NFPA 20 "Centrifugal Fire Pumps"

Code Compliance Evaluation

Unit 1 and 2

Donald C. Cook Nuclear Plant

December, 1988

Patrick Russell

Mechanical Review Performed By:
P.J. Russell
Nuclear Engineering Department
PH&F Section

J.D. Markham

Electrical Review Performed By:
J.D. Markham
Nuclear Engineering Department
I&C Section

JD Grier

Approved By:
J.D. Grier
Nuclear Engineering Department
PH&F Section Manager

9201140272 911202
PDR ADOCK 05000315
F PDR

NFPA 20 Code Compliance Evaluation

For

Donald C. Cook Nuclear Plant

Units 1 and 2

Indiana Michigan Power Company

Prepared by:

Piping, Valves, HVAC & Fire Protection Section

American Electric Power Service Corporation

Report Initiated

December, 1988

Table of Contents

1.0 Introduction

1.1 Overview

This binder contains the results of American Electric Power Service Corporation's (AEPSC) review of the Cook Nuclear Plant's centrifugal fire pump system for its compliance with the National Fire Protection Association (NFPA) Codes. This code compliance review specifically deals with the four high demand fire pumps, as well as the low demand fire pump. These pumps have been evaluated against NFPA 20 "Centrifugal Fire Pumps".

1.2 Background

In developing our Fire Protection Commitment Data Base, it was found that AEPSC had committed to NFPA 20. AEPSC engineers were assigned to review, evaluate and justify code compliance issues for this code. The results of their reviews are contained in this report.

1.3 Scope of Work

This analysis evaluates the centrifugal fire pumps installed at the Donald C. Cook Nuclear Plant to the requirements of NFPA 20. The 1969 edition of NFPA 20 was the edition under which the system was originally installed and therefore, this is the edition year upon which the system has been evaluated.

The fire pumps are to be evaluated against the code requirements to determine compliance, noncompliance and open items. Deviations are to be reevaluated to determine whether each item could be deemed acceptable "as installed" based upon credited plant procedures or past practices at the plant. Deviations and open items which cannot be justified on these bases or on changes to the specific code requirements in later editions, are then to be evaluated based on engineering judgements, calculations, analysis of plant design features, field reviews etc. In instances where the deviation cannot be justified, modifications are to be made to the systems. All justifications, evaluations and recommended modifications are described in the Code Compliance Verification Checklist portion of this report.

The areas of the plant that have been reviewed include:

- Units 1 and 2 Diesel Fire Pump Rooms in the Screenhouse (Fire Zone (FZ) 28 and 30).
- Units 1 and 2 Turbine Building Pump Bays (FZ 2).

Two chapters of NFPA 20 are not applicable to the Donald C. Cook Nuclear Plant. These chapters are as follows:

- Chapter 300 "Special Fire Service Pumps".
- Chapter 800 "Steam Turbine Drive".

Neither of these chapters apply since these types of fire pumps and drivers are not utilized at the Cook Nuclear Plant.

Future modifications to the fire pump systems are to be evaluated for NFPA 20 code compliance. Any noted deviations and/or justifications will be documented and contained within this report.

1.4 Fire Protection Systems Reviewed

The fire pump systems which have been reviewed are identified below:

Fire Area	Fire Zone	Unit	Fire Pump Description
B	2	1	Unit 1 High Demand Electric
B	2	1	Unit 1 Low Demand Electric
B	2	2	Unit 2 High Demand Electric
B	28	1	Unit 1 High Demand Diesel
B	30	2	Unit 2 High Demand Diesel

1.5 General Assumptions

This report utilized the following general assumptions shown below:

(1) Specifications and drawings were used to evaluate the piping, fittings and miscellaneous hardware used in the fire pump systems to confirm compliance with the requirements of NFPA 20 in effect at the time of installation

(2) Workmanship and construction practices during installation of the pumps complied with the code requirements in effect at the time.

(3) It is assumed that all surveillance tests and procedures are properly implemented.

2.0 Purpose

The purpose of NFPA 20 is "to provide a reasonable degree of protection for life and property from fire through installation requirements for centrifugal fire pumps based upon sound engineering principles, test data and field experience. Guidelines are established for the design, installation and maintenance of these pumps, pump drivers and associated equipment. The standard endeavors to continue the excellent record that has been established by centrifugal pump installations and to meet the needs of changing technology. Nothing in this standard is intended to restrict new technologies or alternate arrangements providing the level of safety prescribed by the standard is not lowered."

With this statement in mind, it should be understood that it is recognized that the fire pumps installed at Donald C. Cook Nuclear Plant do not meet this standard verbatim. It is also recognized that the fire pump system is not below the level of safety prescribed per NFPA 20. The plant's fire pump system reliability is derived through redundancy and independence. The following system description should help the reader understand the level of protection at the Donald C. Cook Nuclear Plant.

Two 2,000 gpm at 152 psi horizontal centrifugal electric motor driven fire pumps, two 2,000 gpm at 152 psi diesel driven, vertical turbine fire pumps and a 500 gpm at 152 psi horizontal centrifugal electric motor driven fire pump are provided for the fire water system. These fire pumps discharge into underground ring headers around the outside of the plant and into the interior ring header in the Turbine Building. This arrangement forms a series of smaller interior-exterior loops connected through isolating valves to assure flow from multiple directions.

The fire pumps are started automatically and sequentially so that the system can be supplied immediately with adequate quantities of water at the required pressure. The fire protection water flow may vary from as low as 30 gpm for a single sprinkler in operation to as much as 4,700 gpm for the combined flow, including hose streams, for the Unit 1 main transformer and Turbine Building wall exposure systems. One can see that more than enough pumps exist to supply even the largest water demand system. In fact, it can be argued that two of the 2,000 gpm fire pumps can marginally supply enough water for a fire on the largest demand system. Hence, it is evident that a great deal of redundancy was installed within the plant's fire pump arrangement.

The high demand electric fire pump motors are controlled from 600 V, electrically operated, draw out circuit breakers which are installed in metal clad switchgear enclosures qualified for Class I nuclear service. Each of the electric fire pump circuit breakers is powered from independent busses, and each bus can be energized from separate emergency diesel generators. The pumps and controllers are completely isolated from each other, the pump being located in a separate pump room and the controller (circuit breaker) located in a separate switchgear room. This is consistent with the control of nuclear safety related pumps installed at Donald C. Cook Nuclear Plant. Operation of the pumps is monitored and can be manually controlled form a centralized, continually manned control room. This is consistent with the basic philosophy of operating a nuclear generating unit. Control power for the breakers is supplied from a nuclear Class IE battery system. It is felt that the high demand electric fire pump controllers, being of the same type and quality as those for safety related equipment, are adequate to meet fire protection requirements. They have proven to be reliable.

The redundancy of fire pumps and the complete independence of operation of one fire pump to another (including power sources) provides overall system reliability far greater than can be achieved by a single pump installation meeting the specific requirements of NFPA 20.

3.0 Methodology

NFPA 20 was broken down into two distinct categories (electrical and mechanical). The Piping, Valves, HVAC and Fire Protection Section of the Nuclear Engineering Department was tasked with evaluating all of the mechanical chapters contained within this code (chapters 1, 100, 200, 600 and 900). The Instrumentation and Control Section of the Nuclear Engineering Department was tasked with evaluating all electrical chapters contained within this code (chapters 400, 500 and 700).

NFPA 20 was reviewed in depth to determine which sections specifically addressed the ability of the plant's fire pumps. Code Sections covering topics, such as; information only, references to other NFPA codes, construction or equipment arrangement and nonrelevant types of occupancies were not included in this evaluation as these subjects do not affect the ability of these fire pumps.

The mechanical portion of this review was performed by both a field walkdown (see NFPA 20 Walkdown Checklist portion of this binder) and a document search. A summary of their results is contained in the Mechanical Section f the NFPA 20 Compliance Evaluation portion of this binder. One can see that each paragraph of the code was evaluated for compliance/non-compliance.

The electrical portion of this review was performed by a document search as well as a field walkdown conducted by cognizant Electrical/I&C Engineering personnel. A summary of their results is contained in the Electrical Section of the NFPA 20 Compliance Evaluation portion of this binder. Once again, one can see that each paragraph of the code was evaluated for compliance/noncompliance.

This evaluation lists the applicable code sections; whether the fire pumps did/did not comply or if the code sections are not applicable to the fire pumps; and comments or justifications for each noncomplying/not applicable section. This evaluation also has an additional column to identify the documents reviewed for verification of the specific code sections. One can see that each paragraph of the code was evaluated for compliance/noncompliance.

In addition to the above mentioned portions of this binder, there also exists a "correspondence" section (attachment 1), as well as a section that contains a copy of the 1969 edition of NFPA 20 (attachment 2).

4.0 Conclusions/Recommendations

This evaluation concluded that the Donald C. Cook Nuclear Plant's fire pump installation is generally in compliance with NFPA 20. The fire pump systems were evaluated against the code requirements of the 1969 edition to determine compliance, noncompliance and open items. Deviations were reevaluated to determine whether each item could be deemed acceptable "as installed" based upon credited plant procedures or past practices at the station. Deviations and open items which could not be justified are identified within these text and their recommendations are identified below.

4.1 1969 Code Edition Year (1988 Review Year)

4.1.1 Install new batteries that have sufficient capacity to maintain the engine manufacturer's recommended cranking speed during the following 5 minute cycle (15 seconds crank and 15 seconds rest in 12 consecutive cycles). These batteries shall be installed per Request For Change No. 3028.

5.0 References (Technical Data)

5.1 Mechanical References - 1969 Code Edition Year (1988 Review Year)

1. PSAR, Section 9.8.1 Fire Protection, 1968
2. Specification DCC-HP-122QCS, Fire Pumps, 07-14-69
3. Specification DCC-HP-121QCS, Diesel Engine, 07-07-69
4. 10221-831-0, Diesel Engine Purchase Order, 11-14-69
5. 09563-821-9, Fire Pump Purchase Order, 10-30-69
6. PO-050-508, Pre-operational Test Fire Protection Water, 07-03-74
7. Pump Curve 2896693, Peerless Pump Electric Driven Low Demand Fire Pump Curve, 06-03-70
8. Pump Curve 2896692, Peerless Pump Electric Driven High Demand Fire Pump Curve, 06-03-70
9. Pump Curve 2897027, Peerless Pump Engine Driven High Demand Fire Pump Curve, 08-20-70
10. SD-DCC-HV-105, Turbine Building Ventilation; System Description, 02-03-88
11. SD-DCC-FP-101, Fire Protection System - Water; System Description, 01-17-75
12. DCC-PM-104QCS, Piping Specification, 11-09-72
13. DCC-PM-102QCS, Shop and Field Fabrication and Erection, 05-24-73
14. Drawing #12-5152A, Flow Diagram Fire Protection - Water, 03-23-88

15. Drawing #1-FP-14, Piping Isometric, 12-XX-70

16. Drawing #1-FP-4, Piping Isometric, 12-XX-70

17. Drawing #2-FP-X-2, Piping Isometric, 12-XX-70

18. Drawing #1-FP-X-1, Piping Isometric, 12-XX-70

19. NAVCO Piping Data Log, 1984

20. Drawing #2-5114, Flow Diagram Non-essential Service Water, 11-13-87

21. Drawing #1-5114, Flow Diagram Non-essential Service Water, 04-27-88

22. Cameron Hydraulic Data, 1977

23. Drawing #12-5152A, Flow Diagram Fire Protection - Water Piping at Pump, 01-XX-87

24. FSAR (10.6), Circulating Water System, 07-XX-82

25. Drawing #2-FP-37, Piping Isometric, 05-XX-71

26. Drawing #2-NSW-30, Piping Isometric, 08-26-86

27. Letter from J.D. Grier to J.G. Feinstein, "Diesel Engine Fire Pumps", 08-26-86

28. SD-DCC-HP-119, Circulating Water; System Description, 04-23-87

29. SD-DCC-HP-105, Non-essential Service Water; System Description

30. Underwriters Laboratories Fire Protection Equipment Directory, 01-XX-87

31. Drawing #12-5152, Flow Diagram Fire Protection - Water Yard Piping, 02-XX-87

32. Drawing #MS-1, Fire Pump Arrangement, 12-05-69

33. FSAR (2.6), Limnology and Ecology, 07-XX-86

34. Peerless Pump Installation Manual, Installation Instructions Water Lubricated Vertical Turbine Pumps, N/A

35. Letter from Peerless Pump to AEPSC "Quotation Duplicate Pump S/N 364877-78", 01-31-78

36. Peerless Pump Form #2881604, Replacement Parts Specifications Pump S/N 364877-78, N/A

37. Letter from J.D. Grier to J.A. Kobyra, "Fire Pump Impellers", 09-12-86

38. TM-5029 Allis Chalmers; Operating and Maintenance Manual 25000 Mark II Engines and Power Units, N/A

39. Letter from Peerless Pump to AEPSC, "Fire Protection Pumps - U.L. Listing", 03-03-84

40. Fire Hazards Analysis, Rev. 2, 01-29-88

41. Factory Mutual System Approval Guide, 1984

42. 12.THP.6040.PER.001, Performance Test Procedure, 07-30-87
NOTE: This includes all tests results that have been performed in accordance with this procedure.

43. SD-DCC-HP-113, Vacuum Priming; System Description, 04-19-84

44. Letter from Peerless Pump to AEPSC, "Pearless Job No. 83575-V", 03-24-70

45. Letter from Peerless Pump to AEPSC, "Two Vertical 2000 GPM Pumps", 03-20-70

46. Letter from AEPSC to Rudox Engine and Equipment Company, "AEP Order #10221-821-9", 04-20-70

47. Memo from G. Hines to P.J. Russell, "Re: Diesel Fire Pumps", 07-21-88

48. Drawing #OA-4585-26, Heat Exchanger, 04-30-68

49. DELETED

50. PO-06492-821-1, Purchase Order; Diesel Fire Water Pump Fuel Oil Storage Tank, 1971

51. Drawing #TK-46, Niles Steel Tank Company, 11-04-71

52. Letter from Perless Pump to AEPSC, "Engine Driven Fire Pump", 07-23-71

53. Donald C. Cook, Section 3/4.7.9 Technical Specifications, Fire Suppression Systems, 07-16-86

54. Donald C. Cook Plant, Chrono File: ME-PP-PP-011; Entire File

55. Product Catalog, LaMarche, N/A "Capabilities in Electric Power"

56. 12.MHP.5021.001.034, Maintenance Procedure For Testing Relief Valves, 08-14-87

57. Letter from Peerless Pump to AEPSC "Donald C. Cook Nuclear Plant", 10-06-69

58. Letter from Peerless Pump to AEPSC "Donald C. Cook Plant Fire Protection Pumps U.L. Listing", 02-03-84

59. Letter from M.W. Cherry to Kadlec/Jensen/Williams/Jensen "Diesel Engine Driven for Fire Pumps, 10-03-69

60. 12-5152-P, Flow Diagram-Fire Protection-Diesel Fuel to Engine Driven Fire Pumps, 10-30-87

5.2 Electrical References

E1	National Electrical Code (NFPA No. 70)	1971
E2	Drawing 1-2-98966	06-18-88
E3	Drawing 1-2-98971	03-14-88
E4	Drawing 1-12002	10-06-86
E5	Drawing 2-12002	10-06-86
E6	Drawing 1-12014	10-06-86
E7	Drawing (Numerous Wiring Diagrams)	
E8	Drawings (Numerous Conduit & Cable Schedules)	
E9	ECP 1-2-Z0-02	07-14-88
E10	Relay Setting Sheets	
E11	Vendor Manual (LA Marche Battery Charges)	
E12	Donald C. Cook Voltage Performance Study	12-XX-85

Attachment 6.1

NFPA 20 Correspondence

NFPA 20 Code Compliance Evaluation

For

Donald C. Cook Nuclear Plant

Units 1 and 2

Indiana Michigan Power Company

AEP
AMERICAN
ELECTRIC
POWER

Date November 19, 1991

Subject **Cook Nuclear Plant**
Diesel Fire Pump Batteries/Racks Modifications
RFC-12-3094

From J. J. Kutys

To B. J. Gerwe

This is a response to your request to provide support to implement the above RFC. In review of the current PS&HF resources available, scheduled design changes, and discussions with the long range planning group we will support implementation of the RFC by the end of 1994.

If you have any questions and/or comments, please call the undersigned at extension 1966.

John Kutys
J.J. Kutys

cc: J.C. Jeffrey/J.R. Anderson
R.F. Kroeger
R.L. Shoberg
J.D. Grier

(125.jjk)

Intra-System

AEP
AMERICAN
ELECTRIC
POWER

Date August 9, 1991

Subject Cook Nuclear Plant
Fire Protection System
Fire Pumps

From P.J. Russell PJR 8-9-91

To J.C. Jeffrey

The purpose of this memo is to inform you of a significant change to RFC-12-3065, "Dedicated Fire Protection Water Supply," concerning the licensing process. NS&L has determined that it is necessary to maintain the existing diesel fire pumps as well as the new fire pumps being installed under the new water supply system. This mandate is a result of their concern that the NRC will eventually require the Cook Nuclear Plant to design the fire protection system to handle a simultaneous seismic and fire event.

This change will require us to maintain the existing fire pumps in accordance with all our existing commitments. As you know, one commitment is to be in full compliance with NFPA 20, "Centrifugal Fire Pumps." Hence, all of the concerns which were being addressed in RFC-12-3028 (which was cancelled) have to be reopened. We are requesting that you initiate a new RFC to address these concerns. This RFC is necessary in order to take full credit for the existing diesel fire pumps.

If you should have any questions or require additional information, please contact me at extension 2532.

PJR/th

cc: R.L. Shoberg
R.A. Green
J.D. Grier/B.J. Gerwe/P.J. Russell
File: RFC-12-3065
MF: Y [✓ N]

AEP
AMERICAN
ELECTRIC
POWER

Date February 20, 1991

Subject Cook Nuclear Plant
Diesel Fire Pump Battery Replacements
RFC-12-3028

From P.J. Russell PJR 2-20-91

To J.C. Jeffrey/M.J. Finissi

RFC-12-3028 is upgrading the existing diesel fire pump battery banks to meet the requirements stipulated in NFPA 20. Although the existing battery banks work (no known problems exist), they do not completely meet all the requirements we have committed to.

RFC-12-3065 is installing a new dedicated fire protection water supply. This new water supply will require the installation of new diesel fire pumps. Since it appears that the existing fire pumps will be retired in October of 1992, we would like to cancel RFC-12-3028.

Although we will not be in complete compliance with NFPA 20 until the installation of RFC-12-3065, we can take credit for the defense-in-depth fire protection philosophy to show that the "existing fire pump system" meets the intent of NFPA 20. This defense-in-depth philosophy is defined within the NFPA 20 Code Compliance Evaluation and is shown on Attachment 1 to this letter.

If you should have any questions or require additional information, please contact me at extension 2532.

PJR/gh Patrick J. Russell

Attachment

cc: R.L. Shoberg
P.H Jacques
J.D. Grier/B.J. Gerwe/P.J. Russell
File: NFPA 20 Code Compliance Evaluation

Intra-System

Attachment 1
Page 1 of 2

NFPA 20

"STANDARD FOR THE INSTALLATION OF CENTRIFUGAL FIRE PUMPS"

SCOPE:

This analysis evaluates the centrifugal fire pumps installed at the Donald C. Cook Nuclear Plant to the requirements of NFPA 20. The 1969 edition of NFPA 20 was the edition under which the pumps were installed and evaluated.

PURPOSE:

The purpose of NFPA 20 is "to provide a reasonable degree of protection for life and property from fire through installation requirements for centrifugal fire pumps based upon sound engineering principles, test data and field experience. Guidelines are established for the design, installation and maintenance of these pumps, pump drivers and associated equipment. The standard endeavors to continue the excellent record that has been established by centrifugal pump installations and to meet the needs of changing technology. Nothing in this standard is intended to restrict new technologies or alternate arrangements providing the level of safety prescribed by the standard is not lowered."

With this statement in mind, it should be understood that it is recognized that the fire pumps installed at Donald C. Cook Nuclear Plant do not meet this standard verbatim. It is also recognized that the fire pump system is not below the level of safety prescribed per NFPA 20. The plant's fire pump system reliability is derived through redundancy and independency. The following system description should help the reader understand the level of protection at the Donald C. Cook Nuclear Plant.

Two 2,000 gpm at 152 psi horizontal centrifugal electric motor driven fire pumps, two 2,000 gpm at 152 psi diesel driven, vertical turbine fire pumps and a 500 gpm at 152 psi horizontal centrifugal electric motor driven fire pump are provided for the fire water system. These fire pumps discharge into underground ring headers around the outside of the plant and into the interior ring header in the Turbine Building. This arrangement forms a series of smaller interior-exterior loops connected through isolating valves to assure flow from multiple directions.

The fire pumps are started automatically and sequentially so that the system can be supplied immediately with adequate quantities of water at the required pressure. The fire protection water flow may vary from as low as 30 gpm for a single sprinkler in operation to as much as 4,700 gpm for the combined flow, including hose streams, for the Unit 1 main transformer and Turbine Building wall exposure systems. One can see that more than enough pumps exist to supply even the largest water demand system. In fact, it can be argued that two of the 2,000 gpm fire pumps can marginally supply enough water for a fire on the largest demand system. Hence, it is evident that a great deal of redundancy was installed within the plant's fire pump arrangement.

The high demand electric fire pump motors are controlled from 600 V, electrically operated, draw out circuit breakers which are installed in metal clad switchgear enclosures qualified for Class I nuclear service. Each of the electric fire pump circuit breakers is powered from independent busses, and each bus can be energized from separate emergency diesel generators. The pumps and controllers are completely isolated from each other, the pump being located in a separate pump room and the controller (circuit breaker) located in a separate switchgear room. This is consistent with the control of nuclear safety related pumps installed at Donald C. Cook Nuclear Plant. Operation of the pumps is monitored and can be manually controlled from a centralized, continually manned control room. This is consistent with the basic philosophy of operating a nuclear generating unit. Control power for the breakers is supplied from a nuclear Class IE battery system. It is felt that the high demand electric fire pump controllers, being of the same type and quality as those for safety related equipment, are adequate to meet fire protection requirements. They have proven to be reliable.

The redundancy of fire pumps and the complete independence of operation of one fire pump to another (including power sources) provides overall system reliability far greater than can be achieved by a single pump installation meeting the specific requirements of NFPA 20.

AMERICAN
ELECTRIC
POWER

Date September 4, 1990

Subject Cook Nuclear Plant
NFPA Code Compliance Verification
Response to Impell Comments

From P.J. Russell 9-4-90

To Impell Code Compliance

Several generic deficiencies were identified by ABB Impell's review of AEPSC's NFPA Code Compliance Verification reports and closeouts. A number of these deficiencies impacted documents prepared by the PH&F Section. Our response to the ABB Impell comments are as follows.

NFPA 20 - FIRE PUMP CODE COMPLIANCE REPORT

Item C.1

Sections 41a and 41b. The compliance statement indicated that the fire pumps are isolated in separate fire zones. Although this may be true for the two diesel driven fire pumps, the three electric driven fire pumps are all located within the same fire zone (Fire Zone 2). Further clarification should be provided to address the concern of the installation of these pumps within the same fire zone.

Response

Our response to Sections 41a and 41b have been revised for clarification.

Item C.2

Section 143b. The compliance statement has indicated that the unlined steel suction pipes installed for the fire pumps has not experienced excessive friction loss. The basis for this statement should be indicated (i.e., flow testing). Also, the statement that the internal painting of the suction piping is an "unnecessary expense" should not be provided as a part of any justification. This statement should be deleted.

Response

Our response to Section 143b has been revised to delete the "unnecessary expense" comment. We also added the Performance testing procedures as technical reference for the basis of our statement that excessive friction loss through the suction pipe is not a problem.

Item C.3

Section 222a. This section has been listed as not applying; however, this section is an extension of Sections 222b and 222c and should be addressed accordingly.

Response

Our response to Section 222a has been revised so that there will be no misunderstanding in our complete compliance with Section 222 of NFPA 20.

The following is the PF[illegible] Section's response to ABB Impell's comments concerning AEPSC's memos dated February 8, 1989 and April 26, 1989.

Item A

A hydraulic analysis should be performed to verify the adequacy of the existing water supply system to support the demands of the existing and any new suppression systems installed.

Response

A computerized program has been purchased for the purpose of evaluating existing as well as new fire suppression systems. This program is being installed onto the AEPSC computer system by calculation number DCC-FP-12-MC05-S.

Item B.1

These memos further discuss justifications made for deficiencies identified in Impell's Report No. 09-0120-0123. The evaluations provided in these memos should identify the technical data used in supporting the conclusions made (i.e., AEPSC memo dated June 17, 1988).

Response

These memos are based on the engineering judgement of a qualified fire protection engineer. The justifications were written upon the completion of a field walkdown conducted by the author. This information is contained within these documents.

Item B.2

The memo dated April 26, 1989 made numerous references to the cost of retrofitting certain features of a system as part of the justification. The reference to the cost for not installing equipment for compliance should not since it is believed that the NRC would not consider this a reasonable answer. Therefore, it is recommended that all references to cost be deleted from these justifications. The sections in question include Fire Zones 1, 32, 43, 48, 51, 42, 58 and 69.

Response

All references to the cost of retrofitting certain features of the fire detection systems have been deleted from this memo.

Patrick J Russell
P.J. Russell

PJR/gh

cc: R.L. Shoberg
J.D. Grier/B.J. Gerwe/P.J. Russell
File: 1990 Fire Protection Correspondence

AEP
AMERICAN
ELECTRIC
POWER

Date August 23, 1990

Subject **Response to Impell's Review of Our NFPA 20 Code Compliance Report**

From J.L. Markham

To P.J. Russell

As you requested, the following are our comments to the Impell's review comments of our NFPA 20 Code Compliance Report related to electrical sections:

Comment a and b:

Attached is updated NFPA Code Compliance review Sections 4, 5, and 7 with Technical Data references which were used as a basis for specific conclusion or justification. Also attached is a listing of REFERENCES (Electrical/Instrumentation & Controls). In addition, the following should be added to the introduction: "A field walkdown was made by cognizant Electrical/I&C Engineering personnel to review the arrangement of equipment, installation details, and to obtain other equipment details such as ratings, model numbers, etc. that was not available in reference technical data. This information was used as a basis for those conclusions or justifications marked as WALKDOWN (W)."

done 8/31/90

Comment ~~N~~c4:

Our reply was based on our interpretation of the NFPA 20 requirements and applicability which is noted "Comply".

Comment ~~N~~c5:

The statement "Co[illegible] [illegible] correct. The fire pump motors have NEC Code Letter G. The reason for the statement of "comply with intent of requirement" is that the table listing NEC Code Letter requirements does not list motors above 200HP. The high demand fire pump motors are 300HP.

Comment ~~N~~c6:

Section 455b applies to the 300HP (high demand) motors since they are drip-proof motors, but this section does not apply to the 75HP (low demand) motor since it is totally enclosed. However, the requirements of Section 455b (and 455a) is not applicable (as noted) since the hose valves are located outside the pump room.

Section 455d applies to the 75HP (low demand) motor since it is totally enclosed, but this section does not apply to the 300HP (high demand) motors since they are drip-proof. As noted, the 75HP motor complies with the requirements.

Comment ~~B~~C7:

The compliance statement "Comply" is correct. However, the additional explanation is a typographical error. The technical data reference has been indicated in the revised checklist as - "Technical Data - Vendor Information".

Comment ~~B~~C8:

The incomplete sentence resulted in improper copying. New page has been made available.

J. D. Markham
J.D. Markham

JDM/cld/2149

Approved S K
R.C. Carruth

Attachment

cc: R.F. Kroeger W/O ATTACHMENT
S.K. Farlow/J.V. Ruparel ''
S.Z. Parsons ,,

Attachment
Page 1of5

ABB
ASEA BROWN BOVERI

Inter-Office Correspondence

File: 0120-158
M-013

Copy: GAW
SJC
MJS
DEK

MEMO TO: Brian McLean/Bruce Gerwe

FROM: David E. Kipley DEK

DATE: August 31, 1990

SUBJECT: NFPA Code Compliance Evaluation Review

REFERENCE: Memo from S. J. Brewer to A. A. Blind Et.Al.,
Re: "Action Item Assignments", Rev. 2, Dated 4/26/90

This memo is being issued to document ABB Impell's review of the NFPA code compliance evaluations performed by AEPSC. The evaluations and associated documents reviewed have been listed below. The completion of this review process closes out Action Item No. 21 of the referenced memo.

Safety & Assessment Weekly Activity Report Dated 6/15/88.

PH&FP Memo From B. Gerwe to P. Jacques, "Documentation Revisions Required for NFPA Code Compliance", Dated 7/7/88.

PH&FP Memo From B. Gerwe to J. Kobyra/A. Auvil, "NFPA 14 Code Compliance Justification for Reduced Hose Station Flow", Dated 9/20/88.

PH&FP Memo from P. Russell to RFC-3003, "NFPA 12A Code Compliance Walkdown Impell Report No. 09-0120-0123", dated 1/25/89.

PH&FP Memo from P. Russell to A. Auvil, "Impell Code Compliance Walkdown NFPA 10 Portable Fire Extinguishers", dated 1/25/89.

PH&FP Memo from P. Russell to M. Noronha, "Impell Code Compliance Walkdowns NFPA 14 Standard and Hose Stations", dated 1/30/89.

Attachment
Page 2 of 5

PH&FP Memo from B. Gerwe to J. Kobyra/A. Auvil for NFPA 720 Code Compliance Sections 2032, 2212, & 3111, dated 11/30/88.

PH&FP Memo from P. Russell to Impell Code Compliance Walkdown, "Automatic Sprinkler Systems", dated 2/8/89.

PH&FP Memo from P. Russell to Impell Code Compliance Walkdown, "Automatic Fire Detection System", dated 4/26/89.

Code Compliance Verification Checklist for NFPA 20-1969 "Standard for the Installation of Centrifical Fire Pumps".

ABB Impell's review of the Code Compliance Verification Checklist for NFPA 20 identified several generic deficiencies which are detailed below.

A. Numerous code sections and justification statements have not provided a technical reference to provide a basis for the conclusion made in the compliance statement. The code sections noted, but not limited to, include Sections 243 through 531 and 666c through 934. The technical references are essential for supporting the respective compliance statement or justification.

B. Numerous "Comply" or "Does not Apply" statements made to document compliance to code section requirements, did not indicate the basis for why the system is in compliance. These code sections include Sections 443, 454a, 456c, 456d, 511e, 512c, 513d1, 513d2, 514b2 thru 514b9, 514c1, 514c2, 515d4, 515e, 525 thru 526, 712a thru 712c, 713e2 thru 713g, 714a2, 714a3, 714b1, 714b3, 715b1 thru 715c2, 715d4, 714e3 thru 715f3. The applicable supporting statements should be provided to document why compliance or non-applicability is true.

C. Inconsistencies were noted in a number of statements raised questions which requires additional clarifications. These sections include the following:

  1. Sections 41a and 41b. The compliance statement indicated that the fire pumps are isolated in separate fire zones. Although this may be true for the two diesel driven fire pumps, the three electric driven fire pumps are all located within the same fire zone (Fire Zone 2). Further clarification should be provided to address the concern of the installation of these pumps within the same fire zone.

Attachment
Page 3 of 5

2. Section 143B. The compliance statement has indicated that the unlined steel suction pipes installed for the fire pumps has not experienced excessive friction loss. The basis for this statement should be indicated (i.e., flow testing). Also, the statement that the internal painting of the suction piping is an "unnecessary expense" should not be provided as a part of any justification. This statement should be deleted.

3. Section 222a. This section has been listed as not applying, however, this section is an extension of the Sections 222b and 222c and should be addressed accordingly.

4. Section 440. This section may not apply since this facility is a power plant and does not have a transformer specifically provided for the fire pumps.

5. Section 451c. The compliance statement made for this section implies that there is a non-compliance with the system however, a detailed justification has not been provided. This justification should be provided.

6. Sections 455b and 455d. The compliance statements for these sections seem to be incomplete since the statements only make reference to either the high or low demand fire pumps. Further clarification should be provided to indicate that all electric driven pumps have been reviewed against the requirements of these sections.

7. Section 513d3. The compliance statement does not adequately address the code section requirements. The compliance statement should address whether the pump controller components (i.e., power supplies, fuses), have been rated for continuous duty. This system should be evaluated against this code section's requirements.

8. Section 514a. The last sentence in the justification statement provided has not been completed. This statement should be completed.

Attachment
Page 4 of 5

ABB Impell's review of several station surveillance procedures to verify if that the procedural deficiencies noted in Impell's Report 09-0120-0123, have identified several unresolved issues. These issues include the following:

NFPA Code	Procedure Required for Revision	Requirement
15	12 MHP 4030 STP. 020 SERIES	The filter unit 12-HV-SATFU nozzle system is not verified for operability.
72D	12 SHP 2270 FIRE.004 1&2 OHP 4030 STP.121 SERIES	The fire pump and hose system manual station alarm signals are not verified for their operability.
72E	12 THP 6030 IMP.153	The verification of the alignment of Ultraviolet detectors to confirm proper protection.

ABB Impell's review of numerous evaluations performed by AEPSC to show compliance with deficiencies identified in Impell's Report 09-0120-0123, indicated the following open items.

A. A hydraulic analysis should be performed to verify the adequacy of the existing water supply system to support the demands of the existing and any new suppression system installed.

B. The review of AEPSC's memos dated 2/8/89 (NFPA 13) and 4/26/89 (NFPA 72E) indicated the following open items.

    1. These memos further discuss justifications made for deficiencies identified in ABB Impell's Report 09-0120-0123. The evaluations provided in these memos should identify the technical data used in supporting the conclusions made (i.e., AEPSC memos dated 6/17/88).

Attachment
Page 5 of 5

2. The memo dated 4/26/89 made numerous references to the cost of retrofitting certain features of a system as part of the justification. The reference to the cost for not installing equipment for compliance, should not since it is believed that the NRC would not consider this a reasonable answer. Therefore, it is recommended that all references to cost be deleted from these justifications. The sections in questions include: Fire Zone 1, 32, 43, 48, 51, 52, 58 and 69.

AMERICAN
ELECTRIC
POWER

Date April 20, 1989

Subject Donald C. Cook Nuclear Plant
Fire Water Pump Controls

From J.D. Markham

To P.J. Russell

This memorandum is to document an analysis of the availability of the fire pumps due to a control room fire. This document is at the request of E.A. Taylor as noted in the attached letter.

We had previously indicated in our NFPA 20 Code Compliance Review that the four (4) main (high demand) fire water pumps (two (2) electrical driven and two (2) diesel driven) are completely independent. The fire pumps are independent - physically and electrically (power and control). However, there are some interconnections of fire pump control circuitry between Unit 1 and Unit 2 control rooms that signal a back-up fire pump to start in the event fire water pressure is inadequate. The question arises whether these interconnections would affect an adequate supply of fire water due to a control room fire.

These interconnections are electrically separated but cannot be claimed to be separated according to Appendix R criteria. However, the probability of a fire affecting any two fire pumps is unrealistically remote. A detailed examination of the circuitry indicates the only Appendix R separation concern would be the 24VDC starting control circuits of the two diesel fire pumps. The circuits of the two pumps are located within the same control panel in both Unit 1 and Unit 2 control rooms. A high current short to ground on both start circuits could prevent the diesel fire pumps from starting (including local start), but an open circuit or a short between control conductors would not prevent local starting.

There are no interconnections of the main (high demand) electric driven fire pumps control circuits from Unit 1 to Unit 2 control rooms. Also, in our opinion, a control room fire that would prevent either of the main (high demand) electric driven fire pumps from being started (local manual or automatic) cannot be postulated since the start circuit is ungrounded 250VDC. An open, short or ground (or any combination) of the control room pump control circuit would not prevent starting either of these pumps locally manually or automatically.

In summary in our opinion, a control room fire: (1) would in the most likely worst case situation prevent the starting of one diesel driven pump, (2) could, although highly improbable, prevent the starting of both diesel driven pumps, (3) would not prevent the starting of either electric driven pumps.

