAPCO started to decommission the HNP. On March 30, 2005, all spent fuel and Greater than Class C (GTCC) waste have been removed from the Spent Fuel Pool and stored in an Independent Spent Fuel Storage Installation (ISFSI) at the HNP site. Decommissioning activities are scheduled to be completed in December 2006.

This Updated Final Safety Analysis Report (UFSAR) for the Haddam Neck Plant was prepared using the guidance of Regulatory Guide 1.70, Revision 3, Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, dated November 1978, as applicable. The UFSAR is intended to be responsive to the guide, to existing regulations, and to NUREG-75/087, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, to the extent possible. Since the cessation of operations at the HNP and removal of Spent Fuel from the Spent Fuel Pool the only Structures, Systems and Components (SSC) required to safely store spent fuel are at the ISFSI. Therefore, the UFSAR has been revised to describe the end stage of decommissioning.

REFERENCES

1.1-1 B16066, "Certifications Of Permanent Cessation Of Power Operation And That Fuel Has Been Permanently Removed From The Reactor", December 5, 1996.

1.2 GENERAL PLANT DESCRIPTION

This section includes a summary description of the principal characteristics of the site and a concise description of the Haddam Neck Plant.

1.2.1 General

Prior to the certification of the permanent cessation of operations, the Haddam Neck Plant incorporated a 4-loop closed-cycle pressurized water type nuclear steam supply system (NSSS); a turbine generator and electrical systems; engineered safety features; radioactive waste systems; fuel handling systems; structures and other on-site facilities; instrumentation and control systems; and the necessary auxiliaries required for a complete and operable nuclear power station. As of March 30, 2005, all of the Spent Fuel and GTCC waste has been transferred from the Spent Fuel Pool to the ISFSI at the Haddam Neck Plant site. The general site plan (Figure 2.1-3) and the Connecticut Yankee site plan (Figure 2.1-4) show the general arrangement of the unit at the time the decision was made to decommission.

1.2.2 Site

The Haddam Neck Plant is located in the town of Haddam, on the east bank of the Connecticut River. The site consists of 525 acres. The minimum distance from the ISFSI to the site boundary (Salmon River) is approximately 800 feet. The distance to the nearest residence is approximately 2,000 ft. Except for several small towns and villages and a portion of Middletown, the area within a ten-mile radius is predominantly rural. The majority of this area is wooded, with the remaining open area devoted to general farming, resorts and some minor industry.

An extensive and carefully coordinated program of seismic exploration and borings was developed. Although it was the consensus of seismologists that Connecticut is a seismically stable area, structures and systems essential to the safe storage of spent fuel have been designed for a moderately strong earthquake having a maximum zero period ground [Bedrock] acceleration of 0.17 g.

1.2.3 Structures

With the removal of all remaining plant structures associated with radioactive material control or storage, there are no major remaining structures of the Haddam Neck Plant that continue to serve a function in the decommissioning state.

1.2.4 Plant Systems

1.2.4.1 Normal and Emergency Power Systems

DELETED

1.2.4.2 Fuel Storage and Handling

1.2.4.2.1 Fuel Handling and Storage in the Spent Fuel Pool

DELETED

1.2.4.2.2 Dry Fuel Storage

To enable decommissioning of the Spent Fuel Building and provide for safe storage of the HNP spent fuel, an Independent Spent Fuel Storage Installation (ISFSI) was constructed for the dry storage of spent fuel under the General License provisions of 10 CFR 72 Appendix K (Reference 1.2-1).

1.2.4.3 Fire Protection

DELETED

1.2.4.4 Radioactive Waste Systems

Radioactive wastes are collected, processed, and disposed of in a safe manner complying with appropriate regulations.

REFERENCES

1.2-1 Connecticut Yankee Atomic Power Company – Haddam Neck Plant, Independent Spent Fuel Storage Installation (HNP ISFSI), 10 CFR 72.212 Evaluation Report.

1.3 IDENTIFICATION OF AGENTS AND CONTRACTORS

1.3.1 Decommissioning

In 1996 Connecticut Yankee Atomic Power Company certified to the NRC that power operations of the Haddam Neck Plant has been permanently terminated and that all fuel had been permanently moved from the reactor vessel to the spent fuel pool. Following this certification, decommissioning activities of the Haddam Neck Plant were begun. The decommissioning, and associated decontamination of the site, are being conducted under the control and direction of the Connecticut Yankee Atomic Power Company.

1.4 MATERIAL INCORPORATED BY REFERENCE

1.4.1 License Termination Plan

The License Termination Plan (LTP) is incorporated by reference. Changes to the LTP must be assessed in accordance with the requirements of 10 CFR 50.59 and License Condition 2.(7). The LTP was approved by the NRC as Amendment 197 (Reference 1.4-1)

1.5 CONFORMANCE TO NRC REGULATORY GUIDES

1.5.1 Summary Discussion

The AEC issued Appendix A "General Design Criteria" to 10 CFR 50 in July 1971. In November 1970, Safety Guides, later to become Regulatory Guides, began to be published. These guides provided acceptable means for complying with specified AEC regulations. They were not in effect at the time the Haddam Neck Plant began operation with Provisional Operating License (POL) DPR-61, issued June 30, 1967.

The Haddam Neck Plant submitted summaries of compliance to these guides in 1969 in support of the application for a full-term operating license (Reference 1.5-1). It was concluded that Haddam Neck satisfied and was in compliance with the intent of the Regulatory Guide provisions. The NRC issued the FTOL on December 27, 1974.

REFERENCES

1.5-1 Connecticut Yankee Haddam Neck Power Plant Unit 1, Application for Full-Term Operating License, December 31, 1969.

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SITE CHARACTERISTICS

This chapter contains information on the geological, seismological, hydrological and meteorological characteristics of the site and vicinity, in conjunction with population distribution, land use and site activities and control. The purpose of this section was to indicate how these site characteristics influenced plant design, operation and decommissioning and show the adequacy of the site characteristics from a safety viewpoint. However, much of the information that was presented in this chapter is historical in nature and, as permitted by R.G. 1.181 (Reference 2.1-3), this information does not require updating. Therefore, in order to eliminate confusion between the historical information and information that needs to be maintained as part of the plant's "design basis", sections 2.1.3, 2.3, 2.4, and 2.5 have been annotated to indicate that the information contained in these sections is "Historical Information Only".

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Site Location and Description

2.1.1.1 Specification of Location

The site is located in the Town of Haddam, Middlesex County, Connecticut, on the east bank of the Connecticut River at a point 21 miles south-southeast of Hartford, Connecticut, and 25 miles northeast of New Haven, Connecticut. Figure 2.1-1 shows the site location.

The general plant area was filled and graded from an initial elevation of approximately 12 ft mean sea level (MSL) to a final elevation of 21 ft. This grade is 1.5 ft above the highest recorded river level near the site. At the back or east side of the plant, wooded hillsides rise steeply above the perpendicular rock cut, while the Connecticut River acts as a barrier on the west side as well as at the southern end of the peninsula, approximately one mile from the plant. Access to the site is gained over an improved access road from the north. The general topography is shown on Figure 2.1-2.

2.1.1.2 Site Area Map

The site consists of approximately 432 acres, bounded by the property lines as shown on Figure 2.1-3. The largest nearby city, Middletown, is 8 air miles northwest of the plant.

The location and orientation of the ISFSI within the site area is shown on the General Site Plan, Figure 2.1-3. The location and orientation of the plant structures within the site at the time of permanent shutdown are shown on Connecticut Yankee Site Plan, Figure 2.1-4.

Changes to the site involving structures other than the Independent Spent Fuel Storage Installation (ISFSI) are not considered a change to the facility as described in the UFSAR. As such, Figure 2.1-3 may not reflect the up-to-date configuration of site structures as the plant completes decommissioning.

2.1.1.3 Boundaries for Establishing Effluent Release Limits

Figure 2.1-3 depicts the property line and site boundary line. The property line is that line beyond which land is not owned, leased or otherwise controlled. The area within the site boundary is governed by the HNP Part 50 License (Reference 2.1-8 and 2.1-9).

The land outside the bounds of the site boundary is considered an unrestricted area for radiation protection purposes. The land areas between the site boundary and the security protected area is generally considered a controlled area, access to which can be limited by the licensee. Restricted areas are areas which are limited by the licensee for the purposes of protection of individuals from exposure to radiation and radioactive materials. The ISFSI restricted area and protected area generally correspond. Additional restricted areas may be designated by the licensee in the controlled area as necessary to protect individuals against exposure to radiation and radioactive materials. The ISFSI is a restricted area. The restricted areas, the controlled area, and the unrestricted area are shown on Figure 2.1-3.

The Haddam Neck Plant prepares an Annual Radioactive Effluent and Release Report (Reference 2.1-1) that provides actual plant effluent release data.

2.1.2 Authority and Control Area

2.1.2.1 Authority

The Haddam Neck Plant is owned by the Connecticut Yankee Atomic Power Company (CYAPCO). In a letter dated April 29, 2004, a written request was submitted to the NRC of intent to release the East Side Grounds (Survey Area 9532) from the Part 50 license (Reference 2.1-8). The NRC approved that request on September 1, 2004 (Reference 2.1-9). The site area is reduced as a result of the release of the non-impacted area from the Part 50 License. Figure 2.1-3 shows the new site boundary. Since CYAPCO still owns the property covered by this release area (Survey area 9532) CYAPCO will continue to maintain authority, in accordance with 10 CFR 100.3, over the activities conducted within the site boundary.

2.1.2.2 Control of Activities Unrelated to Plant Operation

No part of the site is leased and all structures located on the site are under the control the Connecticut Yankee Atomic Power Company.

The location and extent of the plant site was one of the considerations entering into the analysis of the overall safety of the plant. To ensure the safety of people within the site area during an emergency, an emergency plan (see Section 13.3) for the site describes procedures for removal of visitors on-site.

2.1.2.3 Arrangements for Traffic Control

During an emergency, the site emergency plan describes procedures to restrict access to the site.

2.1.2.4 Abandonment or Relocation of Roads

No abandonment or relocation of roads is necessary.

2.1.3 Population Distribution

The information provided in this section is "Historical Information." The total 1990 permanent population within 10 miles of the plant is estimated to be 78,141. This population is projected to increase to about 83,496 by the year 2000 and to a total of approximately 88,211 by the year 2030 [Connecticut Office of Policy and Management, 1991 (Reference 2.1-4); U.S. Department of Commerce, 1990 Census of Population (Reference 2.1-5)]. The 10-mile area includes most of Middlesex County and small portions of New London, Hartford, Tolland, and New Haven Counties.

Aside from a scattering of small towns and villages and a portion of the city of Middletown, the area within a ten-mile radius of the site is predominantly rural. About 80% of this area is wooded and much of it is state parks and forests. The remaining area is devoted primarily to general farming and some minor industry. Table 2.1-1 provides the 1990 tabulation of population distribution within 10 miles of the Haddam Neck Plant.

The total population and population density of all municipalities, either completely or partially within the 10-mile radius, is provided in Table 2.1-2.

The Town of Haddam, in which the Haddam Neck Plant is located, contained a total population of 6,769 in 1990, with an average population density of 154 people per square mile (1990 Census of Population and Housing) (Reference 2.1-6). Haddam has experienced a modest population growth, but has slowed considerably compared to previous decades. This growth is projected to continue through 2010 (the last year of projections), at which time the population of Haddam is expected to reach 7,470.

The population distribution within 10 miles of the plant is based on 1990 Census of Population by Census Block (Reference 2.1-5). The population within each Census Block was assumed to be distributed evenly over its land area, unless shown otherwise by USGS 7.5 minute quadrangle maps (Reference 2.1-7) of the area. The proportion of each Census Block area within each grid sector was estimated and applied to the total population within the Block. The population of all Blocks or portions of Blocks within a sector were added to calculate the total population within each sector. Population projections by municipality, generated by the Connecticut Office of Policy and Management (Reference 2.1-4), provided growth factors to calculate the population in each sector in the future.

REFERENCES

2.1-1 R. A. Mellor letter to U.S. Nuclear Regulatory Commission Document Control Desk, transmitting the January - December 1998 Annual Radioactive Effluent Report for the Haddam Neck Plant, dated April 4, 1999 and subsequent revisions thereto submitted on an annual basis

2.1-2 R. A. Mellor letter to U.S. Nuclear Regulatory Commission, Document Control Desk, "Haddam Neck Plant Revision 3 to the Haddam Neck Plant Defueled Emergency Plan," dated April 2000 and subsequent revisions thereto.

2.1-3 Regulatory Guide 1.181, "Content of the Updated Final Safety Analysis Report in Accordance with 10 CFR 50.71(e)."

2.1-4 Connecticut Office of Policy Management, Interim Population Projection Series 91.1, 1991.

2.1-5 U.S. Department of Commerce, Bureau of the Census, 1990 Census of Population, P.L. 94-171 Counts by Census Block, 1991.

2.1-6 U.S. Department of Commerce, Bureau of the Census, 1990 Census of Population and Housing, Connecticut, 1990 CPH-1-8, 1991.

2.1-7 U.S. Geological Survey, 7.5-Minute Quadrangle maps.

2.1.8 W. A. Norton (CYAPCO) letter to the US NRC, "Haddam Neck Plant, Letter of Intent Concerning the Release at the East Side Grounds from the Part 50 License", dated April 29, 2004.

2.1.9 T. Smith (NRC) to W. Norton (CYAPCO), "Haddam Neck Plant, Release of East Site Grounds from Part 50 License", dated September 1, 2004.

REFERENCES

2.1-1 R. A. Mellor letter to U.S. Nuclear Regulatory Commission Document Control Desk, transmitting the January - December 1998 Annual Radioactive Effluent Report for the Haddam Neck Plant, dated April 4, 1999 and subsequent revisions thereto submitted on an annual basis.

2.1-2 Correspondence Letter dated April 27, 1981, Docket No. 50-213, A01452 SEP Topic II-1.A, "Exclusion Area Authority and Control," TO: Dennis M. Crutchfield (NRC), FROM: W.G. Counsil (CYAPC), NUSCO File No. 8113310199.

2.1-3 R. A. Mellor letter to U.S. Nuclear Regulatory Commission, Document Control Desk, "Haddam Neck Plant Revision 3 to the Haddam Neck Plant Defueled Emergency Plan," dated April 2000 and subsequent revisions thereto.

2.1-4 Regulatory Guide 1.181, "Content of the Updated Final Safety Analysis Report in Accordance with 10 CFR 50.71(e)."

2.1-5 State of Connecticut Radiological Emergency Response Plan. Millstone Nuclear Power Station, Waterford, Connecticut Haddam Neck Plant, Haddam Neck Plant, Haddam, Connecticut.

2.1-6 Connecticut Office of Policy Management, Interim Population Projection Series 91.1, 1991.

2.1-7 U.S. Department of Commerce, Bureau of the Census, 1990 Census of Population, P.L. 94-171 Counts by Census Block, 1991.

2.1-8 U.S. Department of Commerce, Bureau of the Census, 1990 Census of Population and Housing, Connecticut, 1990 CPH-1-8, 1991.

2.1-9 U.S. Geological Survey, 7.5-Minute Quadrangle maps.

2.1.10 W. A. Norton (CYAPCO) letter to the US NRC, "Haddam Neck Plant, Letter of Intent Concerning the Release at the East Side Grounds from the Part 50 License", dated April 29, 2004.

2.1.11 T. Smith (NRC) to W. Norton (CYAPCO), "Haddam Neck Plant, Release of East Site Grounds from Part 50 License", dated September 1, 2004.

SUPPORTING REFERENCES

U.S. Department of Commerce, Bureau of the Census, State and Metropolitan Area Book 1991, a Statistical Abstract Supplement, 1991.

U.S. Department of Commerce, Bureau of the Census, Number of Inhabitants: Connecticut, PC(1)-A8, 1971; PC80-1-A8, 1981.

TABLE 2.1-1

POPULATION DISTRIBUTION WITHIN 10 MILES OF HADDAM NECK
1990 CENSUS

Distance to Plant

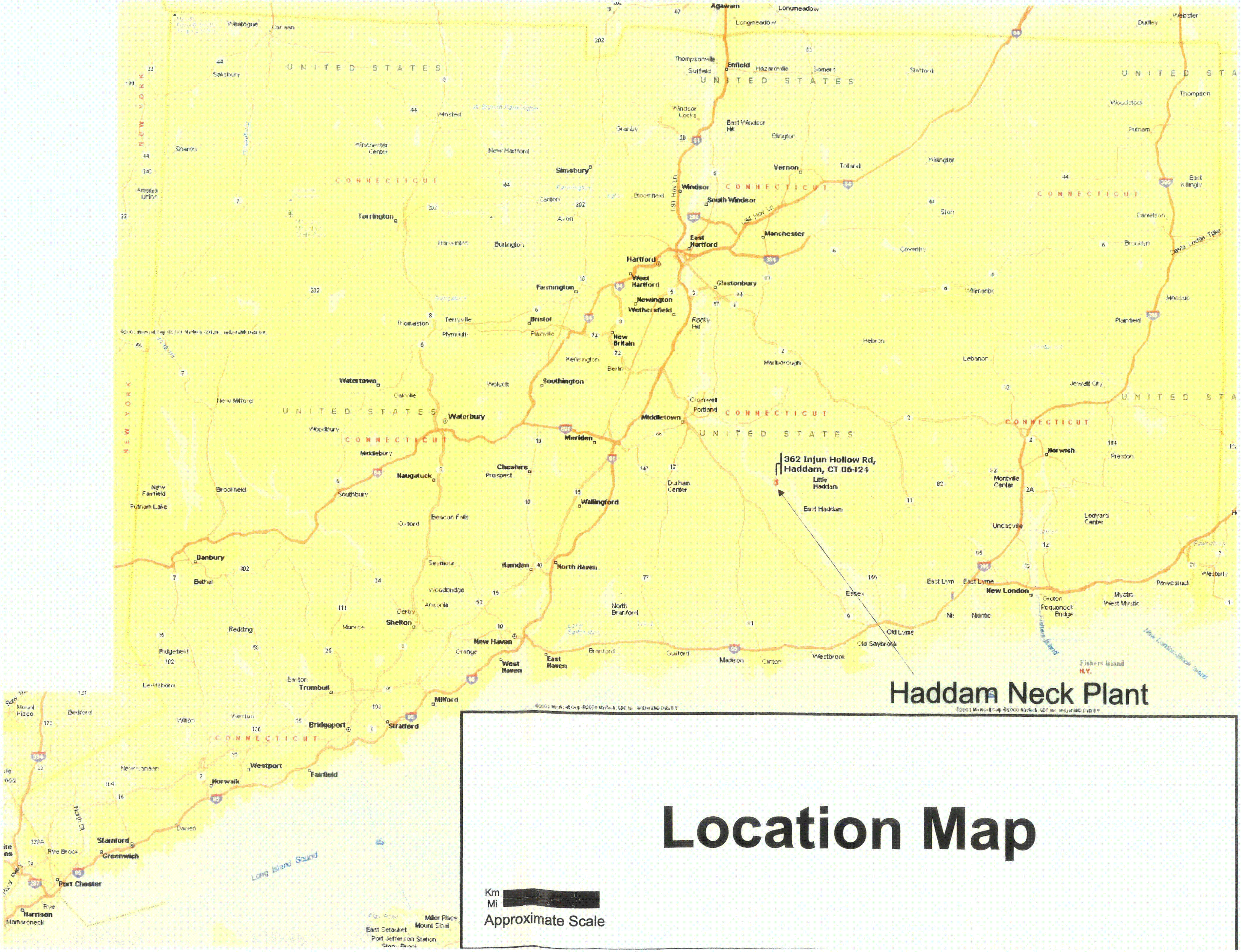
SECTOR	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	TOTAL
N	0	0	104	272	120	867	2319	1746	1445	1086	7959
NNE	0	7	113	87	49	245	88	165	263	509	1526
NE	0	9	111	517	255	257	471	689	415	1570	4294
ENE	0	45	527	333	799	294	4	117	461	850	3430
E	0	60	348	148	341	216	279	288	126	147	1953
ESE	0	9	152	234	94	96	93	182	70	242	1172
SE	2	201	249	56	223	352	238	199	284	412	2216
SSE	122	74	156	74	202	893	1573	1962	720	2403	8179
S	47	86	79	23	62	476	306	194	734	556	2563
SSW	15	132	136	132	72	141	344	686	496	560	2714
SW	38	170	120	78	313	553	315	372	241	217	2417
WSW	125	47	119	302	185	217	133	97	238	377	1840
W	23	276	68	272	309	210	174	186	979	1733	4230
WNW	0	136	158	653	366	179	1395	2098	6029	8288	19302
NW	13	100	8	0	8	145	89	581	2905	6885	10734
NNW	0	47	166	165	200	639	897	907	349	242	3612
TOTAL	385	1399	2614	3346	3598	5780	8718	10469	15755	26077	78141

TABLE 2.1-2

1990 POPULATION AND POPULATION DENSITIES
CITIES AND TOWNS WITHIN 10 MILES OF HADDAM NECK

MUNICIPALITY	1990 POPULATION TOTAL	1990 POPULATION DENSITY	1980 - 1990 CHANGE (%)
Chester	3,417	214	11.4%
Colchester	10,980	224	41.5%
Deep River	4,332	319	8.5%
Durham	5,732	243	11.5%
East Haddam	6,676	123	18.8%
East Hampton	10,428	293	21.7%
Essex	5,904	568	16.3%
Haddam	6,769	154	6.0%
Hebron	7,079	192	29.8%
Killingworth	4,814	136	21.1%
Lyme	1,949	61	7.0%
Madison	15,485	428	10.4%
Marlborough	5,535	238	16.6%
Middlefield	3,925	309	3.4%
Middletown	42,762	1,046	9.5%
Portland	8,418	360	0.4%
Salem	3,310	114	41.8%
Westbrook	5,414	345	3.8%

Notes:
Based on 1990 US Census of Population and Housing
Includes total 1990 population of all municipalities totally or partially within 10 miles of the site.