J.D. Markham
J.D. Markham

JDM/cld/905

Approved: R.C. Carruth

Attachment

cc: R.F. Kroeger
S.K. Farlow/J.V. Ruparel
S.Z. Parsons
A.B. AUVIL
E.A. TAYLOR

AEP
AMERICAN
ELECTRIC
POWER

Date
March 22, 1989

Subject
Cook Plant Fire Pump Controls

From
E. A. Taylor

To
J. D. Markham JDM 3/24/89

This letter is being written as a follow-up to our conversation last week. Region III recently was at the plant doing a fire protection inspection audit on open Fire Protection items. One of the items that they reviewed and subsequently closed was the open item on the Fire Pump controllers and their differences from NFPA 20. The study that you performed on these controllers was given to Jeff Holmes, Region III, for further review. During a follow-up exit phone call last week, Mr. Holmes informed us that he was closing out the item on the Fire Pump Controllers.

Jeff Holmes did however mention a concern of the availability of remote/local control of the various fire pumps given a control room fire. AEPSC, NS&L, informed Mr. Holmes in this meeting that we would document an analysis on the availability of the fire pumps due to a control room fire.

This letter is being written in order to request that this analysis be performed an documented in such a way that it could be included as an appendix/attachment to the NFPA 20 code compliance that you performed on the fire pump controllers. During the above referenced exit meeting, we informed Jeff Holmes that this analysis would be complete before May 31, 1989.

If you have any questions please feel free to contact me on extension 1913 or Bud Auvil on extension 2083.

Elizabeth Taylor
Elizabeth Taylor

cc: S. P. Hodge/S. H. Steinhart
R. F. Kroeger/T. O. Argenta
R. L. Shoberg/File: Fire Protection
R. C. Carruth
A. B. Auvil

Intra-System

APR 20 1989

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, ILLINOIS 60137

C/S APR 25 1989

~~xc: JRK/JDG~~

APR 14 1989

ORIG : SHS/RFK/RLS

cc:
M. P. Alexich
T. O. Argenta
P. A. Barrett
S. J. Brewer
J. G. Feinstein
S. P. Klementowicz
R. F. Kroeger
J. F. Kurgan
D. H. Malin
J. J. Markowsky
R. I. Pawliger
J. B. Shinnock
4/21 S. ~~H.~~ [illegible]inhart APR 20 1989
D. H. Williams, Jr.

Docket No. 50-315
Docket No. 50-316

Indiana Michigan Power Company
ATTN. Mr. Milton P. Alexich
Vice President
Nuclear Operations Division
1 Riverside Plaza
Columbus, OH 43216

Gentlemen:

This refers to the routine safety inspection conducted by Messrs. Jeff Holmes and Joseph Ulie of this office on February 13-17, 1989, March 15 and April 5, 1989, of activities at the D.C. Cook Nuclear Plant, Units 1 and 2, authorized by NRC Operating Licenses No. DPR-58 and No. DPR-74, and to the discussion of our findings with Mr. Wilbur G. Smith and others of your staff at the conclusion of the inspection. The purpose of this inspection was to review the implementation of the licensee's fire protection program.

The enclosed copy of our inspection report identifies areas examined during the inspection. Within these areas, the inspection consisted of a selective examination of procedures and representative records, observations, and interviews with personnel.

During this inspection, certain of your activities appeared to be in violation of NRC requirements, as described in the enclosed Notice. A written response is required.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter, the enclosures, and your response to this letter will be placed in the NRC Public Document Room.

The responses directed by this letter and the accompanying Notice are not subject to the clearance procedures of the Office of Management and Budget as required by the Paperwork Reduction Act of 1980, PL 96-511.

We will gladly discuss any questions you have concerning this inspection.

Sincerely,

R. W. Cooper

R. W. Cooper, Chief
Engineering Branch

Enclosures:
1. Notice of Violation
2. Inspection Reports
   No. 50-315/89004(DRS);
   No. 50-316/89004(DRS)

cc w/enclosures:
W. G. Smith, Jr., Plant Manager
DCD/DCB (RIDS)
Licensing Fee Management Branch
Resident Inspector, RIII
Ronald Callen, Michigan
  Public Service Commission
EIS Coordinator, USEPA
  Region 5 Office
Michigan Department of
  Public Health

U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Reports No. 50-315/89004(DRS); 50-316/89004(DRS)

Docket Nos. 50-315; 50-316 Licenses No. DPR-58; DPR-74

Licensee: Indiana Michigan Power Company
1 Riverside Plaza
Columbus, OH 43216

Facility Name: D.C. Cook Nuclear Power Station, Units 1 and 2

Inspection At: D.C. Cook Site, Bridgman, MI 49106

Inspection Conducted: February 13-17, March 15, and April 5, 1989

D. Butler

Inspectors: D. Butler (In office review only) 4-12-89
Date

Jeff Holmes

Holmes 4-12-89
Date

Joseph M. Ulie

Joseph. M. Ulie 4-12-89
Date

Ronald N. Gardner

Approved By: Ronald N. Gardner, Chief 4-12-89
Plant Systems Section
Date

Inspection Summary

Inspection on February 13-17, March 15, and April 5, 1989 (Reports No. 50-315/89004(DRS); 50-316/89004(DRS))

Areas Inspected: Routine, unannounced inspection to review the implementation of the licensee's fire protection program including a followup of licensee action on previous inspection findings; review of the fire protection organization; administrative controls; fire protection system surveillance test program; Quality Assurance; battery room exhaust fans; and Licensee Event Reports (LER) (30703, 64704, 90712, 92700, and 92701).

Results: Of the seven areas inspected, three violations were identified (failure to properly seal CO_2 system valve in the open position-Paragraph 5; failure to provide adequate design control measures-Paragraph 8; and improper electrical cable routing discovered by corporate reviewers not communicated to the cognizant plant staff in a timely manner resulting in delayed corrective actions-Paragraph 8). Additionally, two other violations were also identified;

engineering evaluation be presented in an auditable form and that the evaluation be expanded to include fire damper manufacturers other than Ruskin.

In response to the inspector's request, the licensee developed an internal memo dated February 23, 1989, from H. Young to J. Grier, which indicated that an evaluation will be performed to confirm that all Ruskin dampers not previously tested were bounded by the testing previously performed and that the scope of the evaluation will be expanded to include dampers other than Ruskin. This evaluation will consider fire dampers in Appendix R and Appendix A fire walls and a report of this evaluation is scheduled to be completed by January 15, 1990.

Based on the licensee's proposed actions, this Part 21 (316/84006-PP) is considered closed. The proposed licensee actions are considered an open item (315/89004-01(DRS); 316/89004-01(DRS)) pending review and acceptance of the damper test results.

c. (Closed) Open Item (315/85013-01(DRS); 316/85C13-01(DRS)): Unprotected structural steel beams support 4 inch poured concrete above each of the diesel fire pump rooms. The rooms were provided with sprinkler protection and the diesel fuel oil tanks were installed in a sand covered pit. Subsequent to the previous inspection, NRR indicated that adequate fire protection features were in place.

During this inspection, the inspector toured the area. Due to the presence of the sprinkler system, the storage of the fuel oil tank in a sand pit, and the availability of fire hoses and foam, it appears that a potential fire can be easily controlled and extinguished. Based on this information, this open item is considered closed.

d. (Closed) Open Item (315/85013-03(DRS); 316/85013-03(DRS)): The licensee utilized tygon plastic tubing as a flexible connector in the reactor coolant piping oil collection system. This item was to remain open pending the licensee's submittal of documentation clarifying the use of tygon plastic tubing in the oil collection system for review by NRR.

During this inspection, the inspector obtained the licensee's documentation regarding the use of tygon plastic tubing and forwarded the documentation to NRR. The results of this review will be documented in a future safety evaluation report.

e. (Closed) Open Item (315/85013-11(DRS); 316/85013-11(DRS)): The licensee was unable to provide the applicable generic test data for penetration fire seals at the time of the inspection. Inspector review of the NRC issued Safety Evaluation Report dated July 31, 1979, identified that the licensee had cited applicable generic test data for the penetration fire stops. This data indicated that the silicone foam material in this (the tested) application provided a three hour fire resistance to an ASTM E-119 type fire exposure. The SER also specified that during a site visit many of the Unit 1 penetration fire stops were observed. In addition, the SER specified that an additional penetration fire stop test was performed for a Unit 2 penetration seal design. As a result, the SER concluded that the penetration fire stops which were in place provided sufficient protection from the unbounded spread of fire along electrical cables. Based on the SER review and a visual inspection of safety-related areas during plant tours on February 13, 14 and 15, 1989, to confirm that selected required penetrations were sealed, this item is considered closed.

f. (Closed) Open Item (315/85013-04(DRS); 316/85013-04(DRS)): The two electric motor-driven high demand fire pumps should be provided with controllers that are specifically tested and approved for fire service use. The controllers should comply with all applicable provisions of NFPA.

The NRC safety evaluation transmitted by letter dated July 31, 1979, to the licensee, indicated that the licensee's position regarding the controller's ability to meet the applicable provisions of NFPA 20 was reviewed and determined to be acceptable. Based on this review, this item is considered closed.

g. (Closed) Unresolved Item (315/86022-04(DRS); 316/86022-04(DRS)): Several Licensee Event Reports were submitted to the NRC regarding fire barriers that were degraded without the licensee establishing compensatory measures as required by Technical Specification (TS) 3.7.10. The failure to have established the required fire watch patrols in accordance with the Action Statement of TS 3.7.10 is considered a violation (315/89004-02(DRS); 316/89004-02(DRS)).

The degraded fire barriers were subsequently repaired. During this inspection, the inspector was informed that improved personnel training has contributed to the prevention of recurrence of this problem for approximately the last two years. This violation meets the tests of 10 CFR 2, Appendix C, Section V.G; consequently, no Notice of Violation will be issued, and this matter is considered closed.

3. Fire Protection Organization

The inspector examined the qualifications of a corporate fire protection engineer, the plant fire protection coordinator, and other personnel who perform fire watch duties.

During this review, the licensee provided the inspector with resumes of the corporate fire protection engineer and the plant fire protection coordinator. The corporate fire protection engineer has degrees in fire

Attachment 6.2

NFPA 20 (1969 Edition)

NFPA 20 Code Compliance Evaluation

For

Donald C. Cook Nuclear Plant

Units 1 and 2

Indiana Michigan Power Company

20

CENTRIFUGAL FIRE PUMPS 1969

NFPA

$2.00

NATIONAL FIRE PROTECTION ASSOCIATION
International
60 Batterymarch Street, Boston, Mass. 02110

G-5

2.5M-6-69-WP-BM
Printed in U.S.A.

Official NFPA Definitions

Adopted Jan. 23, 1964. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

Shall is intended to indicate requirements.

Should is intended to indicate recommendations or that which is advised but not required.

Approved means acceptable to the authority having jurisdiction. The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of nationally recognized testing laboratories,* i.e., laboratories qualified and equipped to conduct the necessary tests, in a position to determine compliance with appropriate standards for the current production of listed items, and the satisfactory performance of such equipment or materials in actual usage.

*Among the laboratories nationally recognized by the authorities having jurisdiction in the United States and Canada are the Underwriters' Laboratories, Inc., the Factory Mutual Engineering Division, the American Gas Association Laboratories, the Underwriters' Laboratories of Canada, the Canadian Standards Association Testing Laboratories, and the Canadian Gas Association Approvals Division.

Listed: Equipment or materials included in a list published by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

Labeled: Equipment or materials to which has been attached a label of a nationally recognized testing laboratory that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling is indicated compliance with nationally recognized standards or the conduct of tests to determine suitable usage in a specified manner.

Authority Having Jurisdiction: The organization, office or individual responsible for "approving" equipment, an installation or a procedure.

Statement on NFPA Procedures

This material has been developed in the interest of safety to life and property under the published procedures of the National Fire Protection Association. These procedures are designed to assure the appointment of technically competent Committees having balanced representation from those vitally interested and active in the areas with which the Committees are concerned. These procedures provide that all Committee recommendations shall be published prior to action on them by the Association itself and that following this publication these recommendations shall be presented for adoption to the Annual Meeting of the Association where anyone in attendance, member or not, may present his views. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

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Standard for the Installation of Centrifugal Fire Pumps.

NFPA No. 20 — 1969

1969 Edition of No. 20

This 1969 edition of the Standard for the Installation of Centrifugal Fire Pumps incorporates amendments prepared by the Committee on Fire Pumps and adopted by the National Fire Protection Association at the 1969 Annual Meeting. It supersedes the 1968 edition.

Revisions or additions in this edition are in: 43e, Fig. 143e, 215, 251a, 333, 451, 451c, 511e, 512b, 514c3, 514d, 514e, 514e3, 515c3a, 520, 627b, and 714a1.

Committee on Fire Pumps

E. W. Fowler, *Chairman*,
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Norman E. Gatsch, Jr., *Secretary*,
Ohio Inspection Bureau, P. O. Box 1290, Columbus, Ohio 43216

John R. Anderson, New England Insurance Rating Assn.

S. E. Auck, Underwriters' Laboratories, Inc.

S. P. Crosby, West Georgetown, Maine.

S. K. Goodwin, Factory Insurance Assn.

Donald D. Henderer, Engine Manufacturers Assn.

George W. Horner, National Electrical Manufacturers Assn.

Raymond Koss, Port of New York Authority.

R. E. Kummer, Hydraulic Institute.

I. L. Lamar, South-Eastern Underwriters Assn.

C. B. Miller, National Automatic Sprinkler & Fire Control Assn.

Richard T. Montgomery, National Park Service, U.S. Dept. of the Interior.

James W. Nolan, James W. Nolan Co.

D. W. Nordbeck, Stone & Webster Engineering Corp.

Chas. J. Shukes, Illinois Inspection and Rating Bureau.

W. P. Thomas, Factory Mutual Engineering Assn.

William P. Underwood, Pacific Fire Rating Bureau.

Emil Wagner, Nebraska Inspection Bureau.

R. J. Wright, Underwriters' Laboratories of Canada.

R. I. Williams, Layne Northern Co., Inc.

Alternates.

V. J. Cantlupe, Hydraulic Institute (Alternate to R. E. Kummer.)

M. E. Cox, Underwriters' Laboratories, Inc. (Alternate to S. E. Auck.)

R. N. Eck, National Electrical Manufacturers Assn. (Alternate to George W. Horner.)

Joel B. Husted, American Insurance Assn. (Alternate to E. W. Fowler.)

R. A. McMaster, National Electrical Manufacturers Assn. (Alternate to George W. Horner.)

A. J. Mercurio, Factory Insurance Assn. (Alternate to S. K. Goodwin.)

Thomas C. Young, Engine Manufacturers Assn. (Alternate to Donald D. Henderer.)

Scope: The selection and installation of pumps supplying water for private fire protection, including suction piping, valves and auxiliary equipment, operation and maintenance, electric driving and control, steam turbine and internal combustion engine driving and control equipment.

C693

G-7

Origin and Development of No. 20

Since the formation of the committee in 1904 each edition of NFPA No. 20 has incorporated appropriate provisions to cover new developments and has omitted obsolete provisions. NFPA action on successive editions has been taken in the following years: 1907, 1910, 1911, 1912, 1913, 1915, 1918, 1919, 1920, 1921, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1931, 1932, 1933, 1937, 1939, 1943, 1944, 1946, 1947, 1948, 1951, 1953, 1955, 1957, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, and 1969.

CONTENTS

General

Part I. Pump Arrangement, Test, and Installation

STANDARD FOR THE INSTALLATION OF CENTRIFUGAL FIRE PUMPS.

NFPA No. 20 — 1969

General

1. **Purpose.** This standard contains, in general, the minimum requirements for centrifugal fire pumps, including horizontal, single and multi-stage pumps and vertical shaft turbine-type pumps; and is prepared to cover the design, installation and maintenance of such pumps together with their drivers, and for the guidance of the authority having jurisdiction and others concerned in judging the acceptability of such equipment.

2. **Approval Prior to Purchase Recommended.**

a. Centrifugal fire pumps should not be purchased until conditions under which they are to be installed and used have been examined by the authority having jurisdiction, and each pump, driver, controlling equipment, the power supply and arrangement, and water supply have been approved by that organization.

b. The pump manufacturer must be given complete information concerning the suction water supply as accepted by the authority having jurisdiction.

3. **Unit Assembly Required.**

a. The pump, driver and all necessary attachments shall be purchased under unit contracts stipulating compliance with this standard and satisfactory performance of the entire unit when installed.

b. The pump manufacturer shall be responsible for the proper operation of the complete unit assembly as indicated by field acceptance tests. (See Article 910 for field acceptance test procedure.)

4. **Complete Plans and Data Required.** A complete plan and detailed data describing pump, driver, controller, power supply, fittings, suction and discharge connections, and suction conditions shall be submitted by the engineer or contractor to the authority having jurisdiction for approval before installation. Certified shop test characteristic curves showing head-delivery, efficiency and brake horsepower shall be furnished by the manufacturer.

PART I — PUMP ARRANGEMENT, TEST AND INSTALLATION.

Chapter 1 — Basic Information

10. General.

11. APPROVED PUMPS REQUIRED. Centrifugal fire pumps shall be specifically approved for fire pump service.

20. Water Supplies.

21. REQUIREMENTS. Fire pumps should be provided with as large and reliable a supply of water as possible. The adequacy and the dependability of the source of water are of primary importance and must be fully determined at the time of installation, also the prospects for its reliability in the future. The minimum water level with maximum discharge from the pump must be determined. Where a stored supply is the only one available, a reliable method of replenishing the supply should be provided. Representatives of the pump manufacturer shall assist in establishing these facts to the satisfaction of the authority having jurisdiction. Water supplies containing salt or other materials deleterious to the fire protection systems should be avoided wherever possible.

30. Pump.

31. RATED CAPACITIES OF PUMPS.

a. STANDARD PUMPS — Standard fire pumps are those having rated capacities of 500, 750, 1,000, 1,500, 2,000 and 2,500 gpm. Larger pumps may be used in specially engineered applications.

b. SPECIAL PUMPS — Special fire service pumps are those having rated capacities of 200, 300 and 450 gpm.

32. TYPES OF PUMPS.

a. STANDARD FIRE PUMPS — Pumps rated at capacities within the standard capacity range and pressures of 100 psi or more.

b. LOW-PRESSURE FIRE PUMPS (BOOSTER PUMPS) — Pumps rated at capacities within the standard capacity range and pressures between 40 and 100 psi.

c. SPECIAL FIRE SERVICE PUMPS — Pumps rated at 200, 300 or 450 gpm limited to 130 per cent capacity maximum and for various pressures. The maximum power required shall not exceed the limitations of a 30-horsepower electric motor.

d. PRESSURE MAINTENANCE PUMPS (JOCKEY OR MAKE-UP PUMPS) — The use of an automatic pressure maintenance pump is desirable under some circumstances to maintain a uniform or a relatively high pressure on the fire protection system. The capacity and pressure rating of the pump shall be sufficient to maintain the desired pressure against the leakage in the system as approved by the authority having jurisdiction. A centrifugal type pump is preferable. Where the discharge pressure at pump shut-off of a centrifugal type pump exceeds the working pressure rating of the fire protection equipment, or a turbine vane (peripheral) or a positive displacement type of pump is used, a suitable relief valve shall be installed on the pump discharge to prevent damage to the fire system. (See Figures 100a-1 and 143e.)

33. STANDARDS ON CAPACITY AND PRESSURE. For requirements on capacity and pressure refer to Standard for the Installation of Sprinkler Systems (NFPA No. 13) and Standard for the Installation of Standpipe and Hose Systems (NFPA No. 14) and for hydrants, Standard for Outside Protection (NFPA No. 24).

34. NAME AND CAPACITY PLATE. Pumps shall be provided with a Name and Capacity Plate.

40. Installation.

41. THE PUMP ROOM.

a. The fire pump shall be protected against possible interruption of service through damage caused by fire or water, in a manner satisfactory to the authority having jurisdiction.

b. Except where there are several pumps on the same system, located in buildings which are not all subject to one fire, or where the pump is automatically controlled and supplies automatic sprinklers only, the pump should be in a room so located and constructed as to protect it from falling floors or machinery and from fire which might drive away the operator or damage the pump or driving equipment.

NOTE: Where the use of brick or reinforced concrete is not feasible, metal lath and cement plaster is recommended for the construction of the pump room.

c. The pump room should be of ample size, and the piping and equipment should be so arranged as to make them readily accessible for operation or repair. The pump room should not be used for storage purposes.

NOTE: With vertical type pumps it may be necessary to provide a removable panel in the pump house roof to permit the pump to be lifted out for repairs.

d. The location of the pump room should be such as to permit installation of short and direct pipe connections, the suction pipe receiving first consideration.

e. Suitable means shall be provided for maintaining the temperature of the pump room above 40°F.

f. Artificial light shall be provided, and provision made for drainage and ventilation of the pump room. A suitable lamp or lantern should be provided for emergency use. Emergency lighting may be provided from the battery circuit of an internal combustion engine.

g. Pump rooms housing electric or engine driven pumps should be dry and free from condensate. Some heat may be required to accomplish this.

42. DISCHARGE PIPE.

a. The size of discharge pipe shall be as given in the following table unless otherwise specified by the authority having jurisdiction.

Capacity of Pump, gpm	500	750-1000	1500-2000	2500
Size of Discharge Pipe, inches	6	8	10	12

b. An approved check valve shall be installed in the discharge pipe.

c. Approved indicating gate valves shall be installed in such places as needed to make the pump and check valve accessible for repair.

NOTE: This requires a valve on the system side of the check valve and on the supply side of the pump if the supply may at any time be under a head.

43. RELIEF VALVE.

a. Pumps connected to adjustable-speed drivers shall be equipped with an approved relief valve. Where pumps are driven by constant-speed motors and the shut-off pressure plus the static suction pressure exceeds the pressure for which the system is designed to operate, relief valves are required.

b. The relief valve should ordinarily be set to prevent pressure on the fire protection system in excess of that pressure at which the system was designed to operate.

c. Where provided, relief valves shall be of the size given in the following table:

Capacity of Pump, gpm	500	750	1000	1500	2000-2500
Size of Relief Valve, inches	3	4	4	6	6

d. The relief valves should be located between the pump and the pump discharge check valve.

e. The relief valve should discharge into an open pipe in plain sight near the pump or into a cone or funnel secured to the outlet of the valve. This cone should be so constructed that the pump operator can easily see any water wasting through the relief valve, and it should be so made as to avoid splashing water into the pump room. If a closed type cone is used, it should be provided with means for detecting motion of water through the cone. The cone should be piped to a point where water can be freely wasted, preferably outside the building.

f. If the relief valve waste pipe is connected to an underground drain, care should be taken that no steam drains enter near enough to work back through the cone and into the pump room. Discharge from the relief valves should not be piped into the suction connection, except with the permission of the authority having jurisdiction.

g. When the supply of water is taken from a suction reservoir of limited capacity, the waste pipe shall drain into such reservoir, entering as far from the pump suction as is necessary to prevent the pump from drafting air which may be carried down by the discharge from the waste pipe.

h. The relief valve waste pipe from an open cone should not be smaller than specified below; if more than one elbow is employed the next size larger pipe should be used to complete the connection.

Capacity of Pump, gpm	500	750	1000-1500	2000-2500
Size of Waste Pipe, inches	5	6	8	10

i. The relief valve waste pipe from a closed cone shall be sized to prevent back pressure in excess of 8 psi.

j. The relief valve shall be so attached as to permit of its ready removal for repairs without disturbing the waste piping.

44. HOSE VALVES.

a. Approved 2½-inch hose valves of the number specified in Paragraph 44b shall be provided for use in testing the pumps. The hose valves should ordinarily be attached to a header or manifold; they shall be connected by suitable piping to the pump discharge piping, preferably at a point between the discharge check valve and the discharge gate valve. The hose valves should be so located as to avoid any possible water damage to the driving motor or engine or their controllers, and should preferably be outside the pump room. Where located outside, or at a distance from the pump, and there is any danger of freezing, an approved indicating gate valve and drain valve shall be located in the line to the hose valves at a point close to the pump.

b. Unless otherwise specified by the authority having jurisdiction, the number of hose valves shall be as given in the following table, except that for special service fire pumps and for booster pumps, only one hose valve is required for five hundred gallon or smaller pumps.

Capacity of Pump, gpm	500	750	1000	1500-2000	2500
Number of Hose Valves	2	3	4	6	8

c. On the larger capacity fire pump installations, there should be installed a fixed nozzle or pipe outlet arranged to discharge at an appropriate place, or a metering device in a pipe line discharging back into the suction supply, for use in making a flow test to the full capacity of the pump or pumps. With such test arrangements the authority having jurisdiction may permit a reduction in the number of hose valves to the number needed for hose stream use.

d. Hose valves shall be threaded to conform to the American (National) Standard B26-1925 for Fire Hose Coupling Screw Threads. Adapter couplings securely attached to each outlet shall be provided if local couplings are not American Standard.

e. When 2 hose valves are required, use 4-inch pipe between the detachable hose header and the connection to the discharge pipe; when 3 or 4 are required use 6-inch pipe; when 6 or 8 are required use 8-inch pipe. When this pipe is over 15 feet long increase one pipe size.

45. PRESSURE GAGES.

a. A pressure gage having a dial not less than $3\frac{1}{2}$ in. in diameter shall be connected near the discharge casting by a $\frac{1}{4}$-in. cock with lever handle. The dial shall indicate pressure to at least twice the rated working pressure of the pump but not less than 200 psi. The face of the dial shall read in pounds per square inch with the manufacturer's standard graduations.

b. A compound pressure and vacuum gage having a dial not less than $3\frac{1}{2}$ in. in diameter shall be connected to the suction pipe near the pump (except in the case of vertical shaft turbine type pumps). The face of the dial shall read in pounds per square inch for the suction range and have a maximum pressure range not less than twice the rated working pressure of the pump, or a lower pressure range may be furnished if the gage is protected from damage by a gage protector.

46. **CIRCULATION RELIEF VALVE TO PREVENT OVERHEATING.** Pumps which are automatically controlled shall be provided with a $\frac{3}{4}$-inch relief valve set slightly below the shut-off pressure and arranged to permit circulation of sufficient water to prevent the pump from overheating when operating with no discharge. This is not needed for submerged type pumps nor for engine driven pumps for which engine cooling water is taken from the pump discharge. Pumps which are manually controlled shall be equipped with either such a relief valve or with a test valve as specified in Section 133. Provision should be made for discharge to a drain.

47. SUMMARY OF PUMP DATA

Capacity of Pump gpm	Size of Discharge Pipe See 42(a)	Size of Relief Valve See 43(c)	Size of Relief Waste See 43(h)	Number Hose Valves See 44(b)
500	6 in	3 in	5 in	2
750	8 in	4 in	6 in	3
1000	8 in	4 in	8 in	4
1500	10 in	6 in	8 in	6
2000	10 in	6 in	10 in	6
2500	12 in	6 in	10 in	8

50. Power Supply.

51. DEPENDABILITY OF POWER SUPPLY. Careful consideration must be given in each case to the dependability of the power supply not overlooking the possible effect on transmission lines of fire in the property or in adjoining buildings which might threaten the property.

60. Tests.

61. SHOP TESTS.

a. Each individual pump shall be tested with a dynamometer or calibrated motor at the factory to provide detailed performance data and to demonstrate its compliance with specifications.

b. The maker shall test each pump hydrostatically before shipment from the factory, to twice the maximum pressure developed at shutoff, but in no case less than 250 pounds per square inch. Pump casings shall be substantially tight at the test pressure. In the case of vertical shaft turbine type pumps both the discharge casting and pump bowl assembly shall be tested.

c. All gear drives shall be operated at the factory under full load before shipment and operate without excessive noise or heating during the test.

Chapter 100 — Horizontal Shaft Pumps

110. General.

111. APPLICATION. The horizontal shaft centrifugal pump with its split casing lends itself to simple operation and repair, and, where a water supply is obtainable under a head, it is especially adaptable to fire service. Because the horizontal shaft centrifugal pump requires priming when installed to operate under lift, a vertical shaft turbine type pump should be used where suction lift is necessary.

112. PERFORMANCE.

a. Pumps shall furnish not less than 150 per cent of rated capacity at a total head not less than 65 per cent of total rated head. The shut-off total head for horizontal shaft pumps should not exceed 120 per cent of total rated head (Fig. 1, Appendix C).

b. The inlet pressure available from a suction water supply shall be figured on a basis of a flow of 150 per cent of the rated capacity of the pump, as indicated by a flow test.

120. Water Supplies.

121. OPERATE UNDER HEAD. Fire pumps, especially those automatically controlled, should be provided with water under head, avoiding suction lifts whenever possible. Operating suction lifts, including allowance for velocity and friction loss through all suction fittings, shall not exceed 15 feet at sea level and the allowable lift must be reduced by 1 foot for each 1000 feet of altitude at the pump installation. Where a suction lift is necessary, a vertical shaft turbine type pump should be used. (See Paragraph 111.)

122. PRIMING SUPPLIES.

a. Provide adequate priming supplies for pumps which may at any time take suction under a lift. Priming equipment should have sufficient capacity to displace the air from the pump and suction pipe within three minutes.

b. Provide two reliable methods of priming the pump. One of these methods of priming should be independent of public water connections or tanks serving as primary supplies for automatic sprinklers, yard hydrants or standpipes.

c. Where the pump is automatically started or provision is made for remote manual starting, the preferred arrangement is a submerged pump (see Fig. 200a, Appendix C), but if priming is needed the priming supply should be of a type which will keep the pump primed at all times. No priming method should be selected which will permit contamination of a potable water supply.

123. PRIMING METHOD A. *An Automatically Filled Priming Tank.*

a. An automatically filled priming tank that keeps the pump primed at all times. The volume of the priming tank should be equal to the volume of the pump and suction pipe but not less than 100 gals. This volume can be readily computed from the following data.

CAPACITY OF PUMP Gpm	PRIMING WATER REQUIRED FOR PUMP AND FITTINGS, Gallons	SIZE OF SUCTION PIPE, Inches	PRIMING WATER REQUIRED FOR SUCTION PIPE Gallons per foot
500	13	6	1.5
750	21	8	2.5
1000	25	10	4.1
1500	38	12	5.9
2000	47	14	8.0
2500	58	16	10.5
		20	16.3

b. The water supply to the tank should be capable of keeping the tank full at all times.

c. The priming tank should be connected to the discharge side of the pump at a point which will insure that all priming water enters the pump and suction pipe, and is not wasted in the discharge pipe of the pump (Fig. 100b, Appendix C). This connection should be 2 inches in diameter irrespective of the capacity of pump, and include an approved O. S. & Y. gate valve and an approved check valve.

124. PRIMING METHOD B. *A Connection to a Domestic Water System.* A connection to a domestic water system (when permitted by health regulations). Install approved check and O. S. & Y. gate valves in the priming pipe near the pump.

125. PRIMING METHOD C. *A Connection to a Domestic-use Tank.* A connection to domestic-use (service) tank

(when permitted by health regulations). Preferably arrange a reserve supply for priming only, by extending service riser up into the tank. Install approved check and O. S. & Y. gate valves in the priming pipe near the pump.

126. PRIMING METHOD D. *An Exhauster or Siphon Ejector.* Where a reliable steam supply or separate water supply under good pressure is available, an exhauster or siphon ejector may be connected between the pump and discharge check valve to exhaust the air from the pump and the suction pipe (Fig. 100b, Appendix C). An approved O. S. & Y. gate valve should be placed in the exhauster connection, to be closed as soon as the pump is primed.

127. PRIMING METHOD E. *A Mechanically-Operated Exhauster Driven by a Separate Motor.* The exhauster should be connected between pump and discharge check valve, so as to completely fill suction pipe and pump (Fig. 100b, Appendix C). An approved O. S. & Y. gate valve should be placed in the exhauster connection, to be closed as soon as pump is primed.

128. PRIMING METHOD F. *A Manually Filled Priming Tank.*

a. The tank to have a capacity of at least three times the volume of the pump and suction pipe, but not less than 250 gallons. A liberal-sized priming tank and large connecting pipe are necessary so that the pump can be primed quickly, even if there should be considerable leakage at the foot valve. As the priming arrangement is so vital a feature to the successful starting of the pump, a considerable safety factor is needed.

b. The volume required for the priming tank can be readily computed by taking 3 times the quantities given under Section 123.

c. The tank should be connected to the pump as covered in Section 123 with the connecting pipe not smaller than given in the following table:

Capacity of Pump, gal. per min.	500	750	1000	1500-2500
Size of Priming Pipe, inches	2½	3	3½	4

d. Where suction pipe is longer than 25 feet, larger priming connection may be required.

e. Provide a means for keeping tank filled such as a connection from public or factory-use water systems or a connection between fire pump and the priming tank to permit refilling tank.

129. PRIMING METHOD G. *A By-Pass Around Discharge Check Valve.* Where a good gravity water supply constitutes the primary supply for automatic sprinklers, yard hydrants or standpipes, a 2-inch by-pass around the check valve in the pump discharge pipe may be used but only as a secondary priming supply.

130. **Pump.**

131. OUTLINE OF REQUIRED ATTACHMENTS.

a. This standard requires horizontal fire pumps to be equipped with the following attachments, depending on the conditions under which the pumps are to be installed:

Automatic air release, Section 132.
Circulation relief valve, Section 46.
Eccentric tapered reducer at suction inlet, Paragraph 143i.
Hose valve manifold with hose valves, Section 44.
Pressure gages, Section 45.
Priming connection, Sections 122 to 129.
Relief valve and discharge cone, Section 43.
Splash shield between pump and motor, Section 455.
Test valve with piping connections, Section 133.

b. These attachments shall be provided by the pump manufacturer unless the authority having jurisdiction permits certain omissions depending on the conditions under which the pumps are to be installed.

132. AUTOMATIC AIR RELEASE. Pumps which are automatically controlled shall be provided with a reliable float-operated air release valve not less than ½ inch in size, or equivalent valve, to automatically release air from the pump.

133. TEST VALVES.

a. Pumps taking suction under lift shall be equipped with test valves of the size specified below, in order to provide means for liberating the air from the pump and suction line within the three-minute time limit for the priming operation.

Capacity of Pump, gpm	500	750	1000	1500-2500
Size of Valve, inches	1¼	1½	2	2½

b. Test valves shall be piped so that water wasted through them can be seen by a man at the pump.

> NOTE: Unless the pump attendant can see the discharge of water, there is danger that he will allow water to be wasted which might be seriously needed for fire fighting.

140. Installation.

141. FOUNDATION AND SETTING.

a. Unless the pump and driver have a common shaft, they shall be connected by an approved flexible coupling arranged to permit end adjustment and to care for minor inaccuracies in alignment.

b. The pump and driver shall be securely attached to a solid foundation in such a way that proper shaft alignment will be assured: such as by having the pump and driver rigidly connected to a substantial bedplate which is securely bolted to the foundation.

c. The foundation should preferably be made of concrete, or, if desired, of brick laid in portland cement mortar.

> NOTE: Where the foundation is of brick a capping of concrete is an advantage in tying it together. In some cases it may be necessary to support the pump on I-beams or a framework of structural steel.

d. Pumps shall be set level, with foundation bolts in position, and the joint between the foundation and bedplate made solid by grouting with neat cement. After the cement has thoroughly set the bolts shall be tightened. For further information see Instructions for Installing Centrifugal Pumps in Centrifugal Pump Section of the Standards of the Hydraulic Institute.