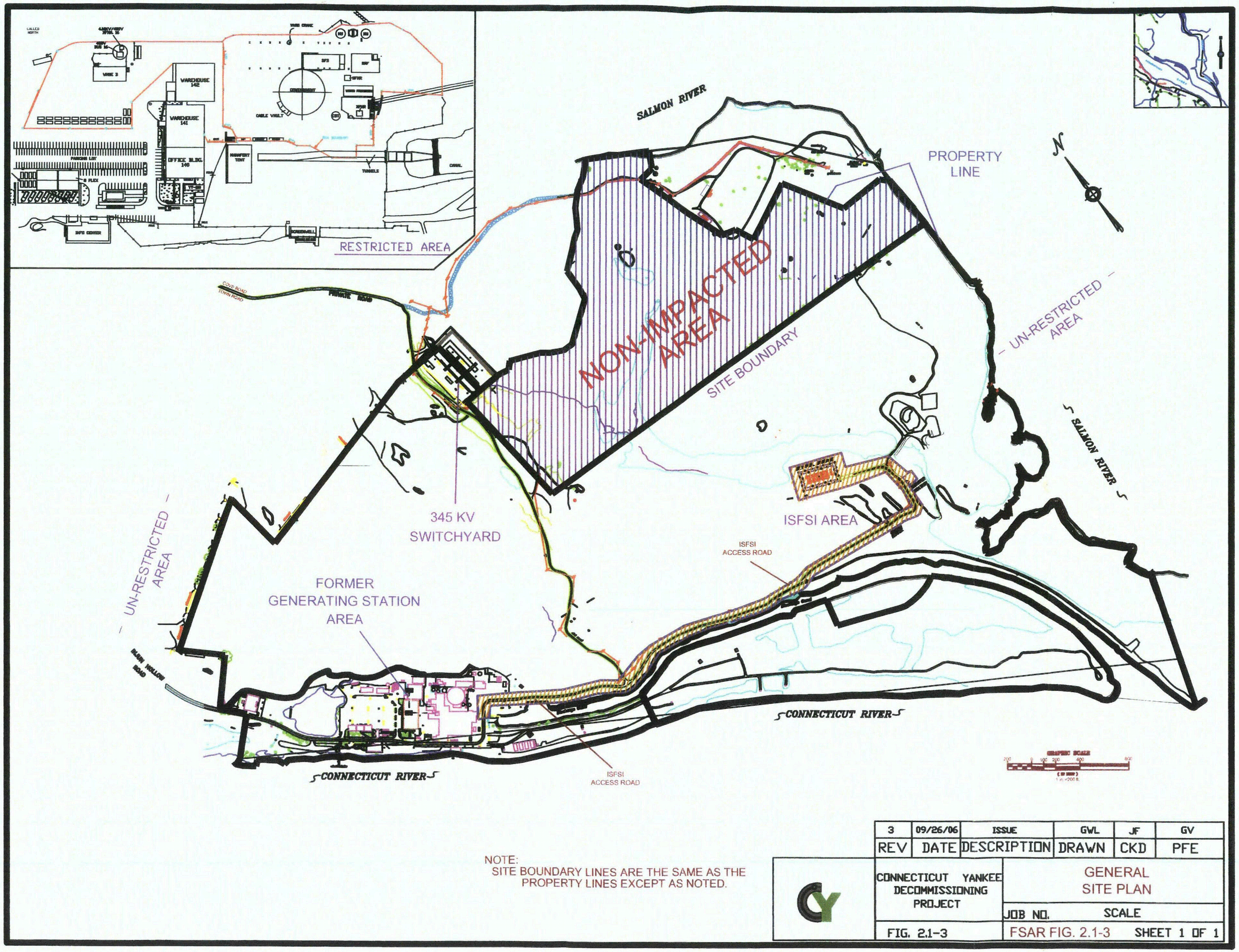


Location Map

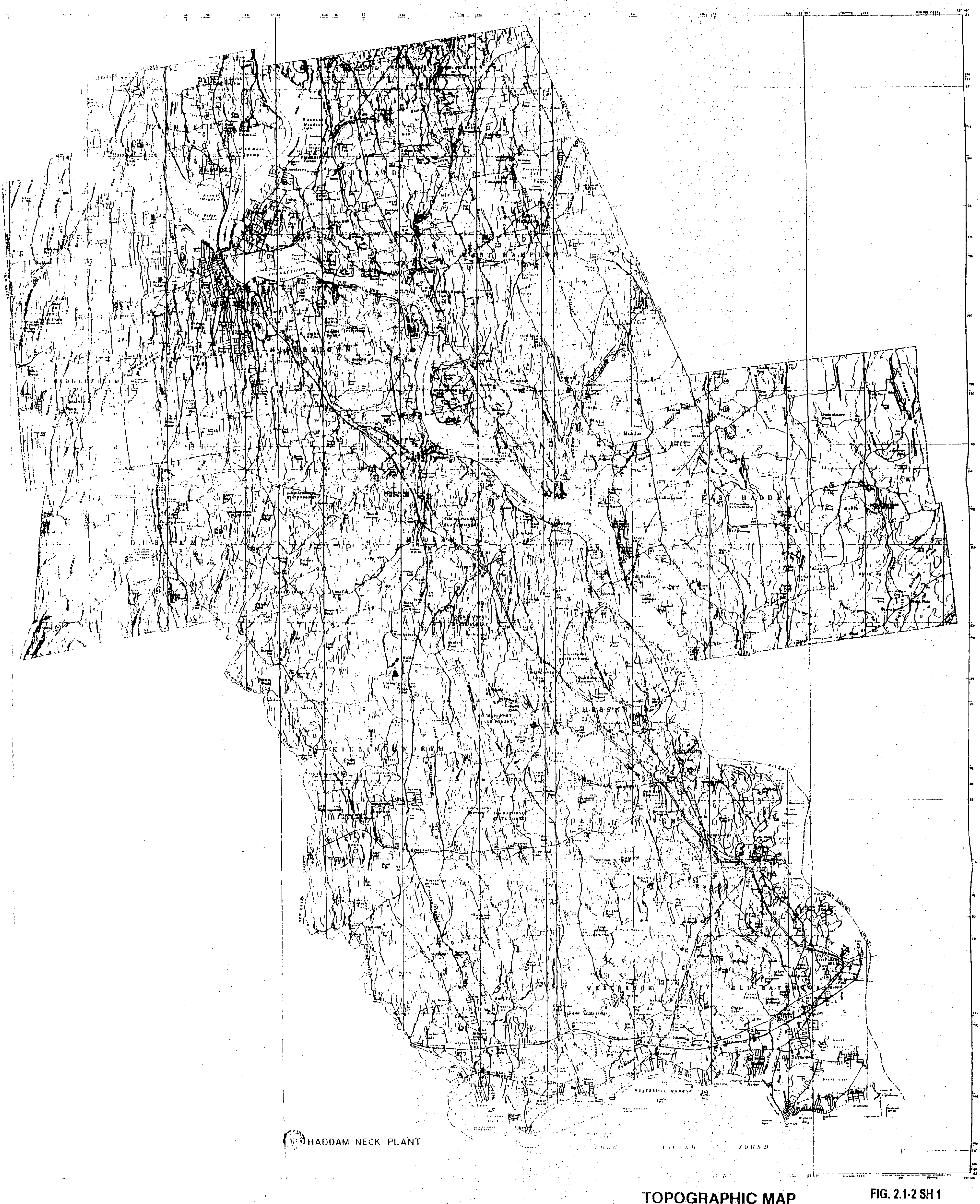
Km
Mi
Approximate Scale

JULY 2002

FIG 2.1-1 Sh1

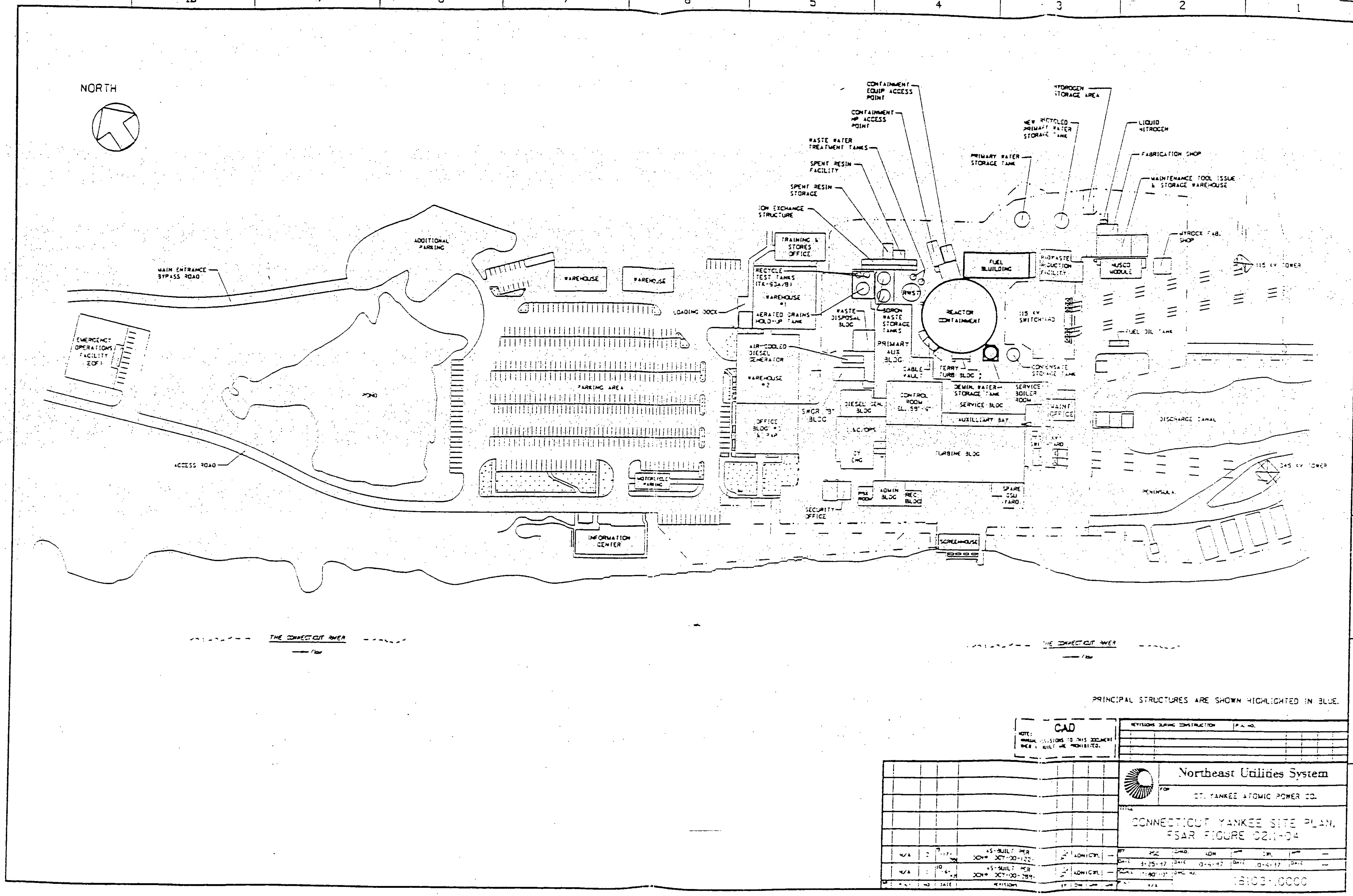


UFSAR FIGURE 2.1-3



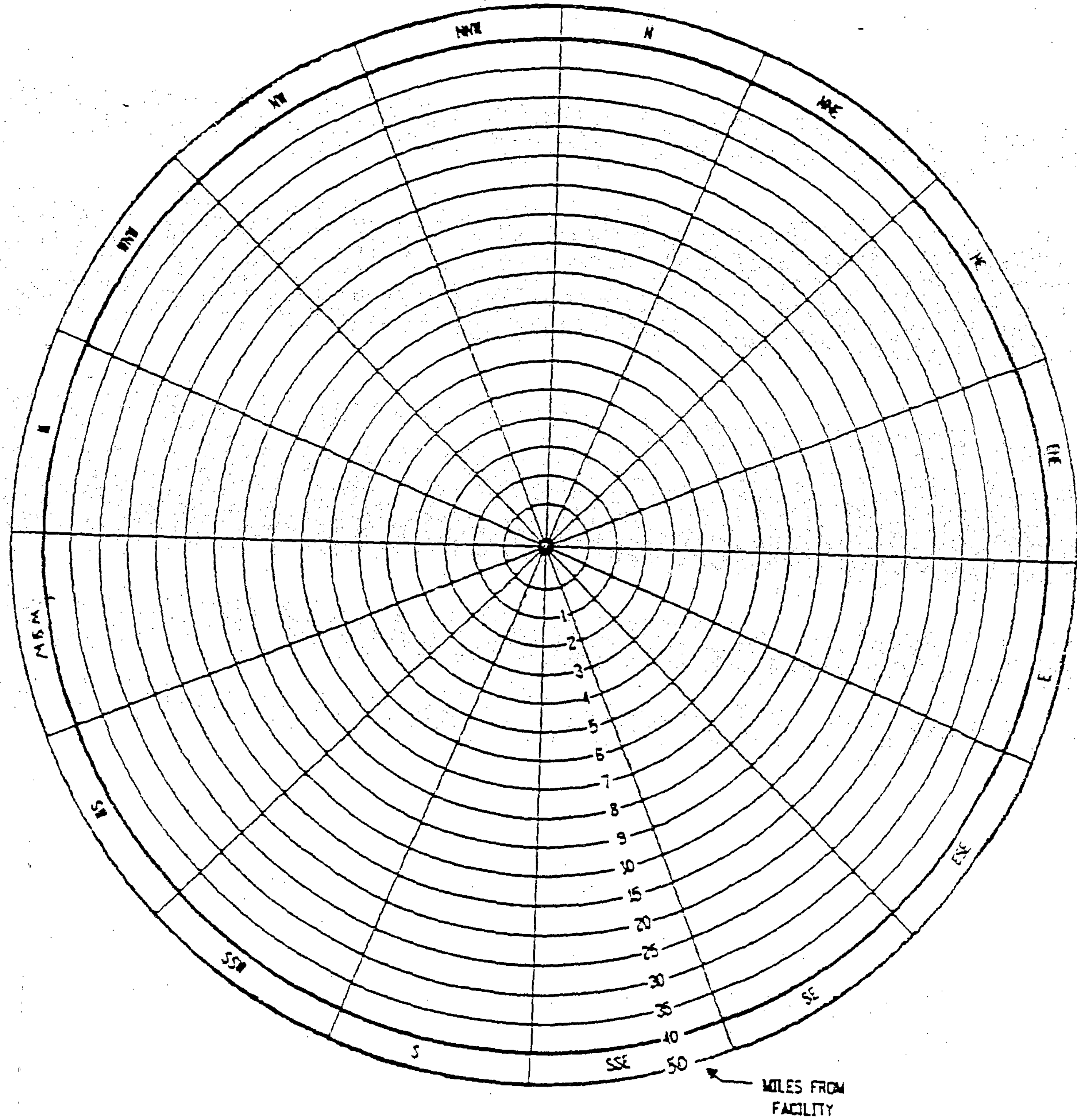
TOPOGRAPHIC MAP

FIG. 2.1-2 SH 1
JANUARY 1998



USFAR FIG. 2.1-4

RESIDENT POPULATION DISTRIBUTION



POPULATION SECTORS WITHIN 50 MILES

FIG. 2.1-6 SH 1
JANUARY 1998

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

2.2.1 Locations and Routes

Connecticut Yankee Atomic Power Company (CYAPCO) has concluded that the industries listed in the following subsection do not pose a potential hazard to the ISFSI. A review of the Haddam Neck site and surrounding area was performed to determine the types and quantities of hazardous chemicals stored on site or within a 5-mile radius of the site. The separation distance between the plant and nearby industries exceeds the minimum distance criteria given in Regulatory Guide 1.91, Revision 1, and therefore provides assurance that any transportation accidents resulting in explosions of truck-size shipments of hazardous materials will not have an adverse effect on the safe operation of the ISFSI. The nearest major highway that would be used for frequent transportation of hazardous materials is State Route 9, which is located at a distance of about 4 miles from the site. There are no railroad lines within 5 miles of the Site that are used to ship hazardous materials; therefore, rail transportation does not pose a hazard to the safe operation of the ISFSI.

2.2.2 Descriptions

2.2.2.1 Description of Facilities

The largest single industrial complex within the 10-mile radius is the Middletown facility of Pratt & Whitney Aircraft at Maromas, 5.5 miles northwest of the site. As of January 1998, approximately 3000 people are employed at this facility. Other industries located within a 10-mile radius of the site, employing large numbers of people are :

Employers	Municipality	Employees (Jan 1998)
Turbo Products	Essex	270
Wheelen Engineering	Chester	200
Silgan Plastics	Deep River	180
Durham Manufacturing	Durham	210
Zygo Corporation	Middlefield	210
Connecticut Valley Hospital	Middletown	1175
Madrigal Laboratories	Middletown	180
Middlesex Memorial Hospital	Middletown	1378
Middlesex Mutual Corporation	Middletown	150
Elmcrest Psychiatric Hospital	Portland	500
Standard-Knapp, Inc.	Portland	150
Stone Container	Portland	157

CYAPCO has concluded that, because of the nature of these industries and the distance from the Haddam Neck site, these facilities do not pose a potential hazard to the ISFSI.

2.2.2.2 Description of Products and Materials

No significant quantities of hazardous chemicals have been identified in the five mile radius area surrounding the site.

2.2.2.3 Pipelines

There are no pipelines or military facilities within 5 miles of the site that present any credible hazard.

2.2.2.4 Waterways

The Connecticut River is used for shipping of materials. The shipping channel near the site is on the far (west) side of the Connecticut River. No significant quantities of hazardous chemicals have been identified that are transported by barge on the Connecticut River.

2.2.2.5 Airports

There is one airport within five miles of the Haddam Neck Plant site. Goodspeed Airport in East Haddam, Connecticut, is a general aviation facility with one runway located approximately three miles from the plant. The airport is used primarily for light, single-engine aircraft activities such as business and pleasure flying. The location of the airport physically prohibits significant expansion. It was determined (Reference 2.2-1) that, due to the size and nature of traffic, operation of the airport does not constitute a hazard to the site. This conclusion was documented in Reference 2.2-3 .

2.2.3 Evaluation of Potential Accidents

The ISFSI is adequately protected and can be operated with an acceptable degree of safety with regard to industrial, transportation and military activities in the vicinity of the plant.

2.2.3.1 Determination of Design Basis Events

Discussion of the design basis events external to the ISFSI is provided in Reference 2.2-5.

The State of Connecticut Radiological Emergency Response Plan (Reference 2.2-4) and its implementing procedures provide the details on how events are classified using the Event Based tables and Federal and State Classification schemes, and provide the notification actions required to be taken for any natural phenomenon or other external condition that poses an actual threat to the safety of the ISFSI.

2.2.3.2 Effects of Design Basis Events

The effects of Design Basis Events external to the ISFSI are discussed in Reference 2.2-5. Reference 2.2-5 concluded that the site is adequately protected and can be operated with an acceptable degree of safety with regard to industrial, transportation, and military activities in the vicinity of the site.

REFERENCES

2.2-1 Letter dated June 28, 1982, Docket No. 50-213, LS-82-06-103, SEP Topic II-1.C, "Potential Hazards Due to Nearby Transportation, Institutional, and Military Facilities," TO: W.G. Counsil, Vice President Nuclear Engineering and Operations, Connecticut Yankee Atomic Power Company, FROM: Dennis M. Crutchfield, Chief Operation Reactors, Branch No. 5, Division of Licensing, USNRC, NUSCO File No. 8311132687.

2.2-2 Letter dated May 26, 1982, Docket No. 50-213, AO2442, Haddam Neck Plant, SEP Topic II-1.C, "Potential Hazards Due to Nearby Transportation, Institutional, Industrial, and Military Facilities," TO: Dennis M. Crutchfield, Chief Operating Reactors, Branch No. 5, USNRC, FROM: W.G. Counsil, Sr. Vice President and J.P. Cagnetta, Vice President Nuclear and Environmental Engineering, NUSCO File No. 8219610355.

2.2-3 Correspondence Letter dated June 25, 1981, SEP Topic III-4.D, "Haddam Neck, Site Proximity Missiles (including Aircraft)," FROM: W. G. Counsil, TO: D. M. Crutchfield, NUSCO File No. 8313331572.

2.2-4 State of Connecticut Radiological Emergency Response Plan, Millstone Nuclear Power Station, Waterford, Connecticut and Haddam Neck Plant, Haddam, Connecticut.

2.2-5 Connecticut Yankee Atomic Power Company , Haddam Neck Plant Independent Spent Fuel Installation (HNP ISFSI), 10 CFR 72.212 Evaluation Report.

2.3 METEOROLOGY

This section provides a description of the meteorology of the site and its surrounding areas. The information contained in this section is "Historical Information." Discussion related to the former plant has been deleted.

2.3.1 Regional Climatology

The climatology of the Haddam Neck Plant region may be reasonably described by the National Weather Service Station for Bridgeport, Connecticut. The Bridgeport National Weather Service Station is located at Sikorsky Memorial (Bridgeport Municipal) Airport, approximately 40 miles southwest of the site. The Haddam Neck plant is approximately 20 miles inland from Long Island Sound, while the airport weather station is located on a peninsula that protrudes into Long Island Sound.

Bridgeport and the site are influenced by similar synoptic scale and mesoscale meteorological conditions. Temperature data prior to January 1, 1948, along with precipitation and snowfall data prior to March 1, 1948, are available from cooperative Bridgeport locations. Following these dates, all data reviewed for this document were collected at Bridgeport Municipal Airport locations. From May 16, 1953 to February 29, 1960, and June 1, 1981 to June 30, 1982, the Bridgeport Weather Station was closed between the hours of 11:00 p.m. and 6:00 a.m. Hourly data were recorded 16 hours per day by the National Weather Service.

Meteorological data for the Haddam Neck Plant site is no longer available.

2.3.1.1 General Climate

The general climate of the region is described with respect to types of air masses, synoptic features, and general airflow patterns.

2.3.1.1.1 Air Masses and Synoptic Features

The general eastward movement of air encircling the globe at middle latitudes transports large air masses into the region. Four types of air masses usually influence the meteorology in the region of the Haddam Neck site: cold, dry continental polar air originating in Canada; warm, moist tropical air originating over the Gulf of Mexico and the Atlantic Ocean; cool, damp maritime air originating over the North Atlantic; and modified maritime air originating over the Pacific Ocean. Constant interaction of these air masses produces a large number of migratory cyclones and accompanying weather fronts affecting the region through the year. These weather systems are strongest during the winter and decrease in intensity during the summer. Infrequently, a storm of tropical origin affects the Haddam Neck site.

2.3.1.1.2 Temperature, Humidity, and Precipitation

The mean annual temperature is approximately 51°F at Bridgeport, Connecticut. Due to the proximity of Long Island Sound and the Atlantic Ocean, both the heat of summer and the cold of winter are moderated. During the summer months, normal monthly temperatures near the shoreline average 3°F to 5°F cooler than nearby inland stations.

Temperatures of 90°F or greater occur an average of seven days per year at Bridgeport, while temperatures of 100°F or greater have occurred only in July and August with an extreme maximum of 103°F occurring in July 1957 (see National Oceanic and Atmospheric Administration (NOAA 1971, 1990), Reference 2.3-1). Freezing temperatures have not been recorded during the summer months.

Winters are moderately cold, but seldom severe. Minimum daily temperatures during the winter months are usually below freezing, but subzero (°F) readings are observed, on the average, less than one day every two years. Below zero temperatures have been observed in each winter month, with an extreme minimum of -20°F occurring in February 1934 (NOAA 1971, 1990, Reference 2.3-1).

The normal annual precipitation at Bridgeport is well distributed throughout the year. Migratory low-pressure systems, and their accompanying frontal zones, produce most of the precipitation throughout the year. From late spring through early fall, bands of thunderstorms and convective showers produce considerable rainfall. These storms, often of short duration, frequently yield the heaviest short-term precipitation amounts. During the remainder of the year, the heaviest amounts of rain and snow are produced by storms moving up the Atlantic coast of the eastern United States. Precipitation of 0.01 inch or more occurs approximately 117 days annually (NOAA, 1971, 1990, Reference 2.3-1).

On the average, relative humidity values are lowest during the winter and spring months in the early afternoon. Relative humidity values are at a maximum during the summer and fall months in the early morning hours. On occasions, the humidity is uncomfortably high for periods up to several days during the warmer months.

2.3.1.1.3 Prevailing Winds

The weather pattern in the region is controlled by the global band of prevailing westerly winds throughout most of the year. These winds act as the steering current for synoptic scale weather systems which produce day-to-day weather changes.

During the winter months, the predominating northwesterly winds transport cold, dry air from the northern United States and Canada into the region. From April through September, warm and often humid southwesterly winds occur most frequently.

2.3.1.2 Regional Meteorological Conditions for Design and Operation

Information for this subsection is contained in Enclosure 1 (Systematic Evaluation Programs, Meteorology, Haddam Neck Nuclear Power Plant) and Enclosure 2 (Tornado and Straight Wind Hazard Probability) to a 1980 letter from D. M. Crutchfield (Reference 2.3-2). The severe weather phenomena evaluated in Reference 2.3-2 did not change the design basis values for winds as stated in Section 3.3.

2.3.1.2.1 Strong Winds

Strong winds, usually caused by intense low-pressure systems, tropical cyclones, or passages of strong winter frontal zones, occasionally affect the region. For the 1961 through 1990 period, the fastest-mile wind speed recorded at Bridgeport was 74 mph occurring with a south wind during Hurricane Gloria in September 1985 (NOAA 1971, 1990, Reference 2.3-1).

2.3.1.2.2 Thunderstorms, Lightning

Thunderstorms most commonly occur during the late spring and summer months, although they have been observed during all months of the year. They occur on an average of 22 days per year. Severe thunderstorms with strong winds, heavy rain, intense lightning, and hail have infrequently affected the region (NOAA 1971, 1990, Reference 2.3-1).

A study of storm data indicates that intense lightning often accompanies strong thunderstorms in the region. Lightning strikes have injured or killed people and animals, have caused power failures, and have damaged or destroyed many dwellings by setting them afire.

2.3.1.2.3 Hurricanes

Storms of tropical origin occasionally affect the region during the summer and fall months. According to a 1971 statistical study by Simpson and Lawrence (Reference 2.3-3), the 50-mile segment of coastline closest to Haddam Neck was crossed by five hurricanes during the period from 1886 through 1970.

2.3.1.2.4 Tornadoes

From a study of tornado occurrences during the period of 1955 through 1967 (augmented by 1968-1981 storm data reports), the mean tornado frequency in the one-degree (latitude-longitude) square where the Haddam Neck site is located is determined to be approximately 0.704 per year (NOAA 1959-1981, Reference 2.3-4, and Pautz 1969, Reference 2.3-5). Applying Thom's method for determining the probability of a tornado striking a point on the site, it is conservatively estimated to be 0.00055 per year with recurrence expected every 1,804 years (Thom 1963, Reference 2.3-6). Crutchfield's 1980 letter (Reference 2.3-2) discusses the design basis tornado.

2.3.1.2.5 Extremes of Precipitation

The normal annual precipitation at Bridgeport is 43.63 inches. Since 1894, annual totals have ranged from a minimum of 23.03 inches in 1964, to a maximum of 73.93 inches in 1972. Monthly precipitation totals have ranged from 0.07 inch in June 1949 to 18.77 inches in July 1897. Since 1949, the maximum measured 24-hour rainfall has been 6.89 inches occurring in June 1972 (NOAA 1971, 1990, Reference 2.3-1).

2.3.1.2.6 Extremes of Snowfall

Measurable snowfall has occurred in the months of October through April, although heavy snowfall occurrences are usually confined to the months of December through March. The mean annual snowfall at Bridgeport is 25.3 inches, with totals since 1931 ranging from 8.2 inches in the 1972-1973 season, to 71.3 inches in the 1933-1934 season. The maximum monthly snowfall, occurring in February 1934, was 47.0 inches. Since 1949, both the maximum measured snowfall in 24 hours (16.7 inches), and the greatest snowfall in one storm (17.7 inches) occurred during the same storm in February 1969. The maximum measured snowfall in 24 hours (16.7 inches) was matched again in January 1978 (NOAA 1971, 1990, Reference 2.3-1).

The 100-year recurrence maximum snow load is estimated to be 31 lb/sq. ft (see American National Standards Institute (ANSI) 1972, Reference 2.3-7). Assuming a snow-to-water ratio of 8.7 to 1 (calculated using data from 10 snowstorms of 0.10 inch precipitation or more during 1974 and 1975) (NOAA 1975, Reference 2.3-8), the corresponding snow depth is estimated to be about 52 inches. The 48-hour probable maximum winter precipitation snow accumulation is about 48 inches. When added to the snowpack of 52 inches, the total snow depth is about 100 inches. Snow load data available from a study conducted by the Housing and Home Finance Agency (HHFA) also suggests that the total weight of the 100-year recurrence maximum snow load when added to the maximum probable single storm accumulation would be about 60 lb/sq. ft. (US HHFA 1952, Reference 2.3-9) or a total depth of about 100 inches.

The resulting 60 lb./sq. ft loading that includes the 100-year recurrence maximum snow load plus the 48-hour probable maximum winter precipitation is considered an extreme load. The maximum 100-year recurrence load of 31 lb./sq. ft. is considered a normal load.

2.3.1.2.7 Hailstorms

Large hail, which sometimes accompanies severe thunderstorms, occurs infrequently in the Haddam Neck area. Based on a 1955 through 1967 study (Pautz 1969, Reference 2.3-5), hailstones with diameters greater than or equal to 0.75 inch occur at an average of 1.4 times per year in the 1-degree (latitude-longitude) square where the Haddam Neck site is located. During the period of 1959 through 1981, the largest hailstones observed in the 1-degree square containing the site were qualitatively described as "baseball" size, and occurred in Groton, Connecticut on May 29, 1969 (NOAA 1981, Reference 2.3-4). Most hail reported in the area is less than 0.50 inch in diameter.

2.3.1.2.8 Freezing Rain, Glaze, and Ice Pellets

Freezing rain and drizzle are occasionally observed during the months of December through March, and only rarely observed in November and April. An average of 18.5 hours of freezing rain and 8.5 hours of freezing drizzle occur annually at Bridgeport. In the 32-year period, 1949 through 1980, all cases of freezing precipitation were reported as light (less than 0.10 inch per hour), except for 1 hour of moderate (0.10 to 0.30 inch per hour).

According to a 1959 study by Bennett (Reference 2.3-10), based on 9 years of data, ice accumulations of greater than 0.25 inch due to freezing precipitation may be expected to occur about one time per year. Ice accumulations greater than 0.50 inch may be expected about once every two years. The maximum ice accumulation is estimated to be 1.68 inches based on Bridgeport observations (NOAA 1949 through 1980, Reference 2.3-11), and assuming a conservative average rainfall of 0.07 inch per hour.

2.3.1.2.9 Fog Conditions

The average annual fog frequency (with visibility less than seven miles) is 13 percent (1,139 hours) at Bridgeport, with the maximum monthly frequency of fog (15.4 percent or 115 hours) occurring in May. The average annual ground fog frequency is 2 percent (175 hours), with October having the maximum monthly frequency of 3.4 percent (25 hours). Only one hour of heavy ice fog, a winter phenomenon, has been recorded during the period of 1949 through 1975 (NOAA 1949-1980, Reference 2.3-11).

Heavy fog (visibility of 0.25 mile or less) occurs an average of 1.5 percent of the time (131 hours), on about 29 days annually, predominantly during the months of December through June. The maximum number of consecutive hours of heavy fog observed during the period 1949 through 1964 was 26 (NOAA 1949-1980, Reference 2.3-11).

2.3.1.2.10 High Air Pollution Potential

The Haddam Neck site is in an area of relatively infrequent episodes of high air pollution potential. The continuous progression of large scale weather systems across North America frequently changes the air mass in the region and allows only infrequent extended periods of air stagnation. According to a 1972 report by G. C. Holzworth (Reference 2.3-12), high meteorological potential for air pollution occurs an average of about two times per year. A stationary high-pressure system over the eastern United States is generally the cause of these high air pollution potential days.

REFERENCES

2.3-1 National Oceanic and Atmospheric Administration (NOAA) 1971, 1990. Local Climatological Data. Annual Summary with Comparative Data, Bridgeport, Connecticut. U.S. Department of Commerce, National Climatic Center, Asheville, NC.

2.3-2 Crutchfield, D. M. USNRC 1980,SEP Topic II-2.A, Severe Weather Phenomena. Letter to W. G. Counsil, dated December 8, 1980, NUSCO File No. 8302738611.

2.3-3 Simpson, R. H. and Lawrence, M. B. 1971. Atlantic Hurricane Frequencies along the U.S. Coastline. NOAA Technical Memorandum NWS SR-58, U.S. Department of Commerce, NOAA, National Weather Service, Asheville, NC.

2.3-4 National Oceanic and Atmospheric Administration (NOAA) 1959-1981. Storm Data. U.S. Department of Commerce, Environmental Data Service, Asheville, NC.

2.3-5 Pautz, M. E. (ed) 1969. Severe Local Storm Occurrences, 1955-1967. ESSA Technical Memorandum WBTM FCST 12, U.S. Department of Commerce, ESSA. Weather Analysis and Prediction Division, Weather Bureau, Silver Spring, MD.

2.3-6 Thom, H.C.S. 1963. Tornado Probabilities. Monthly Weather Review, p. 730-731.

2.3-7 American National Standards Institute (ANSI) 1972. American National Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures. New York, NY.

2.3-8 National Oceanic and Atmospheric Administration (NOAA) 1974-1975. Local Climatological Data, Bridgeport, Connecticut. U.S. Department of Commerce, Environmental Data Source (EDS), January 1974 - December 1975, Asheville, NC.

2.3-9 U.S. Housing and Home Finance Agency, 1952. Snow Load Studies. Housing Research Paper 19. U.S. Department of Housing and Urban Development Headquarters, Washington, D.C.

2.3-10 Bennett, I. 1959. Glaze, Its Meteorology and Climatology, Geographical Distribution, and Economic Effects. Technical Report EP-105. Quartermaster Research and Engineering Command, U.S. Army Environmental Protection Research Division, Office of Chief of Engineers, Washington, D.C.

2.3-11 National Oceanic and Atmospheric Administration (NOAA) 1949-1980. WBAN Surface Observations (on magnetic tape) for Bridgeport, Connecticut. U.S. Department of Commerce, National Climatic Center, Asheville, NC.

2.3-12 Holzworth, G. C. 1972. Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution throughout the Contiguous United States. U.S. Environmental Protection Agency, Office of Air Programs, Washington, D.C.

2.3-13 State of Connecticut. Radiological Emergency Response Plan, Millstone Nuclear Power Station, Waterford, Connecticut, and Haddam Neck Plant, Haddam, Connecticut. Emergency Operations Plan.

2.3-14 Crutchfield, D. M. USNRC 1982. Atmospheric Transport and Diffusion Characteristics for Accident Analysis - Haddam Neck. Letter to W. G. Counsil, NUSCO File No. 8219610587.

2.4 HYDROLOGIC ENGINEERING

The information contained in this section is "Historical Information." Discussion related to the former plant has been deleted.

2.4.1 Hydrologic Description

2.4.1.1 Site and Facilities

The Haddam Neck Nuclear Power Plant went into commercial operation in January 1968 and permanently ceased power operations in December 1996. The plant is located in the Town of Haddam, Middlesex County, Connecticut. The plant is situated on the east bank of the Connecticut River about 21 miles south-southeast of Hartford, Connecticut, and approximately 19.5 river miles north of the Saybrook Breakwater Light.

The site area is approximately 525 acres located immediately upstream from the confluence of the Salmon and Connecticut Rivers. The general plant area was filled and graded from an initial elevation of about 12 ft mean sea level (MSL) to a final plant grade elevation of 21 ft MSL. At the back, or east side, of the plant, wooded slopes rise steeply above the perpendicular rock cut.

2.4.1.2 Hydrosphere

At the back or east side of the plant, wooded hillsides rise steeply above the near-vertical rock cut, while the Connecticut River acts as a barrier on the west side as well as at the southern end of the peninsula, approximately one mile from the plant. Stream flow past the site originates entirely within the Connecticut River Watershed, extending from the Canada-New Hampshire border to Long Island Sound. Most of the hydrological information has been compiled from existing reports. The watershed width tapers from about 40 miles in northern Connecticut to about six miles at the Sound.

The drainage divides are about 25 miles apart at the site. The river's source is 375 miles upstream, and the area drained upstream of the plant is approximately 10,900 square miles. The total Connecticut River drainage basin area is approximately 11,250 square miles.

Many dams have been constructed on the Connecticut River and its tributaries upstream from the plant site. The Quabbin Reservoir, located on a tributary of the Connecticut River about 90 miles upstream from the site, is the largest reservoir in the Connecticut River basin with 1,235,000 acre-feet of storage.

No public drinking water supplies are taken from the Connecticut River in the site area. All drinking water is obtained from wells or reservoirs on tributary streams. There are many private wells in the region that draw primarily upon groundwater rather than on springs or other surface sources. The closest non-domestic community supply well, is approximately three miles from the site. Industrial water use from the EOF wells is limited to supporting decommissioning activities.

regulation and by loss of channel storage, the 1936 flood would result in a peak discharge of about 206,100 cfs and a gage height of 23.5 ft at Bodkin Rock. Table 2.4-2 lists the drainage and storage characteristics of each principal Connecticut River basin reservoir.

Rains or spills on the ground surface eventually arrive at the river by overland flow or as ground-water movement at velocities from a few to several hundred feet per day. All areas are pitched to the river or discharge canal, precluding the need for an extensive storm drainage system. No changes since decommissioning have altered the drainage system for local runoff.

2.4.3.4 Probable Maximum Flood Flow

Connecticut River stream-flow data are available from the U.S. Geological Survey Station at Thompsonville, Connecticut. The Thompsonville records can provide principal information for statistical analyses of the average weekly, monthly and yearly discharge flows.

Upstream of the site, the Quabbin Reservoir is impounded by Windsor Dam and Goodnough Dike. The Corps of Engineers' report, dated November 29, 1978, concluded that the "Quabbin Spillway in combination with the auxiliary spillway at Windsor Dam are adequate in size to safely pass the test flood, calculated from the Probable Maximum Flood, without overtopping Windsor Dam or Goodnough Dike."

A technical evaluation report, dated August 25, 1983, prepared by Franklin Research Center for the Nuclear Regulatory Commission, identified the magnitude and timing of a postulated Quabbin Reservoir dambreak flood wave at the Haddam Neck Plant. The report concluded that a seismic (or other) event that induced failure of both Windsor Dam and Goodnough Dike could result in a peak flood wave reaching approximately 28 ft MSL at the Haddam Neck Plant, approximately 7 ft above plant grade. The time of arrival of flood water at plant grade (21 ft. MSL), was estimated to be approximately 16 hours, while the time of arrival of the maximum flood depth (28 ft. MSL) at the Haddam Neck Plant site was estimated to be approximately 37 hours from the initial time of failure of both earthworks at Quabbin Reservoir. The outflow hydrograph at the Haddam Neck site shows that the length of time the flood water would be above plant grade 21.0 ft MSL is approximately 68 hours (see Figure 2.4-1). This conclusion resulted from the modeling of an extreme flood scenario using failure of both water control structures (Windsor Dam and Goodnough Dike), rapid breach development, high antecedent moisture conditions, high tide on Long Island Sound, and a 10-year initial discharge in the Connecticut River. The choice of input parameters used to develop this conclusion was at all times conservative.

2.4.3.5 Water Level Determinations

The informational requirements for this subsection, with respect to the estimated peak PMF discharge to elevation using cross-section and profile data, are provided in Reference 2.4-1.

2.4.3.6 Coincident Wind Wave Activity

The Connecticut River contains a deepened channel adjacent to its west bank. The east bank of the river is relatively shallow. Waves originating well upstream of the site would be substantially dissipated by Haddam Island. The maximum fetch from this point to the site is relatively short. Wind-generated waves along this distance would be partially dissipated by the shallow area surrounding the east bank.

2.4.4 Potential Dam Failures, Seismically Induced

The Army Corps of Engineers report addressed to the Honorable Michael S. Dukakis, Governor of Massachusetts, dated November 29, 1978, discusses the low probability of a seismic event causing failure of either the Windsor Dam or the Goodnough Dike. The technical evaluation report referenced in Section 2.4.3.4 states that a Quabbin Reservoir dambreak flood wave due to a seismic (or other) event could result in a peak flood wave, approximately 7 ft. above plant grade.

2.4.4.1 Dam Failure Permutations

The postulated effects of both Goodnough Dike and Windsor Dam failure to the Haddam Neck site have been discussed (see Section 2.4.3.4).

2.4.4.2 Unsteady Flow Analysis of Potential Dam Failures

A technical evaluation report was prepared by the Franklin Research Center for the NRC on August 25, 1983, entitled "Quabbin Dam Failure Flooding Consequences for the Haddam Neck Plant." The analytical methods utilized for this report took into consideration the following conservative input parameters with respect to unsteady flow analysis of potential dam failures.

2.4.5 Probable Maximum Surge and Seiche Flooding

Hurricanes, surges, seiches, and tsunamis do not apply to this site per Reference 2.4-1.

2.4.6 Probable Maximum Tsunami Flooding

Probable maximum tsunami flooding does not apply to this site per Reference 2.4-1.

2.4.7 Ice Effects

Ice effects from the Connecticut River do not effect ISFSI operations.

2.4.8 Cooling Water Canals and Reservoirs

There are no cooling water canals or reservoirs at the site related to ISFSI operation.

2.4.9 Channel Diversions

There are no natural channel diversions that would have any effect on ISFSI. Existing uses of the river, including shipping, recreation boating, and sport and commercial fishing, make it unrealistic to consider diverting major portions of the river flow.

2.4.10 Flooding Protection Requirements

Flooding protection is no longer required as the ISFSI grade is above the design basis flood for the ISFSI.

2.4.11 Low Water Water Considerations - DELETED

2.4.12 Dispersion, Dilution and Travel Times of Accidental Releases of Liquid Effluents in Surface Water - DELETED

The Haddam Neck Plant provides an Annual Radioactive Effluent and Waste Disposal Report that provides actual plant effluent releases (see Reference 2.4-2).

2.4.13 Groundwater

2.4.13.1 Description of On-Site Use

Groundwater is used as a source of water supply for the ISFSI.

2.4.13.2 Sources

The present regional use is discussed in Section 2.4.1.2.

Groundwater conditions at the site were inferred from site inspections, samples of the borings and general knowledge of the area. These data were supplemented by exposed conditions during construction and pumping tests on the site from various wells. Pumping data were also available from the CANEL site. The groundwater conditions are approximately as follows:

The groundwater table general gradient slopes downward toward the river. Water in the saturated zone under the flood plain occurs as free groundwater or in a leaky aquifer between alluvium on top and bedrock below, or both. Groundwater on the hillsides occurs under a mixture of "perched" conditions and in minor quantities in cracks in the rocks. The unsaturated zone on the hillsides is relatively thin. The marshes can be fed from the groundwater table (when it rises), by sub-surface and overland runoff from the hill slopes, by tidal action and by the Salmon River at times of high discharge.

The top layer of the flood plain consists of low permeability fine sands and silts. The available boring data show fine sands to depths as great as 70 ft below ground surface and sand and gravel to depths as great as 100 ft (the deepest penetration thus far). CANEL site test borings show gravel outwash deposits between the surface layer of alluvium and the bedrock. CANEL pumping tests indicate permeabilities for the outwash deposits to be 3,000 to 4,000 gal per day per square foot.

2.4.13.3 Accident Effects

The Annual Radioactive Effluent and Waste Disposal Report (Reference 2.4-2) identifies the effluent pathways at the Haddam Neck site. The methods of a calculation for the maximum individual and population doses due to the release of radioactive liquid effluents are provided. This report states that, "At Connecticut Yankee, the algae, shellfish, drinking water and irrigated food pathways do not exist and thus only the other pathways are included in the totals given in Table 5.1."

2.4.13.4 Monitoring Requirements

There are no public drinking water supplies near the site. Actual dose rates are presented in the Haddam Neck Plant Annual Radioactive Effluent and Waste Disposal Report (Reference 2.4-2).

REFERENCES

2.4-1 Letter dated September 10, 1982, Docket No. 50-213, LS05-82- 09-035, "SEP Hydrology Topics II-3.A, II-3.B, II-3.B.1, II-3.C, and III-3.B," Haddam Neck Plant, TO: W.G. Counsil, Vice President Nuclear Engineering and Operations, CYAPCO, FROM: USNRC, NUSCo File No. 8236230024, Attached: Appendix A Technical Evaluation Report Hydrological Considerations (SEP Topics II-3.A, II-3.B, II-3.C, III-3.B).

2.4-2 Connecticut Yankee Atomic Power Co., Haddam Neck Plant, Annual Radioactive Effluent and Waste Disposal Report, dated May 1, 1997, Docket No. 50-213, License DPR-61, and subsequent revisions thereto.

TABLE 2.4-1

HISTORIC FLOODS AT BODKIN ROCK ON CONNECTICUT RIVER

Year	River Stage, Ft MSL	Flow, Cfs
1814	21.4	190,000
1848	20.8	180,000
1854	23.4	210,000
1860	20.8	180,000
1861	20.2	175,000
1927	20.3	175,000
1936 (March 21)	28.2	267,000
1938 (Sept. 23-24)	25.75	239,000
1955 (August 20)	20.44	177,000
1960 (April 7)	18.69	159,000
1984 (June 2)	21.27	186,000

Notes:

(1) Table based on unpublished data obtained from USGS Office, Hartford, Connecticut

(2) Records begun September 1947 by USGS

(3) Drainage area = 10,870 sq miles

(4) Bank full stage about 8 ft

TABLE 2.4-2

PRINCIPAL CONNECTICUT RIVER BASIN RESERVOIRS[(1)(2)]

RESERVOIR	DRAINAGE AREA (SQ MI)	STORAGE (ACRE-FT)
New Hampshire		
Connecticut Lakes	82	88,000
Lake Francis	170	99,300
Moore Reservoir	1,600	114,000
Mascoma Lake	182	24,400
Otter Brook	47	18,300
Surry Mountain	100	33,000
Vermont		
Ball Mountain	172	54,600
Lake Whittingham	184	116,000
North Bartland	220	71,800
North Springfield	158	50,500
Somerset Reservoir	30	57,400
Townsend	106 (net)	33,600
	278 (gross)	
Union Village	126	38,000
Massachusetts		
Barre Falls	55	24,000
Birch Hill	175	49,900
Cobble Mountain	46	77,900
Conant Brook	7.8	3,740
Littleville	52	32,400
Knightville	162	49,000
Otis Reservoir	17	17,900
Tully	50	22,000

TABLE 2.4-2

PRINCIPAL CONNECTICUT RIVER BASIN RESERVOIRS[1][2]

RESERVOIR	DRAINAGE AREA (SQ MI)	STORAGE (ACRE-FT)
Connecticut		
Barkhamstead Reservoir	54	93,000
Colebrook River	118	97,700
Nepaug Reservoir	32	28,500
Mad River	18	9,700
Sucker Brook	3.4	1,480
West Branch Reservoir	122	20,100
Total Storage:		1,326,220
Quabbin Reservoir	186	1,265,000

Data taken from:

(1) Hydrologic Engineering Input to Phase I of Connecticut River Supplemental Study, Hydrologic Engineering Section, Water Control Branch, New England Division, Corps of Engineers, Waltham, Mass. December 1973.

(2) Comprehensive Water and Related Land Resources Investigation - Connecticut River Basin, Appendix C, "A Report of Hydrology," Dept. of the Army, New England Division, Corps of Engineers, Waltham, Mass. June 1970.

TABLE 2.4-3A

HISTORICAL MINIMUM MONTHLY LOW WATER LEVEL
CANEL PIER (MIDDLE HADDAM), CONNECTICUT RIVER (1969-1981)

WY/MONTH[(1)]	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
OCT	-0.86	-1.09	-0.43	-0.31	-0.89	-0.50	-0.65	+0.26	-0.07	+0.62	-0.94	-0.27	-1.13
NOV	-0.05	+0.41	-0.25	-0.61	+0.20	-1.12	-0.14	+0.59	-0.54	+0.55	-0.52	-0.33	-1.15
DEC	-1.23	+0.04	-0.57	-1.24	-0.09	+0.01	-0.09	-0.27	-1.53	-0.39	-1.80[(2)]	-1.46	-1.54
JAN	-1.19	-0.69	-1.28	-0.99	+1.38	+0.03	-0.32	-0.58	-2.09[(2)]	-0.10	-0.71	-1.65	-1.64
FEB	-1.16	0.00	-1.10	-1.71	+0.30	+0.57	-0.59	+0.87	-1.60[(3)]	+0.12	-0.76	-1.17	-0.84
MAR	-0.36	-0.57	-0.44	-0.11	+0.40	+0.77	+0.11	+1.04	+0.52	-1.12	+0.69	-1.81	-0.11
APR	+1.29	+1.78	+0.79	+0.93	+1.64	+1.13	+0.87	+1.43	+1.25	+2.75	+2.37	+1.19	+0.16
MAY	+0.89	+0.45	+1.05	+0.49	+1.40	+1.28	+0.09	+1.11	-0.45	+0.38	-0.10	+0.60	-0.04
JUN	-0.13	-0.20	-0.36	+0.72	+0.41	+0.06	-0.29	-0.20	-0.19	+0.18	-0.61	-0.50	-0.24
JUL	-0.41	-0.65	-0.51	+0.54	-0.13	-0.15	-0.14	-0.30	-0.62	-0.39	-0.56	-0.57	-0.47
AUG	-0.21	-0.54	-0.50	-0.13	-0.32	-0.40	-0.44	-0.50	-0.48	-0.34	-0.40	-0.48	-0.33
SEP	-0.25	-0.58	-0.51	-0.41	-0.24	-0.14	-0.55	-0.25	-0.70	-0.27	-0.57	-1.00	-0.63

(1) WY 1969 - OCT. 1968 TO SEPT. 1969.
(2) OCCURRED TWO TIMES DURING MONTH.
(3) OCCURRED THREE TIMES DURING MONTH.

NOTE: UNDERLINED VALUES WOULD PRODUCE A RIVER LEVEL LESS THAN -2 FT MSL AT THE HADDAM NECK PLANT.

TABLE 2.4-3B

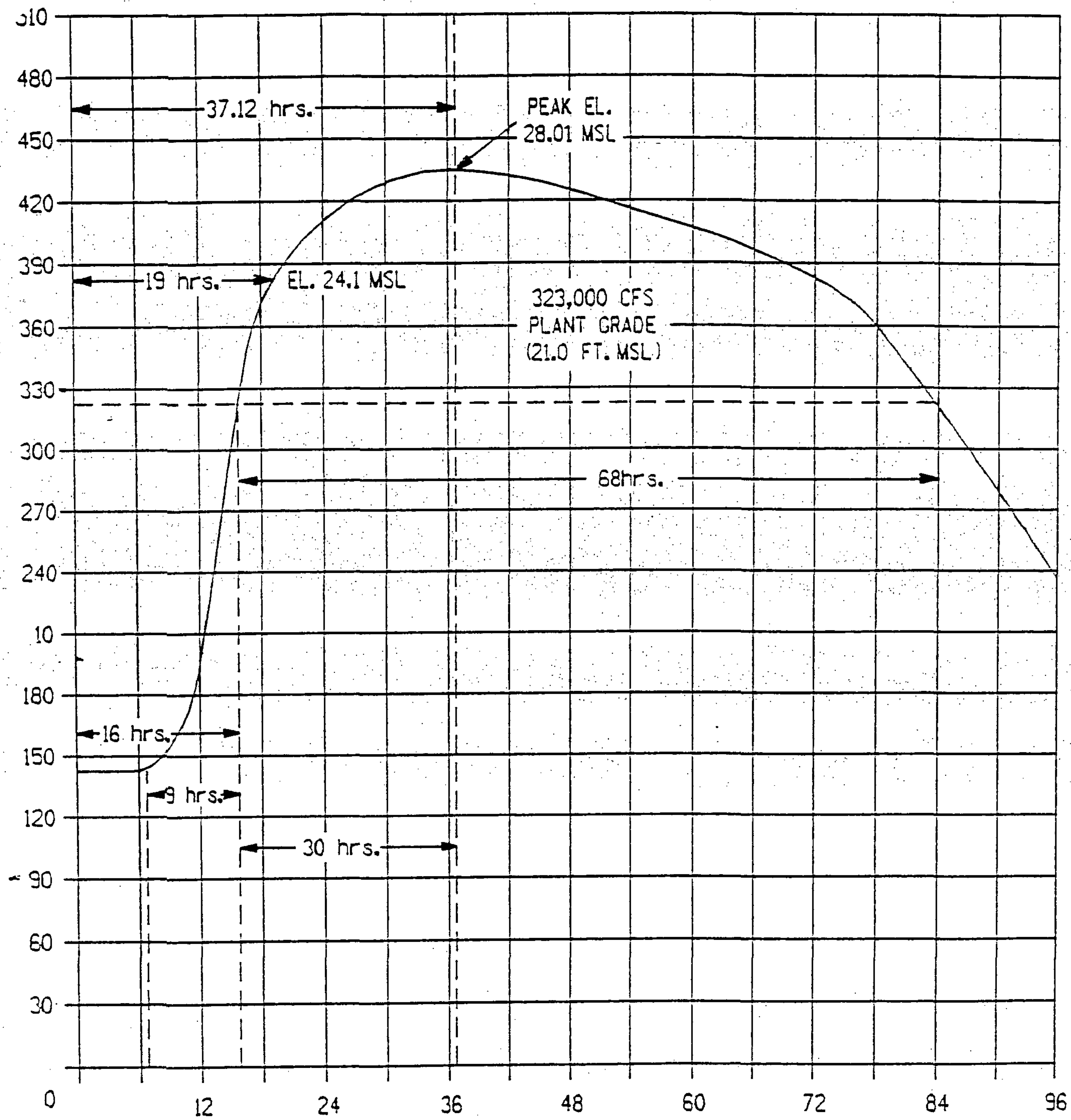
HISTORICAL MINIMUM MONTHLY LOW WATER LEVEL
CANEL PIER (MIDDLE HADDAM), CONNECTICUT RIVER (1982-1992)

WY/MONTH	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
OCT	-0.19	-0.65	-1.18	-0.47	-0.68	-0.17	-0.62	-0.76	-0.12	-0.50	0.22
NOV	-0.05	-1.21	-0.51	-0.71	0.42	-0.37	-0.24	-0.29	0.73	0.65	0.03
DEC	-0.65	-0.81	0.82	-1.08	-0.43	0.05	-0.30	-0.95	-0.61	0.29	0.18
JAN	-0.38	-0.56	-0.54	-1.31	-1.50	-0.72	-1.00	-1.49	-0.54	0.09	0.15
FEB	-0.69	0.22	-0.25	-2.02	0.28	-0.97	-0.64	-1.65	0.08	-0.18	-1.02
MAR	0.08	0.50	-0.38	-0.04	-1.63	-0.28	-1.00	-0.62	0.65	0.72	-0.35
APR	2.54	1.93	1.91	0.17	0.77	1.15	0.35	0.72[1]	1.28	0.97	1.13
MAY	0.17	1.51	1.18	0.08	-0.50	-0.15	0.49	0.69	0.88	-0.05	-0.17
JUN	0.48	-0.04	0.31	-0.39	0.07	-0.11	-0.41	0.23	0.12	-0.28	-0.10
JUL	-0.18[1]	-0.55	0.09	-0.40	-0.32	-0.26	-0.80[1]	-0.30	-0.37	-0.45	-0.14
AUG	-0.47	-0.27	-0.21	-0.31	-0.68	-0.59	-1.31	-0.08	-0.16	-0.45	-0.30
SEP	-0.55	-0.37	-0.83	-0.61	-1.42	-0.55	-0.43	-0.25	-0.34	-0.33	-0.44

[1]OCCURRED TWO TIMES DURING MONTH.

NOTE: UNDERLINED VALUES WOULD PRODUCE A RIVER LEVEL LESS THAN -2 FT MSL AT THE HADDAM NECK PLANT.

DAMBREAK HYDROGRAPH AT THE HADDAM NECK PLANT SITE AT RIVER MILE 80.3



DAM FAILURE FLOOD HYDROGRAPH AT HADDAM NECK PLANT

FIGURE 2.4-1 SH. 1

2.5 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

The information contained in this section is "Historical Information." Discussion of the former plant has been deleted. The Haddam Neck site is located in the general area designated as Cove Meadow on the United States Geological Survey, Deep River Quadrangle, Connecticut Sheet. It lies within a belt of metamorphic rock formations consisting of schists, gneisses and amphibolites. These formations strike in a north-south direction with local variations of 15° to 30° to the west and dip to the east at 65° to 75°. These rock types are exposed in outcrops on the high ground at the site.

Section 2.5.1 presents the regional and site area geology and geologic history. A discussion of regional faulting and tectonics and their relationship to rock types at the site is discussed in detail.

Section 2.5.2 presents the regional seismicity.

Section 2.5.3 describes the faulting encountered at the site during former plant construction. A description of the origin and nature of the faults mapped at final excavation grades is included in this section.

Section 2.5.4 presents the results of geotechnical investigations and studies related to the stability of subsurface materials and plant structures.

Section 2.5.5 presents the results of stability analyses on the one major slope at the site.

2.5.1 Basic Geologic and Seismic Information

The site lies on the eastern shore flood plain of the Connecticut River within the Piedmont Atlantic Coastal Province. Geologically, this province is characterized by a Precambrian basement overlain by early Paleozoic metamorphic rocks which are locally intruded by plutons of Paleozoic age.

The provinces located within 200 miles of the Haddam Neck site are listed in Section 2.5.2.2. The configuration of those provinces with respect to the Haddam Neck site and the locations of historical earthquakes are shown in Reference 2.5-1.

Excavations for the plant structures were not geologically mapped during construction. Original site geological information was developed from literature about the region and from results of borings taken at the site and at the CANEL site. Several major faults or fault systems have been recognized in the site region. No evidence has been found indicating a capable fault. Many of these faults have been recently identified and mapped during the NRC-sponsored New England Seismotectonic Research Program. This study began in 1978 and was completed in 1983 under the direction of the Weston Observatory of Boston College.

Seismicity within the Piedmont Atlantic Coastal Gravity Province is of moderate level. The seismicity of the immediate site region (50 km) is characterized as low to moderate. The majority of the events are in the III-IV Modified Mercalli (MM) scale intensity range with several earthquakes of Intensity V(MM) and one, that of May 16, 1791, with an Intensity VI-VII(MM). This earthquake, centered in the East Haddam-Moodus area of Connecticut, was originally categorized as an Intensity VIII(MM), but was reevaluated as an Intensity V-VI(MM) by Reverend Daniel Linehan, Director, Weston Geophysical Observatory. There has been a noticeable decrease in the frequency of earthquakes over the past 300 years. The area was depressed by the weight of ice during the Pleistocene period and is slowly rising following removal of this ice. Occasional minor earthquakes have been felt in the New England area and the most commonly accepted explanation of these is adjustment of the crust following removal of the ice of the Pleistocene period.

2.5.1.1 Regional Geology

The Haddam Neck site is in the Upland Section of the New England Physiographic Province. The Upland Section ranges in elevations from slightly above sea level in the river valleys near the coast to up to +1200 ft. mean sea level (MSL) near the mountain sections. A detailed geologic map of the site region is provided in Reference 2.5-2.

The New England Physiographic Province is a northern extension of the Appalachian Mountains which has been modified by glaciation. Bedrock is generally overlain by a few feet to a few hundred feet of glacial deposits.

The Haddam Neck Site is within the New England-Piedmont Tectonic Province. The New England-Piedmont Province is comprised of Precambrian and Paleozoic basement and sedimentary rocks that have been extensively folded, faulted, metamorphosed, and intruded by igneous rocks during successive episodes of orogenic activity. The New England-Piedmont Province in New England can be further subdivided based on geology into the Southeastern New England fold belt. The Southeastern New England Platform is separated from the rest of the New England-Piedmont Province in the site region by the Honey Hill-Lake Char thrust fault complexes. The boundary farther to the north and east is the Clinton-Newbury and Bloody Buff thrust fault systems.

The Southeastern New England Platform is composed of Precambrian granitic basement rocks, Silurian and Devonian volcanic and intrusive rocks, Cambro-Permian basin, an area of Late Paleozoic intrusive and metamorphic rocks, and the zone of mid-Paleozoic, post-metamorphic thrust faulting represented in the site region by the Honey Hill-Lake Char fault zones.

The Southeastern New England Platform has undergone relatively little structural deformation or metamorphic alteration since the Paleozoic (240 million years before present mybp). Known faulting is related to basin development during the Cambrian-Permian (570 to 240 mybp). These basins include the Narragansett, Boston, North Scituate, Woonsocket and Norfolk.

The White Mountain Plutonic series is an elongate, north-northwest oriented group of alkaline intrusives that extended from northeastern Massachusetts through New Hampshire. They were emplaced from Permian to Cretaceous. There was a spatial relationship between the zone defined by these intrusives, which represent the youngest significant deformation features in New England, and historic seismicity. The largest New England earthquakes occurred within this zone.

The New England fold belt of the New England-Piedmont Province consists of major northeast-southwest striking anticlinoria and synclinoria composed of metamorphic rocks and plutonic bodies. From the west in Vermont and western Massachusetts to the Atlantic Coast these major folds are: the Green Mountains - Sutton Mountain anticlinorium, the Connecticut Valley - Gaspe synclinorium, the Bronson Hill-Boundary Mountain anticlinorium, the Merrimack synclinorium, and the Coastal anticlinorium. The Haddam Neck site lies within the southern extremity of the Bronson Hill-Boundary Mountain anticlinorium, just north of where it is terminated by the Honey Hill fault system.

2.5.1.1.1 Capability of Faults in the Site Region

Many fault systems have been recognized in the site region. The regional faults that are most significant to the Haddam Neck site include the Connecticut Valley border fault, the Honey Hill fault system and the Bonemill Brook fault. Other regional geological features which probably represent faulting include the Higganum dike complex, the Salmon River photo linear, and the Connecticut River gravity anomaly.