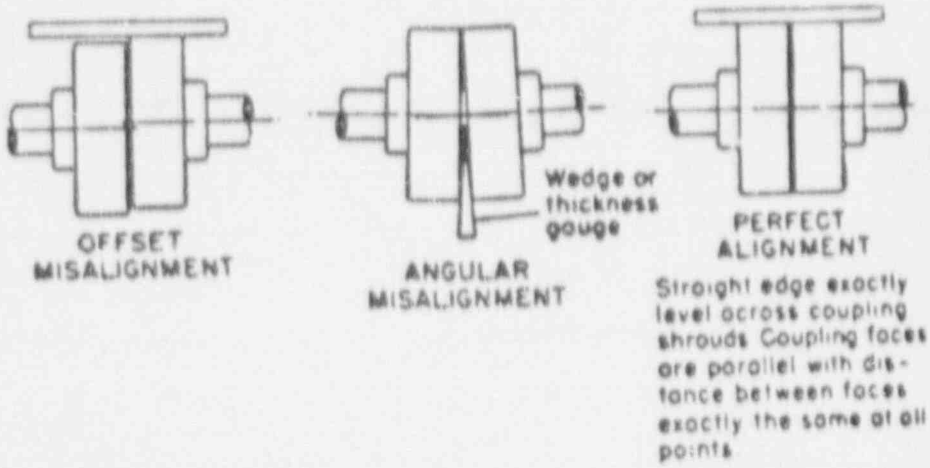
142. ALIGNMENT.

a. A horizontal pump with driver is correctly aligned on bedplate before shipment. This alignment, however, usually is disturbed during transit or by incorrect leveling of bedplate on foundation. The pump manufacturer's instructions on alignment should be carefully followed.

b. Any base plate, no matter how heavily it is built, may be slightly sprung in shipment, or may be distorted by an uneven support on the foundation, or by uneven tightening of the foundation bolts, or by the pull from the pipe connections. It is necessary to be careful when installing the pump to secure perfect alignment of the coupling. A *flexible coupling will not compensate for misalignment.* Inaccurate alignment of the coupling results in rapid wear of the coupling bushings, heating of the bearings and loss of efficiency. Therefore, after the pump is fastened on the foundation it is necessary to see that the shaft of the pump and of the prime mover are in one line. If the prime mover and pump are direct connected remove the coupling bolts, if not already removed. The pump should be completely connected up to its piping and the base plate then leveled up and adjusted to position so as to bring the two halves of the coupling into perfect alignment.

c. With a pair of inside calipers or a wedge, check the distance between the coupling halves at four points and repeat after revolving both halves 180 degrees.

d. Both suction and discharge pipes should be independently supported near the pump so that when the flange bolts are tightened no strain will be transmitted to the pump casing.



Stroight edge exoctly level ocross coupling shrouds Coupling foces ore porollel with distonce between foces exoctly the some ot oll points

Fig. 142. Proper and Improper Shaft Alignment.

143. SUCTION CONNECTIONS.

a. The size of suction pipe should be determined from Fig. 143a (Appendix C). These curves include an allowance for velocity and friction loss through elbows and foot valves.

b. Suction pipe should be of the same pressure rating as the yard piping and installed in accordance with the Standard for Outside Protection, NFPA No. 24. For short pipe, well-supported, flanged cast iron pipe with rubber gaskets should be used. In special cases steel pipe having flanged or screwed joints (flanged joints with flanges welded to the pipe are preferred) may be used above ground in the pump room provided it is galvanized or painted on the inside, prior to installation, with a paint recommended for submerged surfaces. Thick bituminous coatings applied at the plant should not be used. The exterior of steel pipe should be kept painted. Cement asbestos pipe may be used when the pump takes suction under a head at all times.

c. Avoid an excessive length of suction pipe to a pump room under lift by providing a suction well close to the pump. The well can be fed by gravity through a large pipe from the suction source.

d. Provide independent suction pipes where more than one pump is supplied under lift from the same intake or suction well. In special cases where a single suction pipe supplies more than one pump under head, the piping layout at the pumps must be symmetrical so that each pump will receive its proportional supply. The size of the suction pipe should be such that with all pumps operating at overload capacity the total operating suction lift will not exceed 15 feet.

e. When the suction supply is under sufficient pressure to be of material value without the pump, the pump should be installed with a by-pass (Fig. 143e, Appendix C).

f. Suction pipes involving a lift must be carefully laid to avoid air leaks and air pockets, either of which may seriously affect the operation of the pump. Lay a suction pipe involving a lift so that it will have a constantly ascending grade from the water supply to the pump (Fig. 143f, Appendix C).

g. Lay suction pipe below the frost line. Pay special attention where pipe enters streams, ponds, or reservoirs to prevent freezing either underground or under water (Fig. 100b, Appendix C). Avoid horizontal elbows near the pump (Fig. 143f, Appendix C).

h. All pump suction pipe, except short lengths between above-ground suction tanks and pumps, should be hydrostatically tested in accordance with the tests for yard mains given in the Standard for Outside Protection (NFPA No. 24) before back filling.

i. When the suction pipe and pump suction connection are not of the same size, connect them with an eccentric tapered reducer in such a way as to avoid air pockets (Fig. 143f, Appendix C).

j. Equip suction pipes which may at any time involve a lift with approved foot valves except when two completely independent exhaust-type priming methods are provided. Piping should be arranged to permit removing foot valves for inspection and cleaning. Combination foot valves and strainers should not be used.

k. Provide an approved O.S. & Y. or approved indicator type gate valve in the suction pipe if the pump is ever supplied under a head.

NOTE 1: If suction pressure comes from city or service water mains, the gate valve should normally be located at the suction flange on the pump. (item 6A in Figure 100 a)
NOTE 2: If suction pressure comes from a stored water container, the gate valve should normally be located at the outlet of the container. (item 6 in Figure 100 a)

l. Suction inlets should be at least 24 inches below minimum water level to prevent pumps from drafting air, and at least 12 inches above the bottom of sump or suction well to avoid obstruction (Fig. 100b and Fig. 143l, Appendix C).

m. Provide double removable intake screens (Fig. 100b, Appendix C) having an effective net area of openings below minimum water level of one square inch for each gallon per minute of 150 per cent of rated pump capacity at suction intakes where it is necessary to prevent the passage of materials which might clog the pump. Screens should be so arranged that they can be cleaned or repaired without disturbing the suction pipe. A brass or copper wire screen of one-half inch mesh and No. 10 B. & S. gage wire, secured to a metal frame sliding vertically at the entrance to the intake, makes a serviceable arrangement, and permits ready cleaning and overhauling. The over-all area of this particular screen is 1.6 times the net screen opening area. In some localities, suction supply for fire pumps from public water mains may require the installation of an approved strainer to prevent foreign material from passing through the pump into the system piping.

n. When pump and suction supply are on separate foundations with rigid interconnecting piping, the piping should be provided with strain relief. (See Figure 100 a, item 5.)

Chapter 200 — Vertical Shaft Turbine-Type Pumps.

210. General.

211. SUITABILITY. The deep well turbine-type pump is particularly suitable for fire pump service when the source of water is located below the surface of the ground and it would be difficult to install any other type of pump below the minimum water level. It is a vertical shaft centrifugal pump with rotating impellers suspended from the pump head by a column or eduction pipe which also serves as a support for the shaft and bearings. It was originally designed for installation in bored wells, but may also be used to lift water from lakes, streams, open sumps, and other sub-surface sources. Oil-lubricated enclosed line shaft or water-lubricated open line shaft pumps will be acceptable.

212. MAXIMUM DEPTH. Wells should not be considered as a source of supply for fire pump service where the water level when pumping at 150 per cent capacity exceeds 200 feet from the surface of the ground. In all applications where the water level is expected to exceed 50 feet the authority having jurisdiction shall be supplied with data on the draw-down characteristics of the well and the pump performance to determine the available discharge pressure at the discharge flange of the vertical pump.

213. ACCEPTABLE DRIVE. These pumps may be operated by vertical shaft electric motor or, when equipped with a suitable right angle gear drive, they may be operated by an internal combustion engine or a steam turbine. Careful consideration must be given in each case to the dependability of the source of power.

214. SUPERVISION OF INSTALLATION. Satisfactory operation of vertical turbine-type pumps is dependent to a large extent upon careful and correct installation of the unit; therefore, it is recommended that this work be done under direction of a representative of the pump manufacturer.

215. PERFORMANCE. Pumps shall furnish not less than 150 per cent of rated capacity at a total head of not less than 65 per cent of the total rated head. The shut-off total head shall not exceed 140 per cent of total rated head (Fig. 1, Appendix C).

220. Water Supply.

221. SOURCE.

a. The water supply shall be acceptable to the authority having jurisdiction. Stored water supplies from reservoirs or tanks supplying wet pits are preferable. Lakes, streams and ground water supply may be acceptable where investigation shows that they can be expected to provide a suitable and reliable supply.

b. The acceptance of a well as a source of water supply shall be dependent upon satisfactory development of the well and the making of a preliminary test to determine hydraulic conditions. The history of the water table should be carefully investigated. The number of wells already in use in the area and the probable number that may be in use should be considered in relation to the total amount of water available.

222. PUMP SUBMERGENCE.

a. Proper submergence of the pump must be provided for reliability of operation of the fire pump unit.

b. WET PIT INSTALLATIONS. The minimum submergence should be such that the second impeller from the bottom of the pump bowl assembly will be below the lowest standing water level in the open body of water supplying the pit (Fig. 200b, Appendix C). The minimum submergence shall be increased by one foot for each 1000 feet of elevation above sea level.

c. WELL INSTALLATIONS. Submergence of the second impeller from the bottom of the pump bowl assembly should be 10 feet below the pumping water level at 150 per cent of rated capacity. (See Figure 200 a, Appendix C.)

223. WELL CONSTRUCTION.

a. It shall be the ground water supply contractor's responsibility to make one or more test holes, if necessary, in search of water-bearing formation, develop a well to meet the required water production necessary for a specific pump, to perform all work and install all equipment in a thorough and workmanlike manner.

b. Each well completed must be of ample diameter and depth and sufficiently straight to receive the pump. The turbine-type pump is designed to operate in a vertical position with all parts in correct alignment; it cannot operate in a crooked well unless the turbine unit hangs freely without being cramped.

224. UNCONSOLIDATED FORMATIONS.

a. All casings shall be steel of such diameter and installed to such depths as the formation may justify and in the contractor's opinion best meet the conditions. Both inner and outer casing shall conform to the thickness and weight in Table 224.

TABLE 224

Nominal Size (ID) Inches	Wall Thickness Inches	Weight per Foot (Plain Ends) Pounds
8	0.277	24.70
10	0.307	34.24
12	0.330	43.77
16 and larger	0.375	—

b. Outer casing shall extend down to approximately the top of the water-bearing formation. The inner casing of lesser diameter and well screen shall extend into the water-bearing formation as the water-bearing stratum encountered may justify and, in the contractor's opinion, best meet the conditions.

c. It should be emphasized that the well screen is a vital part of the well construction and careful attention should be given to its selection. It shall be the same nominal diameter as the inner casing and of the proper length to provide for the quantity of water to be developed. The screen shall be made of stainless steel material (304) except that Monel metal shall be used where it is anticipated that the chloride content of the well water will exceed 1000 parts per million. The screen shall have adequate strength to resist the external forces that will be applied after it is installed and to minimize the likelihood of damage during the installation.

d. The bottom of the well should be sealed properly with a cement plug or a plate of the same material as the screen. The sides of the outer casing should be sealed by the introduction of neat cement placed under pressure from the bottom to the top.

e. The immediate area surrounding the well screen should be properly prepared with clean and well-rounded gravel of such size and quantity as will create a gravel filter to insure a low velocity and friction loss of water leaving the water-bearing formation and entering the well.

225. CONSOLIDATED FORMATIONS. Where wells take their supply from consolidated formations, such as rock, the specifications should be decided upon by the authority having jurisdiction upon consultation with a recognized ground water consultant in the area. In instances where the drilling penetrates unconsolidated formations above the rock, surface casing shall be installed, seated in solid rock and cemented in place.

226. DEVELOPING A WELL. Developing a new well and cleaning it of sand (not to exceed five parts per million) shall be the ground water supply contractor's responsibility and should be done with a test pump and not the new fire pump which could be ruined before it is placed in service. Freedom from sand shall be determined when the test pump is operating at 150 per cent of rated capacity of the fire pump for which the well is being prepared.

227. TEST AND INSPECTION OF WELL.

a. A test to determine the water production of the well shall be made with an acceptable type of water measuring device such as an orifice, a venturi meter or a calibrated pitot tube, and shall be witnessed by a representative of the customer, contractor and authority having jurisdiction, as required. The test shall be continuous for a period of at least eight hours at 150 per cent of the rated capacity of the fire pump, with averaged hourly readings over the test period. The tests should be evaluated in the light of the effect of other wells in the vicinity and any possible seasonal variation in the water table at the well site. Test data shall describe the static water level and the pumping water level at 100 and 150 per cent of the rated capacity of the fire pump for which the well is being prepared.

b. The well work completed by the ground water supply contractor should be carefully examined and if there is some doubt about straightness of well, gaging and plotting is recommended before acceptance of the well.

c. Before the permanent pump is ordered, the water in the well should be analyzed for corrosiveness including such items as pH, salts such as chlorides, harmful gases such as carbon dioxide (CO_2) or hydrogen sulfide (H_2S). If the water is corrosive, the pumps should be constructed of a suitable corrosion-resisting material such as bronze or red brass in accordance with chemical analysis and experience in the area.

230. Pump.

231. DISCHARGE HEAD. The discharge head should be of the aboveground type (Fig. 200a and b, Appendix C). In every case the discharge head shall be designed to support the driver, the pump column and the oil tube tension nut or packing container. The discharge head shall also act as a water passage to direct the water from the column into the discharge fittings.

232. PUMP COLUMN.

a. The column shall be furnished in sections not exceeding a nominal length of 10 feet, shall be of minimum weight conforming to specifications in Table 232, and shall be connected by threaded sleeve type or flange type couplings. The ends of each section of threaded pipe shall be faced parallel and machined with threads to permit the ends to butt so as to form accurate alignment of pump column. All column flange faces shall be parallel and machined for rabbet fit to permit accurate alignment.

TABLE 232.

Nominal Size (ID), Inches	Outside Diameter, Inches	Weight per Foot (Plain Ends), Pounds	Nominal Size (ID), Inches	Outside Diameter, Inches	Weight per Foot (Plain Ends), Pounds
6	6.625	18.97	10	10.750	31.20
7	7.625	22.26	12	12.750	43.77
8	8.625	24.70	14*	14.000	54.57
9	9.625	28.33			

*OD

b. Open line shaft water-lubricated columns shall not be used where the distance from the pump head to the static water level exceeds 50 feet.

c. If the pump is to be of the enclosed line shaft oil lubricated type the shaft enclosing tube shall be furnished in interchangeable sections not over 10 feet in length, of extra strong pipe. An automatic sight feed oiler shall be provided on a suitable mounting bracket with connection to the shaft tube for oil lubricated pumps.

233. BOWL ASSEMBLY.

a. The pump bowl shall be of close-grained cast iron or bronze, and provided with bronze wearing rings or other suitable material in accordance with the chemical analysis of the water and experience in the area, as per Paragraph 224b.

b. Impellers shall be of bronze of the enclosed or semi-open type.

234. SUCTION STRAINER.

a. A cast or heavy fabricated type of non-ferrous cone or basket type strainer shall be attached to the suction manifold of the pump. The suction strainer shall have a free area of at least four times the area of the suction connections and the openings shall be of such size to restrict the passage of a ½ inch sphere.

b. This suction strainer shall be required in addition to intake screen, specified under Paragraph 143m.

235. FITTINGS.

a. The following fittings to be furnished by the pump manufacturer shall be required for attachment to the pump (Some shown in Fig. 200a, Appendix C).

Discharge tee or elbow.
Hose valve head (separable type), Section 44.
Hose valves, Section 44.
Automatic air release valve and fittings, Paragraph 235b.
Discharge gage conforming to Section 45.
Relief valve and discharge cone, when required by Section 43.
Water level testing device, Paragraph 235 c.

b. A 1½-inch or larger automatic air release valve is required to vent air from the column and discharge head upon starting the pump and also to serve to admit air to the column to dissipate the vacuum when the pump is stopped. This valve shall be located at the highest point in the discharge line between the fire pump and the discharge check valve.

c. Each pump installed in a well must be equipped with a suitable water level detector. The air line method (Section 236) is considered as a satisfactory method of determining depth of water level. This device should be permanently installed.

236. AIR LINE METHOD OF WATER LEVEL DETECTION.

a. A satisfactory method of determining the water level involves the use of an air line of small pipe or tubing and of known vertical length, a pressure or depth gage, and an ordinary bicycle or automobile pump installed as shown by Fig. 236. The air line pipe should be of known length and extend beyond the lowest anticipated water level in the well in order to assure more reliable gage readings and should be properly installed. As noted in Fig. 236 an air pressure gage is used to indicate the pressure in the air line.

b. The air line pipe is lowered into the well, a tee is placed in the line above the ground, and a pressure gage is screwed into one connection and the other is fitted with an ordinary bicycle valve to which a bicycle pump is attached. All joints must be made carefully and must be air tight to obtain correct information. When air is forced into the line by means of the bicycle pump the gage pressure increases until all the water has been expelled. When this point is reached the gage reading becomes constant. The maximum maintained air pressure recorded by the gage is equivalent to that necessary to support a column of water of the same height as that forced out of the air line. The length of this water column is equal to the amount of air line submerged.

c. Deducting this pressure converted to feet (psi pressure × 2.31 = feet) from the known length of the air line will give the amount of submergence.

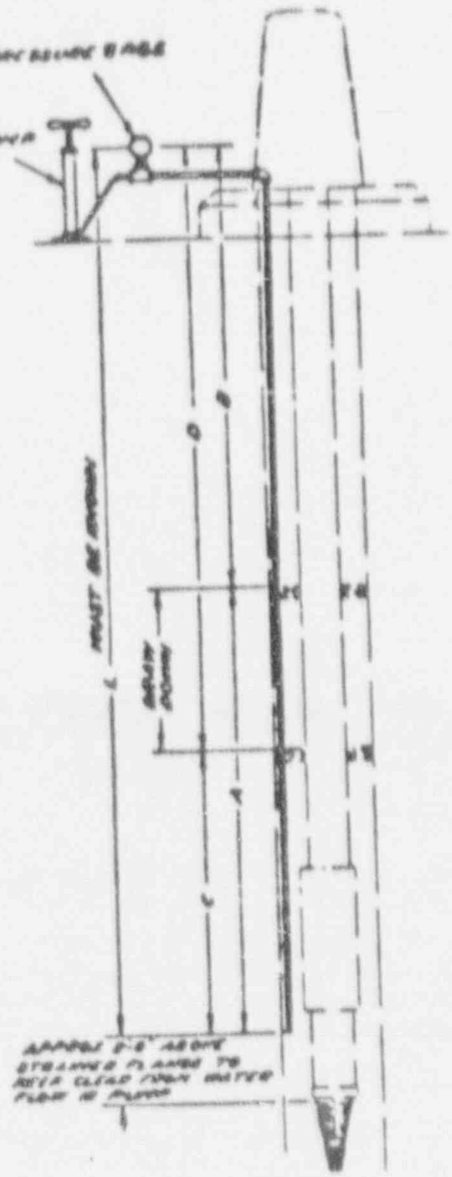


Fig. 256. Air Line Method of Determining Depth of Water Level

EXAMPLES: The following examples with Fig. 236 will serve to clarify the above explanation.

Assume a length (L) of 50 feet.

Pressure gage reading before starting fire pump (p_1) = 10 psi. Then "A" = 10 × 2.31 = 23.1 feet, therefore the water level in the well before starting the pump would be B = L − A = 50 23.1 = 26.9 feet.

Pressure gage reading when pumping = (p_2) = 8 psi. Then C = 8 × 2.31 = 18.5 feet, therefore the water level in the well when pumping would be D = L − C = 50 − 18.5 feet = 31.5 feet.

The drawdown may be determined by any of the following methods:

(a) D − B = 31.5 − 26.9 = 4.6 feet.
(b) A − C = 23.1 − 18.5 = 4.6 feet.
(c) p_1 − p_2 = 10 − 8 = 2 psi.
= 2 × 2.31 = 4.6 feet.

240. Installation.

241. PUMP HOUSE. The pump house should be of such character as will offer the minimum obstruction to the convenient handling and hoisting of vertical pump parts. Otherwise the requirements of Section 41 and Section 666 should apply.

242. OUTDOOR SETTING. If in special cases the authority having jurisdiction does not require a pump room and the unit motor is installed outdoors the motor shall be screened, and adequately protected against tampering. The screen should be easily removable and provision made for ample ventilation. A sheet metal on iron frame is better than wood.

243. FOUNDATION.

a. The pump foundation for vertical type pumps should be substantially built to carry the weight of the entire pump full of water and the driver. It should be rigid enough to withstand and prevent any vibration. Area of the base of foundation should extend at least 3 inches beyond the pump head base plate on all sides and be of sufficient area and strength so that the load per square foot on concrete does not exceed the ordinary foundation standards, or two I-beams of sufficient length and weight may be used on either side of well.

b. Certified prints can be obtained from the pump manufacturer giving the necessary dimensions.

c. Top of the foundation shall be carefully leveled to permit the pump to hang free in the well.

d. Where pump is mounted on I-beam over a pit the right angle gear housing and driver should always be installed parallel to beams, *never at right angle*.

244. METHOD OF ERECTING.

a. Several methods of installing a vertical pump may be followed, depending upon the location of the well and facilities available. Since most of the pump unit is underground, extreme care must be used in assembling and installing it and thoroughly checking the work as it progresses. The installation should be made under supervision of a representative of the pump manufacturer.

b. The following simple method is the most common.

1. Construct a tripod or portable derrick and use two sets of installing clamps over open well or pump house. After the derrick is in place the alignment should be checked carefully with the well or suction pit to avoid any trouble when setting the pump.

2. Attach set of clamps to the suction pipe on which strainer has already been placed and lower into the well until clamps rest on block beside well casing or on pump foundation.

3. Attach clamps to pump stage assembly and bring over well and install pump stages to suction pipe, etc., until each piece has been installed in accordance with manufacturer's instructions.

NOTE A series of drawings illustrating this procedure will be found in Appendix C. See Figures 244b-1, 2, 3 and 4

245. **SETTING IMPELLERS.** The setting of the impellers should only be undertaken by a representative of the pump manufacturer. Improper setting will develop excessive friction loss by rubbing of impellers on pump seals with resultant increase in power demand. If adjusted too high there will be a loss in capacity; full capacity is vital for fire pump service. The top shaft nut should be locked or pinned after proper setting.

250. Driver.

251. METHOD OF DRIVE.

a. The pump may be driven by a vertical hollow shaft electric motor or right angle gear drive or dual drive with internal combustion engine or steam turbine. The driver provided must be so constructed that the total thrust of the pump, which includes the weight of the shaft, impellers, and the hydraulic thrust, can be carried on a thrust bearing of ample capacity so that it will have an average life rating of five-year continuous operation. All drivers must be so constructed that axial adjustment of impellers can be made to permit proper installation and operation of the equipment.

b. Motors shall be direct connected, of the vertical, hollow shaft type, drip proof, normal starting torque, low starting current, squirrel cage induction type. The motor shall be equipped with an antireverse ratchet.

c. Gear drives must be acceptable to the authority having jurisdiction. Gear drives shall be of the hollow shaft type, permitting adjustment of the impellers for proper installation and operation of the equipment. The gear drive shall be equipped with an antireverse rachet.

d. Where internal combustion engines under manual control are used, it shall be the pump manufacturer's responsibility to furnish a coupling of suitable design which will prevent undue strain on either the engine or pump by reverse operation. Automatic starters are equipped with an antidieseling device which serves to prevent reverse operation from self ignition during compression.

e. If dual drive is used, all equipment shall be of approved type and shall include approved free-wheeling clutches (see Paragraph 623.b).

252. CONTROLS. The controls for the motor, steam turbine or internal combustion engine shall comply with the sections of this standard which cover these controls.

260. Tests.

261. FIELD ACCEPTANCE AND SUBSEQUENT TESTS.

a. When the installation is completed, with wells and pumping equipment all in place, and necessary adjustments and connections made, an operating test shall be made in the presence of the customer, pump manufacturer and representative of the authority having jurisdiction. Requirements regarding field acceptance tests in Article 910 should be followed insofar as they apply, excepting that for well installations the test shall include a continuous run long enough to satisfy the authority having jurisdiction that the permanent pump performs as required, but in no event shall the test be for less than one hour.

b. A yearly inspection and test at 150 per cent rated capacity to determine water level and condition of pump should be made.

270. Operation and Maintenance.

271. OPERATION.

a. In starting the unit for the first time after installation it is advisable to check over all electrical connections to the motor and also the discharge piping from the pump. Then momentarily operate the motor to see that the pump shaft rotates in a counter-clockwise direction when viewed from above.

b. With these precautions taken the pump may be started and allowed to run. Observe the operation for vibration while running and also any heating of the motor.

272. VIBRATION.

a. Pumping units are checked at the factory for smoothness of running and performance and should operate satisfactorily on the job. If excessive vibration is present several conditions may cause the trouble — a bent pump or column shaft, impellers not properly set within the pump bowls, pump not hanging freely in the well, or strain transmitted through the discharge piping.

b. If vibration develops later the unit should not be continued in operation. The pump manufacturer should be requested to service the installation and to place it in proper running condition.

273. EXCESSIVE MOTOR TEMPERATURE. This condition is generally caused either by a maintained low voltage of the electric service, or when the impellers are not properly set within the pump bowls.

274. Repair.

a. Manufacturer's instructions must be carefully followed in making repairs, taking apart and reassembling the pumps. This work should only be undertaken by someone familiar with their design.

b. In ordering spare or replacement parts use the pump serial number stamped on the name plate fastened to the pump head.

Chapter 300 — Special Fire Service Pumps.

310. General.

311. APPLICATION. Special fire service pumps are intended for installation in situations where the available supply of water is limited and draft of water in excess of the maximum delivery of the pump would be likely to reduce the supply pressure to an undue extent. It is not usually advisable to reduce the pressure in public mains below 20 pounds per square inch suction pressure while the pump is operating at its rated capacity. Special fire service pumps may also be used as booster pumps in situations where there is no deficiency in the volume of water available but the pressure is inadequate to supply the quantity of water necessary for efficient discharge from the highest sprinklers. The authority having jurisdiction may permit the use of these pumps for other special situations where such use is acceptable to said authority. They are for use only where the conditions are not such as to justify installation of a standard fire pump.

312. USE. Special fire service pumps may be installed instead of standard fire pumps only when their installation is approved by the authority having jurisdiction.

320. Water Supplies.

321. CAPACITY. Installation of pumps shall conform to the applicable provisions of Article 20 and Section 121.

330. Pump.

331. STANDARD PUMPS. Standard special fire service pumps have nominal capacities of 200, 300 and 450 gallons per minute with pressure ratings between 40 and 100 psi. The pumps shall have such performance characteristics that the power required of the driving motor will not exceed 30 horsepower at any rate of water delivery within the delivery range shown by the head-delivery curve of the pump.

332. SELECTION OF PUMP. Selection of a pump for a given condition should be based on the capacity and pressure conditions in the supply mains as determined by test, and the capacity and pressure requirements of the installa-

tion. The pump chosen should be one which has a capacity and pressure rating not less than required without exceeding the capacity limit of the supply main. Where a characteristic curve is not available it should be assumed that the pump may have a maximum suction demand of 130 per cent of its rated capacity.

333. PUMP REQUIREMENTS. The pumps shall be specifically approved for fire service. They should be of the horizontally-split case type. They shall have such performance characteristics that, at zero lift, the maximum capacity will not exceed 130 per cent of the rated capacity.

340. Installation.

341. GENERAL. Installation of pumps shall conform to the applicable provisions of Articles 40 and 140. See particularly Paragraphs 41a, e, and f, and 141a and b.

342. ATTACHMENTS.

a. Two pressure gages conforming to Section 45 shall be provided, one attached on the discharge and one on the suction side of the pump.

b. A discharge fitting with valved outlet for attachment of 2½-inch hose shall be provided for testing purposes.

c. Means shall be provided for automatic release of air from the pump and for circulation of sufficient water to prevent the pump from overheating. An air release valve not less than ½ inch in size, and a ¾ inch pressure relief valve set slightly below the shut-off pressure, are recommended. (See Section 46.)

350. Driver.

351. CAPACITY. Motors shall be of such capacity that at rated voltage (and on a.c. motors at rated frequency) their full load ampere rating will not be exceeded (except as allowed by the service factor stamped on the name plate) under any conditions of pump load. It shall be the pump manufacturer's responsibility to provide a motor of ample size to drive the pump, taking into consideration the suction pressure.

352. INSTALLATION. Motors and their power supply shall conform to the applicable provisions of Chapter 400. See particularly Articles 410, 420 and 430 and Sections 451, 454, 456 and 457.

360. Tests.

361. SHOP TEST. The pump shall be tested in the shop with a dynamometer or calibrated motor, and performance curves showing the head, capacity, efficiency and brake horsepower of the pump shall be furnished to the purchaser promptly after the test, and, upon request, to the authority having jurisdiction.

370. Contracts.

371. PURCHASE CONTRACT. It is recommended that the pump, motor and controller be purchased under a unit contract.

PART II — DRIVE AND DRIVE CONTROLLERS FOR PUMP.

Chapter 400 — Electric Drive

410. General.

411. ELECTRICAL EQUIPMENT. Electrical equipment shall comply with the National Electrical Code (NFPA No. 70), except as modified or provided herein.

NOTE: See Par. 2421 of the NFPA Standard for Installation of Sprinkler Systems (NFPA No. 13) regarding supervision of centrifugal fire pumps constituting the sole sprinkler supply.

420. Power Station.

421. SINGLE POWER STATION. When current is taken from a single power station, the station should be of noncombustible construction, so located or protected as to be free from chances of serious damage by exposure from fire, and the design and arrangement of apparatus within it such that there will be but little chance of interruption of service.

422. FROM A SUB-STATION. Where current is taken through a sub-station this sub-station should also meet the requirement of Section 421 and in addition the number and arrangement of cables between the station and the substation should be such as to practically guarantee continuous power at the sub-station.

423. OTHER SOURCES.

a. Where service cannot be obtained from a power station or sub-station meeting these requirements, it should be obtained from two or more stations or sub-stations so located and equipped that an accident or fire at one will not cause an interruption of the service supplied by the others.

b. A private generating plant located on the premises served by the fire pump, if in a separate power house or cut off from main buildings, will be considered as a power station, and may be used as one source of current supply.

430. Power Supply Lines.
(See Fig. 430, Appendix C, for illustrative Diagrams.)

431. TYPE OF LINES.

a. The lines between the power plants and the pump room should be of such number, so arranged and so located that there will be small chance of an interruption of service to the motor, due to accident to the lines.

b. All wiring in the pump room shall be in approved rigid metal conduit, electrical metallic tubing or liquid-tight flexible metal conduit, or for 600 volts or less may be approved mineral insulated metal sheathed cable (type MI).

NOTE: Where the monetary values involved are large and the crippling of this pump service would seriously affect the protection of the property, at least two separate lines from the power plant or plants to the pump installation should be provided. The lines should be run by separate routes or in such a manner that a failure of both at the same time will be only a remote possibility.

Where current is taken from an underground Edison 3-wire system it will be considered that two independent lines have been provided if connections are brought into the pump room from two street mains or feeders not terminating directly in the same junction box.

A complete underground circuit from generating station to pump is strongly recommended and should be obtained when practicable. When such construction is not available, an overhead circuit may be allowed, but that part of the circuit adjacent to the plant or exposing plants should be run with special reference to damage in case of fire. Where the pump room is a part of, or in close proximity to, the plant which the pump is designed to protect, the wires for some distance from the pump room should be underground.

432. CAPACITY OF LINES.

a. Each line between the power plant and pump room shall be of such size that its carrying capacity, as given by the National Electrical Code (NFPA No. 70), will not be exceeded.

b. The voltage at the motors should not drop more than 5 per cent below the voltage rating of the motors when the pumps are being driven at rated output, pressure, and speed, and the lines between motors and power stations are carrying their peak loads.

c. Where squirrel-cage motors are used, the capacity of the generating station, the connecting lines and the transformers should be ample and such as not to cause the voltage to drop sufficiently to prevent the motor starting (not more than 10 per cent below normal voltage).

d. When 208-220 (or 208-220/440) volt motors are used on 208 volt nominal lines, the 5 per cent voltage drop allowed in 432b shall be figured from the 220 volt rating.

433. POWER SUPPLY PROTECTIVE DEVICES (Fuses or circuit breakers).

a. Such devices when installed in the power supply circuits at utility plants, substations, or plant load distribution centers ahead of the fire pump feeder circuits shall hold indefinitely stalled rotor current conditions of the fire pump motor(s) under maximum plant load.

b. Such devices (fuses not recommended) when installed in the fire pump feeder circuit shall hold indefinitely stalled rotor current of the fire pump motor(s) and other necessary associated fire pump installation electrical accessories.

NOTE: Each ungrounded conductor should be protected. See also 514b.

440. Transformers.

441. INSTALLATION. Transformers shall be installed in accordance with the requirements of the National Electrical Code (NFPA No. 70). If in the transformer room, there should be access from the outside of the building.

442. ISOLATION. Transformers supplying current to the lights and motors in the building served by the fire pump may also supply the pump motor, provided all load except the pump motor load can be quickly cut off when necessary. Switches for doing this must be in the pump room unless transformer room is near pump room, in which case they may be in transformer room.

443. LOCATION. Room containing transformers installed solely to supply current to a pump motor must be dry and heated in cold weather, or else the transformers must be normally left connected to the supply lines.

450. Motors.

451. TYPES — 600 VOLTS OR LESS. Electric motors are an accepted dependable source of power for operation of centrifugal fire pumps. All fire pump motors shall be rated for continuous duty and shall not be used at voltages in

excess of 110 per cent of rated voltage. It is the pump manufacturer's responsibility to provide a motor of ample size as specified in Section 453. Only motors wound for 200 or 208 volts shall be used for 208 volt services when the voltage may be less than that determined in accordance with 432d. Direct- or alternating-current motors may be used in accordance with the following requirements:

a. Direct-current motors shall be either of the stabilized shunt type, or cumulative compound-wound type. The speed of the motor at no load hot shall not exceed the speed at full load hot by more than 10 per cent.

b. Alternating current motors may be of the squirrel-cage induction type with across-the-line type starting equipment unless their starting characteristics would be objectionable to the company furnishing the power, in which case primary resistance primary reactor or auto-transformer type starting may be employed, or a wound rotor type of motor with appropriate starting equipment may be substituted.

c. Squirrel-cage induction motors should have normal *starting and breakdown torque. The locked-rotor current* of three-phase, constant-speed, induction motors, measured with rated voltage and frequency impressed with rotor locked shall not exceed the following values:

Rated Horsepower	*Locked Rotor Current Three-Phase 220 or 230 Volts (See Note 1)*	*Motor Designation (NEC Code Letter)*	
		220 Volts A to and Including	*230 Volts A to and Including*
		(See Note 2)	
5	92	H	J
7½	127	H	H
10	162	G	H
15	232	G	G
20	290	F	G
25	365	F	G
30	435	F	G
40	580	F	G
50	725	F	G
60	870	F	G
75	1085	F	G
100	1450	F	G
125	1815	F	G
150	2170	F	G
200	2900	F	G

NOTE 1: In the foregoing table the locked rotor currents are for motors rated at 220 or 230 volts. They are approximately six times the full-load current. The corresponding values of locked rotor current for motors rated at other voltages shall be determined by multiplication of the values shown by the following factors:

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Rated Voltage	*Factor*
208 Volts	1.1
440 or 460 Volts	0.5
550 or 575 Volts	0.4
Any other Voltage	Ratio of 230 volts to the rated voltage.

(For example: a 15 H.P., 460 Volt motor would have a [illegible] of 116 amperes.)

NOTE 2: Code letters of motors rated for 440 or 550 volts shall conform with those shown for 220 Volts. Code letters of motors rated for 208 Volts, 460 Volts, 575 Volts and all other Voltages shall conform with those shown for 230 Volts.

452. TYPES — IN EXCESS OF 600 VOLTS. All fire pump motors shall be rated for continuous duty and shall not be used at voltages in excess of 110 per cent of rated voltage. Voltages above 600 are not recommended for fire pump service, but where it is impracticable to use low voltage, higher voltages may be accepted by the authority having jurisdiction, for motor ratings of approximately 75 horsepower and larger at 2,300 volts and for motor ratings of approximately 100 horsepower and larger at 4,000 volts.

453. CURRENT LIMITS.

a. All motors shall be of such capacity that at rated voltage (and on a.c. motors at rated frequency) their full load ampere rating will not be exceeded (except as allowed by the service factor stamped on the name plate) under any conditions of pump load.

b. Motors used at altitudes above 3300 feet shall be operated or derated according to NEMA Standard MG1-14.14 (1963).