The Connecticut Valley border fault forms the eastern boundary of the Connecticut Valley graben, or half graben. The border fault and graben were formed as a result of a continental rifting during the early and middle Mesozoic periods (240 to 138 mybp). There is no evidence that the fault has been active since that time. The border fault is about 10 miles (16 kilometers) northwest of the site.

The Honey Hill fault system is described as a zone of highly strained cataclastic rock tending from Chester, Connecticut to North Stonington, Connecticut, where it intersects the north striking Lake Char fault system. It has been active during several tectonic regimes from Devonian through at least Late Permian (410 to 240 mybp). During this time, sense of movement along the fault system changed from strike slip to dip slip (thrust). The thrust faulting is believed to be the result of the collision between a plate containing the Southeast New England Platform and the plate containing the New England fold belt, during which the former was thrust under the latter.

There is evidence of recent movement along the Honey Hill fault system. The evidence consisted of offset drillholes at highway rock cuts on Route 11 and Route 9, and along other artificial rock cuts. Based on a review of these offsets, it was concluded that movement is related to release of insitu stress in the rocks related to excavation, and not to active tectonic displacement on the faults. This conclusion is supported by: (1) the decrease in the magnitude of offset from the top of the rock face (nearer former ground surface, where there is less confinement) to the base of the cut (where constraint would be greater); (2) the presence of the offsets only in the rock remnant between the north lanes and south lanes of the highway where freedom to move would be greater; (3) a survey was made of wells around the area, and no evidence was found that the wells are affected; if relatively deep - most wells or all wells would have been cut; and (4) movements of recently excavated rock is a fairly common phenomenon in New England.

The Bonemill Brook fault is the closest major fault to the Haddam Neck site. It strikes in a north-south direction and is located about 1000 ft. east of the plant. It consists of weathered migmatite at the surface and has been mapped as a ductile fault zone.

During the New England seismotectonic studies, terraces along the Connecticut River were mapped to determine whether or not they had been affected by recent tectonic activity. Deformations were found but the most likely causes of these were interpreted to be non-tectonic phenomena such as slumping, landsliding, or frost-related disturbance. One such area mapped was a gravel pit excavated in terrace deposits that overlay the Bonemill Brook fault zone about 3/4 mile south-southeast of the plant site. The terrace deposits observed were mostly fine, clean, thinbedded sand with gravel, cobbles and boulders, and varved clay. Deformation features were mapped in this pit, but were interpreted as being most likely related to slump near the time of deposition or post-deposition. Based on all of the available evidence, it has been determined that Bonemill Brook fault zone is not a capable fault.

The Higganum dike complex extends from Long Island Sound, south of New Haven, Connecticut, on a strike ranging N15° to 65°E, to at least Worcester, Massachusetts. The closest approach of the dike system to the site is about 3 miles to the northwest. It consists of diabase of Triassic-Jurassic age. Because the dike system is the youngest rock in the area, it was mapped in detail in central Connecticut as part of the New England seismotectonic studies in an attempt to identify post-Mesozoic faulting. Columnar jointing is well-developed where the rocks of the dike complex are exposed, and the dike dips steeply to the north. Minor right lateral strike slip faults have been mapped associated with the dike complex in the site area, based on slickensides along a cooling joint plane that strikes N60°W. The slickensides plunge 40°SE. These features have been used to support the interpretation that northwest-southeast oriented maximum compressive stresses have been present in the region since the Triassic and Jurassic Periods.

Conclusions from the NRC-sponsored study of the Higganum dike complex indicated that a stress field having a principal axis of compression oriented in a north-northwest to south-southeast direction has affected south central Connecticut during the past 175 million years. This is consistent with the offset drillholes within the Honey Hill fault zone described above. It is suggested that such a stress field may be present today and may in some way be responsible for the seismicity in the Moodus area.

A prominent, relatively straight, photo linear is caused by the Salmon River valley, suggesting structural control. A gravity linear is also congruent with the topographic linear. Some mapping has been carried out along the Salmon River northeast of the site by investigators involved in the New England seismotectonic studies. Northwest and northeast striking joints have been identified that appear to correspond to angular bends in the river. A minor northwest striking fault was identified in the Hebron formation exposed in the south bank of the Salmon River about 3/4 mile southwest of highway Route 16.

At Leesville, on the southeast bank of the Salmon River, several hundred feet northeast of highway Route 151, a north striking, easterly dipping thrust fault is present in the Hebron gneiss. The rock east of the fault is relatively flat lying, but near the fault it becomes very contorted and dips steeply to the west. The exposure at this location is interpreted to be the west limb of a north striking anticline. The thrust fault is related to the west flank of the anticline. This location is about 1 mile north of the site.

No evidence has been found during the New England seismotectonic studies to indicate capable faulting. The Moodus area north of the plant has been the focus of moderate seismicity since long before European colonization. The Weston Observatory of Boston College, with Nuclear Regulatory Commission (NRC) funding, installed an earthquake monitoring network in this area. No activity was reported until August 1981 when approximately 350 shallow microearthquakes were recorded. The closest microearthquake to the plant was about 4km to the northeast. Some of these events were felt locally. Studies within a two-part report entitled Geological and Seismological Studies concluded that epicentral locations do not show a one to one correlation with any specific geologic structures.

This is attributed to the low earthquake magnitudes, the uncertainty of epicentral locations, and poor outcrop control due to extensive glacial cover. No evidence of capable faulting has been found and field mapping did not demonstrate the existence of the Salmon River fault being related between local structure and the shallow microearthquakes recorded in the Moodus area.

The Connecticut River gravity anomaly coincides with a strong Landsat and topographic lineament across Middle Haddam that continues down the Connecticut River to the south. A segment of this lineament where it apparently cuts off splays of the Honey Hill fault system is mapped at the Selden Neck fault. Several of the northernmost splays of the Honey Hill fault system, however, extend across the lineament and cut the Bonemill Brook fault farther to the west. As much as 1 kilometer of left lateral offset on the Selden Neck fault is suggested by the geologic data. The northwestern extension of the lineament apparently does not offset the Higganum dike complex. Therefore, if it is a deep-seated fault zone, as suggested by the presence of basic to ultrabasic dikes near the lineament, it is at least pre-Jurassic in age (more than 205 mybp). River terraces overlying the lineament along the Connecticut River in the site vicinity revealed no positive evidence of recent activity.

The Moodus area is characterized by the convergence of the structural trends described above: the Higganum dike, the Salmon River lineament, the Bonemill Brook fault zone, and a major north northwest gravity anomaly. It has been suggested that this intersection is concentrating the release of stress, and may account for the relatively high seismicity in the Moodus area. A detailed analysis was performed for the Moodus area with respect to the several recently recorded microearthquakes in August 1981; (see Reference 2.5-2).

Other minor faults that appear to be relatively common in the region are (1) low angle, both ductile and brittle, thrust faults; and (2) high angle brittle, normal faults that dip steeply in several directions, sometimes forming small grabens. Based on regional considerations, the thrust faults are interpreted to be Paleozoic in age (more than 240 mybp) and the high angle faults to be Triassic-Jurassic in age (240 mybp to 138 mybp).

The youngest tectonic features that have been mapped in the subregion around the site appear to be northwest to north-northeast joints and minor faults. This is based primarily on cross-cutting relationships of linear features and detailed mapping in specific areas. Where these features have been mapped in detail, their characteristics are compatible with a regional horizontal stress regime that is oriented in a north-south to northwest-southeast direction. Boring offsets taken on highway Route 11 are compatible with that stress pattern. It is likely that minor faults and joints similar to those observed and mapped in outcrop around the site area are also present in the bedrock beneath the plant. For more details regarding the regional geology within the site region, see Reference 2.5-2.

2.5.1.2 Site Geology

The Haddam Neck site is located in the town of Haddam on the eastern shore flood plain of the Connecticut River. Elevations on the site range from less than +10 ft. (MSL) to +20 ft. MSL on the flood plain. The topography rises steeply to the northeast. Elevations in the area vary from -30 ft MSL at the bottom of the river to more than +400 ft MSL atop some of the nearby hills and ridges. The flood plain on which the site is located is underlain by 10 to 20 ft. of bedded sands and gravels. The major structures of the plant are founded on bedrock; minor structures are on rock or piles driven to rock, or on spread footing on engineered granular backfill. The rock on which the plant is founded is granitic gneiss of the Middletown formation of Ordovician age (500 mybp to 435 mybp). About 1500 ft. east of the site are outcrops of schists and gneisses of the Hebron formation of Silurian age (435 to 410 mybp). Between these two lithologies is a north-south striking belt of weathered migmatite, several hundred feet wide, which has been mapped as a ductile fault zone, the Bonemill Brook fault.

The Haddam Neck site area, like the rest of New England, was covered with glacial ice until approximately 15,000 years ago. The glaciers deposited a thick layer of glacial till and, as they receded, left end moraine and outwash deposits. The site is underlain by the Monson gneiss and the Tatnic formation. In the site area, the Monson gneiss is a light grey biotite-quartz-plagioclase gneiss with local occurrences of hornblende bearing gneiss; the Tatnic formation is a biotite-muscovite schist.

A seismic survey performed by Weston Geophysical Engineers in 1962 determined the compressional wave velocity of the principal overburden to be 5,300 fps. The velocity of the bedrock, which is the foundation of the Haddam Neck Plant, is in the range of 11,000 to 14,000 fps. For more details regarding the site geology, see Reference 2.5-2.

2.5.1.2.1 Site Geological History

The following information was developed for the Millstone Nuclear Power Station Unit 3 FSAR, Section 2.5.1.2.5, but is representative of southeastern Connecticut to a reasonable degree. The Haddam Neck site is approximately 20 miles away from Millstone Point.

The geological history of southeastern Connecticut is obscured by the complex folding and metamorphism that the area has undergone. The Taconian, Acadian, and Alleghenian orogenies have affected the area to a varying extent (Reference 2.5-3).

The ages of the rocks present in the site area are still in doubt. The Monson gneiss, the New London gneiss, the Mamacoke formation, and the Plainfield formation are pre-Silurian in age, and most probably the rocks range in age from late Precambrian or Cambrian to Ordovician (Reference 2.5-4). The Brimfield schist, which lies unconformably beneath the Bolton Group, is similar to and can be traced into the Partridge formation and the Ammonoosuc volcanics of Middle Ordovician age (Reference 2.5-3). Two major plutonic rocks are present in the site area, the Sterling Plutonic Group and the Westerly Granite. The older Sterling Plutonic Group is believed to be Cambrian or older in southern Connecticut (Reference 2.5-3). However, the Sterling Group is younger than the Monson gneiss, so the Sterling may be Ordovician or younger. The youngest rock type present in the site area is the Westerly Granite, which is regarded as Permian (Reference 2.5-5). A granitic intrusion other than the Sterling Plutonic Group or Westerly Granite occurs in the Lyme dome. This nodular granite is believed to be older than the Westerly Granite and younger than the granitic intrusions of the Sterling Plutonic Group (Reference 2.5-6).

The origin of the oldest rocks found in the site area, the Plainfield and the Mamacoke formations, is obscure. These probably were originally quartz sandstone, limestone and dolostone, and shale (Reference 2.5-7). The age of these rocks is still questioned, although it is believed that the rocks are of Cambrian age (Reference 2.5-8). The remaining rocks in the site region with the exception of the Nodular and Westerly Granites are probably Ordovician in age.

The Monson and New London gneisses are believed to be metamorphosed andesitic and dacitic volcanics and associated intrusions (Reference 2.5-5). The present day Bronson Hill anticlinorium was the location of a series of volcanoes and islands which served as a source area for much of the middle Ordovician period.

The Sterling Plutonic Group is present throughout much of the site area. The youngest unit it intrudes is the Monson gneiss. The age of the Sterling Group is still questioned. Radiometric dates for contiguous granitic gneisses in southern Connecticut suggest a Cambrian or older age (Reference 2.5-3). However, the Monson gneiss, outside of the site area, has been dated as 472 (±15) million years ago (Reference 2.5-9) and radiometric work by Zartman et al. (Reference 2.5-10) implies that the Quinebaug formation, correlated with the Monson, is middle Ordovician. The Sterling gneisses seem to have been emplaced at fairly deep levels in the crust, for they are associated with migmatities and are intimately intermingled with and grade into some associated metasedimentary and metavolcanic gneisses (Reference 2.5-3). The Sterling Plutonic Group is widespread in Rhode Island, underlying most of the central portions of the state and considered to be late Precambrian or Cambrian in age.

Thus, the age relations are problematic and have not been resolved to date.

The Brimfield schist consisted originally of shale imbedded with minor amounts of quartz, sandstone, limestone, andesitic and basaltic pyroclastics, and manganese-bearing chert. The deposition of this pelitic unit represents a major change in the character of sedimentation, as volcanic rocks are of subordinate importance in the section above the base of the Brimfield and Tatnic Hill formations (Reference 2.5-11). The Brimfield and Tatnic Hill formations may have been deposited as geographically separate facies of a single statigraphic unit (Reference 2.5-11). The Brimfield schist is the youngest pre-Pennsylvanian rock found within the site area.

Much of the deformation that occurred in the site region has been attributed to the Acadian orogeny, which affected much of central and eastern New England. The initial states in the formation of the complex structure now observed are the north-south trending recumbent isoclinal folds (Monson anticline and Chester syncline) which were formed in response to east-west compression during early stages of post-Silurian metamorphism (Reference 2.5-11). Deformations continued with the development of the east-west trending anticlines and synclines, the Selden Neck dome and Hunts Brook syncline, respectively. Most of the major features of the map pattern in the rocks south of the Honey Hill fault are the combined results of the formation of the Lyme dome and antiform at Chester. This uplift deformed the Hunts Brook syncline, the Selden Neck dome, and the Honey Hill fault, resulting in the present structural configuration.

Metamorphism accompanied the structural development mentioned above. Metamorphism of all the rocks produced assemblages characteristic of the upper amphibolite facies (Reference 2.5-7). Lundgren believes the metamorphism took place when the rocks were deeply buried, probably at depths of 15 to 20 kilometers where the temperature was 550 to 650°C. Metamorphism presumably began during the Devonian period but may have continued into the Permian (Reference 2.5-11).

The Honey Hill faulting also was initiated during the Acadian orogeny as part of the eastward displacement of the recumbent Chester syncline. Movement along the Honey Hill fault is believed to be southeasterly, continuing beyond the period of peak metamorphism (Reference 2.5-13).

Lundgren and Ebblin proposed that the Honey Hill fault zone is related to the shearing between the Putnam Group and the underlying Ivoryton and Sterling Plutonic Groups during the folding and uplifts of the Acadian orogeny (Reference 2.5-14). Movement along the Honey Hill fault may have continued into the Permian period.

Following the highly active Acadian orogeny was a milder period of gentle folding, granitic intrusion, and localized thermal activity. The Alleghenian orogeny affected only the southeastern portion of New England, mainly Rhode Island and southeastern Connecticut. The main manifestation of the Alleghenian orogeny was the intrusion of the Narragansett Pier Granite and the Westerly Granite. The Pennsylvanian sediments of the Narragansett Basin of Rhode Island exhibit folding associated with this orogeny. The thermal activity is exhibited by a narrow band extending from southern Connecticut to southwestern Maine. These rocks yield potassium-argon dates of 230 to 260 million years ago. The actual cause of this disturbance is still questioned although it could be attributed to contact metamorphism related to contemporaneous igneous activity, alteration associated with major faulting, regional metamorphism in late Paleozoic time, or burial followed by uplift and erosion (Reference 2.5-15).

The most recently known expression of tectonic activity in the local area is faulting related to Triassic-Jurassic rifting. Small high angle faults and joints associated with the larger Triassic faults of the Triassic Basin are common in the Clinton quadrangle to the west (Reference 2.5-16) and in the Moodus and Colchester quadrangles to the north (Reference 2.5-17). Goldsmith (Reference 2.5-18) shows two small high-angle faults in the Uncasville quandrangle, which he believes to be related to the Triassic-Jurassic tectonics (Reference 2.5-19). Also associated with the Triassic-Jurassic periods are the deposits of arkosic clastic sediments in the Connecticut Basin, extrusive igneous activity, and related injection of basic dikes throughout southern New England. Hydrothermal activity, typically silicification, is commonly found along faults related to the Triassic-Jurassic tectonics. This hydrothermal activity is believed to represent the youngest known tectonically related event in southern New England (References 2.5-19, 2.5-20 and 2.5-21).

A recent study of dikes in southwestern Rhode Island and eastern Connecticut indicates that a few lamprophyre dikes may be as young as Cretaceous. Their relation to hydrothermal activity is not known.

Lundgren estimates an uplift of 15,000 to 20,000 ft. occurred between the Permian and late Triassic periods (Reference 2.5-7). A long, continuous period of erosion followed, shaping principal valleys, ridges, and hills, similar to those of today (Reference 2.5-22). Cretaceous and Tertiary sediments are present south of the site. The northernmost previous extent of these deposits is unknown. During Tertiary and Quaternary time, alternating periods of transgression and regression occurred along the coast of southern New England. The two major regressions took place during the Oligocene epoch and during the Pleistocene glaciation (Reference 2.5-23).

Evidence from outside the site area indicates that during the last million years or more, Connecticut was covered by continental glaciers at least twice, and possibly several times; however, evidence of only one glaciation is found locally (Reference 2.5-22). The ice at its maximum reached its outer limit along a line on, or south of, what is now Long Island and culminated approximately 18,000 years ago. Pollen studies and radiocarbon dates on samples taken in New London show that glaciation took place more than 13,000 years ago (References 2.5-24 and 2.5-25). The last deposition of till was approximately 18,000 years ago and ice covered the area until about 14,000 years ago. The cumulative effect of the glaciation was to smooth, round off, and widen some of the valleys and to remove most of the pre-existing regolith (Reference 2.5-22).

The site area is covered with glacial till, end moraine deposits, and outwash sands. The end moraines are common across Rhode Island and southern Connecticut. They were deposited when the recession of the glacial margin slowed or stopped for some period (Reference 2.5-22). A detailed discussion of the regional geologic history can be found in Section 2.5.1.1.5 of the Millstone Nuclear Power Station Unit 3 FSAR.

2.5.1.2.2 Site Area Geological Summary

The two-part report entitled Geological and Seismological Studies, Haddam Neck Nuclear Station (Reference 2.5-2), verified that there are no capable faults or unique geologic features that would indicate that the site is inadequate or needs special modifications. Both NRC-funded contractors and the utilities have not found evidence that demonstrates fault movement in the recent geologic past. Therefore, there is no reason to change past conclusions regarding the seismic and geologic safety of the site.

2.5.2 Vibratory Ground Motion

The seismicity of the immediate site region can be characterized as low to moderate. The majority of the events are in the III-IV(MM) intensity range with several earthquakes of Intensity V(MM), and one, that of May 16, 1791, with an Intensity VI-VII(MM). This earthquake centered in the East Haddam-Moodus area of Connecticut. The earthquake was originally categorized as an Intensity VIII(MM), but was reevaluated as an Intensity V-VI(MM). For purposes of conservatism, it is currently retained in our database as an Intensity VI-VII(MM). Table 2.5-1 lists the Intensity VII(MM) earthquakes which have occurred within the Piedmont Atlantic Coastal Province. The site lies in the Piedmont Atlantic Gravity Province. During the past 300 years there has been a noticeable decrease in the frequency of earthquakes. The maximum ground motion potential at the Haddam Neck site is specified to be an Intensity VIII(MM), resulting from the maximum historical earthquake known for the site (at a local distance of 15 km).

2.5.2.1 Seismicity

The seismic history of the site area is given in Table 2.5-2, which lists all recorded earthquakes with intensities of 5 or greater (Rossi-Forel Scale) with epicenters in Connecticut.

The most severe recorded earthquake occurred in May, 1791. This earthquake was reported to have caused stone walls to be shaken down, tops to be thrown off chimneys and latched doors to be thrown open. As indicated in Table 2.5-2, four other earthquakes, apparently less intense, followed in the relatively short period ending in 1805. These five earthquakes were the most recent to be centered at East Haddam.

Between 1682 and 1977, 81 events have been catalogued for the area between 72°W and 73°W, 41°N and 42°N. These events constitute a diffuse cluster of small activity around a single layer event. Due to poor resolution of all locations, one to one correlation of any events with particular geologic structures, is not advisable. This seismicity pattern is typical of New England.

The number of seismographic stations has greatly increased in recent times. At present, Weston Observatory of Boston College, Lamont-Doherty Geological Observatory of Columbia University, Massachusetts Institute of Technology, University of Connecticut, Pennsylvania State University, and Delaware Geological Survey operate seismographic stations in the northeast and coordinate the publication of the Northeastern United States Seismic Network (NEUSSN) bulletin. Historical reports of earthquakes and information obtained from instrumental coverage in recent years form the basis of this examination of the seismicity of the site region.

Even though major historical catalogs carry entries dating back almost three centuries, the coverage of this period is not continuous. The completeness and reliability of the data are related to population distribution and more recently to the seismograph network coverage. Therefore, accuracy of epicentral coordinates and the assigned maximum intensities must be evaluated. The level of seismicity near the Haddam Neck site is well illustrated in Figures 15 and 16 of Reference 2.5-2, Part I, which displays all cataloged earthquakes that have occurred prior to and after January 1, 1935, within the large portion of New England contained between latitudes 40°N and 43°N and longitudes 70°W and 74°W. A detailed seismicity evaluation is also provided in Reference 2.5-2.

For the earlier historical events, epicenters were located closer to population centers due to the absence of reports from the true epicentral area. The intensity of an earthquake at a given location depends not only on accurate and complete human observations, but also on foundation conditions, design type, and quality of building construction. Construction practices, particularly of chimneys in the earlier centuries, were certainly not those envisioned in the MM scale. Interpretation of historical damage reports, without consideration of construction practices or subsurface conditions, may result in erroneously high intensities.

Approximately 75% of the events in the site region are historical with epicentral locations estimated from felt reports, resulting in a large location uncertainty. The epicentral coordinates of the May 16, 1791, event (41.5°N, 72.5°W) have also been determined in this manner. Because it is the largest event in the site area and one of the earliest, its coordinates have been assigned to numerous subsequent events reported in the East Haddam-Moodus area. In a similar manner, coordinates of reporting towns have been assigned as the epicentral locations of other earthquake tremors which were not widely felt.

Assuming 1935 as a starting point for the instrumental era in New England, numerous events located instrumentally were reexamined, in order to estimate their epicentral uncertainty. Instrumental data were also compared with available felt reports. In general, there is agreement between the two data sets, but the location uncertainty is still variable, between 5 and 25 km. The epicentral locations obtained for small events after 1968 show some activity in the area centered around 41.5°N and 72.5°W, the East Haddam-Moodus area of Connecticut. Reference 2.5-2, Part II, contains a detailed discussion on the recent microseismicity in the Moodus area.

Earthquakes with epicentral intensities greater than III (MM) or with magnitudes greater than 3.0, located within 200 miles of the Haddam Neck site, are listed in Reference 2.5-1. The earthquakes listed in Reference 2.5-1 show that the site is located in an area of low to moderate seismicity.

The cumulative historical seismicity data reveal the presence of several distinct areas of concentrated seismic activity. They are: Moodus, Connecticut; Narragansett Bay, Rhode Island; Cape Ann, Massachusetts; the area around Ossipee, New Hampshire; northern New York; southeastern New York; northeastern New Jersey; and the Hudson River Valley.

Table 2.5-2 lists all major recorded earthquakes with intensities of 5 or greater (Rossi-Forel scale) with epicenters in Connecticut. This table provides latitude and longitude coordinates which can be used to plot the epicenter location of each of these events. The majority of the earthquake epicenters listed on Table 2.5-2 are within 50 miles of the site.

There have been 50 earthquakes of intensity greater than or equal to Intensity IV (MM). Almost half of this earthquake activity has occurred in the Moodus-East Haddam area. A temporary microearthquake network (five stations) was installed in this area by Professor E. Chiburis of Weston Observatory to examine the nature and significance of this activity.

Large earthquakes have occurred in the Moodus area in 1568, with epicentral Intensity VII (MM)J, and on May 16, 1791, with Intensity VI-VII (MM). The earthquake of May 16, 1791, was felt over an area of 35,000 square miles extending from Boston to New York. Several aftershocks were reported for the next few days.

Since 1791, at least 40 earthquakes have been lightly felt in the East Haddam-Moodus area. A moderate earthquake took place in the same epicentral area on November 14, 1925 and, although it reportedly did some minor damage at Hartford and Windham, it was not strong enough to be recorded on seismographs in Cambridge, Massachusetts, or New York City. A discussion with respect to the comparison of hydrology and historical seismicity and hydrology and microseismicity in the Moodus area is provided in Part II of Reference 2.5-2, Sections 2.8.3 and 2.8.4, respectively.

2.5.2.2 Geologic Structures and Tectonic Activity

Provinces located within 200 miles of the Haddam Neck site include the following:

1. Piedmont Atlantic Coastal Gravity Province (site province);
2. Southeast New England Platform;
3. Western New England Fold Belt;
4. Northeast Massachusetts Thrust Fault Complex;
5. Coastal Anticlinorium;
6. Merrimack Synclinorium;
7. Adirondack Uplift;
8. Eastern Stable Platform;
9. Appalachian Plateau;
10. Valley and Ridge.

Discussion will be limited to a review of the tectonics and seismicity of the first four provinces listed above. Due to their proximity and their level of seismicity, these four provinces have the greatest impact on the estimation of the ground motion potential at the site.

Earthquakes with epicentral intensities greater than III (MM) or with magnitudes greater than 3.0, located within 200 miles of the site, are tabulated in Appendix A of Reference 2.5-1.

Piedmont Atlantic Coastal Gravity Province - Site Province

Seismicity within the Piedmont Atlantic Coastal Gravity Province is of a moderate level. The maximum intensity associated with historical earthquakes is VII(MM).

The seismicity of the immediate site region (50 km) is characterized as low to moderate. The majority of the events are in the III-IV(MM) intensity range with several earthquakes of Intensity V(MM) and one, that of May 16, 1791, with an Intensity VI-VII(MM).

Geologically, this province is characterized by a Precambrian basement overlain by Early Paleozoic metamorphic rocks which are locally intruded by plutons of Paleozoic age. The province is characterized by basement rocks which are deformed into a northeast-trending fabric resulting in a northeast-trending gravity high. Within the area of Paleozoic metamorphic rocks, structural basins of Triassic age occur from New Jersey to Georgia. A residual mantle of weathered rock exists throughout the province.

The boundary of the province is clearly defined on the west by folds of the Valley and Ridge Province north of the James River, and by the thrust faults of the Southern Appalachian Province south of the James River. To the east, the province continues under a blanket of coastal plain sediments. The southern boundary of the province is outside the area of this study and has not been investigated in detail. Because of the thick sequence of rocks overlying the crystalline basement in this province, the regional gravity data (due in part to the basement rock) contribute significantly to the eastern and northern boundaries. The gravity data generally correlate with and support the known regional geology.

Southeast New England Platform

Seismically, this province is characterized by generally low and scattered activity (Figure 1 of Reference 2.5-1); the largest historical intensity is V-VI(MM) which is associated with the August 8, 1847, event. Nonetheless, because the 1791 East Haddam event, which occurred in the adjacent Piedmont Atlantic Coastal Gravity Province, is so close to the province boundary, the Intensity VI-VII(MM) associated with this event is conservatively accepted as the historical maximum.

The Southeast New England Platform lies south of the North Border fault of the Boston Basin and largely consists of Late Precambrian-Early Paleozoic granitic basement, with supracrustal basins containing continental sedimentary rocks (with minor interbedded volcanic units) ranging in age from older Paleozoic in the Boston Basin to Carboniferous in the Narragansett and neighboring basins of Rhode Island and southeastern Massachusetts. The Platform is slightly deformed and does not have evidence of Acadian orogenic deformation. In the Boston Basin, the sedimentary rocks have been folded and thrust-faulted from the south, with apparently thin-skinned tectonic deformation. In the southwestern part of the Narragansett Basin, in southeastern Rhode Island, deformation of the

Carboniferous sedimentary rocks includes folding, metamorphism, and two episodes of east-west thrusting during the Paleozoic. In eastern Connecticut, the Precambrian rocks of the Southeast New England Platform underlie a thin cover of pre-Silurian rocks beneath the Lake Char and Honey Hill fault surfaces. Most of the Platform rocks have been affected by an Alleghenian thermal or metamorphic event, locally including granitic plutonism. The Platform has not, however, been deformed internally by through-going crustal fault structures.

The basement offshore to the south, in the area of the Long Island Shelf, slopes to the south and is blanketed by a seaward-thickening wedge of loosely consolidated Coastal Plain sediments of Cretaceous and Tertiary age. The basement of the Southeast New England Platform extends roughly 100 kilometers south of the southern New England shoreline. The southwestern boundary of the province continues under Long Island where it is defined as the eastern edge of a distinct gravity high.

Western New England Fold Belt Province

This province is defined as a separate seismotectonic province on the basis of geologic structure, geophysical signature, and a relative lack of seismic activity. Seismically, the province is characterized by a low level of infrequent activity (Figure 1 of Reference 2.5-1). Intensity V(MM) is representative of the historical upper limit of this province, even though two earthquakes of Intensity VI (MM) have occurred within the province. The first is the Quebec-Maine border event of June 15, 1973, associated with a seismotectonic structure, the Megantic intrusives of southeastern Quebec, one of the mafic intrusives of the White Mountain Plutonic Series. The second one, although listed as Intensity VI(MM), must be characterized by a much lower value. This earthquake, which occurred on January 30, 1952, near Burlington, Vermont, had an extremely small felt area (50 square miles). Such a small perceptible area is certainly not typical of events characterized by an Intensity VI(MM). The probability is that this event was caused by freezing conditions as cracks were noted in the frozen ground near the Winooski River. The occurrence of cryoseisms in New England is well known; these are very small events and have no effect on the selection of design earthquakes for a tectonic province.

The geologic structures which define the province are large-scale, north-northeast-trending thrust faults and folds of Paleozoic age. Geophysically, the province is characterized in part by a pronounced north-trending gravity high in its axial region.

The eastern boundary of the Western New England Fold Belt is defined as the eastern termination of the north-south structures associated with the Bronson Hill Anticlinorium. The western boundary is placed along the limit of Paleozoic overthrusts which have been termed Logan's line or Logan's structure. On the south, the province boundary is generally located along the western edge of a pronounced gravity high associated with the Piedmont Atlantic Coastal Gravity Province where the structural features, as well as the seismicity, appear to change. The northern boundary of the province in eastern Quebec lies north of the study area.

Northeast Massachusetts Thrust Fault Complex

Seismically, this province is characterized by a distinctive pattern of activity (Figure 1 of Reference 2.5-1) which suggests that any seismic event would tend to migrate along the trend of well-defined geologic structures. The largest earthquakes in the province (Intensity VIII (MM)) have been located where these northeast trends are disrupted, for example at the mafic pluton of the White Mountain series of intrusives which is nearly in the middle of the off-shore continuation of the province.

The Northeast Massachusetts Thrust Fault Complex is readily distinguished from neighboring provinces by its high frequency of post-Acadian faulting. The complex is bounded on the northwest by the Clinton-Newbury fault, dated at Middle Permian, and is delineated on the southwest by the North Border fault of the Boston Basin. The complex narrows and ends in a southwesterly direction based on both geologic data and geophysical (aeromagnetic) signature; it can be projected for tens of miles to the east on the basis of aeromagnetic patterns. The predominant pattern of deformation in the Complex is moderately to steeply northwest-dipping thrust faulting, commonly with right-lateral, west-over-east displacements. The Complex is a superimposed tectonic structural feature which exhibits extreme mechanical deformation of rocks both of coastal anticlinorium affinities to the south. The boundary between these two distinctive terrains is the Bloody Bluff fault system, the principal deep crustal fault of the complex.

2.5.2.3 Correlation of Earthquake Activity with Geologic Structures or Tectonic Provinces

The relationship between earthquake locations and geologic structures is important in assessing earthquake hazard for a particular site. The absence of major spatial displacements through historical times that might be associated with tectonic activity in Eastern United States (EUS) makes the association of larger historical earthquakes with specific structures difficult. Only during the past 10 to 15 years have seismologists been able to determine earthquake locations with sufficient precision to relate them to geologic structures.

Correlation with Geologic Structures

White Mountain Plutons

The majority of the significant seismic activity in New England has been associated with the White Mountain plutonic seismotectonic structure within the Western New England Fold Belt Province. The strong concentration of events in southern New Hampshire and northeastern Massachusetts has been spatially associated with plutons of the White Mountains. A detailed investigation of the White Mountains plutons has indicated that the Ossipee, New Hampshire, earthquakes and the Cape Ann earthquake are associated with the plutons (Reference 2.5-26). The largest activity was located off Cape Ann in 1755. It was assigned Intensity VIII (MM). Also, there have been a number of Intensity VII (MM) events, two in Ossipee, New Hampshire in December 1940, and another located off Cape Ann in 1727.

Ramapo Fault

The Ramapo fault system, which bounds the Triassic-Jurassic Newark graben on its northwest side in northeastern New Jersey and southeastern New York, has been known for about 100 years and has been commonly presumed to be an inactive fault. Aggarwal and Sykes (Reference 2.5-27) observed a spatial correlation of some epicenters in southeastern New York with surface traces of faults in the area. A large majority of events lie on or very close (0.5 to 1.2 miles) to the faults. Furthermore, an examination of focal mechanism solutions shows that for each of the solutions, one of the nodal planes trends north to northeast, which is also the predominant trend of the faults in this area. The spatial correlation of one nodal plane with the trend of the mapped faults suggests that earthquakes in this area occur along pre-existing faults.

Considering both geology and seismicity, the Ramapo fault is not considered capable in accordance with the criteria for capable faults in 10 CFR 100, Appendix A. This was established by the Atomic Safety and Licensing Board (ASLB) in 1977, after extensive hearings on the issue.

Correlation with Tectonic Provinces

As most earthquake activity in the site region cannot be correlated with geologic structures, it is assumed (in accordance with 10 CFR 100, Appendix A) that these earthquakes are associated with the tectonic provinces in which they occur. A discussion of earthquake activity in various tectonic provinces is provided in Section 2.5.2.2.

2.5.2.4 Maximum Earthquake Potential

The "tectonic province" approach, as defined by the NRC in Appendix A of 10 CFR 100, is the current method for determining the maximum ground motion potential at an EUS site. The evaluation of the seismic ground motion potential at the Haddam Neck site is based upon this definition of the tectonic framework (Section 2.5.2.2).

The maximum ground motions at the site, in terms of Modified Mercalli intensities, were computed using an attenuation model appropriate for the EUS. Equation 1, which is formulated on observed MM intensity attenuation for Central United States earthquakes was used in this analysis.

$$I(R) = I_o + 3.7 - 0.0011R - 2.7 \log R \quad (R \geq 20\text{km}) \qquad (1)$$

Table 2.5-3 lists the parameters of the largest earthquakes (Intensity VII (MM) and above, located in the northeast, the distances of these events to the site, and the estimated site intensities as computed from Equation 1.

Equation 1 is formulated on intensity data observed at a variety of foundation conditions, most of which are soil sites that have experienced various degrees of local amplification, due to the impedance contrast between soil layers and the underlying baserock. Because of the manner in which Equation 1 was formulated, the predicted intensities at distance are best estimates at average foundation conditions, e.g., at sites overlain by some thickness of soils. The intensity observed on sound foundations, e.g., rock foundation, as in the case of the Haddam Neck site, is lower than the values predicted by Equation 1, since local soil amplification is not a factor at a rock site.

The information in Table 2.5-3 indicates that the maximum intensity on average foundation conditions in the immediate vicinity of the Haddam Neck site is Intensity VI-VIII(MM). On the basis of the previous discussion, the intensity at the rock foundation at the site would be lower than Intensity VI-VII (MM).

The worst case scenario for effects at the site from hypothetical events located in adjacent provinces is associated with an Intensity VIII (MM) earthquake located 100 km from the site at the southwest corner of the Northeast Massachusetts Thrust Fault Complex. The Haddam Neck site intensity for this hypothetical event, using Equation 1, is Intensity VI(MM).

On the basis of the site intensities listed in Table 2.5-3 and also on a review of the effects associated with hypothetical events located in adjacent provinces, the maximum ground motion potential at the Haddam Neck site is specified to be an Intensity VII (MM) at the site, resulting from the maximum historical earthquake known for the site province occurring at the site (at a focal distance of 15 km).

The largest earthquakes in the site province have magnitudes lower than 5.0 m_b (m_b = body wave magnitude). The historical occurrence of earthquake activity near the Haddam Neck site warrants some conservatism in the selection of the design earthquake magnitude. For this reason the mean magnitude for the maximum earthquake potential is designated to be 5.3 m_b.

The mean magnitude for the maximum earthquake potential was calculated using the following body wave magnitude-intensity relation for earthquakes occurring in the Central United States:

$$I_o = 2.0\ m_b - 3.5 \qquad (2)$$

or conversely

$$m_b = 0.5\ I_o + 1.75 \qquad (3)$$

Using Equation 3, an epicentral Intensity VII earthquake is converted to a magnitude 5.25, or rounded to 5.3 m_b.

Next, the magnitudes of the largest recorded earthquakes (Intensity VII (MM) events) in the site province, were computed from total felt areas, A_f, using Equation 4:

$$m_{bLg} = 3.25 - 0.25 \log A_f + 0.098 (\log A_f)^2 \qquad (4)$$

where A_f = total felt area in square km

Table 2.5-1 lists the computed magnitudes for the Intensity VII (MM) earthquakes within the Piedmont Atlantic Coastal Gravity Province.

For statistical analysis of spectral ordinates and definition of the density function of ground motion, the following criteria are defined as a range of magnitudes and distances for these events:

Magnitude Range (m_b)	Focal Distance Range (km)
5.3 ($\pm$0.5)	15 ($\pm$10)

Only accelerograms recorded on foundation conditions approximating the local site geology at Haddam Neck are accepted in the development of the site response spectrum.

Since the maximum earthquake is located near the site, parameters such as fault orientation and mechanism could have significant effect on ground motions. No formal treatment is attempted to account for these effects. The manner in which all of the unknown parameters are accommodated is through the choice of a conservative estimation of earthquake magnitude.

2.5.2.5 Seismic Wave Transmission Characteristics of the Site

Properties of subsurface materials at the site are discussed in detail in Section 2.5.4. A seismic survey determined the compressional wave velocity of the principal overburden to be 5300 fps. The velocity of the bedrock, which is in the range of 11,000 to 14,000 fps, indicates a rather competent rock. The shear wave velocity of the bedrock is estimated to be in the range of 5,000 to 7,000 fps. The groundwater conditions at the site are discussed in Section 2.4.13.

2.5.2.6 Safe Shutdown Earthquake

The SSE is that earthquake which is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material.

As discussed in Sections 2.5.2 and 2.5.2.4, the maximum earthquake potential at the site is an Intensity VII (MM) occurring 15 km from the site. Weston Geophysical Corporation has generated response spectra defining the maximum earthquake potential (SSE) for the Haddam Neck site. The research conducted by Weston Geophysical concluded that original seismic design of the Haddam Neck Plant is adequate and conservative. For more details on the basis for this determination, see Attachment 3, Section 4.3 and 5.0, of the Summary of Seismic Reevaluation Program for the Haddam Neck Plant prepared by Weston Geophysical Corporation for Northeast Utilities Service Company, (NUSCO) July 1980.

2.5.2.7 Operating Basis Earthquake – Deleted

2.5.3 Surface Faulting

A detailed description of the major fault systems within the site region is provided in Section 2.5.1.1.1. In summary, per recent geological and seismological studies for the Haddam Neck site, no capable faults or unique geologic features have been discovered that would indicate that the site is inadequate or needs special modifications. Reference 2.5-2 provides another description with respect to the major faulting systems in the Haddam Neck site region.

2.5.4 Stability of Subsurface Materials and Foundations

The stability of the soil and rock underlying the Haddam Neck site was evaluated using the results of detailed field investigations prior to construction. A discussion with respect to the stability of the soils and rock, and the ability of these materials to perform their support function without incurring unexpected or excessive subsidence and settlement due to their long-term consolidation under load or to their response to natural phenomena, is provided in the following sections.

2.5.4.1 Geologic Features

The Haddam Neck Plant is located in the general area designated as Cove Meadow on the United States Geological Survey, Deep River Quadrangle, Connecticut Sheet. It lies within a belt of metamorphic rock formations consisting of schists, gneisses and amphibolites. These formations strike in a north-south direction with local variations of 15° to 30° to the west and dip to the east at 65° to 75°. These rock types are exposed in outcrops on the high ground at the site. A series of bands of mica schists was found to run across the southern sector of the site. Since these bands are softer than the gneiss, the shearing distortions due to folding and movement of rocks in the geologic past have developed open joint planes and small faults which have resulted in deep weathering of the schists.

Unweathered rock was discovered at depths ranging from 10 to 100 ft below the ground surface. In the northern sector of the site, a broad bank of granitic gneiss substantially covers an area outlined by outcrops. The gneiss is coarsely crystalline. It is considerably stronger and more resistant to weathering than the mica schists. Consequently, this area presents a comparatively uniform rock stratum upon which the plant is located. The bedrock extends from above the original ground level at the outcrops to about 10 to 20 ft. below ground level over most of this area. At the most northerly end and at the river's edge, the rock is 30 to 50 ft. below ground surface. The overburden was excavated, thus permitting thorough examination and removal of weathered or excess rock material. Such a method of founding is extremely safe and stable.

In general, the soils overlying the bedrock consist of interbedded sands and gravels, some of which contain moderate amounts of silt. These materials vary appreciably in density, as indicated by the variation in number of blows on the standard penetration test. There are several small back swamps behind the natural river levees. Soils of these swamps consist of about 3 to 5 ft of highly compressible organic silty sands.

2.5.4.2 Properties of Subsurface Materials

Detailed information on the soil and rock engineering properties is not available. The field seismic survey, discussed in Reference 2.5-28, indicates that the bedrock is sound.

2.5.4.3 Exploration

An extensive and carefully coordinated program of seismic exploration and borings, carried to and into the rock, was developed. All borings were carried to refusal at the rock surface and a number of them were carried into the rock by diamond core drilling.

Twenty-six borings were drilled at the site to determine the extent of the Monson gneiss formation, the bedrock conditions on its flanks, and the soil conditions. The overburden consists chiefly of river alluvial sands, silts, and gravel deposits. Glacial tills, expected in this area, were not found on the site. Rock weathering can be observed in the outcrops, especially along zones where joints or shear zones have created openings in the schistose rock.

In order to assess the stability of the overburden on this slope and its impact on the plant, slope stability analyses were performed to determine the most critical slope failure configuration under both static and pseudostatic earthquake loading conditions. The commercially available computer program, MCAUTO's "Slope" program, was utilized to perform the analysis. The details of this analysis are provided in Section 2.5.5.2.

2.5.5.1 Slope Characteristics

On the northeast side, one major slope exists. The toe of the slope runs parallel to the Connecticut River along the back (east) side of the plant by the station yard crane and continues to the north and south. At the toe of the slope, a vertical rock cut rises approximately 10 to 20 ft. A wooded hillside continues from the top of this cut to approximately elevation 330 ft. above sea level, roughly 2600 ft. back from the plant.

Although the subsurface exploratory program at the plant site consisted of a seismic survey and a test boring program (Reference 2.5-31) of twenty-six borings drilled at the site to determine the extent of the Monson gneiss formation, the bedrock conditions on its flanks, and the plant soil conditions, no boring was drilled at the slope in question. A seismic refraction survey line about 200 ft. in length was, however, performed along the slope and this survey indicates that the overburden has a thickness varying from 10 to 20 ft. with the bedrock surface dipping toward the plant at an angle of 1 vertical to 3 horizontal (Reference 2.5-32). Rock weathering can be observed in the outcrops and along zones where joints or shear zones have created openings in the schistose rock. Based on geologic investigation (Reference 2.5-31), the unweathered rock is similar to that found in the plant area which has measured compressional wave velocities ranging from 11,000 to 14,000 fps.

The overburden along the slope, based on extrapolation from plant boring information and field observation of the ground surface conducted on May 18, 1982, probably consists of glacial till and, locally, outwash gravels. Regrading of the overburden along the edge of the rock cut and local depressions in the overburden on the slope due to sloughing of the overburden were noticed. Dumped rocks were placed locally on the slope to minimize erosion and further sloughing along the slope. At the west end of the slope, near the warehouse, a retaining wall was built at the toe of the slope probably to reduce the sloughing of the overburden over the cut slope. These maintenance measures were performed during plant operation.

Since there was no information on the engineering properties of the soil along the concerned slope, assumptions were made about the soil properties. The material properties used in the slope stability analysis (MCAUTO's "Slope" program) are tabulated below:

Soil Layer No	Soil Type	Thickness Below Top of Slope ft.	Total Unit Weight, pcf	Cohesion c (psf)	Angle of Internal Friction 0 (deg)
1.	Till with outwash gravel	2-20	110	250	0
2.	Schistose rock	N/A	N/A	N/A	N/A

NOTE: 1) Groundwater level was assumed at surface of the bedrock.

2) Earthquake load used equal to the SSE, 0.17 g for the site

2.5.5.2 Design Criteria and Analyses

MCAUTO's "Slope" computer program was selected to determine the most critical slope failure configuration under both static and pseudostatic earthquake loading conditions. The program used the soil engineering properties tabulated in Section 2.5.5.1.

The results of the analyses show that the most critical slope failure would take place along an arc of radius about 80 ft in the overburden material. The lateral spread of the soil away from the face of the rock cut resulting from the slope failure is estimated to be around 13 ft., based on an energy balance criterion.

2.5.5.3 Logs of Borings

As discussed in Section 2.5.5.1, no borings were drilled at the one major slope on the northeast side of the plant. A seismic refraction survey line about 200 ft. in length was performed along the slope.

REFERENCES

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2.5-32 Seismic Survey Profiles. Drawing No. 16103-10023 by Weston Geophysical Engineers, Inc., received from CYAPCO on April 22, 1982.

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TABLE 2.5-1

EARTHQUAKES WITHIN PIEDMONT
ATLANTIC COASTAL GRAVITY PROVINCE OF
INTENSITY VII ON THE MODIFIED MERCALLI SCALE

Year	Month	Day	Lat. (N)	Long. (W)	Epicentral Intensity	Felt Area Km2	Converted mbLg
1737	12	18	40.8	74.0	VII	NA	
1774	02	21	37.3	77.4	VII	150,000	4.6
1791	05	16	41.5	72.5	VI-VII	90,000	4.4
1840	11	11	39.8	75.2	VII	NA	
1871	10	09	39.7	75.5	VII	NA	
1875	12	23	37.6	78.5	VII	130,000	4.5
1884	08	10	40.6	74.0	VII	180,000	4.6
1927	06	01	40.3	74.0	VII	8,000	3.8

TABLE 2.5-2

MAJOR RECORDED EARTHQUAKES
WITH EPICENTERS IN CONNECTICUT
(INTENSITY 5 OR GREATER ON ROSSI-FOREL SCALE)

Date	Location	Approximate Epicenter Latitude North	Approximate Epicenter Longitude West	Approximate Area, Square Miles	Intensity, Rossi-Forel Scale
1791 (May 16)	East Haddam	41.5	72.5	35,000	6-7
1791 (Aug. 28)	East Haddam	41.5	72.5	-	*
1792	East Haddam	41.5	72.5	-	*
1794	East Haddam	41.5	72.5	-	*
1805	East Haddam	41.5	72.5	-	*
1827	New London	41.4	72.7	-	5
1837	Hartford	41.7	72.7	-	5
1840	South Connecticut	41.5	72.9	7,500	6
1858	New Haven	41.3	73.0	1,000	4-5
1875	Connecticut	41.8	73.2	2,000	6
1908	Housatonic Valley	-	-	-	*
1925	Hartford	41.7	72.7	8,000	5
1935	Stamford	41.1	73.5	-	5-6

* Not Available

TABLE 2.5-3

LARGEST EARTHQUAKES IN THE NORTHEAST REGION AND THEIR EFFECTS AT THE HADDAM NECK SITE

YEAR	MONTH	DAY	LAT. (N)	LONG. (W)	INTENSITY (I_o)	DISTANCE (km)	ESTIMATED SITE INTENSITY	PROVINCE/STRUCTURE
1727	NOV.	9	42.8	70.6	VII	214	4.2	NORTHEAST MASSACHUSETTS THRUST FAULT COMPLEX
1732	SEP.	16	45.5	73.6	VIII	455	4.0	WESTERN QUEBEC SEISMIC ZONE
1737	DEC.	18	40.8	74.0	VII	146	4.7	SITE PROVINCE[1]
1755	NOV.	9	42.8	70.6	VIII	226	5.1	NORTHEAST MASSACHUSETTS THRUST FAULT COMPLEX
1774	FEB.	21	37.3	77.4	VII	626	2.5	SITE PROVINCE
1791	MAY	16	41.5	72.5	VI-VII	2	6.0-7.0	SITE PROVINCE
1840	NOV.	11	39.8	75.2	VII	294	3.7	SITE PROVINCE
1875	DEC.	23	37.6	78.5	VII	670	2.3	SITE PROVINCE
1884	AUG.	10	40.6	74.0	VII	159	4.6	SITE PROVINCE
1927	JUN.	1	43.3	73.7	VII	182	4.4	SITE PROVINCE
1931	APR.	20	43.4	73.7	VII	235	4.0	ADIRONDACK UPLIFT
1940	DEC.	24	43.8	71.3	VII	275	3.8	WHITE MTN. PLUTONIC SERIES
1940	DEC.	24	43.8	71.3	VII	275	3.8	WHITE MTN. PLUTONIC SERIES
1944	SEP.	5	44.97	74.9	VIII	433	4.1	WESTERN QUEBEC SEISMIC ZONE

[1] SITE PROVINCE = PIEDMONT ATLANTIC COAST GRAVITY PROVINCE

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CHAPTER 3

DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

3.1 CONFORMANCE WITH NRC GENERAL DESIGN CRITERIA

3.1.1 Summary Discussion

The General Design Criteria (GDC) for Nuclear Power Plants as listed in Appendix A to 10 CFR 50 were effective May 21, 1971 and subsequently amended July 7, 1971. There are 55 total GDCs, divided into six groups; these are intended to establish minimum requirements for the design of nuclear power plants.

The full term operating license (FTOL) was issued December 27, 1974 and the provisional operating license (POL) for the Haddam Neck Plant (HNP) was issued June 30, 1967, thus the plant was designed and licensed prior to the issue of the Nuclear Regulatory Commission (NRC) GDCs. The HNP is not obligated to comply with the GDCs. The HNP was originally evaluated on a plant-specific basis, determined to be safe, and licensed by the Commission, Reference 3.1-1.

However, in support of the application for a full term operating license, Reference 3.1-2, the design of the HNP was analyzed and compared with the 21 proposed August 1968 IEEE Criteria for Nuclear Power Plant Protection Systems and the 70 proposed July 1967 GDC for nuclear power plants issued by the AEC.

The analysis made by Connecticut Yankee Atomic Power Company (CYAPCO) at that time (December 1969) concluded that the plant design did meet most of these criteria. In cases where the criteria were not met, it was concluded the design was such that safety of the plant was adequate. The NRC staff stated in its July 1971 review of the analysis that the HNP conforms with the intent of the GDC proposed in July 1967, Reference 3.1-3.

However, it should be noted that this comparison and conclusion is not a commitment to meet the current GDCs. Instead, the Reference 3.1-2 comparison determined the degree of compliance with the GDCs at that time.

In December of 1996, CYAPCO certified to the NRC of the permanent cessation of operations of the HNP and that all of the fuel assemblies have been permanently removed from the reactor vessel and placed in the Spent Fuel Pool, Reference 1.1-1. Following this certification, CYAPCO has started to decommission the HNP. As part of the process, the Systematic Evaluation Program (SEP) Topics, Reference 3.1-4, Three Mile Island Lessons Learned Items, Reference 3.1-5, the GDC, and the Regulatory Guides applicable to the HNP were assessed for their applicability to the HNP as decommissioning proceeds. The SEP Topics, TMI Items, and Regulatory Guides applicable to the HNP are documented in Reference 3.1-6. This section reflects the applicability of the GDCs to the HNP.

The GDC were not written specifically for a nuclear power plant that is permanently defueled or being decommissioned. When the HNP was an operating plant, CYAPCO made statements in this document of conformance to only GDC 3, 19, 60, 62, 63 and 64. The remaining GDCs are either not applicable to the HNP, or if they are, the respective sections of this document address the degree of conformance to the intent of the criteria. Although not committed to meet the listed GDCs, CYAPCO's conformance is summarized below.

3.1.1.1 Criteria Conformance

3.1.1.1.1 Fire Protection (Criterion 3)

Criterion

"Structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and heat-resistant materials shall be used wherever practical throughout the unit, particularly in locations such as the containment and control room. Fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on structures, systems, and components important to safety. Fire fighting systems shall be designed to assure that their rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems and components."

Design Conformance

The regulatory requirements for the Connecticut Yankee Decommissioning Fire Protection Program are set forth in 10 CFR 50.48(f). In accordance with 10 CFR 50.48(f), the Decommissioning Fire Protection Program shall establish the fire protection policy for the protection of structures, systems and components from fires which could cause the release or spread of radioactive materials from the time that the plant ceases operation until the plant is completely decommissioned. This includes the personnel, procedures and equipment required to implement the program. Subject to the requirements of 10 CFR 50.48(f), the licensee (Haddam Neck Plant) may make changes to the Decommissioning Fire Protection Program without prior NRC approval provided the changes do not reduce the effectiveness of fire protection for structures, systems and equipment that could result in a radiological hazard, taking into account the plant conditions and activities during decommissioning.

3.1.1.1.2 Control of Releases of Radioactive Materials to the Environment (Criterion 60)

Criterion

"The nuclear power unit design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment."

Design Conformance

In all cases, the design for radioactivity control is based on:

1. The requirements of 10 CFR 20, 10 CFR 50, and Appendix I to 10 CFR 50 for normal operations and for any transient situation that might reasonably be anticipated to occur.

2. 10 CFR 100 dose level guidelines for potential accidents of extremely low probability of occurrence.

All release paths, including process streams, are monitored and controlled as described in Section 11.2.

Due to cessation of power operation and near completion of decommissioning, radioactive gases and liquids are no longer being generated at the HNP. Solid wastes are prepared for offsite disposal as described in Section 11.4.

3.1.1.1.3 Prevention of Criticality in Fuel Storage and Handling (Criterion 62)

Criterion

"Criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations."

Design Conformance

Criterion 6.2 is no longer applicable to the HNP since all the Spent Fuel and GTCC waste have been removed from the Spent Fuel Pool and transferred to the ISFSI.

3.1.1.1.4 Monitoring Fuel and Waste Storage (Criterion 63)

Criterion

"Appropriate systems shall be provided in fuel storage and radioactive waste systems and associated handling areas (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions."

Design Conformance

Criterion 63, with respect to monitoring fuel, is no longer applicable to the HNP since all the Spent Fuel have been removed from the Spent Fuel Pool and transferred to the ISFSI.

The minimum amount of radioactivity that remains does not require the installation and operation of monitoring systems. Surveys are conducted as necessary for radioactive waste and handling areas to detect excessive radiation levels and initiate appropriate safety actions.

3.1.1.1.5 Monitoring Radioactivity Releases (Criterion 64)

Criterion

"Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculation of loss-of-coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents."

Design Conformance

The portion of Criterion 64 on reactor containment atmosphere and spaces containing components for recirculation of loss-of-coolant accident fluids is not applicable to the HNP.

Normal liquid effluent discharge paths (stormwater and groundwater) are sampled. Radioactivity levels in the environs are monitored by the collection of samples as part of the offsite radiological monitoring program.

REFERENCES

3.1-1 SECY-92-223, "Resolution of Deviations Identified During the Systematic Evaluation Program," from J. M. Taylor to the Commissioners, June 19, 1992.

3.1-2 Letter from D.C. Switzer (CYAPCO) to USAEC, Connecticut Yankee Full Term Operating License Application and Attachment entitled, "Conformance to General Design Criteria", dated December 31, 1969.

3.1-3 US Atomic Energy Commission Safety Evaluation by the Division of Reactor Licensing, Docket No. 50-213, Connecticut Yankee Atomic Power Company, Haddam Neck Plant, July 1,1971.