454. MARKING.

a. Marking of motor terminals shall be in accordance with the current American Standard C6 for Rotation, Connections and Terminal Markings for Electric Power Apparatus.

b. A name plate shall be provided showing the following information:

DIRECT-CURRENT MOTORS —

Manufacturer's type and frame designation.

Rated horsepower output.

Time rating.
Voltage.
Temperature rise or class of insulation.
Ambient temperature.
RPM at full load.
Full load amperes.
Shunt or compound wound.

ALTERNATING-CURRENT MOTORS —

Squirrel-cage Motors —

Manufacturer's type and frame designation.
Rated horsepower output.
Time rating.
Rpm at full load.
Frequency.
Number of phases.
Voltage.
Full load amperes.
Code letter.
Service factor, if other than 1.0.
Temperature rise or class of insulation and ambient temperature.

Wound Rotor Induction Motor —

In addition to information required in previous paragraph, also show secondary amperes at full load and secondary voltage.

455. WATER PROTECTION.

a. Open motors which are subject to possible splash of water from hose connections close to the pump, shall be protected against such splashing by some means such as a noncombustible, moisture-resisting partition, furnished by the pump manufacturer, installed between the pump and the motor.

b. Drip-proof motors shall be arranged as described above unless the hose valves are located outside the pump room.

c. Splash-proof motors shall be acceptable without splash partition as described above, providing the ventilating inlet and discharge are located so as to prevent impact of dripping or splashing water on windings or other energized mechanisms.

d. Motors of totally enclosed, fan cooled type shall be acceptable without splash partition. They shall be sealed at the joints and have conduit fittings arranged to prevent the entrance of water.

NOTE: See item 19 in Appendix A-Glossary for a description of the various types of electric motors.

456. OTHER FEATURES.

a. Motor shall be equipped with anti-friction ball or roller-type bearings mounted so as to be effectively sealed against dirt and moisture.

b. Instructions as to lubrication and care of motor bearings shall accompany each motor.

c. The terminal box shall be of a type which can be arranged for attaching conduit at sides, top or bottom. A totally-enclosed fan-cooled motor shall be provided with a watertight conduit box.

d. Where unusual moisture or abrasive dust conditions are anticipated, motors shall be of special type or specially insulated to withstand such conditions. Under such conditions high voltage motors shall be totally enclosed.

457. CONFORMANCE. Motors furnished for centrifugal fire pump use shall be guaranteed to conform with these specifications.

Chapter 500

ELECTRIC DRIVE CONTROLLERS

510. Requirements for all Controllers.

511. GENERAL.

a. The following specifications cover controlling equipment of the nonautomatic and automatic types for electric motors driving centrifugal fire pumps. Chapter 400 dealing with the electric motor drive also applies insofar as it is appropriate.

b. Automatic-type controllers are recommended for use only where the fire pump takes its water under positive pressure and their use is not recommended where a suction lift is involved.

c. All controllers shall be specifically approved for fire pump service.

d. The control panel shall be completely assembled, wired, and tested by the manufacturer before shipment from the factory.

e. Voltages above 600 v are not recommended for fire pump service, but where it is impracticable to use a low voltage, higher voltages may be accepted by the authority having jurisdiction. High voltage controllers shall be rated at not more than 5000 v. (See Article 520).

f. Controllers conforming to this Standard shall be marked "Fire Pump Controller" and shall show plainly the name of the manufacturer, the identifying designation and the complete electrical rating.

512. LOCATION.

a. The controller shall be located as close to as is practical and within sight of the motor.

b. The controller shall be so located or protected that it will not be injured by water escaping from the pump or connections. Current carrying parts of the controller shall be not less than 12 inches above the floor level.

c. A clearance of not less than 3½ feet shall be provided at the rear of enclosures designed to be inspected and serviced from the rear.

513. GENERAL CONSTRUCTION.

a. EQUIPMENT. All equipment shall be suitable for use in locations subject to a moderate degree of moisture such as a damp basement.

b. MOUNTING. All equipment shall be mounted in a substantial manner on a single, noncombustible supporting structure.

c. ENCLOSURE. The structure or panel shall be securely mounted in an enclosure(s) which will protect the equipment against mechanical injury and falling drops of water striking the enclosure from the downward vertical.

d. CONNECTIONS AND WIRING.

1. All bus bars and connections shall be readily accessible for maintenance work after installation of the controller without disconnecting the external circuit conductors.

2. Test Connections. Provision shall be made to allow the use of test meters by one of the methods outlined in the following paragraphs (a) or (b).

(a) Terminals shall be so located and arranged that a clamp-on or such type meter can be safely and conveniently used, or

(b) There shall be provided, as part of the controller, a readily accessible test link or equivalent means for connecting a current measuring instrument in one of the motor circuit conductors without the necessity for disconnecting any conductor which runs outside the equipment enclosures. The test link shall be connected between the isolating switch and the circuit breaker.

3. Bus bars and other wiring elements of the controller shall be designed on a continuous duty basis, except that conductors which are in a circuit only during the motor starting period may be designed accordingly.

e. PROTECTION OF AUXILIARY CIRCUITS. Circuits which are depended upon for proper operation of the controller shall not have over-current protective devices connected in them.

f. EXTERNAL OPERATION. All switching equipment for manual use in connecting or disconnecting, or starting or stopping the motor shall be externally operable as defined in the National Electrical Code (NFPA No. 70). The isolating switch shall meet the requirements of Section 514.

g. WIRING DIAGRAMS AND INSTRUCTIONS.

1. A wiring diagram shall be provided and permanently attached to the inside of the enclosure.

2. All the field wiring terminals shall be plainly marked to correspond with the wiring diagram furnished.

h. MARKING. Each motor control device and each switch and circuit breaker shall be marked to plainly indicate the name of the manufacturer, his designated identifying number and the electrical rating in volts, horsepower, amperes, frequency, phases, etc., as may be appropriate. The markings shall be so located as to be visible after installation.

i. INSTRUCTIONS. Complete instructions covering the operation of the controller shall be provided and conspicuously mounted on the controller. Pump operators should be familiar with these instructions and should observe in detail all of their provisions.

514. COMPONENTS.

a. ISOLATING SWITCH. Except as noted in Paragraph 531b for limited service controllers, a manually operated isolating switch shall be provided within the enclosure, connected on the supply side of the circuit breaker with one pole for each branch circuit conductor.

1. The switch shall be externally operable (see 513f) and the operating handle shall be provided with a spring latch which will not interfere with the closing of the switch, but shall be so arranged that it requires the use of the other hand to hold the latch released in order to permit the opening of the isolating switch.

2. The ampere rating of the switch shall be at least 115 per cent of the nameplate current rating of the motor.

3. The following warning shall appear on or immediately adjacent to the isolating switch:

WARNING — DO NOT OPEN OR CLOSE THIS

SWITCH WHILE THE CIRCUIT BREAKER (DISCONNECTING MEANS) IS IN CLOSED POSITION.

b. CIRCUIT BREAKER (DISCONNECTING MEANS). Except as noted in Section 532 for limited service controllers, the motor branch circuit shall be protected by a suitable magnetic trip-type circuit breaker, connected directly to the load side of the isolating switch and conforming with the following requirements:

1. No other overcurrent protective devices shall be in the motor circuit on the load side of the circuit breaker.

NOTE See Article 433 for rating and setting of overcurrent devices in the circuit on the line side of the circuit breaker. See National Electrical Code (NFPA No 70) for the number of overcurrent units required for circuit protection devices.

2. It shall have one pole for each ungrounded branch circuit conductor.

3. It shall be externally operable (see 513f).

4. It shall trip free of the handle.

5. Its rating shall not be less than 115 per cent of the rated full load current of the motor.

6. It shall permit normal starting of the motor without tripping.

7. It shall provide stalled rotor and instantaneous short circuit protection.

(a) For a squirrel cage induction motor, it shall be of the time delay type and have a time delay of not over 20 seconds at locked rotor current (this is 600 per cent of rated full load motor current for squirrel cage induction motors), and shall be calibrated up to and set at 300 per cent of the motor full load current.

(b) For a direct-current motor and wound rotor alternating-current motor, it shall be of the instantaneous type calibrated and set at 400 per cent of the motor full load current.

8. Its interrupting rating shall be adequate for the circuit in which it is used, and in no case be less than 11,000 amperes (symmetrical).

9. The required interrupting rating should be ob-

TABLE 514.

Interrupting Capacity of Circuit Breakers of Fire Pump Controllers When the Electric Supply is Through Transformers

(See Paragraph 514b.8 for general rule for determining the interrupting capacity of circuit breakers of fire pump controllers.)

Capacity of Transformer Bank kva	Transformer Secondary Voltage	Length of Fire Pump Branch Circuit Feet	I C of Cir Br of Fire Pump Controller — Amperes Symmetrical	
			No branch Cir Br (See Fig 430 A-1 and A-2)	With branch Cir Br (See Fig 430 A-3 and A-4)
FIRE PUMP MOTORS OF 75 HP. OR LESS				
750	240	50-75	22000	14000
750	240	Over 75	14000	14000
1000	240	50-85	22000	14000
1000	240	Over 85	14000	14000
1500	480	50-75	22000	14000
1500	480	Over 75	14000	14000
1500	240	50-100	22000	14000
1500	240	Over 100	14000	14000
2000	600	25-65	22000	14000
2000	600	Over 65	14000	14000
2000	480	50-85	22000	14000
2000	480	Over 85	14000	14000
2000	240	20-54	42000	22000
2000	240	55-105	22000	14000
2000	240	Over 105	14000	14000
FIRE PUMP MOTORS OF 100 HP. AND 125 HP.				
1000	240	50-110	22000	14000
1000	240	Over 110	14000	14000
1500	480	50-110	22000	14000
1500	480	Over 110	14000	14000
1500	240	25-65	42000	22000
1500	240	66-125	22000	14000
1500	240	Over 125	14000	14000
2000	600	20-55	42000	22000
2000	600	56-135	22000	14000
2000	600	Over 135	14000	14000
2000	480	20-60	42000	22000
2000	480	61-135	22000	14000
2000	480	Over 135	14000	14000
2000	240	30-80	42000	22000
2000	240	81-140	22000	14000
2000	240	Over 140	14000	14000

tained by the purchaser based upon the maximum possible short-circuit current at the pump room. The values, which are approximate, shown in Table 514 may be used as a guide.

10. A namepl[illegible] with the legend CIRCUIT BREAKER — DISCONN[illegible]NG MEANS in letters not less than ⅜-inch high sh[illegible] on the outside of the enclosure adjacent to the [illegible]pin[illegible] the circuit breaker.

c. MOTOR [illegible] motor starter shall be of the magnetic type [illegible] each conductor.

1. For electr[illegible]educed voltage starters, timed automatic [illegible] the motor shall be provided and the period [illegible]cceleration shall not exceed 10 seconds.

2. Starting resistors shall be designed to permit one 5-second starting operation in each 80 seconds for a period of not less than 1 hour.

3. The operating coil for the main contactor shall be supplied directly from the main power voltage and not through a transformer for controllers of 600 volts or less.

d. ALARMS AND SIGNAL DEVICES (ON CONTROLLER). A 6w or 7w candelabra base 115-125 v. pilot lamp shall be connected to a pair of power supply conductors directly on the line side of the motor starter (load side of the circuit breaker) to indicate that the circuit breaker and test link are closed and that power is available at the controller for starting. The lamp shall be accessible for replacement.

NOTE: It is recommended that the lamp operating voltage be less than the rated voltage of the lamp to insure long operating life. When necessary, suitable resistors or potential transformers should be used to reduce the voltage for operating the lamp.

e. ALARM AND SIGNAL DEVICES (REMOTE). Where the pump room is not constantly attended, the authority having jurisdiction may require the controller to be equipped with contacts to operate circuits, not exceeding 125 volts, for audible or visual alarms at a point of constant attendance indicating the following:

1. Controller has operated into a pump running condition.

2. Trouble on the controller or pumping unit.

3. Power availability signal: An audible or visual alarm, or both may be required to indicate loss of line power on line side of motor starter in any phase. This may be accomplished through use of a drop-out type of relay controlling an alarm circuit energized by a reliable source of power supply. The relay contacts should close on failure of voltage. Unless the power to this alarm circuit is electrically supervised, the controller should be arranged to start upon failure of this alarm circuit power.

515. STARTING AND CONTROL.

a. The following definitions are from the National Electrical Code (1968):

1. Nonautomatic: Nonautomatic means that the implied action requires personal intervention for its control.

As applied to an electric controller, nonautomatic control does not necessarily imply a manual controller, but only that personal intervention is necessary.

2. Automatic: Automatic means self-acting, operating by its own mechanism when actuated by some impersonal influence, as for example, a change in current strength, pressure, temperature, or mechanical configuration.

b. NFPA No. 20 contemplates that:

1. Nonautomatic controller shall be actuated by electrical manual and mechanical manual means.

2. Automatic controller shall be operable as a nonautomatic controller and also by other nonpersonal means such as: low water pressure, tripping of deluge and dry pipe valves, etc.

c. NONAUTOMATIC

1. Manual Electric Control at Controller: There shall be a manually operated switch on the control panel so arranged that when the pumping unit is started manually, its operation cannot be affected by the pressure switch, and so that the unit will remain in operation until manually shut down, except that an autotransformer reduced-voltage type of starter need not have electrical control means for starting the motor.

2. Manual Electric Control at Remote Station: Additional control stations for causing nonautomatic continuous operation of the pumping unit independent of the pressure-actuated control switch may be provided at locations remote

from the controller, but such stations shall not be operable to stop the unit.

3. Manual Mechanical Control at Controller:

(a) The controller shall be equipped with a handle or lever which operates to close the motor-circuit switching mechanism mechanically for nonautomatic continuous running operation of the motors independent of any electric control circuits or magnets (or equivalent devices) and independent of the pressure-activated control switch. Means shall be incorporated for mechanically latching or holding of the handle or lever for manual operation in the actuated position. The mechanical latching shall not be automatic, but at the option of the operator ,

(b) The handle or lever shall be arranged to move in one direction only from off to final position with the exception of the autotransformer reduced-voltage type starter.

(c) The motor starter shall return automatically to the "off" position in case the operator releases the starter handle in any but the full running position.

d. AUTOMATIC

1. Water Pressure Control: An acceptable type pressure switch having independent high and low calibrated adjustments, and which is responsive to water pressure in the fire system shall be provided in the control circuit.

NOTE: Test Device: Suitable provision shall be made for relieving pressure to the pressure switch to test the operation of the controller and the pump (Figure 515d.1. Appendix C).

2. Fire Protection Equipment Control: When the pump supplies special water control equipment (deluge, dry pipe valves, etc.) and it is desired to start the pump before the pressure control(s) would do so, the authority having jurisdiction may require the controller to be equipped to start the pump upon operation of the fire protection equipment. The controller shall be equipped with a relay of the drop-out type to start the pump when the fire protection equipment operates. The relay shall be actuated from a normally closed contact on the fire protection equipment.

NOTE: Deluge System Operation: Where the pump supplies a deluge system the authority having jurisdiction may require the controller to be equipped with a relay of the drop-out type to start the pump when the deluge valve trips. The relay should be actuated from a normally closed contact on the deluge valve.

3. Sequence Starting: Controllers for multiple pump units shall incorporate a sequential timing device to prevent any one pump starting simultaneously with any other pump. If the water requirements are such that more than one pump operates, the units shall start in 5-second intervals or at intervals which will not permit a subsequent starting pump to start until the previous pump has reached full speed. Failure of a leading pump to start shall not prevent subsequent pumps from starting.

4. For sprinkler systems and standpipe systems where an automatically controlled pump constitutes the sole supply or where required by the authority having jurisdiction, the controller shall be wired for automatic start and manual shutdown.

e. METHODS OF STOPPING: Shutdown may be accomplished by either one or both of the following:

1. Manual — the control panel shall have means for electrical operation for stopping the motor which in case of automatic controllers will return the controller to full automatic position.

2. Automatic — after starting causes have returned to normal and the pumping unit has operated for the time fixed by the running period timer.

NOTE: Whenever the controller is arranged for automatic shutdown, a running period timer set for one minute for each ten horsepower of motor rating, but not to exceed 7 minutes, shall be installed.

520. Requirements for Controllers for Voltages in Excess of 600 Volts.

521. CONTROL EQUIPMENT. Where equipment rated in excess of 600 volts is permissible (see Section 511) the control equipment shall comply with the requirements of Article 510 except as indicated in Sections 522 through 528.

522. PROVISIONS FOR TESTING. The provisions of Paragraph 513d.2 shall not apply, but an ammeter with a suitable transfer switch arranged for reading the current in each phase shall be provided on the controller. An indicating voltmeter with scale calibrated to the high voltage

supply and deriving its source of power from the control transformer secondary shall also be provided on the controller.

523. DISCONNECTING UNDER LOAD. Provision shall be made to prevent opening the isolating switch under load.

524. LOCATION OF PRESSURE ACTUATED SWITCH. Special precautions should be taken with regard to the location of the pressure actuated switch called for in Paragraph 515b to prevent any water which may be present due to leakage from coming in contact with high-voltage components.

525. LOW VOLTAGE CONTROL CIRCUIT. The low-voltage control circuit shall be supplied from the high-voltage source through a step-down control circuit transformer protected by suitable high-voltage fuses. Its supply shall be interrupted when the isolating switch is in the open position.

526. PILOT LAMP. For these controllers Section 514d shall be replaced by the following:

A pilot lamp shall be provided to indicate that power is available. The lamp operating voltage shall be less than the lamp voltage rating to insure long life. The supply for the lamp shall be obtained from the secondary of the control circuit transformer through resistors, if found necessary, or a small capacity step-down transformer to reduce the control transformer secondary voltage to that required for the pilot lamp.

527. PERSONNEL PROTECTION FROM HIGH VOLTAGE. The necessary provisions shall be made, including such interlocks as may be needed, to protect the personnel from accidental contact with high voltage.

528. INTERRUPTING CAPACITY. The circuit breaker, or the controller where it also performs the function of the circuit breaker, shall have adequate kilovolt ampere interrupting capacity for the intended service.

530. Limited Service Controllers.

531. APPLICATION. This section is applicable to automatic controllers for across-the-line type squirrel cage mo-

tors of 30 horsepower or less, 600 volts or less, where such use is acceptable to the authority having jurisdiction. All of the requirements of the preceding sections apply except as indicated in the following:

a. MARKING. Each motor controller shall be marked as specified in Paragraph 511f except that the title will be "Limited Service Controller."

b. The manually operated isolating switch mentioned in 514a is not required.

532. CIRCUIT BREAKER. The circuit breaker shall conform to 514b with the following changes:

a. It shall be approved for disconnect purposes.

b. It need not be a magnetic trip type. In general, the rating of a direct heated thermal element breaker should be the standard rating at or next below 250 per cent of the motor full-load current, but not smaller than 150 per cent; and the rating of an indirect heated thermal element breaker should be the standard rating at or next above 125 per cent of the motor full load current.

c. The calibration shall be of the fixed type to discourage adjusting and tampering by unauthorized persons.

d. The interrupting rating of the breaker shall be not less than 10,000 amperes.

Chapter 600.

INTERNAL COMBUSTION ENGINE DRIVE.

610. General.

611. RECOMMENDED USE. a. Selection of internal combustion engine type fire pump equipment for each situation should be based on careful consideration of factors of the most reliable type of control, ignition and fuel (including fuel supply), the starting operation and the running operation of the internal combustion engine.

b. The compression ignition diesel engine is one of the most dependable sources of power for driving fire pumps. Spark ignition type engines are advised as supplemental units with natural gas and gasoline as acceptable fuels in that order of preference.

620. Engines.

621. APPROVAL. Engines shall be specifically approved for fire pump service.

622. RATINGS.

a. The engine shall have a bare engine brake horsepower rating at least 20 per cent greater than the maximum brake horsepower required to drive the fire pump at rated revolutions per minute of the pump unit.

NOTE. The 20 per cent excess power takes account of the fact that new production engines are permitted to run as low as 5 per cent under the official bare engine horsepower curve and that up to 5 per cent may be needed for operation of accessories, allowing at least 10 per cent reserve power for reliability of performance and for normal depreciation of the engine with age and use.

b. A deduction of 5 per cent of the power shown on the curve of the engine, having a standard sea level compression ratio, shall be made for each 1,000 feet rise in altitude above sea level. This correction should be made prior to any other power deductions or rating correction factors.

c. When the authority having jurisdiction permits the use of gear drives between the pump and its driver, (see 623a.) the horsepower requirement of the pump should be increased to allow for power losses.

d. Engines listed for fire pump service by a nationally recognized testing laboratory may be accepted for horsepower ratings established by the laboratories.

623. CONNECTION TO PUMP.

a. Except where otherwise permitted by the authority having jurisdiction the engine shall be directly connected to a horizontal pump by means of a flexible coupling of suitable design. Vertical shaft turbine-type pumps shall have the engine connected to the right angle drive with suitable universal joints.

b. Dual drive units are not recommended. The use of separate pumps provides greater flexibility and reliability. Where dual drive is used, the coupling should be of an automatic type acceptable to the authority having jurisdiction and the engine drive shall be equipped with an approved free-wheeling clutch. If the other drive is an electric motor, it too shall be equipped with an approved free-wheeling clutch.

624. INSTRUMENTATION AND CONTROL.

a. GOVERNOR. A governor shall be provided for the engine to regulate the speed within a range of 10 per cent between shut off and maximum load conditions of the pump. It shall be set to maintain rated pump speed at rated pump load.

b. EMERGENCY GOVERNOR. When an emergency governor is used it should be arranged to shut down the engine at a speed approximately 20 per cent above rated engine speed.

c. TACHOMETER. A tachometer shall be provided to indicate revolutions per minute of the engine. It shall be of the totalizing type or an hour meter shall be provided to record total time of engine operation.

d. OIL PRESSURE GAGE. An oil pressure gage shall be provided to indicate engine lubricating oil pressure.

e. TEMPERATURE GAGE. A temperature gage shall be provided to indicate engine cooling water temperature.

f. CONTROL PANEL. All instruments of control such as gages, switches, indicators and coils should be placed on a suitable board secured to the unit at a suitable point.

g. FACTORY WIRING — AUTOMATIC CONTROLLER. All connecting wires for the automatic controller shall be harnessed or flexibly enclosed, mounted on the engine and connected in an engine junction box to terminals numbered to correspond with numbered terminals in the automatic controller, for ready wiring in the field between the two sets of terminals.

h. MAIN BATTERY CONTACTORS. Main battery contactors shall be manually operable in case of control circuit failure.

625. STARTING METHODS.

a. Compression ignition diesel engines should preferably be equipped with an electric starting device taking current from a storage battery, but may be started by other reliable means.

b. If air starting of diesel engines is used with air pressure in excess of 100 pounds gage pressure, the air tanks shall be so located or guarded as not to be subject to mechanical injury. For air starting there shall be at least two containers each sufficient for six consecutive starts without recharging. There shall be a separate air compressor, suitably powered, or means of obtaining air from some other system shall be installed, independent of any compressor driven by the engine operating the fire pump. Automatic maintenance of air pressure is preferable, but in all cases suitable supervisory service shall be maintained to indicate high and low pressure conditions.

c. If a gasoline starting engine is used to crank the diesel engine, or gasoline is used in connection with electric ignition, the handling and storage of gasoline shall be as required for gasoline engine driving of centrifugal fire pumps.

NOTE. Electric current for ignition may be taken from the storage battery or from a high tension magneto.

d. Gasoline engines shall be equipped with an electric starting device taking current from the storage battery.

626. STORAGE BATTERY.

a. GENERAL. The battery shall have sufficient capacity, at 40°F., to maintain the engine manufacturers recommended cranking speed during the following 6 minute cycle (15 seconds crank and 15 seconds rest in 12 consecutive cycles). The fire pump manufacturer shall provide a certification that the battery which was furnished complies with this requirement.

b. **Lead Acid.** Batteries shall be furnished in a dry charge condition with electrolyte liquid in separate container. Electrolyte should be added at the time the unit is put into service. The battery shall then be given a conditioning charge to bring the electrolyte up to its designated specific gravity.

c. **Nickel Cadmium.** A nickel cadmium alkaline type battery may be used where desired in place of the lead acid battery described above.

d. **Recharging.** Two ways of recharging storage batteries shall be provided. One shall be the generator furnished with the engine. The other shall be an automatically controlled charger taking power from an alternating power source. (Other charging methods must be specified if a reliable alternating power source is not available.)

e. **Chargers.**

1. All chargers shall be specifically approved for fire pump service.

2. The rectifier shall be of the semiconductor type.

3. The charger for a lead acid battery shall be of a type which automatically reduces the charging rate to less than 500 milliamperes when the battery reaches a full charge condition.

4. The control equipment incorporated in an "off-on" type of charger for a lead acid battery shall start the rectifier hourly and automatically shut off when the battery has been fully charged.

5. The charger for a lead acid battery shall be capable of delivering a current within the range of 50 to 100 per cent of the 20-hour discharge rate of the battery.

6. The above charging rates apply to lead acid batteries and should be modified in accordance with the battery manufacturer's recommendation when nickel-cadmium batteries are supplied.

7. An ammeter of an accuracy of 5 per cent of the normal charging rate shall be furnished to indicate the operation of the charger.

8. The charger shall be so designed that it will not be damaged or blow fuses during the cranking cycle of the engine when operated by an automatic or manual controller.

9. A single charger that automatically alternates

from one battery to another on an hourly cycle may be used on two battery installations.

10. A manual charge switch with indicator light shall be provided or in lieu thereof, the charge shall automatically charge at the maximum rate when required by the state of charge of the battery.

f. LOCATION.

Storage batteries shall be substantially supported, secured against displacement, and located where they will not be subject to excessive temperature, vibration, mechanical injury, or flooding with water, and are readily accessible for servicing. Location at the side of and level with the engine is recommended to minimize battery to starter lead length.

627. COOLING.

a. The engine cooling system shall be of the closed circuit type including a circulating pump driven by the engine, a heat exchanger and a reliable engine jacket temperature regulating device ("Fail-Safe" type of thermostat). An opening shall be provided in this circuit for filling the system, checking coolant level, and adding make-up water when required.

b. The cooling water supply for the heat exchanger shall be from the discharge of the fire pump taken off prior to the pump discharge valve. Threaded rigid piping shall be used. The pipe connection shall include a manual shut-off valve, a strainer, a pressure regulating valve, an automatic electric solenoid valve (when required) and a second manual shut-off valve. Provision should be made for a pressure gage to be installed in the cooling water supply system on the engine side of the last control valve.

c. A by-pass line with a manual valve shall be installed around the manual shut-off valve, strainer, pressure regulating valve, automatic solenoid valve (when required) and second manual shut-off valve. (See Figure 627.)

d. An outlet shall be provided for the waste water line from the heat exchanger, and the line shall be at least one size larger than the inlet line. The outlet line shall be short, with the discharge into a visible open waste cone, and no valves shall be used in this line.

e. A water jacketed (cooled) exhaust manifold shall be used since no fan is available to dissipate heat and to avoid hazard to operators or flammable material adjacent to the engine. This exhaust manifold should be cooled by raw water discharging from the heat exchanger.

628. CARBURETION.

a. If a down-draft carburetor is used, suitable provision shall be made in addition to the carburetor float valve to prevent delivery of liquid gasoline to the engine cylinders.

NOTE. This is usually accomplished by a drain from the intake manifold. This should be piped to a safe location.

b. The carburetor drip cup drain should be piped at its lower end to a safe location.

629. ANTI-DIESELING DEVICES.

a. Anti-dieseling devices. A reliable and effective anti-dieseling device shall be provided on automatically controlled spark-ignited gasoline engines with a displacement of 350 cubic inches and larger to insure positive shutdown without dieseling. Control for the device shall be provided by the automatic engine controller or supplemental accessories to the controlled engines.

b. Less than 350 cubic inch displacement engines shall also be equipped with this device unless approval tests show that it is unnecessary.

630. Location.

631. CONSTRUCTION.

a. While it may not always be possible to locate a fire pump driven by an internal combustion engine in a separate pump house it is in every case highly important that the pump room be wholly cut off by noncombustible construction of a heavy character.

b. Floors should be pitched for adequate drainage of escaping water or fuel away from critical equipment such as pump, driver, controller, fuel tank, etc.

c. Where fire pumps constitute the entire water supply or where they constitute the major water supply, gasoline engine driven fire pumps located in the same room with fire pumps driven by other methods should, because of their possible fire hazard, have a heat resistant barrier wall to isolate the gasoline engines from other pumping units.

632. VENTILATION

a. Means for thorough ventilation shall be provided, adequate for engine air supply and for removal of hazardous vapors.

b. Gasoline engine driven fire pump units should not be installed in depressed pump rooms. Installation shall be such that escaping gasoline vapors cannot accumulate in the pump room or vicinity.

640. Fuel Supply Arrangement

641. REVIEW OF PLAN. Before any system is installed the authority having jurisdiction should be consulted as to the system proposed to the end that the suitability of the system for conditions be determined.

642. GUARDS. A guard or protecting pipe shall be provided for all exposed fuel lines.

643. DIESEL.

a. CAPACITY DIESEL FUEL SUPPLY. The capacity of the main diesel fuel supply tank shall be determined by conditions and subject to special consideration in each case by the authority having jurisdiction; minimum storage capacity shall be sufficient to operate the engine for at least eight hours, and a greater capacity should be provided in places where prompt replenishment of supply is unlikely. There shall be a separate fuel line and fuel tank for each engine. Where multiple engine driven pumps are used, the fuel lines shall be interconnected and valved so that all engines may continue to operate even though one or more fuel tanks may be out of service.

Note. Allow one pint of diesel fuel per horsepower per hour.

b. LOCATION DIESEL FUEL SUPPLY. The tank shall be located in accordance with municipal ordinances, and requirements of the authority having jurisdiction. Means shall be provided for determining the amount of fuel in the storage tank. The tank should have suitable filling and vent connections.

c. DIESEL FUEL PIPING. NFPA Standard for the Installation of Oil Burning Equipment (No. 31) may be used as a guide. A suitable flexible connection of approved metallic type shall be provided in the fuel line where it connects to the engine fuel piping. No shutoff valve shall be installed in the fuel return line to the tank. (See Figs. 643a and 643b for suggested arrangements.)

644. NATURAL GAS.

a. RELIABILITY OF SUPPLY. Reliability of the fuel supply is essential. Natural gas can be considered an acceptable fuel only where arrangements can be made for maintaining the fire pump gas supply at all times even when restrictions are applied by the supplier to other uses of the gas. Piping shall be adequate to maintain the required pressure at the fire pump under conditions of maximum demand for other uses. Provision must be made for automatic cut-off in case of a break in the plant service line to insure an uninterrupted supply to the fire pump.

NOTE. Allow 12 cubic feet of 1,000 BTU natural gas per horsepower per hour.

b. BTU CONTENT. The BTU value of the natural gas shall be equal to or greater than that specified by the engine manufacturer for the maximum rated load or allowance shall be made in the rated horsepower of the engine to adjust for the variation.

c. PRESSURE REGULATOR. An approved regulator shall be provided to reduce available natural gas pressure to the low pressure for satisfactory operation of the engine carburetor.

d. FEED. There shall be an electric opening, self-closing safety shutoff valve installed in the fuel line on the engine. This valve shall open when the engine ignition is turned on and close automatically when the ignition is turned off. There shall be a manual valved bypass around this valve in the event of malfunction of the safety shutoff valve and the bypass valve shall be provided with a visual or audible signal to show when it is open. All electric controls shall be powered by the engine pumping unit electrical system. (See Fig. 644.)

e. PIPING. All exterior and interior gas piping shall be in accordance with recommendations of Standard for the Installation of Gas Appliances and Gas Piping, NFPA No. 54. There shall be a manually operated outside shutoff valve in the gas supply line, locked open with a breakable lock. All piping outside the pump house shall be installed with pitch to drain so as to avoid any possible water trap or pocket. There shall be a suitable flexible connection of approved metallic type in the fuel line where it connects to the engine fuel piping.

645. GASOLINE.

a. CAPACITY GASOLINE SUPPLY. The capacity of the main gasoline supply tank shall be determined by conditions and subject to special consideration in each case by the authority having jurisdiction; minimum storage capacity shall be sufficient to operate the engine for at least 8 hours and a greater capacity should be provided in places where prompt replenishment of supply is unlikely.

NOTE. Allow one pint of gasoline per horsepower per hour.

b. LOCATION GASOLINE SUPPLY. The tank shall be located outside the pump room and in accordance with municipal ordinances, and requirements of the authority having jurisdiction. The tank should be so located with respect to pumps drawing gasoline therefrom that the maximum lift will not exceed 6 feet. The fuel tank for an automotive type engine should preferably be installed so that the top of the tank is about on a level with the carburetor. Means shall be provided for determining the amount of gasoline in the storage tank. The tank should have suitable filling and vent connections.

c. GASOLINE FEED.

1. The gasoline shall be fed to the carburetor by a method which will be dependable and safe. The following suggested arrangement may be modified to suit the conditions, subject to approval by the authority having jurisdiction.

2. A pumping system utilizing a gasoline pump, furnished as a part of the engine, which draws gasoline from the storage tank and delivers it to the carburetor. The gasoline pump should be capable of pumping gasoline at a rate of at least 1$\frac{1}{2}$ times the amount needed for the engine while running at rated speed and load. As a supplementary supply there shall also be provided a hand gasoline pump connected to draw gasoline from the storage tank and deliver

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it to a two-quart tank from which the carburetor may be supplied by gravity. (See Fig. 645.)

646. GASOLINE PIPING. All gasoline piping between tanks and between tanks and engines shall be approved seamless copper tubing with flared joints. Fuel pump suction lines shall be at least $^3/_8$ inch in size. A suitable flexible connection of approved metallic type shall be provided in the fuel line where it connects to the engine fuel piping.

650. Exhaust Piping

651. EXHAUST PIPING. Exhaust from the engine shall be piped to a safe point outside the pump room and arranged to exclude water. A seamless or welded corrugated (not interlocked) flexible connection shall be made between the engine exhaust outlet and the exhaust pipe. The exhaust pipe shall be as short as possible and not over 15 feet unless the size of exhaust pipe is increased at least one pipe size, and shall be properly insulated from combustible material. Muffler, receiving vessel or other attachments which may accumulate unburned gases are not recommended, but if used shall not be located in the pump room. Exhaust gases should not be discharged where they will affect persons or endanger buildings, flues or stacks. A free and independent exhaust is essential to the reliability of the equipment.

660. Maintenance.

661. GENERAL. Internal combustion engines necessarily embody moving parts of such design and in such number that the engines cannot give reliable service unless given intelligent care. The manufacturer's instruction book covering care and operation should be preserved and pump operators should be familiar with its contents and should observe in detail all of its provisions.

662. WEEKLY RUN. The engine shall be started at least once a week and run for at least thirty minutes to bring it up to normal running temperature and to make sure that it is running smoothly at rated speed.

663. FUEL TANK. The fuel storage tank shall be kept well supplied. This tank should always be filled through a strainer funnel designed to withhold any water or other

foreign matter that may be present. Any service tank shall also be kept full.

NOTE: Gasoline deteriorates with age. It is therefore desirable that gasoline storage tanks be drained and refilled with fresh supply at least once each year. The occasional use of an upper lubricant is desirable for smooth operation of the engine and preventing sticking valves.

664. ENGINE UPKEEP. The engine should be kept clean, dry and well lubricated, and the proper oil level should be maintained in the crankcase. Oil should be changed in accordance with engine manufacturer's recommendations, but at least annually.

665. STORAGE BATTERIES.

a. Storage batteries should be kept charged at all times and tested frequently with a hydrometer to ascertain the condition of the cells and the amount of charge in the battery.

b. Distilled water only should be used in storage battery cells and the plates should be kept submerged at all times.

c. An automatic battery charger is not a substitute for proper maintenance of the battery and charger. Periodic inspection of the battery and the charger shall be made. This inspection should determine that the charger is operating correctly, the water level in the battery is correct, and the battery shall be checked by means of a hydrometer to show it is maintaining its proper charge.