3.1-4 NUREG 0826 Integrated Plant Safety Assessment Systematic Evaluation Program, Haddam Neck Plant, June 1983.

3.1-5 NUREG-0737, "Clarification of TMI Action Plan Requirements", USNRC, dated November 1980.

3.1-6 Chapter 14, Regulations and Programs, Haddam Neck Plant Licensing Basis/ Design Basis Document.

3.3 WIND AND TORNADO LOADINGS

The original licensing basis of the Haddam Neck Plant (HNP), established by the Facility Description and Safety Analysis Report, did not contain a requirement to design or analyze for the effects of tornado wind or tornado missiles, References 3.3-1 and 3.3-2. In the early 1980's the NRC implemented a program of reviews of older operating commercial nuclear power plants, i.e., Systematic Evaluation Program (SEP) Topics. This program was based on the concern that older plants, such as the HNP, were licensed under regulations that were less stringent than the criteria current at the time. In response to the SEP, a reevaluation of the plant design was initiated to assess the significance of differences between current design criteria and original plant design criteria, References 3.3-1, 3.3-2, 3.3-3 and 3.3-4.

A tornado wind speed, adopted for the SEP review, was as defined in Regulatory Guide 1.76 which showed that the HNP site is in tornado intensity Region I. This correlated with a tornado wind speed of 360 mph with an occurrence frequency of 10^{-7} per year, Reference 3.3-5. This wind speed is considered a conservative upper bound based on current practice and regulatory guidance. The SEP was an analytical review, and in the case of wind and tornado, did not change the original wind and tornado loading licensing and design basis of the HNP.

The wind and tornado loading license basis for the HNP was adopted by the ISFSI as the licensing basis for spent fuel storage in the Vertical Concrete Casks (VCCs).

REFERENCES

3.3-1 Letter from W.G. Counsil to D.L. Ziemann dated September 7, 1979, Subject "SEP Structural Topics." Docket No. 50-213.

3.3-2 Letter from W.G. Counsil to D.M. Crutchfield dated December 14, 1981, Subject: "SEP Topic III-2, Wind and Tornado Loadings, Haddam Neck Plant." Docket No. 50-213, B10273.

3.3-3 Letter from W.G. Counsil to D.M. Crutchfield dated April 6, 1982, Subject "SEP Topic III-2, Wind and Tornado Loading, Haddam Neck Plant." Docket No. 50-213 B10465 N.U. Uniqueness No. 91440033.

3.3-4 Letter from D.M. Crutchfield to W.G. Counsil dated September 2, 1982, Subject: "SEP Topic III-2, Wind and Tornado Loadings Haddam Neck Plant." Docket No. 50-213 LS05-82-09-013 N.U. Uniqueness No. 91740015.

3.3-5 Letter from the NRC to CYAPCO dated August 2, 1982, "SEP Topic III-4.A, Tornado Missiles - Haddam Neck".

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SPENT FUEL

4.1 SUMMARY DESCRIPTION

The spent fuel assembly design parameters are contained in Table 4.1-1.

TABLE 4.1-1

SPENT FUEL DESIGN TABLE

	Fuel Assembly Design Parameters	Cycle 19 Parameters
1.	Design	Rod Cluster Control, Canless, 15 x 15
2.	UO_2 rods per assembly	204
3.	Rod pitch	0.5625 (in)
4.	Overall dimensions	8.426 (in) x 8.426 (in)
5.	Typical Fuel weight, as UO_2	411.5 SS (B&W Fuel) (kg U/assembly) 363.8 Zr-4 (B&W Fuel) (kg U/assembly) 386.2 (W Fuel) (kg U/assembly)
6.	Number of grids per assembly	7
	Fuel Rods	
7.	Number	31,212 (816 SS)
8.	IFBA Rods	1008 (Batch 21C)
9.	Outside diameter	0.4220 (in)
10.	Diametral gap	0.0065/.0070 (in) (B&W Fuel) 0.0075 (in) (W Fuel)
11.	Clad thickness	0.0165/.0270 (in) (B&W Fuel) 0.0243 (in) (W Fuel)
12.	Clad material	304SS/Zr-4
	Fuel Pellets	
13.	Material	Uranium Dioxide
14.	Density, percent of theoretical	94.9 (B&W Fuel) 95.5 (W Fuel)

TABLE 4.1-1

SPENT FUEL DESIGN TABLE

		Cycle 19 Parameters
15.	Diameter	0.3825/0.3610 (in) (B&W Fuel) 0.3659 (in) (W Fuel)
16.	Length	0.458/0.425 (in) (B&W Fuel) 0.439 (in) (W Fuel)
	Rod Cluster Control Assemblies	
17.	Neutron absorber	Silver, Indium, Cadmium
18.	Cladding material	Inconel-625
19.	Clad thickness, inches	0.0195
20.	Number of clusters, full length	45
21.	Number of absorber rods per cluster	20
	Fuel Enrichment (weight percent)	
22.	Batch 18C	4.00
23.	Batches 19A, 20A	3.90
24.	Batch 19B, 20B	3.60
25.	Batch 21A	4.6
26.	Batches 21B, 21C	4.2

4.2 FUEL ASSEMBLY DESIGN

4.2.1 Design Bases

Integrity of the fuel assembly structure was ensured by setting limits on stresses and deformations due to various mechanical force loads and by preventing the assembly structure from interfering with the functioning of other components. Three types of loads were considered:

(1) Nonoperational force loads such as those due to shipping and handling

(2) Normal and abnormal force loads for design basis events

(3) Abnormal force loads defined for severe accidents

4.2.1.1 Cladding

(1) Each fuel rod consists of a stainless steel or zircaloy tube containing the uranium dioxide pellets, sealed at each end by an end plug welded to the tube. Sufficient void volume was provided at the top end of the assembled fuel rods, at the fuel to tube gap, and at the dished ends of the pellets to accommodate fission product buildup and axial thermal expansion of the fuel column relative to the tube. Before the top end plug was installed, a compression spring was inserted into the void volume to prevent shifting of the fuel column during shipment. The spring was preloaded during installation to a load at least 6 times the fuel stack weight. The spring bears on the end fuel pellet.

The type 304 stainless steel cladding material was cold-worked approximately 12 percent by cold drawing to improve its mechanical properties.

(2) <u>Stress-strain Limits</u>

The fuel rod cladding was designed to be free standing under normal reactor operating conditions, i.e., the clad would not require internal support to prevent collapsing either through buckling or yielding of the material.

a. Cladding Stress - Any single cladding primary membrane stress under design basis events will not exceed 2/3 of the applicable material unirradiated yield strength at temperature (650°F). Primary stress intensities will not exceed material yield stress.

b. Cladding Tensile Strain - The total circumferential creep strain is less than 1 percent from the unirradiated condition.

(3) Vibration and Fatigue

a. Strain Fatigue - The fatigue usage factor for the fuel rods was limited to be less than the maximum allowed factor of 0.9. The cumulative strain fatigue cycles were limited to be less than the design strain fatigue life.

b. Vibration - Potential fretting wear due to vibration was prevented, ensuring that the stress-strain limits were not exceeded during design life.

(4) Chemical properties of the cladding conformed to the chemical composition limits specified by ASTM A269 for stainless steel. Restrictions on percent elemental content are given below:

Nickel	9-12 w/o
Chromium	18-20 w/o
Cobalt	.05 w/o max
Carbon	.03-.06 w/o
Boron	.001 w/o max
Silicon	.1 w/o max
Phosphorous	.01 w/o max

4.2.1.2 Fuel Assembly

(1) Structural Design

The structural integrity of the fuel assemblies was ensured by setting design limits on stresses and deformations due to various nonoperation, operations, and accident loads. These limit bases were applied to the design and evaluation of the top and bottom nozzles, guide thimbles, grids, thimble joints, and holddown springs.

The design bases for evaluating the structural integrity of the fuel assemblies were:

a. Nonoperational - 6g loading with dimensional stability.

b. For the normal operating and upset conditions, the fuel assembly component structural design criteria was established for the two primary material categories, namely austenitic steels and zircaloy. However, since the fuel has been permanently removed from the reactor vessel these loading conditions are no longer applicable.

3) Abnormal loads during severe accidents represented by seismic or blowdown loads, combined with normal operational loads. However, since the fuel has been permanently removed from the reactor vessel these loading conditions are no longer applicable.

4.2.2 Design Description

Each fuel assembly consists of 204 fuel rods, 20 guide thimble tubes, and one instrumentation thimble tube arranged within a supporting structure. The instrumentation thimble is located in the center position and provided a channel for insertion of an incore neutron detector, if the fuel assembly was located in an instrumented core position. The guide thimbles provided channels for insertion of either a rod cluster control assembly, a neutron source assembly, or a thimble plug assembly, depending on the position of the particular fuel assembly in the core. The fuel rods were loaded into the fuel assembly structure so that there was clearance between the fuel rod ends and the nozzles.

4.2.2.1 Fuel Rods

The fuel rods consist of uranium dioxide ceramic pellets contained in stainless steel or zircaloy tubing which is plugged and seal-welded at the ends to encapsulate the fuel. A schematic of the fuel rods is shown on Figure 4.2-1. The fuel pellets are right circular cylinders consisting of slightly enriched uranium dioxide powder which has been compacted by cold pressing and then sintered to the required density. The ends of each pellet are dished slightly to allow greater axial expansion at the center of the pellets.

Void volume and clearances are provided within the rods to accommodate fission gases released from the fuel, differential thermal expansion between the clad and the fuel, and fuel density changes during irradiation. Shifting of the fuel within the clad during handling or shipping prior to core loading is prevented by a stainless steel helical spring which bears on top of the fuel. At assembly, the pellets are stacked in the clad to the required fuel height. The spring is then inserted into the top end of the fuel tube and the top end plug is pressed into the end of the tube and welded. All fuel rods are internally pressurized with inert gas during the welding process in order to improve heat transfer from the pellet to the coolant.

4.2.2.2 Fuel Assembly Structure

The fuel assembly structure consists of a bottom nozzle, top nozzle, guide thimbles and grids, as shown on Figures 4.2-2 Sheets 1 and 2, 4.2-3 Sheets 1 and 2, 4.2-4 and 4.2-5 Sheets 1, 2 and 3.

4.2.2.2.1 Bottom Nozzle

Babcock and Wilcox Fuel

The bottom nozzle serves as a bottom structural element of the fuel assembly and directed the coolant flow distribution to the assembly. The square nozzle is fabricated from type 304 stainless steel and consists of a perforated plate and four angle-legs with bearing plates, as shown on Figure 4.2-2 Sheet 1. The plate also prevents accidental downward ejection of the fuel rods from the fuel assembly. The bottom nozzle is fastened to the fuel assembly guide tubes by threaded end plugs which penetrate the nozzle and attach with a lock nut on each guide tube.

Westinghouse VANTAGE 5H Fuel

The Debris Filter Bottom Nozzle (DFBN) is designed to inhibit debris from entering the active fuel region of the core and thereby improves fuel performance by minimizing debris related fuel failures. The DFBN as shown on Figure 4.2-2 Sheet 2 is a low profile bottom nozzle design made of stainless steel, with reduced plate thickness and leg height. In addition, the DFBN incorporates a reinforcing skirt to enhance reliability during postulated adverse handling conditions while refueling.

The DFBN is fastened to the fuel assembly guide thimbles with stainless steel screws. The screws have a thin-walled skirt at the head which is crimped into mating lobes of the DFBN to prevent loosening. This screw fastening design of the DFBN provides removal capability and reconstitution via the bottom nozzle in addition to the top nozzle.

4.2.2.2.2 Top Nozzle

Babcock and Wilcox Fuel

The top nozzle is the upper structural element of the fuel assembly. The top nozzle assembly is a single casting consisting of an adapter plate, enclosure, top plate, and pads. Holddown springs are mounted on the assembly, as shown on Figure 4.2-3 Sheet 1. The springs are made of Inconel 718 whereas other components are made of type 304 stainless steel.

The top nozzle serves as the upper structural member of the fuel assembly. Two holes which mate with the locating pins fixed to the upper core plate are located in diagonally opposite corners of the top plate. The fuel handling tool grips the top plate to lift the assembly. A third smaller hole is provided for orienting the assembly in the core and to orient the handling tool and fuel assembly for proper installation.

Four leaf springs are fastened to the upper plate, parallel to the sides, to provide hold-down forces to oppose abnormal hydraulic forces which could possibly cause the assembly to lift. The springs are clamped by bolts which are later tack welded to prevent loosening.

Westinghouse VANTAGE 5H Fuel

The top nozzle functions as the upper structural and alignment member of the fuel assembly. The Haddam Neck Plant assembly uses the Reconstitutable Top Nozzle (RTN) which includes: 1) a groove in each thimble thru-hole in the nozzle plate to facilitate attachment and removal; 2) a nozzle plate thickness that provides additional axial space for fuel rod growth. The RTN is shown on Figure 4.2-3 Sheet 2.

4.2.2.2.3 Control Rod Guide Thimbles

Babcock and Wilcox Fuel

Control rod guide thimbles, the primary structural element of the fuel assembly, provided guidance for insertion and withdrawal of control rods (Figure 4.2-4). They were fabricated from type 304 stainless steel tubing, drawn to two different diameters. The larger outside diameter at the top provided a relatively large annular area to allow rapid insertion during a reactor trip and to accommodate a small amount of cooling flow during normal operations. The bottom of the guide thimble, approximately 21 inches, is of reduced diameter resulting in a relatively close fit with the control rod to perform a dashpot action when the rods were dropped into the guide thimbles upon a reactor trip.

Westinghouse VANTAGE 5H Fuel

The guide tubes and instrumentation tube are structural members, made of Zircaloy-4, which also provided channels for the control rods, neutron sources, and thimble plugs. The guide tubes in conjunction with the grids and nozzles constituted the basic fuel assembly structure.

4.2.2.2.4 Grid Assemblies

Babcock and Wilcox Fuel

The fuel rods in the fuel assemblies (Figure 4.2-5 Sheet 1) are supported at intervals along their length by grid assemblies which maintain the lateral spacing between the rods. Each fuel rod is supported within each grid by the combination of support dimples and springs. The grid assembly consists of individual slotted straps interlocked and welded in an egg crate arrangement to join the straps permanently at their points of intersection. The straps contain spring fingers, support dimples, and mixing vanes.

The grid material is Inconel 718, which was selected for its mechanical properties to provide the necessary spring forces on the fuel rods. After the grids were welded together they were solution heat-treated to obtain the desired properties.

Westinghouse VANTAGE 5H Fuel

Two types of grids were used in the Haddam Neck Plant fuel assembly, shown on Figure 4.2-5 Sheets 2 and 3, to provide fuel rod and guide tube positioning and retention. Inconel grids were used at the top and bottom of the assembly. Zircaloy-4 was spaced between the Inconel grids to maintain the lateral position of the fuel rods. The grids were positioned to be compatible with the Babcock and Wilcox fuel assemblies.

4.2.3 Design Evaluation

4.2.3.1 Cladding

Fuel rod internal pressure and cladding stresses

The plenum height of the fuel rod was designed to ensure that the maximum internal pressure of the fuel rod will not exceed the value which would cause: (1) the fuel/clad diametral gap to increase during steady state operation, and (2) extensive DNB propagation to occur. Since the HNP has permanently ceased power operations, the maximum internal pressure of the fuel rod cannot exceed the value which would cause the fuel/clad diametral gap to increase or extensive DNB propagation to occur.

4.2.3.2 Fuel Materials Considerations

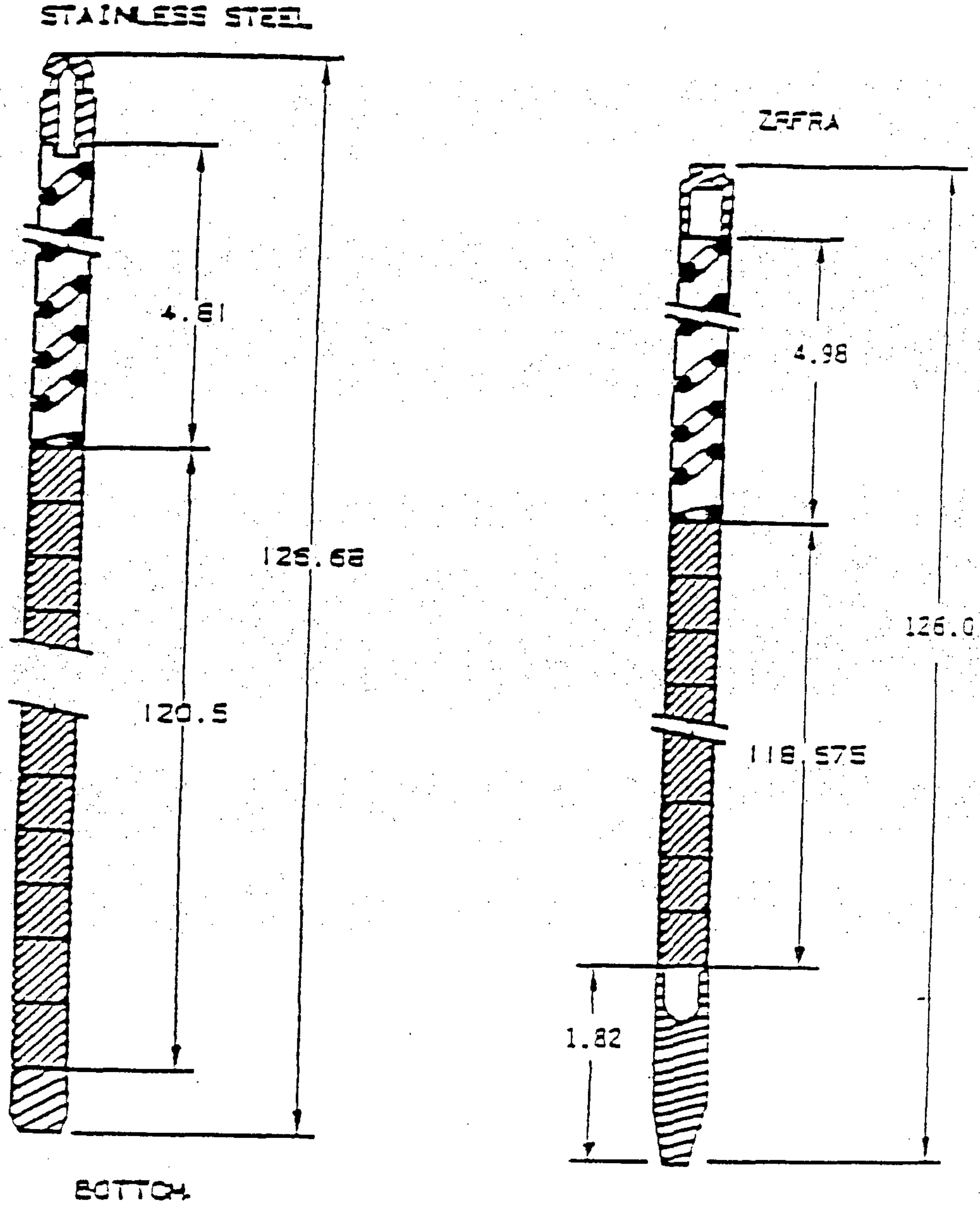
In the event of clad defects, the high resistance of uranium dioxide to attack by water protects against fuel deterioration although limited fuel erosion can occur. The consequences of defects in the clad are greatly reduced by the ability of uranium dioxide to retain fission products including those which are gaseous or highly volatile.

4.2.3.3 Spacer Grids

The lateral spacing between fuel rods is provided and controlled by the support dimples of adjacent grid cells. Contact of the fuel rods on the dimples is maintained through the clamping force of the grid springs. Lateral motion of the fuel rods is opposed by the spring force and the internal moments generated between the spring and the support dimples.

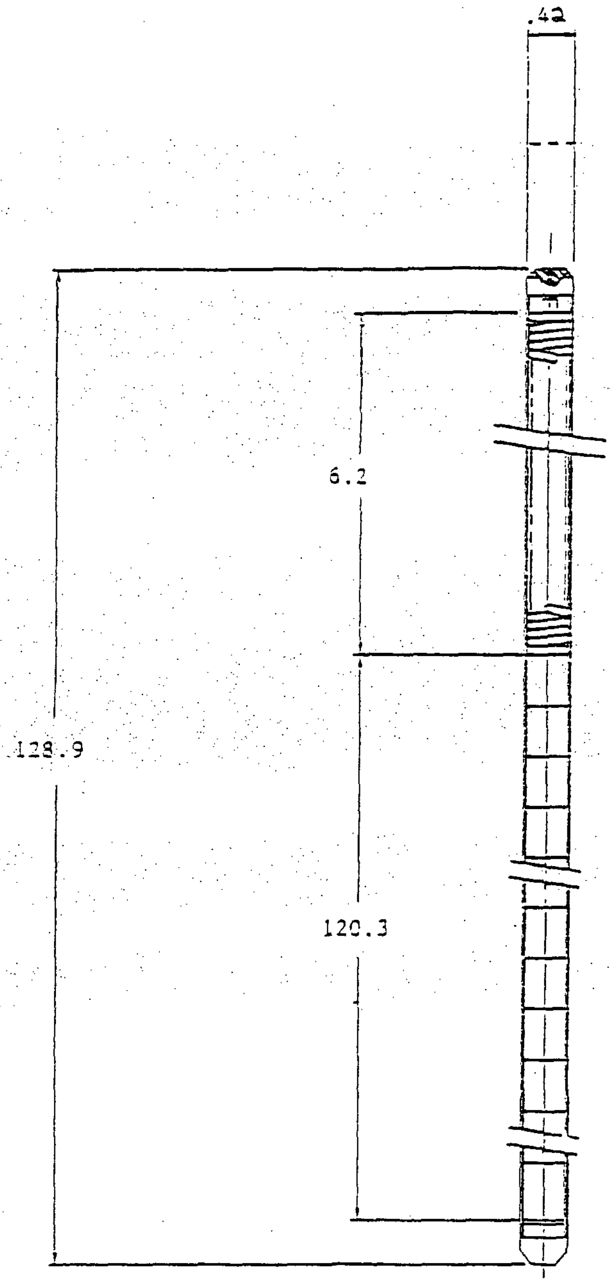
4.2.3.4 Fuel Assembly

The fuel assembly component stress levels are limited by the design. For example, stresses in the fuel rod due to thermal expansion is limited by the relative motion of the rod as it slips over the grid spring and dimple surfaces. Clearances between the fuel rod ends and nozzles are provided so that stainless steel or zircaloy thermal growth does not result in rod end interferences. Stresses in the fuel assembly have little influence on fatigue because of the small number of events during the life of an assembly. Assembly components and prototype fuel assemblies made from production parts have been subjected to structural tests to verify that the design bases requirements are met.



FUEL ROD ASSEMBLY

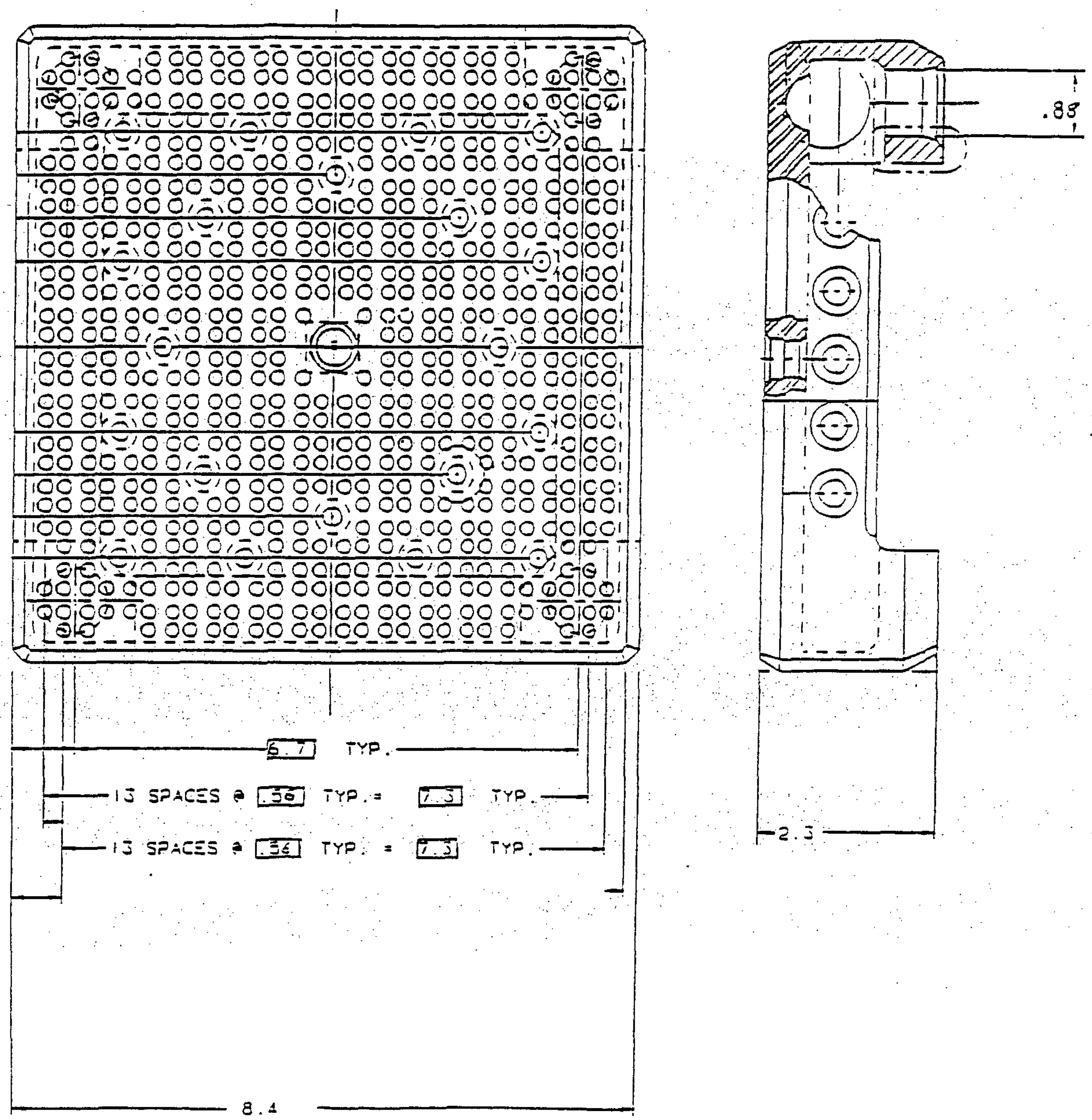
FIG. 4.2-1 SH 1
JANUARY 1998



* All Dimensions are Rounded to the last Digit

FUEL ROD ASSEMBLY

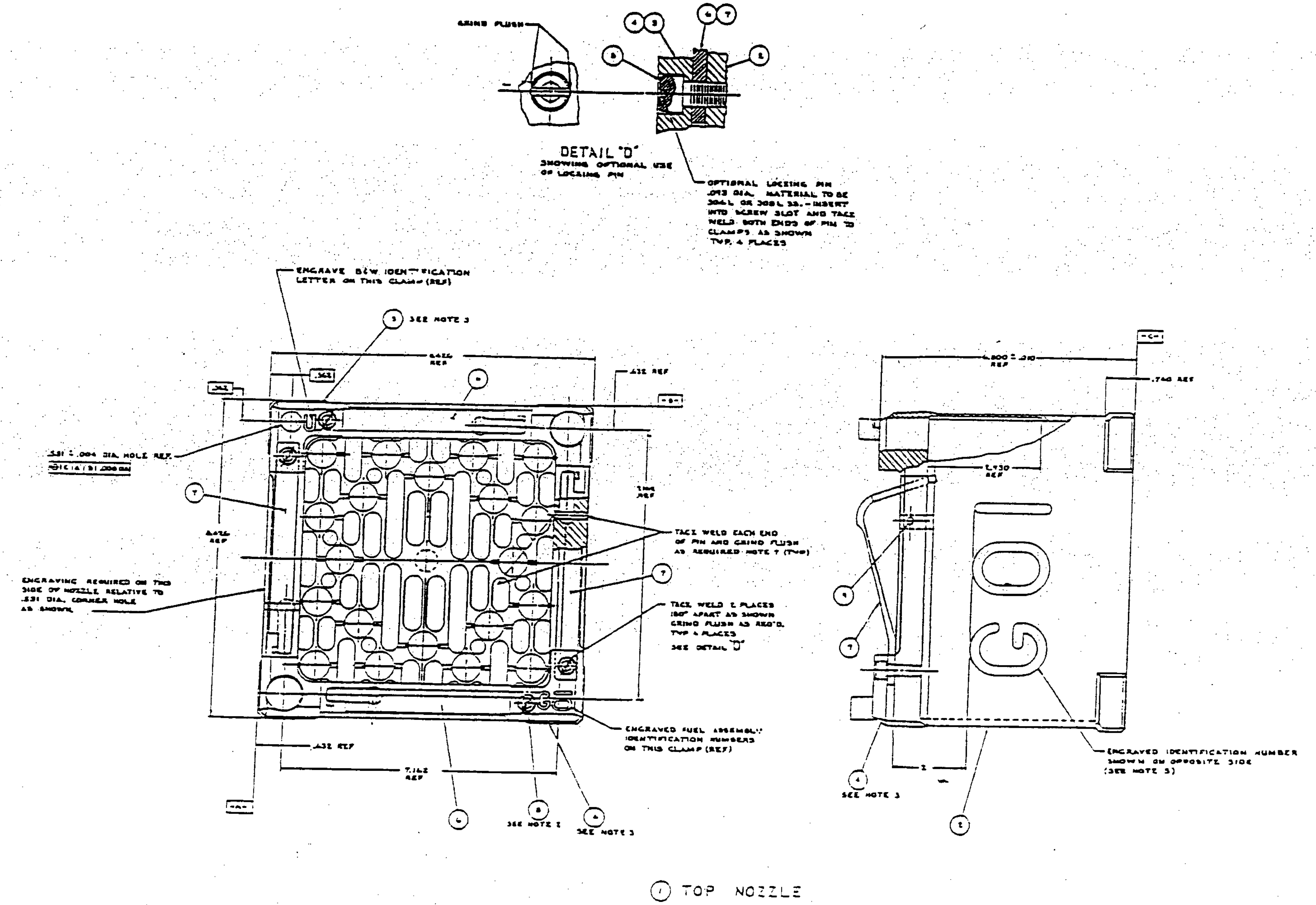
FIG 4.2-1 SH 2
JANUARY 1998



* All Dimensions are Rounded to the last Digit

BOTTOM NOZZLE

FIG. 4.2-2 SH 2
JANUARY 1998



Item	Qty	Description
1	—	TOP NOZZLE ASSY.
2	1	TOP NOZZLE MACH.
4	1	CLAMP TYPE I
5	1	CLAMP TYPE II
6	2	HOLD-DOWN SPRING
7	2	HOLD-DOWN SPRING
8	4	CAP SCREW
9	4	RETAINER PIN

NOTES:

1. FOR ADDITIONAL REQUIREMENTS SEE ST-0004
2. TORQUE ITEM 8 TO 95-105 INCH LBS. DRY.
3. ALL EXTERNAL SURFACES OF ITEM 4 & 5 TO BE FLUSH OR WITHIN THE MATCHING SURFACES OF ITEM 2.
4. DELETED
5. IDENTIFICATION NUMBER SHOWN IS FOR ILLUSTRATION ONLY. NUMBERS TO BE PROVIDED IN ACCORDANCE WITH PURCHASE ORDER OR DOCUMENT TO WHICH THIS DOCUMENT IS ATTACHED. ENGRAVED CHARACTERS 1.000 INCHES IN HEIGHT, .150 INCH WIDE AND APPROXIMATELY .015 INCH DEEP. ENGRAVING DIMENSIONS ARE NOMINAL TOLERANCES ARE TO BE IN ACCORDANCE WITH GOOD SHOP PRACTICE.
7. DYE PENETRANT INSPECTION OF TACK WELDS NOT REQUIRED.
8. .010 MAX. WELD BUILD-UP PERMISSIBLE. NO SHARP EDGES. MACHINE IF REQUIRED.

SCS: CONNECTICUT YANKEE RELOAD FUEL BATCHES 11-15

SEE: NUSCO DRAWING 16103-29696 SH. FOR THE APPLICABILITY DOCUMENT LISTING.

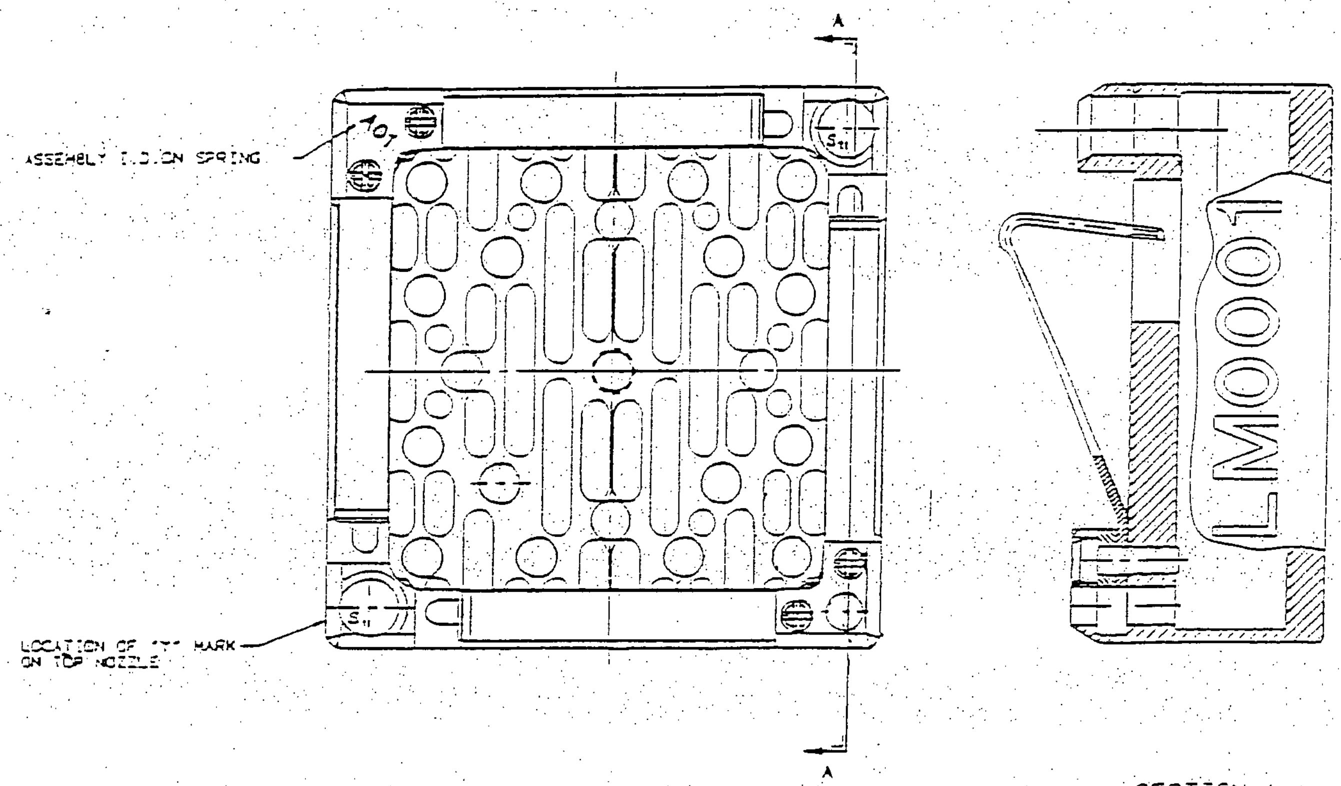
Q.A.

16103-29696 SH. 47

THIS DWG SUPERSEDES DWG. 16103-29421 SH. — REV. 0

TOP NOZZLE ASSEMBLY

1006316 F 7



TOP NOZZLE

FIG. 4.2-3 SH 2
JANUARY 1998

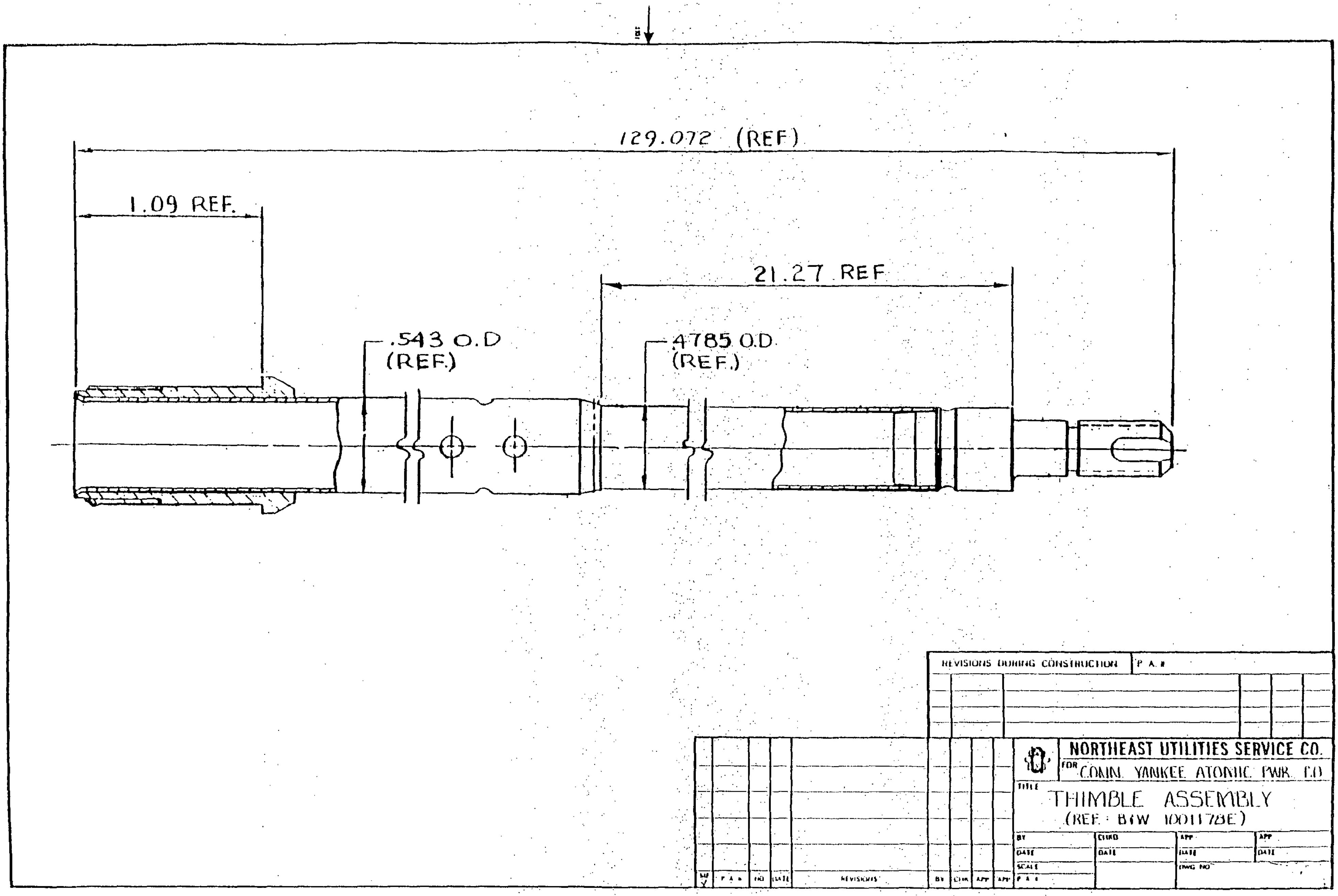
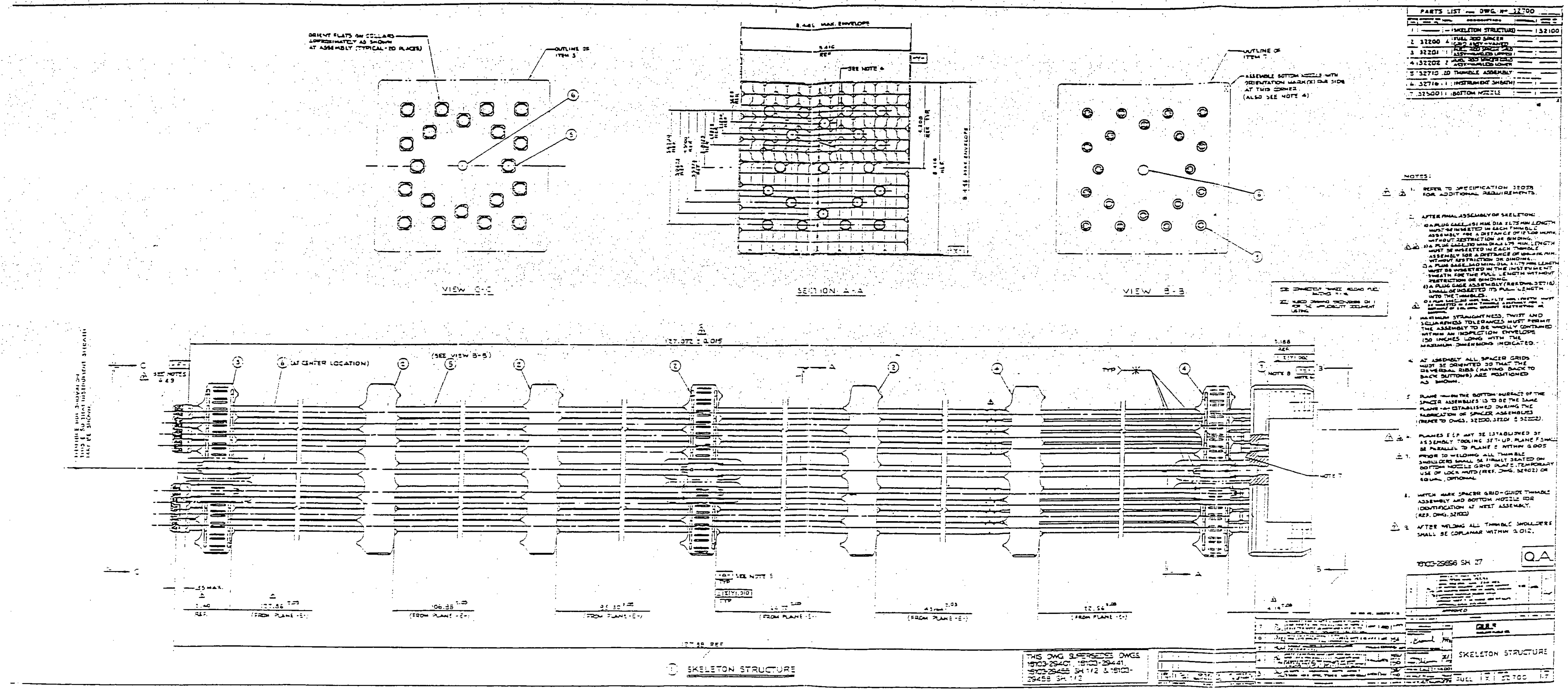


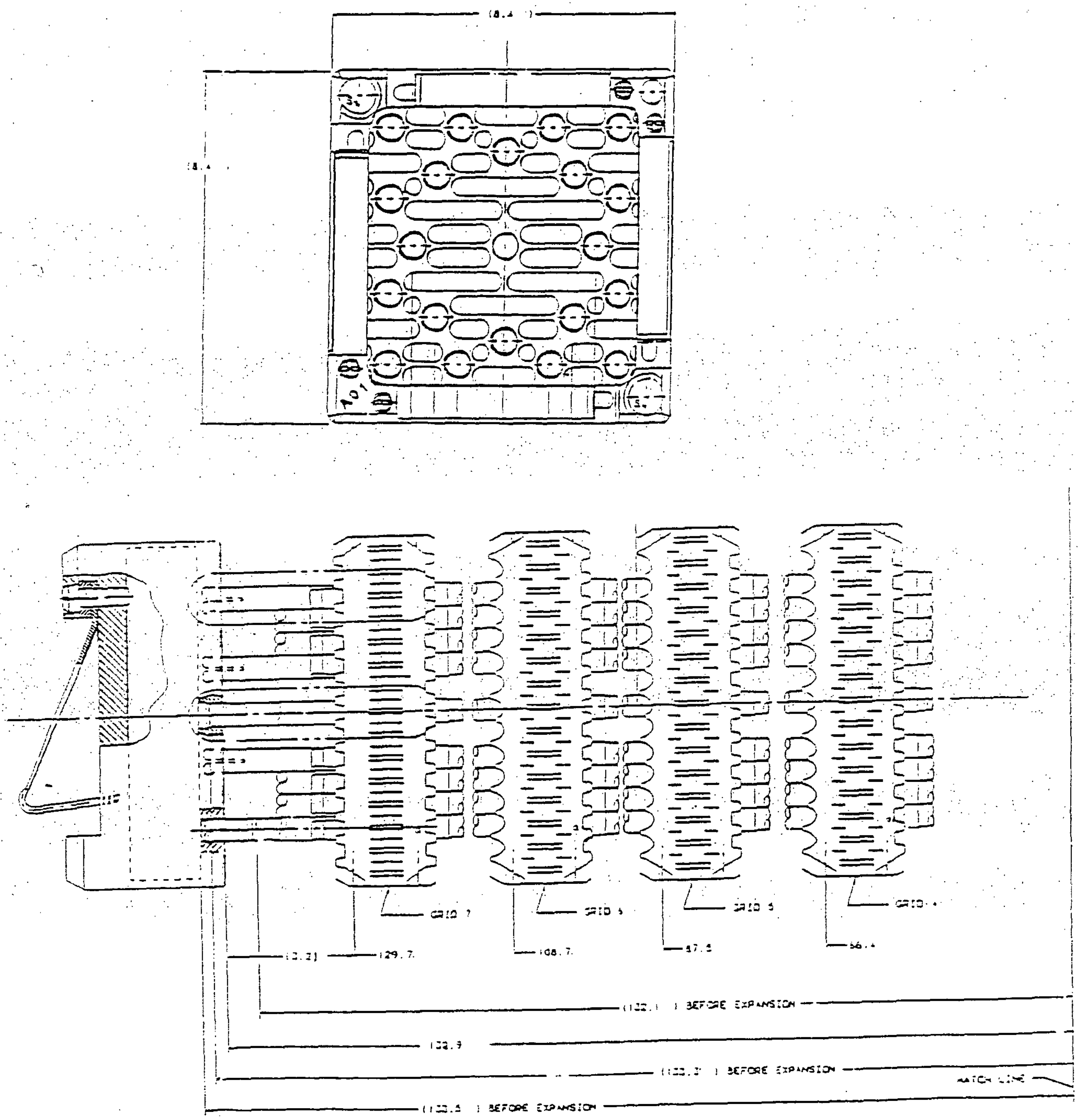
FIG. 4.2-4 SH 1
JANUARY 1998

THIMBLE ASSEMBLY



PARTS LIST — DWG. No 32700
1 — SKELETON STRUCTURE — 132100
2 32200 4 FULL ROD SPACER GRID ASSY-VANED
3 32201 1 FULL ROD SPACER GRID ASSY-UPPER
4 32202 2 FULL ROD SPACER GRID ASSY-LOWER
5 32710 20 THIMBLE ASSEMBLY
6 32716 1 INSTRUMENT SHEATH
7 325001 1 BOTTOM NOZZLE
ORIENT FLATS ON COLLARS APPROXIMATELY AS SHOWN AT ASSEMBLY (TYPICAL-20 PLACES)
OUTLINE OF ITEM 3
VIEW C-C
8.446 MAX. ENVELOPE
SEE NOTE 4
SECTION A-A
OUTLINE OF ITEM 7
ASSEMBLE BOTTOM NOZZLE WITH ORIENTATION MARK (X) ON SIDE AT THIS CORNER (ALSO SEE NOTE 4)
VIEW B-B
NOTES:
1. REFER TO SPECIFICATION 32037 FOR ADDITIONAL REQUIREMENTS.
2. AFTER FINAL ASSEMBLY OF SKELETON:
3. MAXIMUM STRAIGHTNESS, TWIST AND SQUARENESS TOLERANCES MUST PERMIT THE ASSEMBLY TO BE WHOLLY CONTAINED WITHIN AN INSPECTION ENVELOPE 150 INCHES LONG WITH THE MAXIMUM DIMENSIONS INDICATED.
4. AT ASSEMBLY ALL SPACER GRIDS MUST BE ORIENTED SO THAT THE DIVERSAL RIBS (HAVING BACK TO BACK BUTTONS) ARE POSITIONED AS SHOWN.
5. PLANE ON THE BOTTOM SURFACE OF THE SPACER ASSEMBLIES IS TO BE THE SAME PLANE AS ESTABLISHED DURING THE FABRICATION OF SPACER ASSEMBLIES (REFER TO DWGS. 32200, 32201 & 32202).
6. PLANES E & F MAY BE ESTABLISHED BY ASSEMBLY TOOLING SET-UP. PLANE F SHALL BE PARALLEL TO PLANE E WITHIN 0.005
7. PRIOR TO WELDING ALL THIMBLE SHOULDERS SHALL BE FIRMLY SEATED ON BOTTOM NOZZLE GRID PLATE. TEMPORARY USE OF LOCK NUTS (REF. DWG. 32902) OR EQUAL, OPTIONAL
8. MATCH MARK SPACER GRID-GUIDE THIMBLE ASSEMBLY AND BOTTOM NOZZLE FOR IDENTIFICATION AT NEXT ASSEMBLY. (REF. DWG. 32100)
9. AFTER WELDING ALL THIMBLE SHOULDERS SHALL BE COPLANAR WITHIN 0.012.
QA
(SEE VIEW B-B)
(AT CENTER LOCATION)
SEE NOTE 5
SEE NOTE 8
NOTE 7
(FROM PLANE E)
1 SKELETON STRUCTURE
THIS DWG SUPERSEDES DWGS. 19103-29401, 19103-29441, 19103-29455 SH 1/2 & 19103-29459 SH 1/2
SKELETON STRUCTURE
FULL 32700

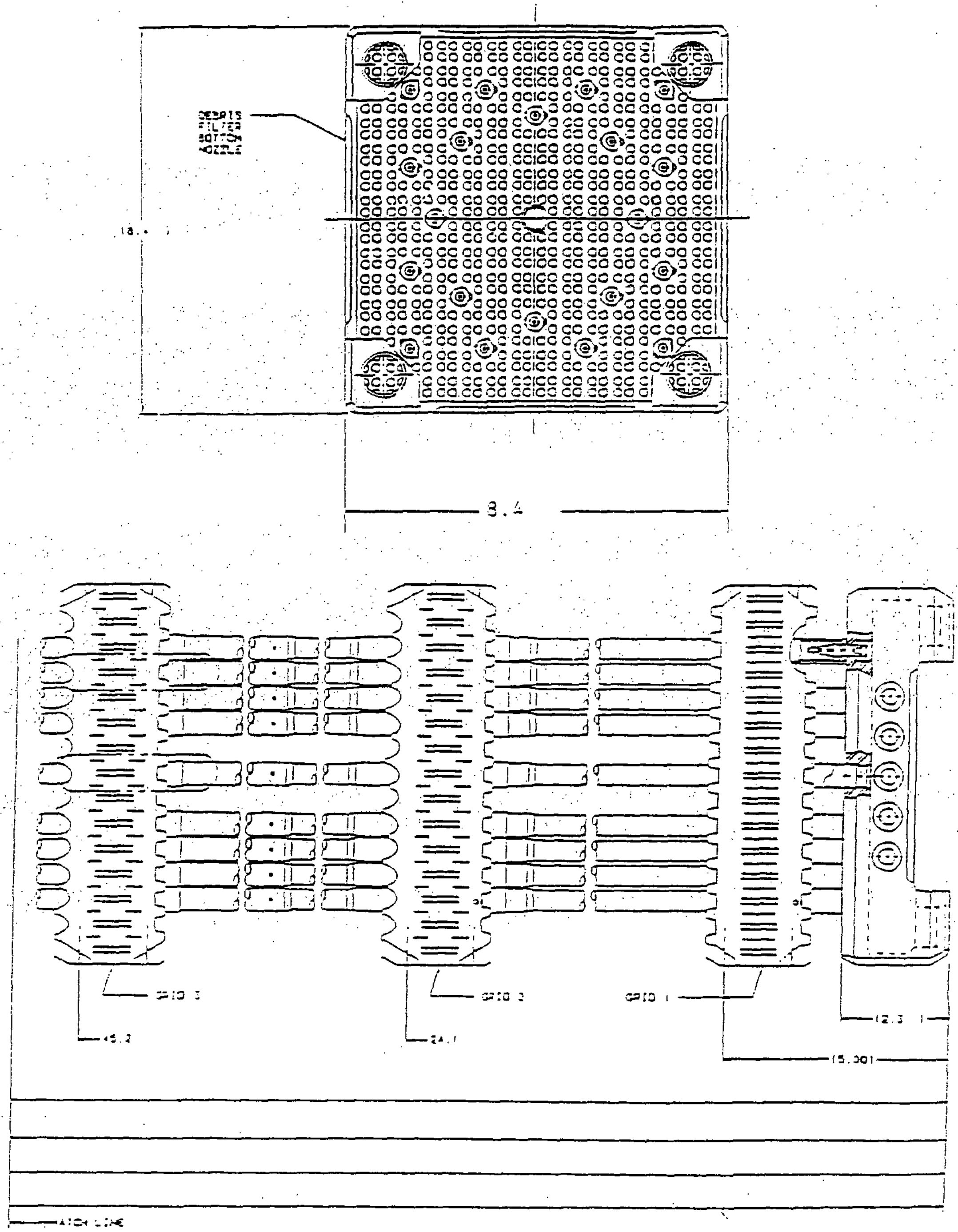
FIG. 4.2.5 SH 1



*All Dimensions are Rounded to the last Digit

SKELETON STRUCTURE

FIG. 4.2-5 SH 2
JANUARY 1998



* All Dimensions are Rounded to the last Digit

SKELETON STRUCTURE

FIG. 4.2-5 SH 3
JANUARY 1998

4.3 NUCLEAR DESIGN

DELETED

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CHAPTER 8

ELECTRIC POWER

8.1 ISFSI and Monitoring Station 120/240V System

Power to the ISFSI Electrical Equipment Enclosure (EEE) Building, ISFSI Monitoring Station and Guard House is supplied from a 23 kV overhead utility line that feeds a 23 kV to 120/240V, single phase transformer located near the ISFSI Monitoring Station. The system provides power to emergency and non-emergency loads.

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CHAPTER 9

AUXILIARY SYSTEMS

9.1 FUEL STORAGE AND HANDLING

9.1.1 New Fuel Storage

Since the Haddam Neck Plant has permanently ceased operations there is no longer a need for new fuel on the site. In addition, all new fuel that was onsite has been removed.

9.1.2 Spent Fuel Storage

Approval to store spent fuel at the HNP Independent Spent Fuel Storage Installation (ISFSI) was granted by the NRC under Subpart K of 10 CFR 72. The ISFSI is a passive, dry cask storage system. A single dry storage cask consists of a transportable storage canister within a vertical concrete cask. The dry storage casks are arranged on a concrete storage pad (Reference 9.1-1).

REFERENCES

9.1-1 Connecticut Yankee Atomic Power Company – Haddam neck Plant – Independent Spent Fuel Storage Installation (HNP – ISFSI), 10 CFR 72.212 Evaluation Report.

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 Fire Protection Systems

A Fire Protection Program that addresses the decommissioned status of the plant, as required by 10 CFR 50.48(f), has been established and is procedurally controlled at the Haddam Neck Plant. The Connecticut Yankee Decommissioning Fire Protection Program Manual, Reference 9.5-1, has been developed to ensure that the risk of fire-induced radiological hazards to the public, environment, and plant personnel is minimized. The Connecticut Yankee Fire Hazard Analysis (FHA) (Reference 9.5-2) addresses the plant areas that are a concern in a fire. The FHA evaluates the status of the fire areas where there is a potential for fires which could cause the release or spread of radioactive materials, that could result in a radiological hazard. As plant conditions change during decommissioning, the FHA may be revised as applicable to support plant conditions in accordance with 10CFR50.48(c).

9.5.2 Communication Systems

9.5.2.1 Design Bases

Reliable communication systems are provided for in plant and plant-to-offsite communication. The systems are available for day-to-day communication and to support the emergency response activities related to the emergencies that may arise at the HNP during decommissioning activities and emergencies that may arise while spent fuel and GTCC waste are stored at the ISFSI.