666. TEMPERATURE.

a. Pump room temperatures must be maintained above 40° F. (see 41e).

b. Diesel engines, at temperatures below 70° F, may require some form of starting aid as recommended by the engine manufacturer.

c. Automatically started engines should be installed in enclosed pump rooms where a minimum temperature of 60° F for gasoline engines and 70° F for diesel engines is maintained.

d. Since fire pump engines must carry full load as soon as started, automatic heaters should be employed to maintain jacket water temperatures of liquid cooled engines at (a minimum of 120° F) or near operating temperatures. This may be accomplished through the circulation of hot water through the jacket or through heating of engine water by electric elements inserted into the block. The benefits to be gained are (1) quick starting, (2) reduction in engine wear, (3) reduced drain on batteries, (4) reduced oil dilution, (5) reduction in carbon deposits, and (6) with gasoline fueled engines it becomes possible to adjust the automatic choke so that the engine is far more likely to start every time.

667. PARTS. Spare parts of such portions of the machine as may be expected to give trouble should be kept on hand.

Chapter 700

ENGINE DRIVE CONTROLLERS

710. Requirements for All Controllers.

711. GENERAL.

a. The following specifications cover controlling equipment of the combined nonautomatic and automatic types for internal combustion engines driving centrifugal fire pumps. Chapter 600 dealing with the internal combustion engine drive also applies where appropriate.

b. Automatic-type controllers are recommended for use only where the fire pump takes its water under positive pressure and their use is not recommended where a suction lift is involved.

c. All controllers shall be specifically approved for fire pump service.

d. The control panel shall be completely assembled, wired and tested by the manufacturer before shipment from the factory.

e. Controllers conforming to this Standard shall be marked "Fire Pump Controller" and shall show plainly the name of the manufacturer, the identifying designation and the complete electrical rating.

f. The services of a representative of the manufacturer may be required for installation and adjustment of the equipment. It shall be the responsibility of the installing contractor to make the necessary arrangements for this service.

712. LOCATION.

a. The controller shall be located as close to as is practical and within sight of the engine.

b. The controller shall be so located or protected that it will not be injured by water escaping from the pump or connections.

c. A clearance of not less than 2½ feet shall be provided at the rear of enclosures designed to be inspected and serviced from the rear.

71 GENERAL CONSTRUCTION.

a. EQUIPMENT. All equipment shall be suitable for use in locations subject to a moderate degree of moisture such as a damp basement. Reliability of operation shall not be adversely affected by normal dust accumulations.

NOTE: In areas affected by excessive moisture, heat may be useful in reducing the dampness.

b. MOUNTING. All equipment except engine mounted shall be mounted in a substantial manner on a single, noncombustible supporting structure.

c. ENCLOSURE. The structure or panel shall be securely mounted in an enclosure(s) which will protect the equipment against mechanical injury and falling drops of water striking the enclosure from the downward vertical.

d. LOCKS: All switches required to keep the controller in the "automatic" position shall be within locked cabinets having break glass panels.

e. WIRING DIAGRAMS.

1. A wiring diagram shall be provided and perma-

nently attached to the inside of the enclosure showing exact wiring for this controller including a legend of identifying numbers of individual components.

2. All wiring terminals shall be plainly marked to correspond with the wiring diagram furnished.

f. CONNECTIONS AND WIRING.

1. Wiring elements of the controller shall be designed on a continuous duty basis, except that conductors which are in a circuit only during the engine starting period may be designed accordingly.

2. Field Wiring. All wiring leading from the panel to the engine and batteries shall have adequate carrying capacity and shall be protected against mechanical injury. Controller manufacturer's specifications regarding distance and wire size shall be followed.

g. MARKING. Each operating component of the controller shall be marked to plainly indicate an identifying number referenced to the wiring diagram. The markings shall be located so as to be visible after installation.

h. INSTRUCTIONS. Complete instructions covering the operation of the controller shall be provided and conspicuously mounted on the controller. Pump operators should be familiar with these instructions and should observe in detail all of their provisions.

714. COMPONENTS.

a. ALARM AND SIGNAL DEVICES (On Controller)

1. A pilot lamp(s) shall be provided in the line side of the starting equipment circuit to indicate that the controller is in the "automatic" position with power available for starting. The lamp shall be accessible for replacement.

NOTE: It is recommended that the lamp operating voltage be less than the rated voltage of the lamp to insure long operating life. When necessary, suitable resistors should be used to reduce the voltage for operating the lamp.

2. A pilot lamp shall be provided in each battery supply to indicate that batteries are connected to the controller and are at least partially charged when the controller is set in the automatic position.

3. Pilot lamps and a common bell shall be provided to indicate trouble caused by:

(a) Low oil pressure in the lubrication system.
(b) High engine jacket water temperature.
(c) Failure of engine to start automatically.
(d) Shutdown from overspeed (diesel only).

b. ALARM AND SIGNAL DEVICES (remote). Where the pump room is not constantly attended, the controller shall be equipped with contacts (open or closed) to operate circuits powered by a source other than engine starting batteries, not exceeding 125 volts, for audible or visual alarms at a point of constant attendance indicating the following:

1. Controller has operated into a pump running condition. (separate signal)

2. Controller main switch has been turned to "off" or "manual" position (separate signal).

3. Trouble on the controller or engine: (A common signal may be used for trouble indication)

(a) Items in 714.a.3.

(b) Loss of A.C. power to the battery chargers and controller. This may be accomplished through use of a drop-out type of relay. The relay contacts should close on failure of voltage. Unless the power is electrically supervised as above, the controller should be arranged to start upon failure of this power. (See Paragraph 715.d.6)

715. STARTING AND CONTROL.

a. DEFINITIONS (from the National Electrical Code, 1968 Edition).

1. Nonautomatic — Nonautomatic means that the implied action requires personal intervention for its control.

As applied to an electric controller, nonautomatic control does not necessarily imply a manual controller, but only that personal intervention is necessary.

2. Automatic — Automatic means self-acting, operating by its own mechanism when actuated by some impersonal influence, as for example, a change in current strength, pressure, temperature or mechanical configuration.

b. This Standard contemplates that:

1. Nonautomatic controller shall be actuated by electrical manual means.

2. Automatic controller shall be operable as a nonautomatic controller and also by other nonpersonal means such as: low water pressure, tripping of deluge and dry pipe valves, etc.

c. NONAUTOMATIC.

1. Manual Electric Control at Controller. There shall be a manually operated switch on the control panel. This switch shall be so arranged that when the pumping unit is started manually, its operation cannot be affected by the pressure switch so that the unit will remain in operation until manually shut down.

2. Manual Electric Control at Remote Station. Additional control stations for causing nonautomatic continuous operation of the pumping unit independent of the pressure actuated control switch may be provided at locations remote from the controller, but such stations shall not be operable to stop the unit except through the established operation of the controller.

d. AUTOMATIC.

1. Water Pressure Control. An acceptable type pressure switch having independent high and low calibrated adjustments and which is responsive to water pressure in the fire system shall be provided in the control circuit.

NOTE. Test Device. Suitable provision must be made for relieving pressure to the pressure switch to test the operation of the controller and the pump. (Figure 515 d. 1. Appendix C.)

2. Fire Protection Equipment Control. When the pump supplies special water control equipment (deluge, dry pipe valves, etc.) and it is desired to start the pump before the pressure control(s) would do so, the authority having jurisdiction may require the controller to be equipped to start the pump upon operation of the fire protection equipment. The controller shall be equipped with a relay of the drop-out type to start the pump when the fire protection equipment operates. The relay shall be actuated from a normally closed contact on the fire protection equipment with this circuit supplied by the batteries.

3. Sequence Starting. Controllers for multiple

pump units shall incorporate a sequential timing device to prevent any one pump starting simultaneously with any other pump. If the water requirements are such that more than one pump operates, the units shall start at intervals which will not permit a subsequent starting pump to start until the previous pump has reached full speed. Failure of a leading pump to start shall not prevent subsequent pumps from starting.

4. For sprinkler systems and standpipe systems where an automatically controlled pump constitutes the sole supply or where required by the authority having jurisdiction, the controller shall be wired for automatic start and manual shutdown.

5. Weekly Program Timer. To assure dependable operation of the pumping unit and its controller, the controlling equipment may be arranged to automatically start the unit at least once a week. A solenoid drain valve on the pressure control line shall be the initiating means. Such performance may be automatically indicated on a recording pressure gage.

6. Power Failure Start. The controller may be equipped with a power failure relay, which shall be time delayed, to start the unit upon loss of A.C. power to the battery chargers and timers. (See Paragraph 714.a.3(b).)

e. STARTING EQUIPMENT ARRANGEMENT.

1. Two storage batteries, each complying with the requirements of Section 626, shall be provided and so arranged that manual and automatic starting of the equipment can be accomplished with either battery. The starting current shall be furnished by first one battery and then the other on successive operations of the starter. The changeover must be made automatically, except for manual start.

2. In the event that the engine does not start after approximately six attempts have been made, or after approximately $1\frac{1}{2}$ minutes of cranking, the controller shall stop all further cranking and operate the trouble lamp and bell.

3. In the event that one battery is nonoperative, the control shall lock-in on the remaining battery during the cranking sequence.

4. Circuits shall be provided in the controller to operate chokes or similar devices where required on spark ignited engines.

5. When dual drive units are used and one or both are under automatic control, see Paragraph 623.b. Breakage or disconnection of any wires that interconnect the electric motor control and the engine control, or failure of either power source and/or controller shall not interfere with the proper operation of the other power source and/or its controller.

f. METHODS OF STOPPING. Shutdown may be accomplished by either one or both of the following:

1. Manual — by operation of the selector switch on the controller or other shutdown features.

2. Automatic — after starting causes have been returned to normal and the pumping unit has operated for the time fixed by the running period timer. Whenever the controller is arranged for automatic shutdown, a running period timer set for at least 30 minutes shall be installed.

3. Anti-Dieseling. Circuits shall be provided in the controller to operate anti-dieseling devices where required on spark ignited engine (see Paragraph 629).

g. EMERGENCY CONTROL. Automatic control circuits, the failure of which could prevent starting, shall be completely bypassed for manual control.

Chapter 800.

STEAM TURBINE DRIVE.

810. General Features.

811. ACCEPTABILITY.

a. Steam turbines of adequate power direct connected to fire pumps and designed to run at the same speed may be used acceptably as prime movers. The steam turbine should be one whose reliability has been proved in commercial work.

b. When gear drives or other power transmission devices are used between the pump and its driver, the horsepower requirement of the pump should be increased to allow for power losses in these devices.

812. POWER.

a. For boiler pressures of 120 pounds per square inch gage or lower, the steam turbine must be capable of driving the pump at its rated speed and maximum pump load with a pressure as low as 80 pounds per square inch gage at the turbine throttle when exhausting against atmospheric back pressure, with the hand valve open.

b. For boiler pressures above 120 pounds per square inch gage where steam is continuously maintained, a steam pressure 70 per cent of the usual boiler pressure may be taken in place of 80 pounds per square inch mentioned in Paragraph 812a.

c. In ordering turbines for centrifugal fire pumps, the purchaser should state the rated and maximum pump loads at rated speed, the rated speed, the boiler pressure and if possible the pressure at the turbine throttle, and the steam superheat.

813. STEAM CONSUMPTION. Prime consideration shall be given to the selection of a turbine having a total steam consumption commensurate with the steam supply available. Single stage turbines of maximum reliability and simplicity

are recommended where the available steam supply will permit. When multistage turbines are used they shall be so designed as to allow the pump to be brought up to speed without "warm up" time being required.

820. Turbine.

821. CASING AND OTHER PARTS.

a. The casing may be of cast-iron and should be so designed as to permit access with the least possible removal of parts or piping.

b. A safety valve, to give warning of high steam pressure in the casing, shall be connected directly to the turbine casing.

c. The main throttle valve and any automatically operated throttle valve shall be located in a horizontal run of pipe connected directly to the turbine. There shall be a water leg on the supply side of the throttle valve connected to a suitable steam trap to automatically drain all condensate from the line supplying steam to the turbine. Steam and exhaust chambers shall be equipped with suitable condensate drains which shall discharge through adequate traps where a turbine is automatically controlled. In addition, if the exhaust pipe discharges vertically there shall be an open drain at the bottom elbow, which drain shall not be valved but shall discharge to a safe location.

d. The nozzle chamber, governor-valve body, pressure regulator and other parts through which steam passes shall be of a suitable metal to withstand the maximum temperatures involved.

822. SPEED GOVERNOR.

a. The steam turbine shall be equipped with a speed governor set to maintain rated speed at rated capacity which should be capable of maintaining, at all loads, the rated speed within a total range of approximately 8 per cent from no turbine load to full rated turbine load with normal steam pressure and hand valve closed; and at steam pressures down to 80 pounds per square inch gage, or to 70 per cent of full pressure where this is in excess of 120 pounds per square inch, with hand valve open.

b. The speed governor shall be capable of adjustment while the turbine is running at rated pump load to secure speeds approximately 5 per cent above and 5 per cent below the rated speed of the pump.

c. There shall also be provided an independent emergency governing device arranged to shut off the steam supply at a turbine speed approximately 20 per cent higher than the pump speed at rated load.

823. AUTOMATICALLY CONTROLLED TURBINES.

a. Where the application requires a turbine driven fire pump to start automatically but where there is no desire to have the turbine on pressure control after starting, a satisfactory quick opening manual-reset valve installed in a by-pass of the steam feeder line around a manual control valve may be used.

b. Where the application requires the pump to start automatically and after starting continue to operate by means of a pressure signal, the use of a satisfactory pilot type pressure control valve located in the by-pass around the manual control valve in the steam feeder line is recommended. The turbine governor control valve when set at approximately 5 per cent above the normal full load speed of the pump under automatic control would act as a pre-emergency control.

c. In the arrangements set forth in Paragraphs 823a and b, the automatic valve should be located in the by-pass around the manual control valve that would normally be kept in the closed position. In the event of failure of the automatic valve this manual control valve could be opened allowing the turbine to come to speed and be controlled by the turbine governor control valve, or valves.

d. The use of a direct-acting pressure regulator operating on the control valve (or valves) of a steam turbine is not recommended.

824. GAGE AND GAGE CONNECTIONS.

a. An approved steam pressure gage should be provided on the entrance side of the speed-governor, and ¼-inch pipe tap for a gage connection on the nozzle chamber of the turbine.

b. The gage shall indicate pressures up to 1½ times the boiler pressure, but not less than 240 pounds per square inch, and should be marked STEAM.

825. Rotor. The rotor of the turbine shall be of suitable material and the first unit of a design shall be type tested in the manufacturer's shop at a speed 40 per cent above rated speed. All subsequent units of the same design shall be tested at a speed 25 per cent above rated speed.

826. Shaft.

a. The shaft shall be of high-grade steel, such as open-hearth carbon steel or nickel steel.

b. Where the pump and turbine are assembled as independent units, a flexible coupling shall be provided between the two units.

c. Where the overhung rotor is adopted, the shaft for the combined unit shall be in one piece with only two bearings.

d. The critical speed of the shaft must be well above the highest speed of the turbine so that the turbine will operate at all speeds up to 120 per cent rated speed without objectionable vibration.

827. Bearings. Turbines having sleeve bearings shall have their bearing shells and caps of the split type. Turbines with ball bearings may be accepted only after such turbines and bearings have established a satisfactory record in the commercial field. Means shall be provided to give visual indication of the oil level.

830. Installation.

831. Steam Pipe.

a. The steam supply for the fire pump should preferably be an independent line from the boilers and should be so run as not to be liable to injury at time of fire in any part of the property. The other steam lines from the boilers should be controlled by valves located in the boiler room so that in an emergency, steam can be promptly shut off from these lines, leaving the steam supply still available for the fire pump. Strainers in steam lines to turbines are recommended.

b. The steam throttle at the pump should close against the steam pressure and should preferably be of the globe pattern with a solid disk. If, however, the type of valve having the disk fitted with a removable composition ring is used, the disk should be of bronze and the ring made of sufficiently hard and durable material and so held in place in the disk as to satisfactorily meet severe service conditions.

NOTE: Gate valves are undesirable for this service, as they cannot so readily be made tight if leaking, as is possible with the globe type of valve. The steam piping should be so arranged and trapped that the pipes can be kept free of condensed steam.

c. In general, a reducing valve should not be placed in the steam pipe supplying the fire pump.

NOTE: There is no difficulty in designing turbines for modern high steam pressures and this gives the simplest and most dependable unit.

A reducing valve introduces a possible obstruction in the steam line in case it becomes deranged; in most cases the turbines may be protected by making the safety valve required by Paragraph 821b of such size that the pressure in the casing will not exceed 25 pounds per square inch. This valve should be piped outside of the pump room, and if possible, to some point where the discharge could be seen by the pump attendant. Where a reducing valve is used the following points should be carefully considered:

1. The valve should not contain a stuffing box or a piston working in a cylinder.

2. The reducing valve should be provided with a by-pass with a globe valve to be opened in case of an emergency. The by-pass and stop valve should be one pipe size smaller than the reducing valve, and should be located so as to be readily accessible. This by-pass should be arranged to prevent the accumulation of condensate above the valve.

3. The size of the reducing valve should be smaller than that of the steam pipe required by the specifications for the pump.

832. **EXHAUST PIPE** The exhaust pipe should run direct to the atmosphere and should not contain valves of any sort. It should not be connected with any condenser, heater, or other system of exhaust piping.

833. EMERGENCY BOILER FEED.

a. A convenient method of insuring a supply of steam for the fire pump in case the usual boiler-feed supply fails, is to provide an emergency connection from the discharge of the fire pump, with a controlling valve at the fire pump and also, if desired, an additional valve located in the boiler room. A check valve also should be located in this pipe, preferably in the boiler room. This emergency connection should be about 2-inch diameter.

b. This method should not be used when there is any danger of contaminating a potable water supply.

NOTE: In situations where the fire pump is handling salt or brackish water, it may be undesirable to make this emergency boiler-feed connection. In such situations an effort should be made to secure some other secondary boiler-feed supply that will be always available.

PART III — ACCEPTANCE, OPERATION AND MAINTENANCE.

Chapter 900 — Tests and Instructions.

910. Field Acceptance Tests.

911. THOSE PRESENT. The pump manufacturer shall have an engineer present at the field acceptance tests when requested by the installing contractor.

912. The field acceptance test results shall be as good as the manufacturer's certified shop test characteristic curve for the pump being tested within the accuracy limits of the test equipment.

913. If pump takes suction under a lift, the suction pipe should be drained if possible before tests are started so that the maximum time required to start the pump with available priming facilities can be determined and conditions remedied if necessary.

914. OVERHEATING. As installed, at operating speed, the pump shall be able to operate at peak load conditions without objectionable heating of the bearings or of the prime mover. The operating pump speed shall be the speed at which the pumping unit would be expected to operate during a fire, for example:

a. A squirrel cage electric motor has no speed control and would normally drive the pump slightly in excess of rated pump speed at all loads.

b. Combustion engines and steam turbines under automatic control with governors set for rated pump speed at rated pump capacity might slow down slightly at maximum (peak) load.

c. Combustion engines and steam turbines under manual control (and automatic control where speed adjustment is easily obtained) have their speed adjusted to rated pump speed at maximum (peak) pump load.

915. OPERATING CONDITIONS.

a. By varying the number and/or size of the discharge outlets in connection with tests (Section 912) the operating conditions under minimum to peak loads shall be determined.

b. During such test:

1. For electric motors at rated voltage (and on a.c. motors at rated frequency), the full load ampere rating should not be exceeded (except as allowed by the service factor stamped on the nameplate) under any conditions of pump load.

2. For electric motors under conditions of acceptable high or low voltage, the product of the rated voltage (and on a.c. motors at rated frequency) and rated full load current will not be exceeded (except as allowed by the service factor stamped on the nameplate). The voltage at the motor should not vary more than 5 per cent below or 10 per cent above rated (nameplate) voltage during test (see Paragraph 432d).

3. An internal combustion engine shall not show signs of overload or stress and its governor shall properly regulate the speed (see Paragraphs 624a and b).

4. A steam turbine shall maintain its speed within the limits specified in Paragraphs 822 a, b, and c.

c. With discharge outlets open (corresponding to the outlets used in test at peak load) pump shall be started and brought up to rated speed without interruption due to opening of circuit breaker or other cause.

916. CONTROLLERS.

a. Manual controllers for pumps shall be put through not less than ten complete operations.

b. Combined manual and automatic controllers shall be put through not less than ten automatic and ten manual operations.

c. A running interval of at least five minutes at full speed should be allowed before repeating the starting cycle.

d. Automatic operation of the controller shall start the pump from all the provided starting features, such as pressure switches, deluge valves, etc.

e. Electric motor shall attain rated speed within ten seconds.

917. EMERGENCY GOVERNOR. On turbines for pumps the emergency governor valve shall be tripped. (Hand tripping will be accepted.)

918. LENGTH OF TEST. The pump shall be in operation not less than one hour (total time) during the foregoing tests.

921. AT THE ALARM.

a. When an alarm is given, do not wait to see how serious the fire may be, but get pump started as soon as possible and maintain its rated speed, pumping into sprinkler and hydrant systems.

b. Do not be afraid to run a centrifugal fire pump at its full rated speed, even if the demand for water is small. The characteristic curve or the relief valve will usually keep pressures within reasonable limits.

NOTE: The best way to prevent a small fire from becoming a large one is to give the sprinklers a liberal high pressure water supply at the start. Fifty open sprinklers may take the full capacity of a 750-gpm pump. Even with a good public water supply the opening of a large number of sprinklers often materially reduces the pressure so that the pumps are needed to reinforce the public supply and insure ample water at good pressure.

922. TO START A CENTRIFUGAL PUMP.

a. Never start or run a centrifugal pump before priming or first filling casing with water; otherwise the interior wearing rings that depend on water for lubrication may be damaged and the pump made inoperative.

b. If pump is primed from a tank or other gravity supply, the pump may be started as soon as water shows at vent cocks. If primed by an exhauster, action of the device will indicate when casing is filled with water.

c. Close attention should be given to the bearings and stuffing boxes during the first few minutes of running to see that there is no heating up or need of adjustment. With water seal supplied with water, a small leak at stuffing box glands is necessary to seal, lubricate and cool the packing. The suction inlet gage as well as the discharge pressure gage should be read occasionally to see that inlet is not obstructed by a choked screen or foot valve.

923. MOTOR-DRIVEN PUMP. To start a motor driven pump the following steps should be taken in the order given below:

1. See that pump is completely primed.
2. Note that normal voltage is indicated at voltmeter.
3. Close isolating switch and *then* close circuit breaker.
4. Operate starter without undue haste, observing ammeter at each step to avoid excessively large starting currents which may cause circuit breaker to open.

NOTE: Circuit breaker tripping mechanism should be so set that it will not operate except when current in circuit is excessively large.

924. TURBINE DRIVEN PUMP. To start a steam turbine driven pump, steam should be admitted slowly at first to permit warming up of turbine casing before allowing full head of steam upon the turbine. If the pop safety valve on the casing blows, steam should be shut off and the exhaust piping examined for a possible closed valve or an obstructed portion of piping. Steam turbines are provided with governors to maintain speed at a predetermined point, with

some small adjustment for higher or lower speeds. Desired speeds below this range may be had by throttling main throttle valve.

925. INTERNAL COMBUSTION ENGINE DRIVEN PUMP.

a. To start an internal combustion engine driven pump one should familiarize himself beforehand with the operation of this type of engine. The Instruction Book issued by the engine manufacturer should be studied to this end.

b. The storage batteries should always be maintained in good order to insure prompt satisfactory operation of these equipments.

c. Replacement storage batteries shall comply with the performance requirements of Section 626.

930. Care of Pump.

931. WEEKLY TESTS. A centrifugal pump should be operated every week at rated speed with water discharging through some convenient opening. This is desirable to make sure of the condition of the pump, bearings, stuffing boxes, suction pipe and strainers, and the various other details pertaining to the driver and control equipment (see Paragraphs 515.d.1, 662, 715.d.1, and 715.d.5).

When automatically controlled pumping units are to be tested weekly by manual means at least one start shall be accomplished by reducing the water pressure either with the test drain on the pressure sensing line or with a larger flow from the entire system.

932. YEARLY TEST. A yearly test at full capacity and over is necessary, to make sure that neither pump nor suction pipe is obstructed.

933. KEEPING OF PUMP ROOM. Pump rooms should be kept clean, orderly, free from miscellaneous storage, well lighted and heated.

934. READINESS. Always keep the pump ready to start at a moment's notice.

Attachment 6.3

NFPA 20 Walkdown Checklist

NFPA 20 Code Compliance Evaluation

For

Donald C. Cook Nuclear Plant

Units 1 and 2

Indiana Michigan Power Company

NFPA 20 - 1969
CENTRIFUGAL FIRE PUMPS
CODE COMPLIANCE WALKDOWN CHECKLIST

I = Information Only
CN = CAN NOT verify by walkdown
N/A = NOT APPLICABLE
✓ = COMPLIANCE
ⓧ = NON COMPLIANCE

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
1	**Purpose.** This standard contains, in general, the minimum requirements for centrifugal fire pumps, including horizontal, single and multi-stage pumps and vertical design, installation and maintenance of such pumps together with their drivers, and for the guidance of the authority having jurisdiction and others concerned in judging the acceptability of such equipment.	I	I	I	I	I
2	**Approval Prior to Purchase Recommended.**					
2a	Centrifugal fire pumps should not be purchased until conditions under which they are to be installed and used have been examined by the authority having jurisdiction, and each pump, driver, controlling equipment, the power supply and arrangement, and water supply have been approved by that organization.	CN	CN	CN	CN	CN
2b	The pump manufacturer must be given complete information concerning the suction water supply as accepted b, the authority having jurisdiction.	CN	CN	CN	CN	CN
3	**Unit Assembly Required.**					
3a	The pump, driver and all necessary attachments shall be purchased under unit contracts stipulating compliance with this standard and satisfactory performance of the entire unit when installed.	CN	CN	CN	CN	CN

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
3b	The pump manufacturer shall be responsible for the proper operation of the complete unit assembly as indicated by field acceptance tests. (See Article 910 for field acceptance test procedure.)	CN	CN	CN	CN	CN
4	**Complete Plans and Data Required.** A complete plan and detailed data describing pump, driver, controller, power supply, fittings, suction and discharge connections, and suction conditions shall be submitted by the engineer or contractor to the authority having jurisdiction for approval before installation. Certified shop test characteristic curves showing head-delivery, efficiency and brake horsepower shall be furnished by the manufacturer.	CN	CN	CN	CN	CN
	PART 1 - PUMP ARRANGEMENT, TEST AND INSTALLATION.					
	Chapter 1 - Basic Information.					
10	General.					
11	**Approved Pumps Required.** Centrifugal fire pumps shall be specifically approved for fire pump service.	CN	CN	CN	CN	CN
20	**Water Supplies.**					
21	**Requirements.** Fire pumps should be provided with as large and reliable a supply of water as possible. The adequacy and the dependability of the source of water are of primary importance and must be fully determined at the time of installation, also the prospects for its reliability in the future. The minimum water level with maximum	✓	✓	✓	✓	✓

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	discharge from the pump must be determined. Where a stored supply is the only one available, a reliable method of replenishing the supply should be provided. Representatives of the pump manufacturer shall assist in establishing these facts to the satisfaction of the authority having jurisdiction. Water supplies containing salt or other materials deleterious to the fire protection systems should be avoided whereever possible.					
30	Pump.					
31	Rated Capacities of Pumps.					
31a	**Standard Pumps.** Standard fire pumps are those having rated capacities of 500, 750, 1,000, 1,500, 2,000 and 2,500 gpm. Larger pumps may be used in specially engineered applications.	I	I	I	I	I
31b	**Special Pumps.** Special fire service pumps are those having rated capacities of 200, 300 and 450 gpm.	I	I	I	I	I
32	Types of Pumps.					
32a	**Standard Fire Pumps.** Pumps rated at capacities within the standard capacity range and pressures of 100 psi or more.	I	I	I	I	I
32b	**Low-Pressure Fire Pumps (Booster Pumps).** Pumps rated at capacities within the standard capacity range and pressures between 40 and 100 psi.	I	I	I	I	I

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
32c	**Special Fire Service Pumps.** Pumps rated at 200, 300 or 450 gpm limited to 130 per cent capacity maximum, and for various pressures. The maximum power required shall not exceed the limitations of a 30-horsepower electric motor.	I	I	I	I	I
32d	**Pressure Maintenance Pumps (Jockey or Make-Up Pump).** The use of an automatic pressure maintenance pump is desirable under some circumstances to maintain a uniform or a relatively high pressure on the fire protection system. The capacity and pressure rating of the pump shall be sufficient to maintain the desired pressure against the leakage in the system as approved by the authority having jurisdiction. A centrifugal type pump is preferable. Where the discharge pressure at pump shutoff of a centrifugal type pump exceeds the working pressure rating of the fire protection equipment, or a turbine vane (peripheral) or a positive displacement type of pump is used, a suitable relief valve shall be installed on the pump discharge to prevent damage to the fire system. (See Figures 100a-1 and 143e).	I	I	I	I	I
33	**Standards on Capacity and Pressure.** For requirements on capacity and pressure relief to Standard for the Installation of Sprinkler Systems (NFPA No. 13) and Standard for the Installation of Standpipe and Hose Systems (NFPA No. 14) and for hydrants, Standard for Outside Protection (NFPA No. 24).	I	I	I	I	I

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
34	**Name and Capacity Plate.** Pumps shall be provided with a Name and Capacity Plate.	⊗	✓	✓	✓	✓
40	**Installation**					
41	**The Pump Room.**					
41a	The fire pump shall be protected against possible interruption of service through damage caused by fire or water, in a manner satisfactory to the authority having jurisdiction.	✓	✓	✓	✓	✓
41b	Except where there are several pumps on the same system, located in buildings which are not all subject to one fire, or where the pump is automatically controlled and supplies automatic sprinklers only, the pump should be in a room so located and constructed as to protect it from falling floors or machinery and from fire which might drive away the operator or damage the pump or driving equipment. Note: Where the use of brick or reinforced concrete is not feasible, metal lath and cement plaster is recommended for the construction of the pump room.	✓	✓	✓	✓	✓
41c	The pump room should be of ample sizwe, and the piping and equipment should be so arranged as to make them readily accessible for operation or repair. The pumproom should not be used for storage purposes.	✓	✓	✓	✓	✓

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	Note: With vertical type pumps it may be necessary to provide a removable panel in the pump house roof to permit the pump to be lifted out for repairs.					
41d	The location of the pump room should be such as to permit installation of short and direct pipe connections, the suction pipe receiving first consideration.	✓	✓	✓	✓	✓
41c	Suitable means shall be provided for maintaining the temperature of the pump room above 40^{0}F.	✓	✓	✓	✓	✓
41f	Artificial light shall be provided, and provision made for drainage and ventilation of the pump room. A suitable lamp or lantern should be provided for emergency use. Emergency lighting may be provided from the battery circuit of an internal combustion engine.	✓	✓	✓	✓	✓
41g	Pump rooms housing electric or engine driven pumps should be dry and free from condensate. Some heat may be required to accomplish this.	✓	✓	✓	✓	✓
42	**Discharge Pipe.**					
42a	The ~~size~~ [illegible] of discharge pipe shall be as given in the following table unless otherwise specified by the authority having jurisdiction.	✓	✓	✓	✓	✓

Code Section No.	Code Section	LDFP	U1 DHDFP	V2 DHDFP	U1 EHDFP	U2 EHDFP
	Capicity of Pump, gpm 500 750-1000 1500-2000 2500 Size of Discharge Pipe, inches 6 8 10 12					
42b	An approved check valve shall be installed in the discharge pipe.	⊗	⊗	⊗	⊗	⊗
42c	Approved indicating gate valves shall be installed in such places as needed to make the pump and check valve accessible for repair.	⊗	⊗	⊗	⊗	⊗
43	**Relief Valve.**					
43a	Pumps connected to adjustable-speed drivers shall be equipped with an <u>approved relief valve</u>. Where pumps are driven by constant-speed motors and the shut-off pressure plus the static suction pressure exceeds the pressure for which the system is designed to operate, relief valves are required.	N/A	✓ [illegible] check to see if approved	✓ [illegible] check to see if approved	N/A	N/A
43b	The relief valve should ordinarily be set to prevent pressure on the fire protection system in excess of that pressure at which the system was designed to opetate.	N/A	CN	CN	N/A	N/A
43c	Where provided, relief valves shall be of the size given in the following table: Capacity of Pump, gmp 500 750 1000 1500 2000-2500 Size of Relief Valve, Inches 3 4 4 6 6	N/A	✓	✓	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
43d	The relief valves should be located between the pump and the pump discharge check valve.	N/A	✓	✓	N/A	N/A
43e	The relief valve should discharge into an open pipe in plain sight near the pump or into a cone or funnel secured to the outlet of the valve. This cone should be so constructed that the pump operator can easily see any water wasting through the relief valve, and it should be so made as to avoid splashing water into the pump room. If a closed type cone is used, it should be provided with means for detecting motion of water through the cone. The cone should be piped to a point where water can be freely wasted, preferably outside the building.	N/A	⊗	⊗	N/A	N/A
43f	The relief valve waste pipe is connected to an underground drain, care should be taken that no steam drains enter near enough to work back through the cone and into the pump room. Discharge from the relief valves should not be piped into the suction connection, except with the permission of the authority having jurisdiction.	N/A	N/A	N/A	N/A	N/A
43g	When the supply of water is taken from a suction reservoir of limited capacity, the waste pipe shall drain into such reservoir, entering as far from the pump suction as is necessary to prevent the pump from drafting air which may be carried down by the discharge from waste pipe.	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
43h	The relief valve waste pipe from an open cone should not be smaller than specified below; if more than one elbow is employed the next size larger pipe should be used to complete the connection. Capacity of Pump, gmp 500 750 1000-1500 2000-2500 Size of Waste Pipe, Inches 5 6 8 10	N/A	✓	✓	N/A	N/A
43i	The relief valve waste pipe from a closed cone shall be sized to prevent back pressure in excess of 6 psi.	N/A	N/A	N/A	N/A	N/A
43j	The relief valve shall be so attached as to permit of its ready removal for repairs without disturbing the waste piping.	N/A	✓	✓	N/A	N/A
44	**Hose Valves.**					
44a	Hose valve test header (see NFPA 20 C for exact statement)	N/A	N/A	N/A	N/A	N/A
44b	Unless otherwise specified by the authority having jurisdiction, the number of hose valves shall be as given in the following table, except that for special service fire pumps and for booster pumps, only one hose valve is required for five hundred gallon or smaller pumps. Capacity of Pump, gmp 500 750 1000 1500-2000 2500 Number of Hose Valves 2 3 4 6 8	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
44c	On the larger capacity fire pump installations, there should be installed a fixed nozzle or pipe outlet arranged to discharge at an appropriate place, or a metering device in a pipe line discharging back into the suction supply, for use in making a flow test to the full capacity of the pump or pumps. With such test arrangements the authority having jurisdiction may permit a reduction in the number of hose valves to the number needed for hose stream use.	✓	✓	✓	✓	✓
44d	Hose valves shall be threaded to conform to the American (National) Standard B26-1925 for Fire Hose Coupling Screw Threads. Adapter couplings securely attached to each outlet shall be provided if local couplings are not American Standard.	N/A	N/A	N/A	N/A	N/A
44e	When 2 hose valves are required, use 4-inch pipe between the detachable hose header and the connection to the discharge pipe; when 3 or 4 are required use 6-inch pipe; when 6 or 8 are required use 8-inch pipe. When this pipe is over 15 feet long increase one pipe size.	N/A	N/A	N/A	N/A	N/A
45	**Pressure Gages.**					
45a	A pressure gage having a dial not less than 3 1/2 in. in diameter shall be connected near the discharge casting by a 1/2 in. cock with lever handle. The dial shall indicate pressure to at least twice the rated working pressure of the pump but not less than 200 psi. The face of the dial shall read in pounds per square inch with the manufacturer's standard graduations.	✓	X [illegible]	⊗ [illegible]	⊗ [illegible]	⊗ [illegible]

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
45b	A compound pressure and vacuum gage having a dial not less than 3 1/2 in. in diameter shall be connected to the suction pipe near the pump (except in the case of vertical shaft turbine type pumps). The face of the dial shall read in pounds per square inch for the suction range and have a maximum pressure range not less than twice the rated working pressure of the pump, or a lower pressure range may be furnished if the gage is protected from damage by a gage protector.	⊗	N/A	N/A	⊗	⊗
46	**Circulation Relief Valve to Prevent Overheating.** Pumps which are automatically controlled shall be provided with a 3/4 inch relief valve set slightly below the shut-off pressure and arranged to permit circulation of sufficient water to prevent the pump from overheating when operating with no discharge. This is not needed for submerged type pumps nor for engine driven pumps for which engine cooling water is taken from the pump discharge. Pumps which are manually controlled shall be equipped with either such a relief valve or with a test valve as specified in Section 133. Provision should be made for discharge to a drain.	⊗ could not find check dwgs ✓ no valve but relief line is available	N/A	N/A	⊗ could not find check dwg ✓ no valve but relief line are available to cool pump	⊗ could not find check dwg. ✓

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
47	Summary of Pump Data.	I	I	I	I	I

Capacity of Pump gpm	Size of Discharge Pipe Sec. 42(a)	Size of Relief Valve Sec 43(c)	Size of Relief Waste Sec 43(h)	Number Hose Valves Sec 44(b)
500	6 in.	3 in.	5 in.	2
750	8 in.	4 in.	6 in.	3
1,000	8 in.	4 in.	8 in.	4
1,500	10 in.	6 in.	8 in.	6
2,000	10 in.	6 in.	10 in.	6
2,500	12 in.	6 in.	10 in.	8

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
50	Power Supply.					
51	Dependability of Power Supply. Careful consideration must be given to each case to the dependability of the power supply not overlooking the possible effect of transmission lines of fire in adjoining buildings which might threaten the property.	I	I	I	I	I
60	' sts.					
61	Shop Tests.					
61a	Each individual pump shall be tested with a dynamometer or calibrated motor at the factory to provide detailed performance data and to demonstrate its compliance with specifications.	CN	CN	CN	CN	CN

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
61b	The maker shall test each pump hydrostatically before shipment from the factory, to twice the maximum pressure developed at shutoff, but in no case less than 250 pounds per square inch. Pump casings shall be substantially tight at the test pressure. In the case of vertical shaft turbine type pumps both the discharge castings and pump bowl assembly shall be tested.	CN	CN	CN	CN	CN
61c	All gear drives shall be operated at the factory under full load before shipment and operate without excessive noise or heating during the test.	CN	CN	CN	CN	CN
	CHAPTER 100 - HORIZONTAL SHAFT PUMPS.					
110	General.					
111	Application. The horizontal shaft centrifugal pump with its split casings lends itself to a simple operation and repair, and, where a water supply is obtainable under a head, it is especially adaptable to fire service. Because the horizontal shaft centrifugal pump requires priming when installed to operate under lift, a vertical shaft turbine type pump should be used where suction lift is necessary.	I	N/A	N/A	I	I
112	Performance.					
112a	Pumps shall furnish not less than 150 per cent of rated capacity at a total head not less than 65 per cent of total rated head. The shut-off total head for horizontal shaft pumps should not exceed 120 per cent of total rated head (Fig. 1, Appendix C).	CN	N/A	N/A	CN	CN

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
112b	The inlet pressure available from a suction water supply shall be figured on a basis of a flow of 150 per cent of the rated capacity of the pump, as indicated by a flow test.	CN	N/A	N/A	CN	CN
120	**Water Supplies.**					
121	**Operate Under Head.** Fire pumps, especially those automatically controlled, should be provided with water under head, avoiding suction lifts whenever possible. Operating suction lifts, including allowance for velocity and friction loss through all suction fittings, shall not exceed 15 feet at sea level and the allowable lift must be reduced by 1 foot for each 1,000 feet of altitude at the pump installation. Where a suction lift is necessary, a vertical shaft turbine type pump should be used. (See Paragraph 111.)	CN	N/A	N/A	CN	CN
122	**Priming Supplies.**					
122a	Provide adequate priming supplies for pumps which may at any time take suction under a lift. Priming equipment should have sufficient capacity to displace the air from the pump and suction pipe within three minutes.	✓	N/A	N/A	✓	✓
122b	Provide two reliable methods of priming the pump. One of these methods of priming should be independent of public water connections or tanks serving as primary supplies for automatic sprinklers, yard hydrants or standpipes.	✓	N/A	N/A	✓	✓

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
122c	Where the pump is automatically started or provision is made for remote manual starting, the preferred arrangement is a submerged pump (See Fig. 200a, Appendix C), but if priming is needed the priming supply should be of a type which will keep the pump primed at all times. No priming method should be selected which will permit contamination of a potable water supply.	CN	N/A	N/A	CN	CN
123	**Priming Method A. An Automatically Filled Priming Task.**					
123a	An automatically filled priming tank that keeps the pump primed at all times. The volume of the priming tank should be equal to the volume of the pump and suction pipe but not less than 10C gals. This volume can be readily computed from the following data.	N/A	N/A	N/A	N/A	N/A

Capacity of Pump gpm	Priming Water Required for Pump and Fittings, Gals.	Size of Suction Pipe Inches	Priming Water Required for Suction Pipe Gals. per Foot
500	13	6	1.5
750	21	8	2.5
1,000	25	10	4.1
1,500	38	12	5.9
2,000	47	14	8.0
2,500	58	16	10.5
		20	16.3

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
123b	The water supply to the tank should be capable of keeping the tank full at all times.	N/A	N/A	N/A	N/A	N/A
123c	The priming tank should be connected to the discharge side of the pump at a point which will insure that all priming water enters the pump and suction pipe, and is not wasted in the discharge pipe of the pump (Fig. 100b, Appendix C). This connection should be 2 inches in diameter irrespective of the capacity of pump, and include an approved O.S. & Y. gate valve and an approved check valve.	N/A	N/A	N/A	N/A	N/A
124	**Priming Method B. A Connection to a Domestic Water System.** A connection to a domestic water system (when permitted by health regulations). Install approved check and O.S. & Y. gate valves in the priming pipe near the pump.	N/A	N/A	N/A	N/A	N/A
125	**Priming Method C. A Connection to a Domestic-use Tank.** A connection to domestic-use (service) tank (when permitted by health regulations). Preferably arrange a reserve supply for priming only, by extending service riser up into the tank. Install approved check and O.S. & Y. gate valves in the priming pipe near the pump.	N/A	N/A	N/A	N/A	N/A
126	**Priming Method D. An Exhauster or Siphon Ejector.** Where a reliable steam supply or separate water supply under good pressure is available, an exhauster or siphon ejector may be connected between the pump and discharge check valve to exhaust the air from the pump and the suction pipe (fig. 100b, Appendix C). An approved	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	O. S. & Y. gate valve should be placed in the exhauster connection, to be closed as soon as the pump is primed.					
127	**Priming Method E. A Mechanically-operated Exhauster Driven by a Separate Motor.** The exhauster should be connected between pump and discharge check valve, so as to completely fill suction pipe and pump (Fig. 100b, Appendix C). An approved O.S. & Y. gate valve should be placed in the exhauster connection, to be closed as soon as pump is primed.	✓	N/A	N/A	✓	✓
128	**Priming Method F. A Manually Filled Priming Tank.**					
128a	The tank to have a capacity of at least three times the volume of the pump and usction pipe, but not less than 250 gallons. A liberal-sized priming tank and large connecting pipe are necessary so that the pump can be primed quickly, even if there should be considerable leakage at the foot valve. As the priming arrangement is so vital a feature to the successful starting of the pump, a considerable safety factor is needed.	N/A	N/A	N/A	N/A	N/A
128b	The volume required for the priming tank can be readily computed by taking 3 times the quantities given under Section 123.	N/A	N/A	N/A	N/A	N/A
128c	The tank should be connected to the pump as covered in Section 123 with the connecting pipe not smaller than given in the following table:	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	Capacity of Pump, gal. per min. 500 750 1000 1000-2500					
	Size of Priming Pump, inches 2 1/2 3 3 1/2 4					
128d	Where suction pipe is longer than 25 feet, larger priming connection may be required.	N/A	N/A	N/A	N/A	N/A
128e	Provide a means for keeping tank filled such as a connection from public or factory-use water systems or a connection between fire pump and the priming tank to permit refilling tank.	N/A	N/A	N/A	N/A	N/A
129	**Priming Metaod G. A By-pass Around Discharge Check Valve.** Where a good gravity water supply constitutes the primary supply for automatic sprinklers, yard hydrants or standpipes, a 2 inch by-pass around the check valve in the pump discharge pipe may be used but only as a secondary priming supply.	N/A	N/A	N/A	N/A	N/A
130	Pump.					
131	Outline of Required Attachments.					
131a	This standard requires horizontal fire pumps to be equipped with the following attachments, depending on the conditions under which the pumps are to be installed:	I	N/A	N/A	I	I

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	Automatic air release, Section 132.	⊗	↑	↑	⊗	☑
	Circulation relief valve, Section 46.	⊗			⊗	⊗ ~~✓~~ [illegible]
	Eccentric tapered reducer at suction inlet, Paragraph 143i.	✓			✓	✓
	Hose valve manifold with hose valves, Section 44.	I	N/A	N/A	I	I
	Pressure gages, Section 45.	⊗			⊗	⊗
	Priming connection, Section 122 to 129.	✓	↓	↓	✓	✓
	Relief valve and discharge cone, Section 43.	N/A			N/A	N/A
	Splash shield between pump and motor, Section 455.	✓			✓	✓
	Test valve with piping connections, Section 133.	✓			✓	✓
131b	These attachments shall be provided by the pump manufacturer unless the authority having jurisdiction permits certain omissions depending on the conditions under which the pumps are to be installed.	CN	N/A	N/A	CN	CN
132	**Automatic Air Release.** Pumps which are automatically controlled shall be provided with a reliable float-operated air release valve not less than 1/2 inch in size, or equivalent valve, to automatically release air from the pump.	⊗ [illegible] data	N/A	N/A	⊗ [illegible] data	⊗ [illegible]
133	**Test Valves.**					

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
133a	Pumps taking suction under lift shall be equipped with test valves of the size specified below, in order to provide means for liberating the air from the pump and suction line within the three-minute time limit for the priming operation. Capacity of Pump, gpm 500 750 1000 1500-2500 Size of Valve, Inches 1 1/4 1 1/2 2 2 1/2	N/A	N/A	N/A	N/A	N/A
133b	Test valves shall be piped so that water wasted through them can be seen by a man at the pump. NOTE: Unless the pump attendant can see the dischage of water, there is danger that he will allow water to be wasted which might be seriously needed for fire fighting.	⊗	N/A	N/A	⊗	⊗
140	**Installation.**					
141	**Foundation and Setting.**					
141a	Unless the pump and driver have a common shaft, they shall be connected by an approved flexible coupling arranged to permit end adjustment and to care for minor inaccuracies in alignment.	✓	N/A	N/A	✓	✓
141b	The pump and driver shall be securely attached to a solid foundation in such a way that proper shaft alignment will be assured: such as by having the pump and driver rigidly connected to a substantial bedplate which is securely bolted to the foundation.	✓	N/A	N/A	✓	✓

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
141c	The foundation should preferably be made of concrete, or, if desired, of brick laid in portland cement mortar. NOTE: Where the foundation is of brick a capping of concrete is an advantage in tying it together. In some cases it may be necessary to support the pump on I-beams or a framework of structural steel.	✓	N/A	N/A	✓	✓
141d	Pumps shall be set level, with foundation bolts in position, and the joint between the foundation and bedplate made solid by grouting with neat cement. After the cement has thoroughly set the bolts shall be tightened. For further information see Instructions for Installing Centrifugal Pumps in Centrifugal Pump Section of the Standards of the Hydraulic Institute.	✓ visual inspection only	N/A	N/A	✓ visual inspection only	✓ visual inspection only
142	**Alignment.**					
142a	A horizontal pump with driver is correctly aligned on bedplate before shipment. This alignment, however, usually is disturbed during transit or by incorrect leveling of bedplate on foundation. The pump manufacturer's instructions on alignment should be carefully followed.	I	N/A	N/A	I	I
142b	Any baseplate, no matter how heavily it is built may be slightly sprung in shipment, or may be distorted by an uneven support on the foundation, or by uneven tightening of the foundation bolts, or by the pull from the pipe connections. It is necessary to be careful when installing the pump	I	N/A	N/A	I	I

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	to secure perfect alignment of the coupling **A flexible coupling will not compensate for misalignment.** Inaccurate alignment of the coupling results in rapid wear of the coupling bushings, heating of the bearings and loss of efficiency. Therefore, after the pump is fastened on the foundation it is necessary to see that the shaft of the pump and of the prime mover are in one line. If the prime mover and pump are direct connected up to its piping and the base plate then leveled up and adjusted to position so as to bring the two halves of the coupling into perfect alignment.	I	N/A	N/A	I	I
142c	With a pair of inside calipers or a wedge, check the distance between the coupling halves at four points and repeat after revolving both halves 180 degrees.	CN	N/A	N/A	CN	CN ~~CN~~ ✓ [illegible] 8/1:30
142d	Both suction and discharge pipes should be independently supported near the pump so that when the flange bolts are tightened no strain will be transmitted to the pump casing.	✓	N/A	N/A	✓	✓
143	Suction Connections.					
143a	The size of suction pipe should be determined from Fig. 143a (Appendix C). These curves include an allowance for velocity and friction loss through elbows and foot valves.	✓	N/A	N/A	✓	✓
143b	Suction pip d be of the same pressure rating as the var g and installed in accordance with ndard for Outside Protection, NFPA No.	CN	N/A	N/A	CN	CN

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	24. For short pipe well-supported, flanged cast iron pipe with rubber gaskets should be used. In special cases steel pipe having flanged or screwed joints (flanged joints with flanges welded to the pipe are preferred) may be used above ground in the pump room provided it is galvanized or painted on the inside, prior to installation, with a paint recommended for submerged surfaces. Thick bituminous coatings applied at the plant should not be used. The exterior of steel pipe should be kept painted. Cement asbestos pipe may be used when the pump takes suction under a head at all times.	✓ same as U2EHDFP	N/A	N/A	✓ same as U2EHDFP	✓ cast iron welded = welded flange w/ rubber gaskets
143c	Avoid an excessive length of suction pipe to a pump room under lift by providing a suction well close to the pump. The well can be fed by gravity through a large pipe from the suction source.	N/A	N/A	N/A	N/A	N/A
143d	Provide independent suction pipes where more than one pump is supplied under lift from the same intake or suction well. In special cases where a single suction pipe supplies more than one pump under head, the piping layout at the pumps must be symmetrical so that each pump will receive its proportional supply. The size of the suction pipe should be such that with all pumps operating at overload capacity the total operating suction lift will not exceed 15 feet.	✓	N/A	N/A	✓	✓
143e	When the suction supply is under sufficient pressure to be of material value without the pump, the pump should be installed with a by-pass (Fig. 143e, Appendix C).	✓ [illegible]	N/A	N/A	✓ [illegible]	✓ [illegible]

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
143f	Suction pipes involving a lift must be carefully laid to avoid air leaks and air pockets, either of which may seriously affect the operation of the pump. Lay a suction pipe involving a lift so that it will have a constantly ascending grade from the water supply to the pump (Fig. 143f, Appendix C).	✓ no lift	N/A	N/A	✓ no lift	✓ no lift
143g	Lay suction pipe below the frost line. Pay special attention where pipe enters streams, ponds, or reservoirs to prevent freezing either underground or under water (Fig. 100b, Appendix C).	✓	N/A	N/A	✓	✓
143h	All pump suction pipe, except short lengths between above-ground suction tanks and pumps, should be hydrostatically tested in accordance with the tests for yard mains given in the Standard for Outside Protection (NFPA No. 24) before back filling.	CN	N/A	N/A	CN	CN
143i	When the suction pipe and pump suction connection are not of the same size, connect them with an eccentric tapered reducer in such a way as to avoid air pockets (Fig. 143f, Appendix C).	✓	N/A	N/A	✓	✓
143j	Equip suction pipes which may at any time involve a lift with approved foot valves except when two completely independent exhaust-type priming methods are provided. Piping should be arranged to permit removing foot valves for inspection and cleaning. Combination foot valves and strainers should not be used.	✓	N/A	N/A	✓	✓

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
143k	Provide an approved O.S. & Y. or approved indicator type gate valve in the suction pipe if the pump is ever supplied under a head. NOTE 1: If suction pressure comes from city or service water mains, the gate valve should normally be located at the suction flange on the pump. (Item 6A in Figure 100a.) NOTE 2: If suction pressure comes from a stored water container, the gate valve should normally be located at the outlet of the container. (Item 6 in Figure 100a.)	Ⓧ	N/A	N/A	Ⓧ	⊗
1431	Suction inlets should be at least 24 inches below minimum water level to prevent pumps from drafting air and at least 12 inches above the bottom of sump or suction well to avoid obstruction (Fig. 100 b and Fig. 1431, Appendix C).	N/A	N/A	N/A	N/A	N/A
143m	Provide double removalble intake screens (Fig. 100b, Appendix C) having an effective net area of openings below minimum water level of one square inch for each gallon per minute of 150 per cent of rated pump capacity at suction intakes where it is necessary to prevent the passage of materials which might clog the pump. Screens should be so arranged that they can be cleaned or repaired without distrubing the suction pipe. A brass or copper wire screen of one-half inch mesh and No. 10 B. & S. gage wire secured to a metal frame sliding vertically at the entrance to the intake, makes a serviceable arrangement, and permits ready cleaning and overhauling. The over-all area of	✓	N/A	N/A	✓	✓

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	this particular screen is 1.6 times the net screen opening area. In some localities, suction supply for fire pumps from public water mains may require the installation of an approved strainer to prevent foreign material from passing through the pump into the system piping.	✓	N/A	N/A	✓	✓
143n	When pump and suction supply are on separate foundations with rigid interconnecting piping, the piping should be provided with strain relief. (See Fig. 100a, Item 5.)	✓	N/A	N/A	✓	✓
	CHAPTER 200 - VERTICAL SHAFT TURBINE-TYPE PUMPS.					
210	General.					
211	Suitability. The deep well turbine-type pump is particularly suitable for fire pump service when the source of water is located below the surface of the ground and it would be difficult to install any other type of pump below the minimum water level. It is a vertical shaft centrifugal pump with rotating impellers suspended from the pump head by a column or eduction pipe which also serves as a support for the shaft and bearings. It was originally designed for installation in bored wells, but may also be used to lift water from lakes, streams, open sumps, and other subsurface sources. Oil-lubricated enclosed line shaft or water-lubricated open line shaft pumps will be acceptable.	N/A	I	I	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
212	**Maximum Depth.** Wells should not be considered as a source of supply for fire pump service where the water level when pumping at 150 per cent capacity exceeds 200 feet from the surface of the gound. in all applications where the water level is expected to exceed 50 feet the authority having jurisdiction shall be supplied with data on the draw-down characteristics of the well and the pump performance to determine the available discharge pressure at the discharge flange of the vertical pump.	N/A	N/A	N/A	N/A	N/A
213	**Acceptable Drive.** These pumps may be operated by vertical shaft electric motor or, when equipped with a suitable right angle gear drive, they may be operated by an internal combustion engine or a steam turbine. Careful consideration must be given in each case to the dependability of the source of power.	N/A	I	I	N/A	N/A
214	**Supervision of Installation.** Satisfactory operation of vertical turbine-type pumps is dependent to a large extend upon careful and correct installation of the unit; therefore, it is recommended that this work be done under direction of a representative of the pump manufacturer.	N/A	CN	CN	N/A	N/A
215	**Performance.** Pumps shall furnish not less than 150 per cent of rated capacity at a total head of not less than 65 per cent of the total rated head. The shut-off total head shall not exceed 140 per cent of total rated head (Fig. 1, Appendix C).	N/A	CN	CN	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
220	Water Supply.					
221	Source.					
221a	The water supply shall be acceptable to the authority having jurisdiction. Stored water supplies from reservoirs or tanks supplying wet pits are preferable. Lakes, streams and ground water supply may be acceptable where investigation shows that they can be expected to provide a suitable and reliable supply.	N/A	✓	✓	N/A	N/A
221b	The acceptance of a well as a source of water supply shall be dependent upon statisfactory development of the well and the making of a preliminary test to determine hydraulic conditions. The history of the water table should be carefully investigated. The number of wells already in use in the area and the probable number that may be in use should be considered in relation to the total amount of water available.	N/A	N/A	N/A	N/A	N/A
222	Pump Submergence.					
222a	Proper submergence of the pump must be provided for reliability of operation of the fire pump unit.	N/A	N/A	N/A	N/A	N/A
222b	**Wet Pit Installations.** The minimum submergence should be such that the second impeller from the bottom of the pump bowl assembly will be below the lowest standing water level in the open body of water supplying the pit (Fig. 200b, Appendix C).	N/A	OW	OW	N/A	N/A

Code Section No.	Code Section	IDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	The minimum submergence shall be increased by one foot for each 1000 feet of elevation above sea level.					
222c	**Well Installations.** Submergence of the second impeller from the bottom of the pump bowl assembly should be 10 feet below the pumping water level at 150 per cent of rated capacity. (See Figure 200a, Appendix C.)	N/A	N/A	N/A	N/A	N/A
223	**Well Construction.**					
223a	It shall be the ground water supply contractor's responsibility to make one or more test holes, if necessary, in search of water-bearing formation, develop a well to meet the required water production necessary for a specific pump, to perform all work and install all equipment in a thorough and workmanlike manner.	N/A	N/A	N/A	N/A	N/A
223b	Each well completed must be of ample diameter and depth and sufficiently straight to receive the pump. The turbine-type pump is designed to operate in a vertical position with all parts in correct alignment; it cannot operate in a crooked well unless the turbine unit hangs freely without being cramped.	N/A	N/A	N/A	N/A	N/A
224	**Unconsolidated Formations.**					

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
224a	All casings shall be steel of such diameter and installed to such depths as the formation may justify and in the contractor's opinion best meet the conditions. Both inner and outer casing shall conform to the thickness and weight in Table 224.	N/A	N/A	N/A	N/A	N/A
224b	Outer casing shall extend down to approximately the top of the water-bearing formation. The inner casing of lesser diameter and well screen shall extend into the water-bearing formation as the water-bearing stratum encountered may justify and, in the contractor's opinion, best meet the conditions.	N/A	N/A	N/A	N/A	N/A
224c	It should be emphasized that the well screen is a vital part of the well construction and careful attention should be given to its selection. It shall be the same nominal diameter as the inner casing and of the proper length to provide for the quantity of water to be developed. The screen shall be made of stainless steel material (304) except the Monel metal shall be used where it is anticipated that the chloride content of the well	N/A	N/A	N/A	N/A	N/A

Table 224

Nominal Size (ID) Inches	Wall Thickness Inches	Weight per Foot (Plain Ends) Pounds
8	0.277	24.70
10	0.307	34.24
12	0.330	43.77
16 & Larger	0.375	-

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	water will exceed 1000 parts per million. The screen shall have adequate strength to resist the external forces that will be applied after it is installed and to minimize the likelihood of damage during the installation.					
224d	The bottom of the well should be sealed properly with a cement plug or a plate of the same material as the screen. The sides of the outer casing should be sealed by the introduction of neat cement placed under pressure from the bottom to the top.	N/A	N/A	N/A	N/A	N/A
224e	The immediate area surrounding the well screen should be properly prepared with clean and well-rounded gravel of such size and quantity as will create a gravel filter to insure a low velocity and friction loss of water leaving the water-bearing formation and entering the well.	N/A	N/A	N/A	N/A	N/A
225	**Consolidated Formations.** Where wells take their supply from consolidated formations, such as rock, the specifications should be decided upon by the authority having jurisdiction upon consultation with a recognized ground water consultant in the area. In instances where the drilling penetrates unconsolidated formations above the rock, surface casing shall be installed, seated in solid rock and cemented in place.	N/A	N/A	N/A	N/A	N/A
226	**Developing a Well.** Developing a new well and cleaning it of sand (not to exceed five parts per million) shall be the ground water supply	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	contractor's responsibility and should be done with a test pump and not the new fire pump which could be ruined before it is placed in service. Freedom from sand shall be determined when the test pump is operating at 150 per cent of rated capacity of the fire pump fow which the well is being prepared.					
227	**Test and Inspection of Well.**					
227a	A test to determine the water production of the well shall be made with an acceptable type of water measuring device such as an orifice, a venturi meter or a calibrated pilot tube, and shall be witnessed by a representative of the customer, contractor and authority having jurisdiction, as required. The test shall be continuous for a period of at least eight hours at 150 per cent of the rated capacity of the fire pump, with average hourly readings over the test period. The tests should be evaluated in the light of the effect of other wells in the vicinity and any possible seasonal variation in the water table at the well site. Test data shall describe the static water level and the pumping water level at 100 and 150 per cent of the rated capacity of the fire pump for which the well is being prepared.	N/A	N/A	N/A	N/A	N/A
227b	The well work completed by the ground water supply contractor should be carefully examined and if there is some doubt about straightness of well, gaging and plotting is recommended before acceptance of the well.	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
227c	Before the permanent pump is ordered, the water in the well should be analyzed for corrosiveness including such items as pH, salts such as chlorides, harmful gases such as carbon dioxide (CO_2) or hydrogen sulfide (H_2S). If the water is corrosive, the pumps should be constructed of a suitable corrosion-resisting material such as bronze or red brass in accordance with chemical analysis and experience in the area.	N/A	N/A	N/A	N/A	N/A
230	Pump.					
231	**Discharge Head.** The discharge head should be of the aboveground type (Fig. 200a and b, Appendix C). In every case the discharge head shall be designed to support the driver, the pump column and the oil tube tension nut or packing container. The discharge head shall also act as a water passage to direct the water from the column into the discharge fittings.	N/A	✓ visual inspection only	✓ visual inspection only	N/A	N/A
232	Pump Column.					
232a	The column shall be furnished in sections not exceeding a nominal length of 10 feet, shall be of minimum weight conforming to specifications in Table 232, and shall be connected by threaded sleeve type or flange type couplings. The ends of each section of threaded pipe shall be faced parallel and machined with threads to permit the ends to butt so as to form accurate alignment of pump column. All column flange faces shall be parallel and machined for rabbet fit to permit accurate alignment.	N/A	CN	CN	N/A	N/A

<table>
<tr><th>Code Section No.</th><th>Code Section</th><th>LDFP</th><th>U1 DHDFP</th><th>U2 DHDFP</th><th>U1 EHDFP</th><th>U2 EHDFP</th></tr>
<tr><td></td><td>
<table>
<tr><th>Nominal Size (ID) Inches</th><th>Outside Diameter Inches</th><th>Weight per Foot (Plain Ends) lbs.</th><th>Nominal Size (ID) Inches</th><th>Outside Diameter Inches</th><th>Weight per Foot (Plain Ends) lbs.</th></tr>
<tr><td>6</td><td>6.625</td><td>18.97</td><td>10</td><td>10.750</td><td>31.20</td></tr>
<tr><td>7</td><td>7.625</td><td>22.26</td><td>12</td><td>12.750</td><td>43.77</td></tr>
<tr><td>8</td><td>8.625</td><td>24.70</td><td>14*</td><td>14.000</td><td>54.57</td></tr>
</table>
*OD</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>232b</td><td>Open line shaft water-lubricated columns shall not be used where the distance from the pump head to the static water level exceeds 50 feet.</td><td>N/A</td><td>✓</td><td>✓</td><td>N/A</td><td>N/A</td></tr>
<tr><td>232c</td><td>If the pump is to be of the enclosed line shaft oil lubricated type the shaft enclosing tube shall be furnished in interchangeable sections not over 10 feet in length of extra strong pipe. An automatic sight feed oiler shall be provided on a suitable mounting bracket with connection to the shaft tube for oil lubricated pumps.</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>233</td><td>Bowl Assembly.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>233a</td><td>The pump bowl shall be of close-grained cast iron or bronze, and provided with bronze wearing rings or other suitable material in accordance with the chemical analysis of the water and experience in the area, as per Paragraph 224b.</td><td>N/A</td><td>CN</td><td>CN</td><td>N/A</td><td>N/A</td></tr>
</table>

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
233b	Impellers shall be of bronze of the enclosed or semi-open type.	N/A	CN	CN	N/A	N/A
234	**Suction Strainer.**					
234a	A cast or heavy fabricated type of non-ferrous cone or basket type strainer shall be attached to the suction manifold of the pump. The suction strainer shall have a free area of at least four times the area of the suction connections and the openings shall be of such size to restrict the passage of a 1/2 inch sphere.	N/A	CN	CN	N/A	N/A
234b	This suction strainer shall be required in addition to intake screen, specified under Paragraph 143m.	N/A	CN	CN	N/A	N/A
235	**Fittings.**					
235a	The following fittings to be furnished by the pump manufacturer shall be required for attachment to the pump. (Some shown in Fig. 200a, Appendix C.)	N/A			N/A	N/A
	Discharge tee or elbow.		✓	✓		
	Hose valve head (separable type), Section 44.		⊗	⊗		
	Hose valves, Section 44.		⊗	⊗		
	Automatic air release valve and fittings, Paragraph 235b.		✓	✓		
	Discharge gage conforming to Section 45.		⊗	⊗		

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFF
	Relief valve and discharge cone, when required by Section 43.		⊗	⊗		
	Water level testing device, Paragraph 235c.		N/A	N/A		
235b	A 1 1/2 inch or larger automatic air release valve is required to vent air from the column and discharge head upon starting the pump and also to serve to admit air to the column to dissipate the vacuum when the pump is stopped. This valve shall be located at the highest point in the discharge line between the fire pump and the discharge check valve.	N/A	✓	✓	N/A	N/A
235c	Each pump installed in a well must be equipped with a suitable water level detector. The air line method (Section 236) is considered as a satisfactory method of determining depth of water level. This device should be permanently installed.	N/A	N/A	N/A	N/A	N/A
236	**Air Line Method of Water Level Detection.**					
236a	A satisfactory method of determining the water level involves the use of an air line of small pipe or tubing and of known vertical length, a pressure or depth gage, and an ordinary bicycle or automobile pump installed as shown by Fig. 236. The air line pipe should be of known length and extend beyond the lowest anticipated water level in the well in order to assure more reliable gage readings and should be properly installed. As noted in Fig. 236 an air pressure gage is used to indicate the pressure in the air line.	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
236b	The air line pipe is lowered into the well, a tee is placed in the line above the ground, and a pressure gage is screwed into one connection and the other is fitted with an ordinary bicycle valve to which a bicycle pump is attached. All joints must be made carefully and must be air tight to obtain correct information. When air is forced into the line by means of the bicycle pump the gage pressure increases until all the water has been expelled. When this point is reached the gage reading becomes constant. The maximum maintained air pressure recorded by the gage is equivalent to that necessary to support a column of water of the same height as that forced out of the air line. The length of this water column is equal to the amount of air line submerged.	N/A	N/A	N/A	N/A	N/A
236c	Duducting this pressure converted to feet (psi pressure X 2.31 = feet) from the known length of the air line will give the amount of submergence.	N/A	N/A	N/A	N/A	N/A
240	Installation.					
241	Pump House. The pump house should be of such character as will offer the minimum obstruction to the convenient handling and hoisting of vertical pump parts. Otherwise the requirements of Section 41 and Section 666 should apply.	N/A	✓	✓	N/A	N/A
242	Outdoor Setting. If in special cases the authority having jurisdiction does not require a pump room and the unit motor is installed outdoors the motor shall be screened, and adequately protected against tampering. The screen should be	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	easily removable and provision made f[illegible]e ventilation. A sheet metal on iron frame is better than wood.					
243	Foundation.					
243a	The pump foundation for vertical type pumps should be substantially built to carry the weight of the entire pump full of water and the driver. It should be rigid enough to withstand and prevent any vibration. Area of the base of foundation should extend at least 3 inches beyond the pump head base plate on all sides and be of sufficient area and strength so that the load per square foot on concrete does not exceed the ordinary foundation standards, or two I-beams of sufficient length and weight may be used on either side of well.	N/A	✓ visual inspection only	✓ visual inspection only	N/A	N/A
243b	Certified prints can be obtained from the pump manufacturer giving the necessary dimensions.	N/A	I	I	N/A	N/A
243c	Top of the foundation shall be carefully leveled to permit the pump to hang free in the well.	N/A	✓	✓	N/A	N/A
243d	Where pump is mounted on I-beam over a pit the right angle gear housing and driver should always be installed parallel to beams, never at right angle.	N/A	N/A	N/A	N/A	N/A

Pumps are not mounted on I-beam

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
244	**Method of Erecting.**					
244a	Several methods of installing a vertical pump may be followed, depending upon the location of the well and facilities available. Since most of the pump unit is underground, extreme care must be used in assembling and installing it and throughly checking the work as it progresses. The installation should be made under supervision of a representative of the pump manufacturer.	N/A	I	I	N/A	N/A
244b	The following simple method is the most common.	N/A	I	I	N/A	N/A
244b1	Construct a tripod or potable derrick and use two sets of installing clamps over open well or pump house. After the derrick is in place the alignment should be checked carefully with the well or suction pit to avoid any trouble when setting the pump.	N/A	I	I	N/A	N/A
244b2	Attached set of clamps to the suction pipe on which strainer has already been placed and lower onto the well until clamps rest on block beside well casing or on pump foundation.	N/A	I	I	N/A	N/A
244b3	Attach clamps to pump stage assembly and bring over well and install pump stages to suction pipe, etc., until each piece has been installed in accordance with manufacturer's instructions.	N/A	I	I	N/A	N/A
	Note: A series of drawings illustrating this procedure will be found in Appendix C. See Figures 244b-1, 2, 3 and 4.					