9.5.3 Lighting Systems

DELETED

REFERENCES

9.5-1 CY Decommissioning Fire Protection Program Manual.

9.5-2 Connecticut Yankee Decommissioning Fire Hazards Analysis.

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CHAPTER 11

RADIOACTIVE WASTE MANAGEMENT

11.1 SOURCE TERMS

As described in Chapter 15, "Accident Analysis," the accident analysis for the Radioactive Waste System includes consideration of an accident concerning the solid waste management system. In FSAR Section 15.2.1 "Radioactive Waste System Failure," there is a description of the analysis assumptions concerning the sources of radioactivity for the one remaining accident case.

11.2 LIQUID WASTE MANAGEMENT SYSTEMS

During decommissioning, the liquid waste system was used to collect, hold, process, and dispose of potentially radioactive water in the plant. This system has been abandoned since all remaining liquid radioactive waste water has been processed.

11.2.1 Design Bases

Liquid effluents are controlled and monitored as described in Section 11.5, to meet the intent of General Design Criteria 60 and 64 of Appendix A to 10 CFR 50.

11.2.2 System Description - DELETED

11.2.3 Radioactive Releases

A current summation of all releases and current off-site dose estimates resulting from liquid effluents are provided in Reference 11.2-1, the Annual Radioactive Effluents Release Report. The methods and criteria for determining the contents of Reference 11.2-1 are contained in Reference 11.2-2, the Radiological Effluent Monitoring and Off-Site Dose Calculation Manual and Process Control Program. Reference 11.2-2 provides sampling and analysis programs and meets the intent of 10 CFR 10 and 10 CFR 50. In addition, it outlines the information to be submitted to the NRC in Reference 11.2-1 and in Reference 11.2-3, the Annual Radiological Environmental Operating Report.

11.2.4 Safety Evaluation - DELETED

11.2.5 Disposition of Discharge Canal Dredging Spoils On-Site

Reference 11.2-5 presents historical information concerning the disposition of discharge canal spoils on owner controlled property in 1987.

Reference 11.2-5 presented the dose analysis results (developed in Reference 11.2-6) that at no time has the total effective dose equivalent from the material exceeded 1 millirem in a year.

HADDAM NECK PLANT UFSAR

REFERENCES

11.2-1 J. F. Opeka letter to U.S. Nuclear Regulatory Commission Document Control Desk, transmitting the July 92-December 1992 Semi-Annual Radioactive Effluent and Waste Disposal Report for the Haddam Neck Plant, dated February 26, 1993 and subsequent revisions thereto submitted on an annual basis.

11.2-2 Haddam Neck Plant, Docket No. 50-213, Radiological Effluent Monitoring and Off-Site Dose Calculation Manual and Process Control Program

11.2-3 Haddam Neck Plant, Docket No. 50-213, Annual Radiological Environmental Operating Report

11.2-4 DELETED

11.2-5 R. A. Mellor letter to U. S. Nuclear Regulatory Commission Document Control Desk, transmitting CY-98-062, Re: 10 CFR20.2002, Haddam Neck Plant, of Historical Information, dated October 28, 1998.

11.2-6 DE&S Memo, "Dose Assessment of Canal Sediment Stored on the Peninsula", REG 98-095, dated June 30, 1998.

11.4 SOLID WASTE MANAGEMENT SYSTEM

The function of the solid waste system is to receive, concentrate, solidify (as necessary) package, collect and store radioactive wastes that result from plant operation, maintenance and decommissioning activities.

11.4.1 Design Bases

The radioactive solid waste system is designed to:

(1) Package radioactive solid wastes for off-site shipment and disposal in accordance with the applicable Nuclear Regulatory Commission and Department of Transportation (DOT) regulations. DOT approved steel or high integrity liners and shipping containers are used for the packaging of dry solid wastes, solidified liquid waste, spent resins, and spent filter cartridges.

(2) Achieve system safety compliance requirements by the equipment layout, shielding, accurate radiation and process monitoring, and remotely operated and reliable equipment.

(3) Contain selected equipment and storage capacities which meet the station's solid waste processing requirements.

(4) DELETED

(5) Hold Dry Activated Waste (DAW) in designated storage areas.

(6) Collect and store dried spent filter cartridges and/or other similar dried radioactive waste in on-site storage containers.

(7) Collect and store DAW in Sea/Land type containers

(8) *Store three canisters of Greater Than Class C radioactive waste in three* concrete casks on the ISFSI pad.

11.4.2 System Description

The types of wastes handled and processed include the following:

(1) Demineralizer spent resins

(2) Expended cartridge filter elements

(3) Contaminated dry wastes consisting of air filters, miscellaneous paper, rags, etc., from contaminated areas; contaminated clothing; tools and equipment parts; and solid laboratory wastes.

The estimated volumes and the activities and isotopic contents of solid wastes are given in Reference 11.2-1, the Annual Radioactive Effluent and Waste Disposal Report.

11.4.2.1 Handling of Spent Resins

Spent resins from radioactive demineralizers are handled/disposed of by using temporary equipment and plant procedures.

11.4.2.2 Handling of Dry Solid Wastes

Contaminated DAW and metallic materials are placed into suitable transport packages, for storage and transport to a waste processor and/or disposal. Equipment too large to be handled in this way are first cut into small pieces before placement in the packages.

11.4.2.3 GTCC Waste Storage

The GTCC waste is stored in three stainless steel canisters which have been evacuated of water, filled with helium and welded shut. Each canister is stored within a concrete cask on the ISFSI pad. The canister and casks are described in reference 11.4.1.

REFERENCES

11.4-1 NAC-MPC Final Safety Analysis Report (FSAR), Docket 72-1025

11.5 PROCESS AND EFFLUENT RADIOLOGICAL MONITORING

11.5.1 Process Radiological Monitoring

Since all spent fuel have been removed from the Spent Fuel Pool and stored at the ISFSI, process radiation monitoring is no longer required. Area monitoring for personnel protection during decommissioning is controlled by Health Physics Procedures.

11.5.2 Effluent Radiological Monitoring - DELETED

REFERENCES

11.5-1 Haddam Neck Plant, Docket No. 50-213, Radiological Effluent Monitoring and Offsite Dose Calculation Manual

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CHAPTER 12

RADIATION PROTECTION

12.1 ENSURING THAT OCCUPATIONAL RADIATION EXPOSURES ARE AS LOW AS IS REASONABLY ACHIEVABLE (ALARA)

It is Connecticut Yankee Atomic Power Company (CYAPCO) corporate policy to implement a program that meets the intent of 10 CFR 20 and ensure that occupational radiation exposures are kept "as low as reasonably achievable" (ALARA). 98-04 3/98

The ALARA program ensures that:

- Annual exposures (rem) to individual personnel are ALARA;
- Annual collective exposures (person-rem) to all personnel are ALARA; 98-04 3/98
- Individual exposures within various work groups are balanced to be consistent with experience, manpower availability and existing agreements.

In addition, annual man-rem targets are established to ensure that exposures are maintained ALARA.

REFERENCES

12.1-1 CY Decommissioning Project, Health Physics Procedure GGGR-R0021 Radiological Work Control Program (RPM 2.1-0).

12.3 RADIATION PROTECTION DESIGN FEATURES

12.3.1 Facility Design Features

The radiation shielding was designed to ensure that the criteria specified in 10 CFR 20, "Standards for Protection Against Radiation," would be met with the plant at a power level of 1,825 Mwt. However, the Haddam Neck Plant has permanently ceased power operations and the fuel has been permanently moved from the spent fuel pool, and stored at the ISFSI. Since all fuel resides at the ISFSI, and will never be returned to the plant, radiation shielding is only required at the ISFSI as part of the NAC-MPC system design.

12.3.2 Shielding

Fuel Handling Shielding

The NAC-MPC canister has 5/8 inch cylinder walls with a 5 inch and 3 inch shield and structural lids. The canister is contained in a concrete cask with side walls constructed of 3.5 inches of steel and 21 inches of concrete as described in reference 12.3-1.

12.3.3 Area Radiation Monitoring Instrumentation

Area monitoring for personnel protection during decommissioning is conducted on an as needed basis in accordance with Health Physics Procedures.

REFERENCES

12.3-1 NAC-MPC Final Status Safety Analysis Report (FSAR), Docket 72-1025.

12.5 HEALTH PHYSICS PROGRAM

12.5.1 Organization

The health physics program is established to provide an effective means of radiation protection for employees and visitors at the station. To provide an effective means of radiation protection, the health physics program incorporates a philosophy from management (Section 12.1); employs qualified personnel to supervise and implement the program (Section 13.2); provides appropriate equipment and facilities; and utilizes written procedures designed to provide protection of station personnel against exposure to radiation and radioactive materials in a manner consistent with Federal and State regulations (Section 13.5). The health physics program was developed and is implemented based upon regulations, and regulatory and industry guidance.

Station procedures and policies provide the overall guidance for establishing the health physics program. Programmatic procedures and policies provide the requirements and philosophies from which station implementing procedures are derived.

The Health Physics Manager shall meet or exceed the qualifications for Radiation Protection Manager in Regulatory Guide 1.8, Revision 1. Health Physics technicians shall meet or exceed the qualifications specified in ANSI N18.1, 1971. Additional information on the qualifications and experience of the Health Physics personnel can be found in CYQAP.

The Health Physics Department provides health physics coverage for activities that involve radiation or radioactive material.

The assigned personnel are responsible for measuring the radioactive content of liquid effluents from the site in accordance with plant procedures, the CY QAP and 10 CFR 20.

12.5.2 Equipment, Instrumentation, Facilities

The criteria for purchasing the various types of portable and laboratory equipment used in the Health Physics Department are based on several factors. Portable survey and laboratory radiation detection equipment is selected to provide the appropriate detection capabilities, ranges, accuracy and durability required for the expected types and levels of radiation anticipated during decommissioning or emergency conditions. Respiratory protection equipment such as respirators, self-contained breathing apparatus, and respirator filters is consistent with the guidance in 10 CFR 20 and/or National Institute for Occupational Safety and Health (NIOSH). Respiratory protection equipment is used and stored in accordance with station procedures.

Health physics equipment, such as portable survey meters, is maintained by the Health Physics Department. Equipment, such as personnel air samplers, is available from the Health Physics Department and will be used at the discretion of the Health Physics Manager or designee.

Portable instruments for measuring radiation or radioactivity are used as required by 10 CFR 20. Calibration of all portable health physics instrumentation is performed within frequencies specified by procedural requirements. Calibration and maintenance procedures shall be followed for each specific type of instrument. Records of calibration and maintenance of each instrument are maintained at the station. Calibrations are performed using radiation sources of known activity, traceable to the National Institute of Standards and Technology. Calibration of equipment is performed in the Calibration Laboratory or other appropriate facilities.

The Health Physics and Chemistry laboratory instruments are checked at regular intervals to determine counting efficiencies, proper voltage settings, and background count rates. Records are maintained for each instrument or counting system. Repair and maintenance of laboratory equipment is performed by station personnel or through vendor repair contracts.

A Radiologically Controlled Area/Radiological Control Area (RCA) is an area posted with an RCA boundary sign for the purpose of protecting individuals from exposure to radiation and/or radioactive materials. Dosimetry is always required within an RCA. Portal monitors and/or friskers and/or personnel contamination monitors are provided to detect the spread of radioactive contamination. At the discretion of the Health Physics Manager, a personnel contamination monitor or frisker is placed in specific areas at the station where contamination or the potential for contamination may be present. Areas are surveyed and posted in accordance with 10 CFR 20. Access to high radiation areas is controlled in accordance with the CY QAP and in accordance with 10 CFR 20.

Health physics services and facilities are developed to provide workers the necessary protection and controls for work in radioactive environments. The health physics facilities are located at the plant site. Personnel decontamination supplies and equipment are available on site. A low background counting room is used for counting and/or identifying radioactivity in samples. All personnel entering contaminated areas are required to wear protective clothing.

Protective clothing is cleaned and decontaminated at a vendor laundry or on-site laundry, or is disposed of as radioactive waste. Appropriate written procedures govern the decontamination facilities for personnel and equipment. Respiratory protective equipment is available to station personnel and is issued to individuals as required by the actual or potential radiological conditions of the work assignment. The respiratory protection program complies with 10 CFR 20, Subpart H. Respiratory protection equipment is stored at designated locations.

All respiratory equipment is cleaned, sanitized, repaired, and decontaminated at station or vendor cleaning facilities.

The official and permanent record of accumulated external radiation exposure received by station personnel and support personnel is obtained principally from the interpretation of thermoluminescent dosimeters (TLDs) or equivalent. Persons likely to exceed 10 percent of the annual occupational radiation exposure limits are issued TLDs. Direct-reading pocket ion chambers (PICs) and/or electronic dosimeters are issued as a method for tracking incremental gamma exposure. Special or additional dosimetry, such as finger ring dosimeters, multiple whole body TLDs, and audible-alarm dosimeters, are issued as necessary to ensure exposures are monitored in accordance with regulatory requirements. Personnel dosimetry complies with the applicable performance provisions of 10 CFR 20.1501(c). Except for TLDs used in emergency kits, TLDs are processed periodically in accordance with Health Physics procedures by a dosimetry laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP). TLDs can be processed promptly, if necessary. Dosimeter records furnish the exposure data for the administrative control of radiation exposure. Exposure records for each individual are maintained in accordance with the guidance of 10 CFR 20, Subpart L.

12.5.3 Procedures

Access to restricted/radiological areas is controlled by administrative measures as required by 10 CFR 20, Subparts G and J. Station management controls entry to high radiation areas through the administration of RWPs that specify, as applicable, purpose of entry, work location, radiological conditions, surveillance and dosimetry requirements, protective clothing, respiratory protective equipment, and special personnel monitoring devices.

RWPs are issued for routine and nonroutine activities performed in radiation areas, contaminated areas, airborne radioactivity areas, and for all activities that require entrance into high radiation areas as defined in 10 CFR 20, Section 20.1003. RWPs are also issued prior to maintenance or inspection of contaminated or radioactive equipment with removable contamination in excess of 1,000 dpm/100cm^2 beta-gamma and/or 20 dpm/100cm^2 alpha. Under limited situations, such as an emergency that threatens personnel or plant safety, and at the discretion of the Health Physics Manager or designee, continuous health physics personnel coverage may be substituted for an RWP.

Health physics personnel routinely survey selected areas of the plant to assess and control exposure to radiation and radioactive materials in accordance with 10 CFR 20, Section 20.1501. Depending on the type of survey required and anticipated types and levels of radioactivity, various portable instruments and techniques are used to perform these surveys. Health Physics records are maintained in accordance with 10 CFR 20, Subpart L. Reporting practices for all normal and accident conditions comply with the regulations set forth in 10 CFR 20, Subpart M. Area surveys are performed at scheduled frequencies, based on location, radiation levels, and occupancy. All area survey readings are recorded and filed as required by 10 CFR 20, Section 20.2103. Areas are posted to comply with the requirements of 10 CFR 20, Section 20.1902. Surveys for contamination are used to assess containment of radioactive materials and the need for decontamination of an area. Contamination is measured at selected locations throughout the plant where the potential for the spread of contamination exists. Contamination surveys are made using the "smear" or "swipe" technique, or by using an appropriate portable instrument. Scheduled frequencies are based on location, radiation levels, plant status and occupancy, or as required by actual operating conditions, and as directed by the Health Physics Manager or designee. Contamination surveys are also performed on personnel and equipment to ensure that radiological control methods are adequate. Personnel, equipment, and material leaving the contamination areas are monitored to prevent the spread of contamination into clean areas. Areas, equipment, and personnel that may be contaminated with radioactive material are decontaminated using applicable methods and techniques. Contamination levels are also used to judge the potential for airborne radioactive material and the need for monitoring air and the use of engineering controls or respiratory protection.

Management's intent is to control airborne radioactivity levels as effectively as practicable by proper preventive measures, engineering controls, and good housekeeping techniques. In the event of a radioactive airborne problem, every effort is made to promptly assess the situation.

Control of airborne radioactivity levels is ensured through use of heating, ventilation, and air-conditioning (HVAC) equipment and portable air movers and filters. Filtered ventilation provides controlled air movement and filtration capability for areas with high potential for airborne radioactivity problems. Special control techniques are used to minimize airborne exposure arising from special work projects. Respiratory protection equipment is available for use in those situations where airborne radioactivity hazards warrant its use. The special control techniques used to minimize airborne exposure include decontamination of the component or area prior to performing work, keeping work surfaces damp while work is in progress, and using tents or glove bags in conjunction with appropriate filtered ventilation systems.

The air sampling program provides information on the potential inhalation of radioactive material by workers. The information is used to determine what remedial action or protective measures such as respirators, glove boxes, or engineering controls are necessary to protect the worker. Air samples are taken for all work on systems that have the potential for creating an airborne radioactivity area. Surveys are performed on a routine basis, depending on location and occupancy.

Prior to issuance of respiratory protection equipment, each individual must have satisfactorily completed the following:

(1) A medical evaluation to ensure that the individual is medically fit to use respiratory protection devices.

(2) Training for the device to be used.

(3) A fit test (for face-sealing devices only)

Procedures have been implemented to control the handling and movement of material within and from restricted and radiologically controlled areas, such as the shipment and receipt of radioactive materials. These procedures comply with the regulations stipulated in 49 CFR Parts 172 through 177, and 10 CFR Parts 20, 70 and 71.

Personnel, who are likely to exceed 10 percent of the annual occupational radiation exposure limits, receive a TLD and PIC and/or electronic dosimetry to monitor personnel exposures. Exposure records are filed and retained for each individual as required by 10 CFR 20, Subpart L. Reports of overexposures and excessive levels and concentrations comply with the regulations of 10 CFR 20, Subpart M. Reports of personnel monitoring and reports of theft or loss of licensed material are issued in accordance with the regulations required by 10 CFR 20, Subpart M.

Monitoring of internal radiation exposure for personnel who enter radiological areas is achieved primarily through air sampling and bioassays. The bioassay program meets the requirements of 10 CFR 20.1204.

Station employees, contractors, and other supporting personnel are given orientation training at the beginning of their work assignments. All personnel who work in radiological areas are required to successfully complete basic training courses, lectures, and/or practical exercises to demonstrate their proficiency and competence. The Health Physics Training Program maintains the proficiency of employees through training and periodic retraining lectures and exercises. 98-04 3/98

Personnel are given training followed by written and practical tests designed to meet the objectives of 10 CFR 19.12. The content of the Health Physics Training Program meets the intent of Regulatory Guides 8.13, Revision 2; 8.27, Revision 0; and 8.29, Revision 0. Assessments shall be performed periodically (at least annually) to review the radiation protection program content and implementation (10 CFR 20.1101(c)). 98-04 3/98

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CONDUCT OF OPERATIONS

13.1 ORGANIZATIONAL STRUCTURE

Northeast Utilities System (NU) owns 49 percent of the Haddam Neck Plant (HNP) and is the parent company of the following electric utility subsidiaries:

(1) The Connecticut Light and Power Company (CL&P)

(2) Western Massachusetts Electric Company (WMECO)

(3) Holyoke Water Power Company (HWP)

(4) Public Service Company of New Hampshire (PSNH)

The remaining 51 percent ownership of the HNP is held by other New England electric utilities.

Connecticut Yankee Atomic Power Company (CYAPCO) is the licensee and operator of the HNP and provides licensing, engineering, design and construction services. Some technical and administrative support services are provided by outside contractors as needed including fuel management, materials procurement, and nuclear records maintenance and retention for the spent fuel storage operation and decommissioning of the HNP.

CYAPCO was responsible for the design, construction and operations of the HNP. However, CYAPCO has decided to permanently cease power operations and the fuel has been permanently removed from the reactor vessel, Reference 1.1-1.

13.1.1 Organization

The management and technical support organization is provided by CYAPCO. CYAPCO is responsible for the spent fuel storage and decommissioning activities. These activities are coordinated between the support organizations with CYAPCO having lead responsibility for an activity. CYAPCO is committed to ensuring that it maintains an organization and adequate resources to provide both onsite and offsite technical support for spent fuel storage, and decommissioning of the HNP. The organization is maintained in accordance with the Connecticut Yankee Quality Assurance Program and the Operating License.

13.2 TRAINING PROGRAMS

Formal training programs have been established to train and qualify the personnel who operate the ISFSI and decommission the Haddam Neck Plant.

13.3 EMERGENCY PLANNING

The Connecticut Yankee Atomic Power Company, Haddam Neck Plant, Emergency Plan, describes CYAPCO's plan for responding to emergencies that may arise while spent nuclear fuel and GTCC waste are stored at the ISFSI and to emergencies that may arise at the HNP site during on going decommissioning activities.

13.4 REVIEW AND AUDIT

On-site reviews, independent reviews, and audits of activities shall be implemented in accordance with the Connecticut Yankee Quality Assurance Program (CYQAP) for the Haddam Neck Plant.

13.5 PLANT PROCEDURES

Written procedures are established, implemented and maintained in accordance with the Haddam Neck Plant (HNP) Connecticut Yankee Quality Assurance Program.

13.6 PHYSICAL SECURITY PLANS

The Haddam Neck Plant Physical Security Plan provides the security measures for the protection of the Haddam Neck ISFSI and complies with the requirements of 10 CFR 73.55 (with approved exemptions).

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ACCIDENT ANALYSES

15.1 SUMMARY

In December of 1996, Connecticut Yankee Atomic Power Company (CYAPCO) certified to the NRC of the permanent cessation of operations of the Haddam Neck Plant (HNP) and that all of the fuel assemblies have been permanently removed from the Reactor Vessel and placed in the Spent Fuel Pool (Reference 15.1-1). Since the HNP will never again enter any operational mode, reactor related accidents are no longer a possibility. Therefore, this chapter of the Updated Final Safety Analysis Report (UFSAR) has been revised to delete the reactor and spent fuel pool storage related accidents. All of Spent Fuel and GTCC waste have been removed from the spent fuel pool and transferred to the ISFSI.

Conservatism in equipment design, conformance to high standards of material and construction, the control of mechanical and pressure loads, the control of the environment of material exposure, and strict administrative control over plant operations all serve to assure the integrity of the spent fuel assemblies in dry storage casks at the ISFSI. Similar designs and conformance controls mitigate the consequences of radioactive releases from postulated subsystems or components.

15.2 RADIOACTIVE WASTE SYSTEM FAILURE

All spent fuel has been removed from the reactor and the spent fuel building and is maintained in dry storage at the ISFSI. The relocation of the spent fuel has eliminated fuel handling as a potential accident source as well as the potential for any storage cask transportation events. Events that may result in a radioactive release are limited to failures in the solid radioactive waste system.

15.2.1 Identification of Causes and Accident Description

One accident is an uncontrolled release of airborne radioactivity from the solid waste disposal system.

15.2.2 Solid Waste System Failure

The current accident considered is the release of airborne radioactivity due to a fire involving dry radioactive waste. During the initial years of decommissioning, a fire involving burning resin was considered bounding because class C resin was being produced and dewatered in plastic High Integrity Containers (HICs) where the potential for an exothermic reaction causing a fire existed. All resin used at the site for the remainder of the decommissioning will be contained in metal vessels and dewatering for disposal at an offsite radioactive waste processing facility. Resin waste will no longer be collected or stored in poly HICs for dewatering. Therefore the resin fire accident is no longer a credible accident.

The current bounding accident analysis (ref. 15.2-14) assumes an 1800 cubic foot pile of Dry Active Waste with a dose rate of 100 millrem per hour at 30 centimeters burns uncontrollably and releases 0.5% of the material to the atmosphere. The curie content of the waste is based on a conservative mixture of radionuclides that exist in HNP waste from actual samples. Administrative controls at the site ensure that a pile of DAW of this magnitude will not be exceeded and therefore the analysis is conservative. The release fraction of 0.5% as described in Reference 15.2-14 is considered bounding for a fire of this type.

The accident analysis takes no credit for filtration, confinement inside a building, or plateout of particulated on building surfaces.

The site boundary TEDE dose due to a DAW fire accident is bounded at 0.0014 Rem. This dose is much less than the EPA Protective Action Guidelines (Reference 15.2-3).

15.2.3 Liquid Waste System Failure – DELETED

15.2.4 Other Decommissioning Activity Accidents

Other accidents involving the release of radioactive airborne particulate may possibly occur during decommissioning. Accidents that have been evaluated include:

- A radiological HEPA filter rupture
- A dropped component being removed from the site
- Segmentation of components or structures during loss of local engineering controls.
- An oxyacetylene explosion while performing cutting of radiologically contaminated components.
- An explosion of liquid propane gas leaked from a front-end loader while handling radiologically contaminated components.

The actual radioactivity available for release from the components involved in the types of accidents listed above will be estimated based on surface dose measurements and calculations. The decommissioning activity involving those components will be controlled by limiting the quantities of radioactivity, or by engineering or design controls, to ensure that the amount of radioactivity that can be released is within the bounds of the dry active waste fire accident.

Therefore, the dry active waste fire accident calculated in Section 15.2.2 bounds the dose effects of the other types of decommissioning activity accidents listed in this section.

REFERENCES

15.2-1 Safety Guide 24, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Pressurized Water Reactor Radioactive Gas Storage Tank." U.S. Nuclear Regulatory Commission, March 23, 1972.

15.2-2 "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I", Regulatory Guide 1.109, Rev. 1, U.S. Nuclear Regulatory Commission, October 1977.

15.2-3 EPA 400-R-92-001, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents," U.S. Environmental Protection Agency, October 1991.

15.2-4 NRC Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants", dated August, 1979.

15.2-5 Code of Federal Regulations, Title 10, Part 100, "Reactor Site Criteria."

15.2-6 DELETED

15.2-7 Code of Federal Regulations, Title 10, Part 20, "Standards for Protection Against Radiation".

15.2-8 NUREG 0782, Environmental Impact Statement on 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste", September, 1981.

15.2-9 10 CFR 61.55, Criteria for Disposal of Radioactive Material, 1/1/97 edition.

15.2-10 CY Calculation, CY RESIN 2-01666 RY, Rev. 0, Resin Source Terms and Accident Dose Analysis, July 7, 1999.

15.2-11 DELETED

15.2-12 Health Physics Department Technical Support Document BCY-HP-007

15.2-13 NUREG-0586, Final Generic Environmental Impact Statement, August 1988

15.2-14 CY Health Physics Department Technical Support Document CY-HP-0199, Revised Analysis of Consequences of DAW Fire and other Radiologically related fires for Elimination of Insipient Fire Brigade and Fire Suppression System, March 22, 2005.

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TECHNICAL SPECIFICATIONS

Technical Specifications set forth the limits, operating conditions and other requirements for the protection of the health and safety of the public. These specifications have been written in fulfillment of 10 CFR 50.36 and are controlled pursuant to 10 CFR 50.90, 50.91, and 50.92.

Technical Specifications include:

(1) Definitions

(2) Safety Limits and Limiting Safety System Settings

(3) Limiting Conditions for Operation

(4) Surveillance Requirements

(5) Design Features

(6) Administrative Controls

Technical Specifications are maintained as Appendix A to the operating license.

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QUALITY ASSURANCE

17.1 CONNECTICUT YANKEE QUALITY ASSURANCE PROGRAM

Connecticut Yankee Atomic Power Company (CYAPCO) has developed and is implementing a comprehensive Quality Assurance Program to assure conformance with established regulatory requirements, set forth by the Nuclear Regulatory Commission (NRC), and accepted industry standards. The participants in the Connecticut Yankee Quality Assurance Program (CYQAP) assure that the design, procurement, construction, testing, operation, maintenance, repair, and modification of nuclear power plants are performed in a safe and effective manner.

The CYQAP complies with the requirements set forth in Appendix B, of 10 CFR Part 50, along with applicable sections of the Updated Final Safety Analysis Report (UFSAR) for the license application, and is responsive to Regulatory Guide 1.70, which describes the information presented in the Quality Assurance Section of the UFSAR for nuclear power plants. 98-16 7/98

This CYQAP is also established, maintained and executed with regard to Radioactive Material Transport Packages as allowed by 10 CFR 71.101(f).

The CYQAP is submitted periodically to the NRC in accordance with 10 CFR 50.54(a).