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DSDFP	U1 EHDFT	U2 EHDFP
245	**Setting Impellers.** The setting of the impellers should only be undertaken by a representative of the pump manufacturer. Improper setting will develop excessive friction loss by rubbing of impellers on pump seats with resultant increase in power demand. If adjusted too high there will be a loss in capacity; full capacity is vital for fire pump service. The top shaft nut should be locked or pinned after proper setting.	N/A	I	I	N/A	N/A
250	**Driver.**					
251	**Method of Drive.**					
251a	The pump may be driven by a vertical hollow shaft electric motor or a right angle gear drive or dual drive with internal combustion engine or steam turbine. The drives provided must be so constructed that the total thrust of the pump, which includes the weight of the shaft, impellers, and the hydraulic thrust, can be carried on a thrust bearing of ample capacity so that it will have an average life rating of five-year continuous operation. All drivers must be so constructed that axial adjustment of impellers can be made to permit proper installation and operation of the equipment.	N/A	✓ right angle gear drive w/ means to adjust impellers if necessary	✓ right angle gear drive w/ means to adjust impellers if necessary	N/A	N/A
251b	Motors shall be direct connected, of the vertical, hollow shaft type, drip proof, normal starting torque, low starting current, squirrel cage induction type. The motor shall be equipped with an antireverse rachet.	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
251c	Gear drives must be acceptable to the authority having jurisdiction. Gear drives shall be of the hallow shaft type, permitting adjustment of the impellers for proper installation and operation of the equipment. The gear drive shall be equipped with an antireverse rachet.	N/A	✓ gear drive is capable [illegible] impeller	✓ gear drive able to adjust impeller	N/A	N/A
251d	Where internal combustion engines under manual control are used, it shall be the pump manufacurer's responsibility to furnish a coupling of suitable design which will prevent undue strain on either the engine or pump by reverse operation. Automatic starters are equipped with an antiieseling device which serves to prevent reverse operation from self ignition during compression.	N/A	N/A	N/A	N/A	N/A
251e	If dual drive is used, all equipment shall be of approved type and shall include approved freewheeling clutches (see Paragraph 623.b).	N/A	N/A	N/A	N/A	N/A
252	**Controls.** The controls for the motor, steam turbine or internal combustion engine shall comply with the sections of this standard which cover these controls.	N/A	I	I	N/A	N/A
260	**Tests.**					
261	**Field Acceptance And Subsequent Tests.**					

dual drive does not exist

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
261a	When the installation is completed, with wells and pumping equipment all in place, and necessary adjustments and connections made, an operating test shall be made in the presence of the customer, pump manufacturer and representative of the authority having jurisdiction. Requirements regarding field acceptance tests in Article 910 should be followed insofar as they apply, excepting that for well installations the test shall include a continuous run long enough to satisfy the authority having jurisdiction that the permanent pump performs are required, but in no event shall the test be for less than one hour.	N/A	CN	CN	N/A	N/A
261b	A yearly inspection and test at 150 per cent rated capacity to determine water level and condition of pump should be made.	N/A	CN	CN	N/A	N/A
270	**Operation and Maintenance.**					
271	**Operation.**					
271a	In starting the unit for the first time after installation it is advisable to check over all electrical connections to the motor and also the discharge piping from the pump. Then momentarily operate the motor to see that the pump shaft rotates in a counter-clockwise direction when viewed from above.	N/A	I	I	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
271b	With these precautions taken the pump may be started and allowed to run. Observe the operation for vibration while running and also any heating of the motor.	N/A	I	I	N/A	N/A
272	**Vibration.**					
272a	Pumping units are checked at the factory for smoothness of running and performance and should operate satisfactorily on the job. If excessive vibration is present several conditions may cause the trouble - a bent pump or column shaft, impellers not properly set within the pump bowls, pump not hanging freely in the well, or strain transmitted through the discharge piping.	N/A	I	I	N/A	N/A
272b	If vibration develops later the unit should not be continued in operation. The pump manufacturer should be requested to service the installation and to place it in proper running condition.	N/A	I	I	N/A	N/A
273	**Excessive Motor Temperature**. This condition is generally caused either by a maintained low voltage of the electric service, or when the impellers are not properly set within the pump bowls.	N/A	I	I	N/A	N/A
274	**Repair.**					
274a	Manufacturer's instructions must be carefully followed in making repairs, taking apart and reassembling the pumps. This work should only be undertaken by someone familiar with their design.	N/A	I	I	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
274b	In ordering spare or replacement parts use the pump serial number stamped on the name plate fastened to the pump head.	N/A	I	I	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	Chapter 300 - Special Fire Service Pumps. Chapter 300 is not applicable to D. C. Cook and is omitted from this report in its entirety.	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	Part II - Drive and Drive Controllers for Pump. **Chapter 400 - Electric Drive** The scope of chapter 400 is not included in this report. Chapter 400 is being revised (reviewed) in its [illegible] entirety by Electrical Engineering - Nuclear.	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	Chapter 500 **Electric Drive Controllers** The scope of chapter 500 is not included in this report. Chapter 500 is being reviewed in its entirety by Electrical Engineering - Nuclear.	n/a	n/a	n/a	n/a	n/a

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	Chapter 600 Internal Combustion Engine Drive.					
610	General.					
611a	Recommended Use. Selection of internal combustion engine type fire pump equipment for each situation should be based on careful consideration of factors of the most reliable type of control, ignition and fuel (including fuel supply), the starting operation and the running operation of the internal combustion engine.	N/A	I	I	N/A	N/A
611b	The compression ignition diesel engine is one of the most dependable sources of power for driving fire pumps. Spark ignition type engines are advised as supplemental units with natural gas and gasoline as acceptable fuels in that order for preference.	N/A	I	I	N/A	N/A
620	Engines.					
621	Approval. Engines shall be specifically approved for fire pump service.	N/A	CN	CN	N/A	N/A
622	Ratings.					
622a	The engine shall have a bare engine brake horsepower rating at least 20 per cent greater than the maximum brake horsepower required to drive the fire pump at rated revolutions per minute of the pump unit.	N/A	CN	CN	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	Note: The 20 per cent excess power takes account of the fact that new production engines are permitted to run as low as 5 per cent under the official bare engine horsepower curve and that up to 5 per cent may be needed for operation of accessories, allowing at least 10 per cent reserve power for reliability of performance and for normal depreciation of the engine with age and use.					
622b	A deduction of 5 per cent of the power shown on the curve of the engine, having a standard sea level compression ratio, shall be made for each 1,000 feet rise in altitude above sea level. This correction should be made prior to any other power deductions or rating correction factors.	N/A	CN	CN	N/A	N/A
622c	When the authority having jurisdiction permits the use of gear drives between the pump and its drive, (see 623a.) the horsepower requirement of the pump should be increased to allow for power losses.	N/A	CN	CN	N/A	N/A
622d	Engines listed for fire pump service by a nationally recognized testing laboratory may be accepted for horsepower ratings established by the laboratories.	N/A	I	I	N/A	N/A
623	Connection to Pump					

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
623a	Except where otherwise permitted by the authority having jurisdiction the engine shall be directly connected to a horizontal pump by means of a flexible coupling of suitable design. Vertical shaft turbine-type pumps shall have the engine connected to the right angle drive with suitable universal joints.	N/A	✓	✓	N/A	N/A
623b	Dual drive units are not recommended. The use of separate pumps provides greater flexibility and reliability. Where dual drive is used, the coupling should be of an automatic type acceptable to the authority having jurisdiction and the engine drive shall be equipped with an approved free-wheeling clutch. If the other drive is an electric motor, it too shall be equipped with an approved freewheeling clutch.	N/A	N/A	N/A	N/A	N/A
624	**Insturmentation and Control.**					
624a	**Governor.** An adjustable governor shall be provided for the engine to regulate the speed within a range of 10 percent between shutoff and maximum load conditions of the pump. It shall be set to maintain rated pump speed at maximum pump load.	N/A	✓	✓	N/A	N/A
624b	**Emergency Governor.** An emergency governor shall be provided for a diesel engine. It should be arranged to shut down the engine at a speed approximately 20 percent above rated engine speed. The emergency governor shall be arranged for manual reset.	N/A	✓	✓	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
624c	**Tachometer.** A tachometer shall be provided to indicate revolutions per minute of the engine. It shall be of the totalizing type or an hour meter shall be provided to record total time of engine operation.	N/A	✓	✓	N/A	N/A
624d	**Oil Pressure Gage.** An oil pressure gage shall be provided to indicate engine lubricating oil pressure.	N/A	✓	✓	N/A	N/A
624e	**Temperature Gage.** A temperature gage shall be provided to indicate engine cooling water temperature.	N/A	✓	✓	N/A	N/A
624f	**Control Panel.** All instruments of control such as gages, switches, indicators and coils should be placed on a suitable board secured to the unit at a suitable point.	N/A	✓	✓	N/A	N/A
624g	**Factory Wiring - Automatic Controller.** All connecting wires for the automatic controller shall be harnessed or flexibly enclosed, mounted on the engine and connected in an engine junction box to terminals numbered to correspond with numbered terminals in the automatic controller, for ready wiring in the field between the two sets of terminals.	N/A	✓	✓	N/A	N/A
624h	**Main Battery Contractors.** Main bettery contractors shall be manually operable in case of control circuit failure.	N/A	✓ [illegible]	✓ [illegible]	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
625	**Starting Methods.**					
625a	Compression ignition diesel engines should perferably be equipped with an electric starting device taking current from a storage battery, but may be started by other reliable means.	N/A	✓	✓	N/A	N/A
625b	If air starting of diesel engins is used with air pressure in excess of 100 pounds gage pressure, the air tanks shall be so located or guarded as not to be subject to mechanical injury. For air starting there shall be at least two containers each sufficient for six consecutive starts without recharging. There shall be a separate air compressor, suitably powered, or means of obtaining air from some other system shall be installed, independent of any compressor driven by the engine operating the fire pump. Automatic maintenance of air pressure is preferable, but in all cases suitable supervisory service shall be maintained to indicate high and low pressure conditions.	N/A	N/A no air starting	N/A	N/A	N/A
625c	If a gasoline starting engine is used to crank the diesel engine, or gasoline is used in connection with electric ignition, the handling and storage of gasoline shall be as required for gasoline engine driving of centrifugal fire pumps. NOTE: Electric current for ignition may be taken from the storage battery or from a high tension magneto	N/A	N/A No gasoline engines	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
625d	Gasoline engines shall be equipped with an electric starting device taking current from the storage battery.	N/A	N/A	N/A	N/A	N/A
626	Storage Battery.					
626a	**General.** The battery shall have sufficient capacity, at 40°F, to maintain the engine manufacturer's recommended cranking speed during the following 6 minute cycle (15 seconds crank and 15 seconds rest in 12 consecutive cycles). The fire pump manufacturer shall provide a certification that the battery which was furnished complies with this requirement.	N/A	CN	CN	N/A	N/A
626b	**Lead Acid.** Batteries shall be furnished in a dry charge condition with electrolyte liquid in separate container. Electrolyte should be added at the time the unit is put into service. The battery shall then be given a conditioning charge to bring the electrolyte up to its designated specific gravity.	N/A	✓	✓	N/A	N/A
626c	**Nickel Cadmium.** A nickel cadmium alkaline type battery may be used where desired in place of the lead acid battery described above.	N/A	N/A	N/A Does not apply	N/A	N/A
626d	**Recharging.** Two ways of recharging storage batteries shall be provided. One shall be the generator furnished with the engine. The other shall be an automatically controlled charger taking power from an alternating power source. (Other charging methods must be specified if a reliable alternating power source is not available.)	N/A	✓	✓	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
626e	Chargers.					
626e1	All chargers shall be specifically approved for fire pump service.	N/A	[illegible]		N/A	N/A
626e2	The rectifier shall be of the semiconductor type.	N/A	CN	CN	N/A	N/A
626e3	The charger for a lead acid battery shall be of a type which automatically reduces the charging rate to less than 500 milliamperes when the battery reaches a full charge condition.	N/A	CN	CN	N/A	N/A
626e4	The control equipment incorporated in an "off- ." type of charger for a lead acid battery shall start the rectifier hourly and automatically shut off when the battery has been fully charged.	N/A	CN	CN	N/A	N/A
626e5	The charger for a lead acid battery shall be capable of delivering a current within the range of 50 to 100 per cent of the 20-hour discharge rate of the battery.	N/A	[illegible] CN	CN	N/A	N/A
626e6	The above charging rates apply to lead acid batteries and should be modified in accordance with the battery manufacturer's recommendation when nickel-cadmium batteries are supplied.	N/A	N/A	N/A	N/A	N/A
626e7	An ammeter of an accuracy of 5 per cent of the normal charging rate shall be furnished to indicate the operation of the charger.	N/A	✓	✓	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
626e8	The charger shall be so designed that it will not be damaged or blow fuses during the cranking cycle of the engine when operated by an automatic or manual controller.	N/A	✓	✓	N/A	N/A
626e9	A single charger that automatically alternates from one battery to another on an hourly cycle may be used on two battery installations.	N/A	N/A 2 chargers	N/A 2 chargers	N/A	N/A
626e10	A manual charge switch with indicator light shall be provided or in lieu thereof, the charge shall automatically charge at the maximum rate when required by the state of charge of the battery.	N/A	✓	✓	N/A	N/A
626f	Location. Storage batteries shall be substantially supported, secured against displacement, and located where they will not be subject to excessive temperature, vibration, mechanical injury, or flooding with water, and are readily accessible for servicing. Location at the side of and level with the engine is recommended to minimize battery to starter lead length.	N/A	✓	✓	N/A	N/A
627	Cooling.					
627a	The engine cooling system shall be of the closed circuit type including a circulating pump driven by the engine, a heat exchanger and a reliable engine jacket temperature regulating device ("Fail-Safe" type of thermostat). An opening shall be provided in this circuit for filling the system, checking coolant level and adding make-up water when required.	N/A	✓	✓	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
627b	The cooling water supply for the heat exchanger shall be from the discharge of the fire pump taken off prior to the pump discharge valve. Threaded rigid piping shall be used. The pipe connection shall include a manual shut-off valve, a strainer, a pressure regulating valve, an automatic electric solenoid valve (when required) and a second manual shut-off valve. Provision should be made for a pressure gage to be installed in the cooling water supply system on the engine side of the last control valve.	N/A	✓ No pressure gauge pipe is welded w/ welded flanges	✓ No pressure gauge Pipe is welded w/ welded flange.	N/A	N/A
627c	A by-pass line with a manual valve shall be installed around the manual shut-off valve, strainer, pressure regulating valve, automatic solenoid valve (when required) and second manual shut-off valve (See Fig. 627.)	N/A	✓	✓	N/A	N/A
627d	An outlet shall be provided for the waste water line from the heat exchanger, and the line shall be at least one size larger than the inlet line. The outlet line shall be short, with the discharge into a visible open waste cone, and no valves shall be used in this line.	N/A	✓	✓	N/A	N/A
627e	A water jacketed (cooled) exhaust manifold shall be used since no fan is available to dissipate heat and to avoid hazard to operators or flammable material adjacent to the engine. This exhaust manifold should be cooled by raw water discharging from the heat exchanger.	N/A	CN	CN	N/A	N/A
628	Carburetion.					

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
628a	If a down-draft carburetor is used, suitable provision shall be made in addition to the carburetor float valve to prevent delivery of liquid gasoline to the engine cylinders. NOTE: This is usually accomplished by a drain from the intake manifold. This should be piped to a safe location.	N/A	N/A	N/A	N/A	N/A
628b	The carburetor drip cup drain should be piped at its lower end to a safe location.	N/A	N/A	N/A	N/A	N/A
629	**Anti-dieseling Devices.**					
629a	**Anti-dieseling devices.** A reliable and effective anti-dieseling device shall be provided on automatically controlled spark-ignited gasoline engines with a displacement of 350 cubic inches and larger to insure positive shut-diwb without dieseling. Control for the device shall be provided by the automatic engine controller or supplemental accessories to the controlled engines.	N/A	N/A	N/A	N/A	N/A
629b	Less than 350 cubic inch displacement engines shall also be equipped with this device unless approval tests shown that it is unnecessary.	N/A	N/A	N/A	N/A	N/A
630	Location.					
631	Construction.					

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
631a	While it may not always be possible to locate a fire pump driven by an internal combustion engine in a separate pump house it is in every case highly important that the pump room be wholly cut off by noncombustible construction of a heavy character.	N/A	✓	✓	N/A	N/A
631b	Floors should be pitched for adequate drainage of escaping water or fuel away from critical equipment such as pump, driver, controller, fuel tank, etc.	N/A	✓	✓	N/A	N/A
631c	Where fire pumps constitute the entire water supply or where they constitute the major water supply, gasoline engine driven fire pumps located in the same room with fire pumps driven by other methods should, because of their possible fire hazard, have a heat resistant barrier wall to isolate the gasoline engines from other pumping units.	N/A	N/A	N/A no gasoline engines	N/A	N/A
632	Ventilation.					
632a	Means for thorough ventilation shall be provided, adequate for engine air supply and for removal of hazardous vapors.	N/A	✓	✓	N/A	N/A
632b	Gasoline engine driven fire pump units should not be installed in depressed pump rooms. Installation shall be such that escaping gasoline vapors cannot accumulate in the pump room or vicinity.	N/A	N/A	N/A	N/A	N/A
640	Fuel Supply Arrangement.					

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
641	**Review of Plan.** Before any system is installed the authority having jurisdiction should be consulted as to the system proposed to the end that the suitability of the system for conditions be determined.	N/A	CN	CN	N/A	N/A
642	**Guards.** A guard or protecting pipe shall be provided for all exposed fuel lines.	N/A	✓ Equivalent [illegible] fuel lines [illegible] safe from damage	✓ Equivalent [illegible] fuel lines are safe from damage	N/A	N/A
643	**Diesel.**					
643a	**Capacity Diesel Fuel Supply.** The capacity of the main diesel fuel supply tank shall be determined by conditions and subject to special consideration in each case by the authority having jurisdiction; minimum storage capacity shall be sufficient to operate the engine for at least eight hours, and a greater capacity should be provided in places where prompt replenishment of supply is unlikely. There shall be a separate fuel line and fuel tank for each engine. Where multiple engine driven pumps are used, the fuel lines shall be interconnected and valved so that all engines may continue to operate even though one or more fuel tanks may be out of service. NOTE: Allow one pint of diesel fuel per horsepower per hour.	N/A	✓	✓	N/A	N/A
643b	**Location Diesel Fuel Supply.** The tank shall be located in accordance with municipal ordinances, and requirements of the authority having jurisdiction. Means shall be provided for determining the	N/A	CN	CN	N/A	N/A

Code Section No.	Code Section	LDF	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	amount of fuel in the storage tank. The tank should have suitable filling and vent connections.					
643c	**Diesel Fuel Piping.** NFPA Standard for the Installation of Oil Burning Equipment (No. 81) may be used as a guide. A suitable flexible connection of approved metallic type shall be provided in the fuel line where it connects to the engine fuel piping. No shutoff valve shall be installed in the fuel return line to the tank. (See Figs. 643a and 643b for suggested arrangements.)	N/A	✓	✓	N/A	N/A
644	**Natural Gas.**					
644a	**Reliability of Supply.** Reliability of the fuel supply is essential. Natural gas can be considered an acceptable fuel only where arrangements can be made for maintaining the fire pump gas supply at all times even when restrictions are applied by the supplier to other uses of the gas. Piping shall be adequate to maintain the required pressure at the fire pump under conditions of maximum demand for other uses. Provision must be made for automatic cut-off in case of a break in the plant service line to insure an uninterrupted supply to the fire pump. NOTE: Allow 12 cubic feet of 1000 BTU natural gas per horsepower per hour.	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
644b	**BTU Content.** The BUT value of the natural gas shall be equal to or greater than that specified by the engine manufacturer for the maximum rated load or allowance shall be made in the rated horsepower of the engine to adjust for the variation.	N/A	N/A	N/A	N/A	N/A
644c	**Pressure Regulator.** An approved regulator shall be provided to reduce available natural gas pressure to the low pressure for satisfactory operation of the engine carburetor.	N/A	N/A	N/A	N/A	N/A
644d	**Feed.** There shall be an electric opening, self-closing safety shutoff valve installed in the fuel line to the engine. This valve shall open when the engine ignition is turned on and close automatically when the ignition is turned off. There shall be a manual valved bypass around this valve in the event of malfunction of the safety shutoff valve and the bypass valve shall be provided with a visual or audible signal to show when it is open. All electric controls shall be powered by the engine pumping unit electrical system.	N/A	N/A	N/A	N/A	N/A
644e	**Piping.** All exterior and interior gas piping shall be in accordance with recommendations of Standard for the Installation of Gas Appliances and Gas Piping, NFPA No. 54. There shall be a manually operated outside shutoff valve in the gas supply line, locked open with a breakable lock. All piping outside the pump house shall be installed with pitch to drain so as to avoid	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	any possible water trap or pocket. There shall be a suitable flexible connection of approved metallic type in the fuel line where it connects to the engine fuel piping.					
645	Gasoline.					
645a	**Capacity Gasoline Supply.** The capacity of the main gasoline supply tank shall be determined by conditions and subject to special consideration in each case by the authority having jurisdiction; minimum storage capacity shall be sufficient to operate the engine for at least 8 hours and a greater capacity should be provided in places where prompt replenishment of supply is unlikely. NOTE: Allow one pint of gasoline per horsepower per hour.	N/A	N/A	N/A	N/A	N/A
645b	**Location Gasoline Supply.** The tank shall be located outside the pump room and in accordance with municipal ordinances, and requirements of the authority having jurisdiction. The tank should be so located with respect to pumps drawing gasoline therefrom that the maximum lift will not exceed 5 feet. The fuel tank for an automotive type engine should preferably be installed so that the top of the tank is about on a level with the carburetor. Means shall be provided for determining the amount of gasoline in the storage tank. The tank should have suitable filling and vent connections.	N/A	N/A	N/A	N/A	N/A
645c	Gasoline Feed.	N/A	N/A	N/A	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
645c1	The gasoline shall be fed to the carburetor by a method which will be dependable and safe. The following suggested arrangement may be modified to suit the conditions, subject to approval by the authority having jurisdiction.	N/A	N/A	N/A	N/A	N/A
645c2	A pumping system utilizing a gasoline pump, furnished as part of the engine, which draws gasoline from the storage tank and delivers it to the carburetor. The gasoline pump should be capable of pumping gasoline at a rate of at least 1 1/2 times the amount needed for the engine while running at rated speed and load. As a supplementary supply there shall also be provided a hand gasoline pump connected to draw gasoline from the storage tank and deliver it to a two-quart tank from which the carburetor may be supplied by gravity. (See Fig. 645.)	N/A	N/A	N/A	N/A	N/A
646	**Gasoline Piping.** All gasoline piping between tanks and between tanks and engines shall be approved seamless copper tubing with flared joints. Fuel pump suction lines shall be at least 3/8 inch in size. A suitable flexible connection of approved metallic type shall be provided in the fuel line where it connects to the engine fuel piping.	N/A	N/A	N/A	N/A	N/A
650	**Exhaust Piping**					

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
651	**Exhause Piping.** Exhaust from the engine shall be piped to a safe point outside the pump room and arranged to exclude water. A seamless or welded corrugated (not interlocked) flexible connection shall be made between the engine exhaust outlet and the exhaust pipe. The exhaust pipe shall be as short as possible and not over 15 feet unless the size of exhaust pipe is increased at least one pipe size, and shall be properly insulated from combustible material. Muffler, receiving vessel or other attachments which may accumulate unburned gases are not recommended, but if used shall not be located in the pump room. Exhaust gases should not be discharged where they will affect persons or endanger buildings, flues or stacks. A free and independent exhaust is essential to reliability of the equipment.	N/A	✓	✓	N/A	N/A
660	**Maintenance.**					
661	**General.** Internal combustion engines necessarily embody moving parts of such design and in such number that the engines cannot give reliable service unless given intelligent care. The manufacturer's instruction book covering care and operation should be preserved and pump operators should be familiar with its contents and should observe in detail all of its provisions.	N/A	I	I	N/A	N/A
662	**Weekly Run.** The engine shall be started at least once a week and run for at least thirty minutes to bring it up to normal running temperature and to make sure that it is running smoothly at rate speed.	N/A	ⓧ [illegible]	ⓧ [illegible]	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
663	**Fuel Tank**. The fuel storage tank shall be kept well supplied. This tank should always be filled through a strainer funnel designed to withold any water or other foreign matter that mey be present. Any service tank shall also be kept full. Note: Gasoline deteriorates with age. It is therefore desirable that gasoline storage tanks be drained and refilled with fresh supply at lease once each year. The occasional use of an upper lubricant is desirable for smooth operation of the engine and preventing sticking valves.	N/A	✓	✓	N/A	N/A
664	**Engine Upkeep**. The engine should be kept clean, dry and well lubricated, and the proper oil level should be maintained in the crtankcase. Oil should be changed in accordance with engine manufacturer's recommendations, but at least annually.	N/A	✓	✓	N/A	N/A
665	**Storage Batteries**.					
665a	Storage batteries should be kept charged at all times and tested frequently with a hydrometer to ascertain the condition of the cells and the amount of charge in the battery.	N/A	✓	✓	N/A	N/A
665b	Distilled water only should be used in storage battery cells and the plates should be kept submerged at all times.	N/A	CN Could not verify if dist. water [illegible]	CN Could not verify if dist. water [illegible]	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 FHDFP
665c	An automatic battery charger is not a substitute for proper maintenance for the battery and charger. Periodic inspection of the battery and the charger shall be made. This inspection should determine that the charger is operating correctly, the water level in the battery is correct, and the battery shall be checked by means of a hydrometer to show it is maintaining its proper charge.	N/A	✓ Sections 4.7.9.1.3 of Tech Spec	✓ Sections 4.7.9.1.3 of Tech Spec	N/A	N/A
666	**Temperature.**					
666a	Pump room temperatures must be maintained above 40^{0}F. (see 41e).	N/A	CN	CN	N/A	N/A
666b	Diesel engines, at temperatures below 70^{0}F, may require some form of starting aid as recommended by the engine manufacturer.	N/A	I	I	N/A	N/A
666c	Automatically started egines should be installed in enclosed pump rooms where a minimum temperature of 60^{0}F for gasoline engines and 70^{0}F for diesel engines is maintained.	N/A	CN	CN	N/A	N/A
666d	Since fire pump engines must carry full load as soon as started, automatic heaters should be employed to maintain jacket water temperatures of liquid cooled engines at (a minimum of 120^{0}F) or near operating temperatures. This may be accomplished through the circulation of hot water through heating of engine water by electric elements inserted into the block. The benefits to be gained are (1) quick starting, (2) reduction in engine wear, (3) reduced drain on batteries,	N/A	ⓧ no heating indicated [illegible] temperature	ⓧ no heating indicated [illegible] temperature	N/A	N/A

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	(4) reduced oil dilution, (5) reduction in carbon deposits, and (6) with gasoline fueled engines it becomes possible to adjust the automatic choke so that the engine is far more likely to start every time.					
667	Parts. Spare parts of such portions of the machine as may be expected to give trouble should be kept on hand.	N/A	✓	✓	N/A	N/A
	CHAPTER 700 - ENGINE DRIVE CONTROLLERS					
	The scope of Chapter 700 is not included in this report. Chapter 700 is being reviewed in its entirety by Electrical Engineering - Nuclear.	N/A	N/A	N/A	N/A	N/A
	CHAPTER 800 - STEAM TURBINE DRIVE					
	Chapter 800 is not applicable to Donald C. Cook Nuclear Plant and is omitted from this report in its entirety.	N/A	N/A	N/A	N/A	N/A
	PART III - ACCEPTANCE, OPERATION AND MAINTENANCE					
	900 CHAPTER 800 TESTS AND INSTRUCTIONS [illegible]					
910	Field Acceptance Tests.					
911	Those Present. The pump manufacturer shall have an engineer present at the field acceptance tests when requested by the installing contractor.	CN	CN	CN	CN	CN

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
912	The field acceptance test results shall be as good as the manufacturer's certified shop test characteristic curve for the pump being tested within the accuracy limits of the test equipment.	CN	CN	CN	CN	CN
913	If pump takes suction under a lift, the suction pipe should be drained if possible before tests are started so that the maximum time requried to start the pump with available priming facilities can be determined and conditions remedied if necessary.	N/A	CN	CN	N/A	N/A
914	Overheating. As installed, at operating speed, the pump shall be able to operate at peak load conditions without objectionable heating of the bearings or of the prime mover. The operating pump speed shall be the speed at which the pumping unit would be expected to operate during a fire, for example:	CN	C	CN	CN	CN
914a	A squirrel cage electric motor has no speed control and would normally drive the pump slightly in excess of rated pump speed at all loads.	I	I	I	I	I
914b	Combustion engines and steam turbines under manual control (and automatic control where speed adjustment is easily obtained) have their speed adjusted to rated pump speed at maximum (peak) pump load.	I	I	I	I	I
915	Operating Conditions.					

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
915a	By varying the number and/or size of the discharge outlets in connection with tests (Section 912) the operating conditions under minimum to peak loads shall be determined.	CN	CN	CN	CN	CN
915b	During such test:					
915b1	For electric motors at rated voltage (and on a.c. motors at rated frequency), the full load ampere rating should not be exceeded (except as allowed by the service factor stamped on the nameplate) under any conditions of pump load.	✓	N/A	N/A	✓	✓
915b2	For electric motors under conditions of acceptable high or low voltage, the product of the rated voltage (and on a.c. motors at rated frequency) and rated full load current will not be exceeded (except as allowed by the service factor stamped on the nameplate). The voltage at the motor should not vary more than 5 per cent below or 10 per cent above rated (nameplate) voltage during test (see Paragraph 432d).	✓	N/A	N/A	✓	✓
915b3	An internal combustion engine shall not show signs of overload or stress and its governor shall properly regulate the speed (see Paragraphs 624a and b).	N/A	✓ [illegible]	✓ [illegible]	N/A	N/A
915b4	A steam turbine shall maintain its speed within the limits specified in Paragraphs 822 a, b, and c.	N/A	N/A	N/A	N/A	N/A

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Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
915c	With discharge outlets open (corresponding to the outlets used in test at peak load) pump shall be started and brought up to rated speed without interruption due to opening of circuit breaker or other cause.	CN	CN	CN	CN	CN
916	**Controllers.**					
916a	Manual controllers for pumps shall be put through not less than ten complete operations.	CN	CN	CN	CN	CN
916b	Combined manual and automatic controllers shall be put through not less than ten automatic and ten manual operations.	CN	CN	CN	CN	CN
916c	A running interval of at least five minutes at full speed should be allowed before repeating the starting cycle.	CN	CN	CN	CN	CN
916d	Automatic operation of the controller shall start the pump from all the provided starting features, such as pressure switches, deluge valves, etc.	CN	CN	CN	CN	CN
916e	Electric motor shall attain rated speed within ten seconds.	CN	CN	CN	CN	CN
917	**Emergency Governor.** On turbines for pumps the emergency governor valve shall be tripped (Hand tripping will be accepted.)	CN	CN	CN	CN	CN
918	**Length of Test.** The pump shall be in operation not less than one hour (total time) during the foregoing tests.	CN	CN	CN	CN	CN

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 D[illegible]	U1 EHDFP	U2 EHDFP
921	**At the Alarm.**					
921a	When an alarm is given, do not wait to see how serious the fire may be, but get pump started as soon as possible and maintain its rated speed, pumping into sprinkler and hydrant systems.	I	I	I	I	I
921b	Do not be afraid to run a centrifugal fire pump at its full rated speed, even if the demand for water is small The characteristic curve or the relief valve will usually keep pressures within reasonable limits.	I	I	I	I	I
	NOTE: The best way to prevent a small fire from becoming a large one is to give the sprinklers a liberal high pressure water supply at the start. Fifty open sprinklers may take the full capacity of a 750-gpm pump. Even with a good public water supply the opening of a large number of sprinklers often materially reduces the pressure so that the pumps are needed to reinforce the public supply and insure ample water at good pressure.					
922	**To Start a Centrifugal Pump.**					
922a	Never start or run a centrifugal pump before priming or first filling case with water; otherwise the interior wearing rings that depend on water for lubrication may be damaged and the pump made inoperative.	I	I	I	I	I

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
922b	If pump is primed from a tank or other gravity supply, the pump may be started as soon as water shows at vent cocks. If primed by an exhauster, action of the device will indicate when casing is filled with water.	I	I	I	I	I
922c	Close attention should be given to the bearings and stuffing boxes during the first few minutes of running to see that there is no heating up or need of adjustment. With water seal supplied with water, a small leak at stuffing box glands is necessary to seal, lubricate and cook the packing. The suction inlet gage as well as the discharge pressure gage should be read occasionally to see that inlet is not obstructed by a choked screen or foot valve.	I	I	I	I	I
923	**Motor-driven Pump.** To start a motor driven pump the following steps should be taken in the order given below:	I	I	I	I	I
923.1	See that pump is competely primed.	I	I	I	I	I
923.2	Note that normal voltage is indicated at voltmeter.	I	I	I	I	I
923.3	Close isolating switch and then close circuit breaker.	I	I	I	I	I
923.4	Operate starter without undue haste, observing ammeter at each step to avoid excessively large starting currents which may cause circuit breaker to open.	I	I	I	I	I

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
	NOTE: Circuit breaker tripping mechanism should be so set that it will not operate except when current in circuit is excessively large.					
924	**Turbine Driven Pump.** To start a steam turbine driven pump, steam should be admitted slowly at first to permit warming up of turbine casing before allowing full head of steam upon the turbine. If the pop safety valve on the casing blows, steam should be shut off and the exhaust piping examined for a possible closed valve or an obstructed portion of piping. Steam turbines are provided with governors to maintain speed at a predetemined point, with some small adjustment for higher or lower speeds. Desired speeds below this range may be had by throttling main throttle valve.	N/A	N/A	N/A	N/A	N/A
925	**Internal Combustion Engine Driven Pump.**					
925a	To start an internal combustion engine driven pump one should familiarize himself beforehand with the operation of this type of engine. The Instruction Book issued by the engine manufacturer should be studied to this end.	I	I	I	I	I
925b	The storage batteries should always be maintained in good order to insure prompt satisfactory operation of these equipments.	I	I	I	I	I
925c	Replacement storage batteries shall comply with the performance requirements of Section 626.	I	I	I	I	I

Code Section No.	Code Section	LDFP	U1 DHDFP	U2 DHDFP	U1 EHDFP	U2 EHDFP
930	Care of Pump.					
931	**Weekly Tests.** A centrifugal pump should be operated every week at rated speed with water discharging through some convenient opening. This is desirable to make sure of the condition of the pump, bearings, stuffing boxes, suction pipe and strainers, and the various other details pertaining to the driver and control equipment (see Paragraphs 515d1, 662, 715d1 and 715d5). When automatically controlled pumping units are to be tested weekly by manual means at least one start shall be accomplished by reducing the water pressure either with the test drain on the pressure sensing line or with a larger flow from the entire system.	CN	CN	CN	CN	CN
932	**Yearly Test.** A yearly test at full capacity and over is necessary, to make sure that neither pump nor suction pipe is obstructed.	CN	CN	CN	CN	CN
933	**Keeping of Pump Room.** Pump rooms should be kept clean, orderly, free from miscellaneous storage, well lighted and heated.	✓	✓	✓	✓	✓
934	**Readiness.** Always keep the pump ready to start at a moment's notice.	✓	✓	✓	✓	✓

Attachment 6.4

NFPA 20 Compliance Evaluation

NFPA 20 Code Compliance Evaluation

For

Donald C. Cook Nuclear Plant

Units 1 and 2

Indiana Michigan Power Company

NFPA 20

"STANDARD FOR THE INSTALLATION OF CENTRIFUGAL FIRE PUMPS"

SCOPE:

This analysis evaluates the centrifugal fire pumps installed at the Donald C. Cook Nuclear Plant to the requirements of NFPA 20. The 1969 edition of NFPA 20 was the edition under which the pumps were installed and evaluated.

PURPOSE:

The purpose of NFPA 20 is "to provide a reasonable degree of protection for life and property from fire through installation requirements for centrifugal fire pumps based upon sound engineering principles, test data and field experience. Guidelines are established for the design, installation and maintenance of these pumps, pump drivers and associated equipment. The standard endeavors to continue the excellent record that has been established by centrifugal pump installations and to meet the needs of changing technology. Nothing in this standard is intended to restrict new technologies or alternate arrangements providing the level of safety prescribed by the standard is not lowered."

With this statement in mind, it should be understood that it is recognized that the fire pumps installed at Donald C. Cook Nuclear Plant do not meet this standard verbatim. It is also recognized that the fire pump system is not below the level of safety prescribed per NFPA 20. The plant's fire pump system reliability is derived through redundancy and independency. The following system description should help the reader understand the level of protection at the Donald C. Cook Nuclear Plant.

Two 2,000 gpm at 152 psi horizontal centrifugal electric motor driven fire pumps, two 2,000 gpm at 152 psi diesel driven, vertical turbine fire pumps and a 500 gpm at 152 psi horizontal centrifugal electric motor driven fire pump are provided for the fire water system. These fire pumps discharge into underground ring headers around the outside of the plant and into the interior ring header in the Turbine Building. This arrangement forms a series of smaller interior-exterior loops connected through isolating valves to assure flow from multiple directions.

The fire pumps are started automatically and sequentially so that the system can be supplied immediately with adequate quantities of water at the required pressure. The fire protection water flow may vary from as low as 30 gpm for a single sprinkler in operation to as much as 4,700 gpm for the combined flow, including hose streams, for the Unit 1 main transformer and Turbine Building wall exposure systems. One can see that more than enough pumps exist to supply even the largest water demand system. In fact, it can be argued that two of the 2,000 gpm fire pumps can marginally supply enough water for a fire on the largest demand system. Hence, it is evident that a great deal of redundancy was installed within the plant's fire pump arrangement.

The high demand electric fire pump motors are controlled from 600 V, electrically operated, draw out circuit breakers which are installed in metal clad switchgear enclosures qualified for Class I nuclear service. Each of the electric fire pump circuit breakers is powered from independent busses, and each bus can be energized from separate emergency diesel generators. The pumps and controllers are completely isolated from each other, the pump being located in a separate pump room and the controller (circuit breaker) located in a separate switchgear room. This is consistent with the control of nuclear safety related pumps installed at Donald C. Cook Nuclear Plant. Operation of the pumps is monitored and can be manually controlled from a centralized, continually manned control room. This is consistent with the basic philosophy of operating a nuclear generating unit. Control power for the breakers is supplied from a nuclear Class IE battery system. It is felt that the high demand electric fire pump controllers, being of the same type and quality as those for safety related equipment, are adequate to meet fire protection requirements. They have proven to be reliable.

The redundancy of fire pumps and the complete independence of operation of one fire pump to another (including power sources) provides overall system reliability far greater than can be achieved by a single pump installation meeting the specific requirements of NFPA 20.

Attachment 6.4

NFPA 20 Compliance Evaluation

Mechanical Evaluation Section

REFERENCES

(Technical Data)

1. PSAR	Section 9.8.1 Fire Protection	1968
2. Specification DCC-HP-122QCS	Fire Pumps	07-14-69
3. Specification DCC-HP-121QCS	Diesel Engine	07-07-69
4. 10221-831-0	Diesel Engine Purchase Order	11-14-69
5. 09563-821-9	Fire Pump Purchase Order	10-30-69
6. PO-050-508	Pre-operational Test Fire Protection Water	07-03-74
7. Pump Curve 2896693	Peerless Pump Electric Driven Low Demand Fire Pump Curve	06-03-70
8. Pump Curve 2896692	Peerless Pump Electric Driven High Demand Fire Pump Curve	06-03-70
9. Pump Curve 2897027	Peerless Pump Engine Driven High Demand Fire Pump Curve	08-20-70
10. SD-DCC-HV-105	Turbine Building Ventilation; System Description	02-03-88
11. SD-DCC-FP-101	Fire Protection System - Water; System Description	01-17-75
12. DCC-PM-104QCS	Piping Specification	11-09-72
13. DCC-PM-102QCS	Shop and Field Fabrication and Erection	05-24-73
14. Drawing #12-5152A	Flow Diagram Fire Protection - Water	03-23-88
15. Drawing #1-FP-14	Piping Isometric	12-XX-70
16. Drawing #1-FP-4	Piping Isometric	12-XX-70
17. Drawing #2-FP-X-2	Piping Isometric	12-XX-70

18. Drawing #1-FP-X-1	Piping Isometric	12-XX-70
19.	NAVCO Piping Data Log	1984
20. Drawing #2-5114	Flow Diagram Non-essential Service Water	11-13-87
21. Drawing #1-5114	Flow Diagram Non-essential Service Water	04-27-88
22.	Cameron Hydraulic Data	1977
23. Drawing #12-5152A	Flow Diagram Fire Protection Water Piping at Pump	01-XX-87
24. FSAR (10.6)	Circulating Water System	07-XX-82
25. Drawing #2-FP-27	Piping Isometric	05-XX-71
26. Drawing #2-NSW-30	Piping Isometric	08-26-86
27.	Letter from J.D. Grier to J.G. Feinstein, "Diesel Engine Fire Pumps"	08-26-86
28. SD-DCC-HP-119	Circulating Water; System Description	04-23-87
29. SD-DCC-HP-105	Non-essential Service Water; System Description	
30.	Underwriters Laboratories Fire Protection Equipment Directory	01-XX-87
31. Drawing #12-5152	Flow Diagram Fire Protection - Water Yard Piping	02-XX-87
32. Drawing #MS-1	Fire Pump Arrangement	12-05-69
33. FSAR (2.6)	Limnology and Ecology	07-XX-86
34. Peerless Pump Installation Manual	Installation Instructions Water Lubricated Vertical Turbine Pumps	N/A
35.	Letter from Peerless Pump to AEPSC "Quotation Duplicate Pump S/N 364877-78"	01-31-78

36. Peerless Pump Form #2881604	Replacement Parts Specifications Pump S/N 364877-78	N/A
37.	Letter from J.D. Grier to J.A. Kobyra, "Fire Pump Impellers"	09-12-86
38. TM-5029	Allis Chalmers; Operating and Maintenance Manual 25000 Mark II Engines and Power Units	N/A
39.	Letter from Peerless Pump to AEPSC, "Fire Protection Pumps - U.L. Listing"	03-03-84
40.	Fire Hazards Analysis, Rev. 2	01-29-88
41.	Factory Mutual System Approval Guide	1984
42. 12.THP.6040.PER.001	Performance Test Procedure NOTE: This includes all tests results that have been performed in accordance with this procedure.	07-30-87
43. SD-DCC-HP-113	Vacuum Priming; System Description	04-19-84
44.	Letter from Peerless Pump to AEPSC, "Pearless Job No. 83575-V"	03-24-70
45.	Letter from Peerless Pump to AEPSC, "Two Vertical 2000 GPM Pumps"	03-20-70
46.	Letter from AEPSC to Rudox Engine and Equipment Company, "AEP Order #10221-821-9"	04-20-70
47.	Memo from G. Hines to P.J. Russell, "Re: Diesel Fire Pumps"	07-21-88
48. Drawing #OA-4585-26	Heat Exchanger	04-30-68
49. DELETED		

50. PO-06492-821-1	Purchase Order; Diesel Fire Water Pump Fuel Oil Storage Tank	1971
51. Drawing #TK-46	Niles Steel Tank Company	11-04-71
52.	Letter from Perless Pump to AEPSC, "Engine Driven Fire Pump"	07-23-71
53. Donald C. Cook Technical Specifications	Section 3/4.7.9 Fire Suppression Systems	07-16-86
54.	Donald C. Cook Plant File: ME-PP-PT-011; Entire File	Chrono
55. Product Catalog	LaMarche "Capabilities in Electric Power"	N/A
56. 12.MHP.5021.001.034	Maintenance Procedure For Testing Relief Valves	08-14-87
57.	Letter from Peerless Pump to AEPSC "Donald C. Cook Nuclear Plant"	10-06-69
58.	Letter from Peerless Pump to AEPSC "Donald C. Cook Plant Fire Protection Pumps U.L. Listing"	02-03-84
59.	Letter from M.W. Cherry to Kadlec/Jensen/Williams/Jensen "Diesel Engine Driven for Fire Pumps	10-03-69
60. 12-5152-P	Flow Diagram-Fire Protection-Diesel Fuel to Engine Driven Fire Pumps	10-30-87

CODE COMPLIANCE VERIFICATION CHECKLIST
NFPA 20 - 1969
CENTRIFUGAL FIRE PUMPS

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
	General		Title
1	Purpose. This standard contains, in general, the minimum requirements for centrifugal fire pumps, including horizontal, single and multi-stage pumps and vertical design, installation and maintenance of such pumps together with their drivers, and for the guidance of the authority having jurisdiction and others concerned in judging the acceptability of such equipment.		Information Only
2	Approval Prior to Purchase Recommended.		Title
2a	Centrifugal fire pumps should not be purchased until conditions under which they are to be installed and used have been examined by the authority having jurisdiction, and each pump, driver, controlling equipment, the power supply and arrangement, and water supply have been approved by that organization.	D	Comply: The entire fire protection system was reviewed and approved prior to purchasing equipment. Technical Data #1
2b	The pump manufacturer must be given complete information concerning the suction water supply as accepted by the authority having jurisdiction.	D	Comply: The water supply information was supplied to the pump manufacturer. Technical Data #2
3	Unit Assembly Required.		Title

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
3a	The pump, driver and all necessary attachments shall be purchased under unit contracts stipulating compliance with this standard and satisfactory performance of the entire unit when installed.	D	Comply With Exception: The pumps, drivers and necessary attachments were not purchased under unit contract. This report will show that the equipment purchased to make up the fire pump system does not lower the level of safety as prescribed per NFPA 20. Satisfactory performance of the entire unit has been proven by testing requirements and over fifteen years of successful operation.
3b	The pump manufacturer shall be responsible for the proper operation of the complete unit assembly as indicated by field acceptance tests. (See Article 910 for field acceptance test procedure.)	D	No documentation could be found to verify that pump manufacturer performed a field acceptance test. Justification: See Article 910 for specific compliance statements.
4	**Complete Plans and Data Required.** A complete plan and detailed data describing pump, driver, controller, power supply, fittings, suction and discharge connections, and suction conditions shall be submitted by the engineer or contractor to the authority having jurisdiction for approval before installation. Certified shop test characteristic curves showing head-delivery, efficiency and brake horsepower shall be furnished by the manufacturer.	D	Comply: Plans were submitted to purchaser for review and approval prior to installation. Technical Data #2, 3, 4, 5
	PART 1 - PUMP ARRANGEMENT, TEST AND INSTALLATION.		Title
	Chapter 1 - Basic Information.		Title
10	General.		Title

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
11	**Approved Pumps Required.** Centrifugal fire pumps shall be specifically approved for fire pump service.	D	Comply: All fire pumps purchased for the Donald C. Cook Plant were bought with a U.L. listing for fire pump service. These labels are not located on the pumps. Technical Data #2, 5, 58
20	**Water Supplies.**		Title
21	**Requirements.** Fire pumps should be provided with as large and reliable a supply of water as possible. The adequacy and the dependability of the source of water are of primary importance and must be fully determined at the time of installation, also the prospects for its reliability in the future. The minimum water level with maximum discharge from the pump must be determined. Where a stored supply is the only one available, a reliable method of replenishing the supply should be provided. Representatives of the pump manufacturer shall assist in establishing these facts to the satisfaction of the authority having jurisdiction. Water supplies containing salt or other materials deleterious to the fire protection systems should be avoided whereever possible.	W,D	Comply: Fire pumps take suction from Lake Michigan. The adequacy and dependability of the water supply was evaluated and approved. Minimum and maximum water levels were determined. Technical Data #1, 11, 33
30	**Pump.**		Title
31	**Rated Capacities of Pumps.**		Title
31a	**Standard Pumps.** Standard fire pumps are those having rated capacities of 500, 750, 1,000, 1,500, 2,000 and 2,500 gpm. Larger pumps may be used in specially engineered applications.		Information Only

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
31b	**Special Pumps.** Special fire service pumps are those having rated capacities of 200, 300 and 450 gpm.		Information Only
32	**Types of Pumps.**		Information Only
32a	**Standard Fire Pumps.** Pumps rated at capacities within the standard capacity range and pressures of 100 psi or more.		Information Only
32b	**Low-Pressure Fire Pumps (Booster Pumps).** Pumps rated at capacities within the standard capacity range and pressures between 40 and 100 psi.		Information Only
32c	**Special Fire Service Pumps.** Pumps rated at 200, 300 or 450 gpm limited to 130 per cent capacity maximum, and for various pressures. The maximum power required shall not exceed the limitations of a 30-horsepower electric motor.		Information Only
32d	**Pressure Maintenance Pumps (Jockey or Make-Up Pump).** The use of an automatic pressure maintenance pump is desirable under some circumstances to maintain a uniform or a relatively high pressure on the fire protection system. The capacity and pressure rating of the pump shall be sufficient to maintain the desired pressure against the leakage in the system as approved by the authority having jurisdiction. A centrifugal type pump is preferable. Where the discharge pressure at pump shutoff of a centrifugal type pump exceeds the working pressure rating of the fire protection equipment, or a turbine vane (peripheral) or a positive displacement type of pump is used, a suitable relief valve shall		Information Only

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
	be installed on the pump discharge to prevent damage to the fire system. (See Figures 100a-1 and 143e).		
33	**Standards on Capacity and Pressure**. For requirements on capacity and pressure relief to Standard for the Installation of Sprinkler Systems (NFPA No. 13) and Standard for the Installation of Standpipe and Hose Systems (NFPA No. 14) and for hydrants, Standard for Outside Protection (NFPA No. 24).		Information Only
34	**Name and Capacity Plate**. Pumps shall be provided with a Name and Capacity Plate.	W,D	Comply: Name and capacity plates exist for all fire protection pumps. Technical Data #39
40	**Installation**		Title
41	**The Pump Room.**		Title
41a	The fire pump shall be protected against possible interruption of service through damage caused by fire or water, in a manner satisfactory to the authority having jurisdiction.	W,D	Comply: Pumps have been installed in an enclosed, heated building within a secured area. Sprinklers are located above the engine driven pumps. Insufficient combustibles exist near the motor driven pumps to support a fire. The diesel fire pumps and electric fire pumps are protected through redundancy (located in different fire zones) from water. Therefore, water will not effect more than two pumps at any one time. Technical Data #40

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
41b	Except where there are several pumps on the same system, located in buildings which are not all subject to one fire, or where the pump is automatically controlled and supplies automatic sprinklers only, the pump should be in a room so located and constructed as to protect it from falling floors or machinery and from fire which might drive away the operator or damage the pump or driving equipment. Note: Where the use of brick or reinforced concrete is not feasible, metal lath and cement plaster is recommended for the construction of the pump room.	W,D	Comply: Pumps are installed in separate fire zones. Technical Data #2, 28, 30, 40
41c	The pump room should be of ample size, and the piping and equipment should be so arranged as to make them readily accessible for operation or repair. The pumproom should not be used for storage purposes. Note: With vertical type pumps it may be necessary to provide a removable panel in the pump house roof to permit the pump to be lifted out for repairs.	W	Comply: Pump rooms are of sufficient size and equipment is located so that it can be readily repaired. No storage exists near the fire pumps.
41d	The location of the pump room should be such as to permit installation of short and direct pipe connections, the suction pipe receiving first consideration.	W	Comply: The pumps have been installed in such a manner as to permit installation of short and direct pipe connections.
41e	Suitable means shall be provided for maintaining the temperature of the pump room above 40°F.	W,D	Comply: Pump areas are sufficiently heated and temperatures are maintained above 40°F. Technical Data #10

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
41f	Artificial light shall be provided, and provision made for drainage and ventilation of the pump room. A suitable lamp or lantern should be provided for emergency use. Emergency lighting may be provided from the battery circuit of an internal combustion engine.	W,D	Comply: Pump areas are artificially lit and suitable drainage exists. Ventilation of the areas is adequate. Emergency lighting is available. Technical Data #10, 40
41g	Pump rooms housing electric or engine driven pumps should be dry and free from condensate. Some heat may be required to accomplish this.	W,D	Comply: All pump areas are free of condensate. The areas are heated. Technical Data #10
42	**Discharge Pipe.**		Title
42a	The size of discharge pipe shall be as given in the following table unless otherwise specified by the authority having jurisdiction. Capicity of Pump, gpm 500 750-1000 1500-2000 2500 Sixe of Discharge Pipe, inches 6 8 10 12	W,D	Comply: The discharge piping of the centrifugal fire pumps meet the size requirements stipulated in NFPA 20. Technical Data #23
42b	An approved check valve shall be installed in the discharge pipe.	W,D	Comply With Exception: Although the valve is not listed for fire protection service, experience has shown that the installed valve (Centerline Check) performs its designed function without detrimental affects on the system. System pressure is maintained upstream of these check valves, and performance testing has proven the fire pumps perform in accordance with the manufacturer's curves even with these nonlisted valves installed in the system. Technical Data #30, 41, 6, 42

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
42c	Approved indicating gate valves shall be installed in such places as needed to make the pump and check valve accessible for repair. Note: This requires a valve on the system side of the check valve and on the supply side of the pump if the supply mat at any time be under a head.	W,D	Comply With Exception: Although the Jamesbury Wafer Sphere Butterfly valves are not listed for fire protection service, experience has shown that these valves have performed their designed purpose. The pumps can be easily isolated to allow maintenance work. Also, past performance testing has proven that no detrimental friction loss is lost through these valves. In addition, these valves have shown to need only required maintenance and have proven to be reliable. Technical Data #30, 41, 42
43	**Relief Valve.**		Title
43a	Pumps connected to adjustable-speed drivers shall be equipped with an approved relief valve. Where pumps are driven by constant-speed motors and the shut-off pressure plus the static suction pressure exceeds the pressure for which the system is designed to operate, relief valves are required.	W,D	Comply With Exception: A relief valve set at 165 psi is available for the diesel fire pump systems. This valve is not listed for fire protection service, but it has proven to be reliable and safe. The valve is currently being bench tested yearly to verify proper performance. The constant speed motor pumps are not equipped with relief valves even though their shutoff pressure plus static suction pressure will produce a total system pressure slightly

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
			above the acceptable rated pressure of the yard hydrants (150 psi). Past performance of these pumps has shown no detrimental effects to the yard hydrants as a result of overpressurization. Technical Data #14, 20, 56
43b	The relief valve should ordinarily be set to prevent pressure on the fire protection system in excess of that pressure at which the system was designed to operate.	D	Comply: This section of the code is only a recommendation. Relief valves for the diesel fire pumps are set at 165 psi. The constant speed motor pumps are not equipped with relief valves even though their shutoff pressure will produce a total system pressure slightly above the acceptable rated pressure of the yard hydrants (150 psi). Past performance of these pumps has shown no detrimental effects to the yard hydrants as a result of overpressurization. Technical Data #14, 20

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
43c	Where provided, relief valves shall be of the size given in the following table: Capacity of Pump, gmp 500 750 1000 1500 2000-2500 Size of Relief Valve, Inches 3 4 4 6 6	W,D	Comply: Relief valves are six inches in size. Technical Data #14, 20
43d	The relief valves should be located between the pump and the pump discharge check valve.	W,D	Comply: Relief valves are located between the pump and the pump discharge check valve. Technical Data #14, 20
43e	The relief valve should discharge into an open pipe in plain sight near the pump or into a cone or funnel secured to the outlet of the valve. This cone should be so constructed that the pump operator can easily see any water wasting through the relief valve, and it should be so made as to avoid splashing water into the pump room. If a closed type cone is used, it should be provided with means for detecting motion of water through the cone. The cone should be piped to a point where water can be freely wasted, preferably outside the building.	W,D	Comply With Exception: Since the fire pumps and fire water system is monitored from a central, continually manned control room, an operator would be able to check system pressure on the appropriate "EF" panel. It is not believed that seeing water discharge through the relief valve back into the suction reservoir makes the fire water system any more reliable. This particular section of NFPA 20 is only a recommendation and, therefore, not a requirement.
43f	If the relief valve waste pipe is connected to an underground drain, care should be taken that no steam drains enter near enough to work back through the cone and into the pump room. Discharge from the relief valves should not be piped into the suction connection, except with the permission of the authority having jurisdiction.	D	Does Not Apply: The waste pipes are not connected to underground drains. Technical Data #14, 20

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
43g	When the supply of water is taken from a suction reservoir of limited capacity, the waste pipe shall drain into such reservoir, entering as far from the pump suction as is necessary to prevent the pump from drafting air which may be carried down by the discharge from waste pipe.	D	Does Not Apply: The suction supply has an unlimited capacity. Technical Data #11
43h	The relief valve waste pipe from an open cone should not be smaller than specified below; if more than one elbow is employed the next size larger pipe should be used to complete the connection. Capacity of Pump, gpm 500 750 1000-1500 2000-2500 Size of Waste Pipe, Inches 5 6 8 10	W,D	Comply: The relief valve discharge pipe is ten inches in diameter. Technical Data #14, 20
43i	The relief valve waste pipe from a closed cone shall be sized to prevent back pressure in excess of 8 psi.	D	Does Not Apply: The relief valve waste pipe is open. Technical Data #14, 20
43j	The relief valve shall be so attached as to permit of its ready removal for repairs without disturbing the waste piping.	W,D	Comply: The relief valve can be repaired without disturbing the waste piping. Technical Data #14, 20
44	**Hose Valves.**		Title
44a	Approved 2 1/2 inch hose valves of the number specified in Paragraph 44b shall be provided for use in testing the pumps. The hose valves should ordinarily be attached to a header or manifold; they shall be connected by suitable piping to the pump discharge piping, preferably at a point between the discharge check valve and the dis-	W,D	Does Not Apply: A hose valve test header is not installed at Donald C. Cook Plant. See Code Section 44c. Technical Data #14, 20, 31

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
	charge gate valve. The hose valves should be so located as to avoid any possible water damage to the driving motor or engine or their controllers, and should preferably be outside the pump room. Where located outside, or at a distance from the pump, and there is any danger of freezing, an approved indicating gate valve and drain valve shall be located in the line to the hose valves at a point close to the pump.		
44b	Unless otherwise specified by the authority having jurisdiction, the number of hose valves shall be as given in the following table, except that for special service fire pumps and for booster pumps, only one hose valve is required for five hundred gallon or smaller pumps. Capacity of Pump, gpm 500 750 1000 1500-2000 2500 Number of Hose Valves 2 3 4 6 8	D	Does Not Apply: See comment from Code Section 44a.
44c	On the larger capacity fire pump installations, there should be installed a fixed nozzle or pipe outlet arranged to discharge at an appropriate place, or a metering device in a pipe line discharging back into the suction supply, for use in making a flow test to the full capacity of the pump or pumps. With such test arrangements the authority having jurisdiction may permit a reduction in the number of hose valves to the number needed for hose stream use.	W,D	Comply: A metering device is installed in a test line that discharges back into Lake Michigan. Technical Data #14, 20.

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
44d	Hose valves shall be threaded to conform to the American (National) Standard B26-1925 for Fire Hose Coupling Screw Threads. Adapter couplings securely attached to each outlet shall be provided if local couplings are not American Standard.	D	Does Not Apply: See comment from Code Section 44a.
44e	When 2 hose valves are required, use 4-inch pipe between the detachable hose header and the connection to the discharge pipe; when 3 or 4 are required use 6-inch pipe; when 6 or 8 are required use 8-inch pipe. When this pipe is over 15 feet long increase one pipe size.	D	Does Not Apply: See comment from Code Section 44a.
45	**Pressure Gages.**		Title
45a	A pressure gage having a dial not less than 3 1/2 in. in diameter shall be connected near the discharge casting by a 1/2 in. cock with lever handle. The dial shall indicate pressure to at least twice the rated working pressure of the pump but not less than 200 psi. The face of the dial shall read in pounds per square inch with the manufacturer's standard graduations.	W	Comply With Intent: Pressure gages are installed on the discharge side of the pump, and although they are not rated for twice the rated working pressure, they are rated for 1.97 times the rated working pressure. A gate valve is installed in the pressure gage line. (NOTE: Newer versions of NFPA 20 no longer require cock valves with lever handles.)
45b	A compound pressure and vacuum gage having a dial not less than 3 1/2 in. in diameter shall be connected to the suction pipe near the pump (except in the case of vertical shaft turbine type pumps). The face of the dial shall read in pounds per square inch for the suction range and have a maximum pressure range not less than twice the rated working pressure of the pump, or a lower pressure range may be furnished if the gage is protected from damage by a gage protector.	W	Does Not Comply: No pressure gage is installed in the suction pipe. Justification: Due to the size of Lake Michigan, water levels tend to vary very little. Therefore, the suction head tends to remain constant. Suction pressures are recorded from calibrated test gages during full flow pump tests.

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
			It is felt that very little benefit would be gained from installing a permanent pressure gage in the suction pipe of the horizontal fire pumps. Technical Data #14, 42
46	**Circulation Relief Valve to Prevent Overheating.** Pumps which are automatically controlled shall be provided with a 3/4 inch relief valve set slightly below the shut-off pressure and arranged to permit circulation of sufficient water to prevent the pump from overheating when operating with no discharge. This is not needed for submerged type pumps nor for engine driven pumps for which engine cooling water is taken from the pump discharge. Pumps which are manually controlled shall be equipped with either such a relief valve or with a test valve as specified in Section 133. Provision should be made for discharge to a drain.	W,D	Comply: Sufficient circulation relief is provided for the electric driven fire pumps. Although no relief valves are installed in the circulation relief line, past performance has proven that the pumps will not overheat. Technical Data #23
47	**Summary of Pump Data.**		Information Only

Capacity of Pump gpm	Size of Discharge Pipe Sec. 42(a)	Size of Relief Valve Sec 43(c)	Size of Relief Waste Sec 43(h)	Number Hose Valves Sec 44(b)
500	6 in.	3 in.	5 in.	2
750	8 in.	4 in.	6 in.	3
1,000	8 in.	4 in.	8 in.	4
1,500	10 in.	6 in.	8 in.	6
2,000	10 in.	6 in.	10 in.	6
2,500	12 in.	6 in.	10 in.	8

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
50	**Power Supply.**		Title

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
51	**Dependability of Power Supply.** Careful consideration must be given in each case to the dependability of the power supply not overlooking the possible effect of transmission lines of fire in adjoining buildings which might threaten the property.		Information Only
60	**Tests.**		Title
61	**Shop Tests.**		Title
61a	Each individual pump shall be tested with a dynamometer or calibrated motor at the factory to provide detailed performance data and to demonstrate its compliance with specifications.	D	Comply: Shop tests have been provided by the manufacturer. Technical Data #2, 7. 8, 9
61b	The maker shall test each pump hydrostatically before shipment from the factory, to twice the maximum pressure developed at shutoff, but in no case less than 250 pounds per square inch. Pump casings shall be substantially tight at the test pressure. In the case of vertical shaft turbine type pumps both the discharge castings and pump bowl assembly shall be tested.	 D	Open Item: No documentation could be found to verify that this section of NFPA 20 was complied with. Justification: Experience has proven that the pumps were built of sound construction. The maintenance and testing procedures assure that the pumps will not fail as a result of increased working pressures. In addition, although no records could be found, it is recognized that the purchase order and the fire pump specification included a clause that the pumps meet the requirements of NFPA 20. Peerless, in turn, wrote a letter (dated 10-6-69) to AEPSC guaranteeing that the pumps will conform to NFPA 20. The hydrostatic

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
			test would have to be performed in order for Peerless to make this statement. Technical Data #4, 5, 57
61c	All gear drives shall be operated at the factory under full load before shipment and operate without excessive noise or heating during the test.	D	Open Item: No documentation could be found to verify that this section of NFPA 20 was complied with. See Code Section 61b. Justification: Performance of the gear drives has been proven many times by plant testing procedures. Technical Data #4, 5, 57
	CHAPTER 100 - HORIZONTAL SHAFT PUMPS.		Title
110	**General.**		Title
111	**Application.** The horizontal shaft centrifugal pump with its split casings lends itself to simple operation and repair, and, where a water supply is obtainable under a head, it is especially adaptable to fire service. Because the horizontal shaft centrifugal pump requires priming when installed to operate under lift, a vertical shaft turbine type pump should be used where suction lift is necessary.		Information Only
112	**Performance.**		Title
112a	Pumps shall furnish not less than 150 per cent of rated capacity at a total head not less than 65 per cent of total rated head. The shut-off total head for horizontal shaft pumps should not exceed 120 per cent of total rated head (Fig. 1, Appendix C).	D	Comply: The fire pumps were designed to meet this criteria. Technical Data #2, 7, 8, 9

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
112b	The inlet pressure available from a suction water supply shall be figured on a basis of a flow of 150 per cent of the rated capacity of the pump, as indicated by a flow test.	D	Comply: Suction pressure is tested and recorded at full flow (150%) of the pump. Technical Data #42
120	**Water Supplies.**		Title
121	**Operate Under Head.** Fire pumps, especially those automatically controlled, should be provided with water under head, avoiding suction lifts whenever possible. Operating suction lift including allowance for velocity and friction loss through all suction fittings, shall not exceed 15 feet at sea level and the allowable lift must be reduced by 1 foot for each 1,000 feet of altitude at the pump installation. Where a suction lift is necessary, a vertical shaft turbine type pump should be used. (See Paragraph 111.)	D	Comply: The horizontal fire pumps take suction under a positive pressure. Technical Data #2, 42
122	**Priming Supplies.**		Title
122a	Provide adequate priming supplies for pumps which may at any time take suction under a lift. Priming equipment should have sufficient capacity to displace the air from the pump and suction pipe within three minutes.	W,D	Comply: The horizontal centrifugal pumps are equipped with a vacuum priming system. Technical Data #43
122b	Provide two reliable methods of priming the pump. One of these methods of priming should be independent of public water connections or tanks serving as primary supplies for automatic sprinklers, yard hydrants or standpipes.	W,D	Comply: The horizontal pumps are installed below lake water level; therefore, the pumps are primed all the time. The plant's vacuum priming system assures that the gravity fed lake water priming system performs as designed. Technical Data #43, 14, 20, 31

<table>
<tr><th>Code Section No.</th><th>Code Section</th><th>Information Obtained By:
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D-Document</th><th>Summary of Results</th></tr>
<tr><td>122c</td><td>Where the pump is automatically started or provision is made for remote manual starting, the preferred arrangement is a submerged pump (See Fig. 200a, Appendix C), but if priming is needed the priming supply should be of a type which will keep the pump primed at all times. No priming method should be selected which will permit contamination of a potable water supply.</td><td>D</td><td>Comply: The only time that the vacuum priming system can be taken out of service is when both units are shut down.
Technical Data #43</td></tr>
<tr><td>123</td><td>Priming Method A. An Automatically Filled Priming Task.</td><td></td><td>Title</td></tr>
<tr><td>123a</td><td>An automatically filled priming tank that keeps the pump primed at all times. The volume of the priming tank should be equal to the volume of the pump and suction pipe but not less than 100 gals. This volume can be readily computed from the following data.
<table>
<tr><th>Capacity of Pump gpm</th><th>Priming Water Required for Pump and Fittings, Gals.</th><th>Size of Suction Pipe Inches</th><th>Priming Water Required for Suction Pipe Gals. per Foot</th></tr>
<tr><td>500</td><td>13</td><td>6</td><td>1.5</td></tr>
<tr><td>750</td><td>21</td><td>8</td><td>2.5</td></tr>
<tr><td>1,000</td><td>25</td><td>10</td><td>4.1</td></tr>
<tr><td>1,500</td><td>38</td><td>12</td><td>5.9</td></tr>
<tr><td>2,000</td><td>47</td><td>14</td><td>8.0</td></tr>
<tr><td>2,500</td><td>58</td><td>16</td><td>10.5</td></tr>
<tr><td></td><td></td><td>20</td><td>16.3</td></tr>
</table></td><td>D</td><td>Does Not Apply: An automatically filled priming tank is not installed at Donald C. Cook Plant.
Technical Data #14, 20, 31, 43</td></tr>
<tr><td>123b</td><td>The water supply to the tank should be capable of keeping the tank full at all times.</td><td>D</td><td>Does Not Apply: See comments from Section 123a.</td></tr>
</table>

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
123c	The priming tank should be connected to the discharge side of the pump at a point which will insure that all priming water enters the pump and suction pipe, and is not wasted in the discharge pipe of the pump (Fig. 100b, Appendix C). This connection should be 2 inches in diameter irrespective of the capacity of pump, and include an approved O.S. & Y. gate valve and an approved check valve.	D	Does Not Apply: See comments from Section 123a.
124	**Priming Method B. A Connection to a Domestic Water System.** A connection to a domestic water system (when permitted by health regulations). Install appro [illegible] and O.S. & Y. gate valves in the priming pipe near the pump.	D	Does Not Apply: This type of priming system is not utilized at Donald C. Cook Plant. Technical Data #14, 20, 31, 43
125	**Priming Method C. A Connection to a Domestic-use Tank.** A connection to domestic-use (service) tank (when permitted by health regulations). Preferably arrange a reserve supply for priming only, by extending service riser up into the tank. Install approved check and O.S. & Y. gate valves in the priming pipe near the pump.	D	Does not Apply: This type of priming system is not utilized at Donald C. Cook Plant. Technical Data #14, 20, 31, 43
126	**Priming Method D. An Exhauster or Siphon Ejector.** Where a reliable steam supply or separate water supply under good pressure is available, an exhauster or siphon ejector may be connected between the pump and discharge check valve to exhaust the air from the pump and the suction pipe (fig. 100b, Appendix C). An approved O. S. & Y. gate valve should be placed in the exhauster connection, to be closed as soon as the pump is primed.	D	Does Not Apply: This type of priming system is not utilized at Donald C. Cook Plant. Technical Data #14, 20, 31, 43

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
127	**Priming Method E. A Mechanically-operated Exhauster Driven by a Separate Motor.** The exhauster should be connected between pump and discharge check valve, so as to completely fill suction pipe and pump (Fig. 100b, Appendix C). An approved O.S. & Y. gate valve should be placed in the exhauster connection, to be closed as soon as pump is primed.	W,D	Comply: A mechanically operated exhauster driven by several vacuum priming pumps is installed at the high point of the suction pipe. Technical Data #14, 20, 43
128	**Priming Method F. A Manually Filled Priming Tank.**		Title
128a	The tank to have a capacity of at least three times the volume of the pump and suction pipe, but not less than 250 gallons. A liberal-sized priming tank and large connecting pipe are necessary so that the pump can be primed quickly, even if there should be considerable leakage at the foot valve. As the priming arrangement is so vital a feature to the successful starting of the pump, a considerable safety factor is needed.	D	Does Not Apply: This type of priming system is not installed at Donald C. Cook Plant. Technical Data #14, 20, 31, 43
128b	The volume required for the priming tank can be readily computed by taking 3 times the quantities given under Section 123.	D	Does Not Apply: See comments from Section 128a.
128c	The tank should be connected to the pump as covered in Section 123 with the connecting pipe not smaller than given in the following table:	D	Does Not Apply: See comments from Section 128a.

Capacity of Pump, gal. per min.	500	750	1000	1000-2500
Size of Priming Pump, inches	2 1/2	3	3 1/2	4

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128d	Where suction pipe is longer than 25 feet, larger priming connection may be required.	D	Does Not Apply: See comments from Section 128a.
128e	Provide a means for keeping tank filled such as a connection from public or factory-use water systems or a connection between fire pump and the priming tank to permit refilling tank.	D	Does Not Apply: See comments from Section 128a.
129	**Priming Method G. A By-pass Around Discharge Check Valve.** Where a good gravity water supply constitutes the primary supply for automatic sprinklers, yard hydrants or standpipes, a 2 inch by-pass around the check valve in the pump discharge pipe may be used but only as a secondary priming supply.	D	Does Not Apply: This type of priming system is not installed at Donald C. Cook Plant. Technical Data #14, 20, 31, 43
130	**Pump.**		Title
131	**Outline of Required Attachments.**		Title
131a	This standard requires horizontal fire pumps to be equipped with the following attachments, depending on the conditions under which the pumps are to be installed: Automatic air release, Section 132. Circulation relief valve, Section 46. Eccentric tapered reducer at suction inlet, Paragraph 143i. Hose valve manifold with hose valves, Section 44. Pressure gages, Section 45.		Information Only: See referenced sections for compliance/non-compliance.

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
	Priming connection, Section 122 to 129.		
	Relief valve and discharge cone, Section 43.		
	Splash shield between pump and motor, Section 455.		
	Test valve with piping connections, Section 133.		
131b	These attachments shall be provided by the pump manufacturer unless the authority having jurisdiction permits certain omissions depending on the conditions under which the pumps are to be installed.	D	Comply: Specific requirements for pump accessories were spelled out on purchase order. Technical Data #2, 5
132	**Automatic Air Release.** Pumps which are automatically controlled shall be provided with a reliable float-operated air release valve not less than 1/2 inch in size, or equivalent valve, to automatically release air from the pump.	W	Comply: An automatic air release valve is not installed for the electric driven fire pumps; however, the exhauster will serve the same purpose. See Code Section 127.
133	**Test Valves.**		Title
133a	Pumps taking suction under lift shall be equipped with test valves of the size specified below, in order to provide means for liberating the air from the pump and suction line within the three-minute time limit for the priming operation. Capacity of Pump, gpm 500 750 1000 1500-2500 Size of Valve, Inches 1 1/4 1 1/2 2 2 1/2	D	Does Not Apply: The horizontal centrifugal fire pumps at Donald C. Cook Plant do not take suction under lift. Technical Data #2, 14, 20, 31
133b	Test valves shall be piped so that water wasted through them can be seen by a man at the pump.	D	Does Not Apply: See comments from Section 133a.

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
	NOTE: Unless the pump attendant can see the dischage of water, there is danger that he will allow water to be wasted which might be seriously needed for fire fighting.		
140	**Installation.**		Title
141	**Foundation and Setting.**		Title
141a	Unless the pump and driver have a common shaft, they shall be connected by an approved flexible coupling arranged to permit end adjustment and to care for minor inaccuracies in alignment.	W	Comply: The pump and driver are connected by a flexible coupling.
141b	The pump and driver shall be securely attached to a solid foundation in such a way that proper shaft alignment will be assured: such as by having the pump and driver rigidly connected to a substantial bedplate which is securely bolted to the foundation.	W	Comply: The pump and driver are mounted on a common base plate which is securely bolted into a concrete foundation.
141c	The foundation should preferably be made of concrete, or, if desired, of brick laid in portland cement mortar.	W	Comply: The pump foundation is made of poured concrete.
	NOTE: Where the foundation is of brick a capping of concrete is an advantage in tying it together. In some cases it may be necessary to support the pump on I-beams or a framework of structural steel.		

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
141d	Pumps shall be set level, with foundation bolts in position, and the joint between the foundation and bedplate made solid by grouting with neat cement. After the cement has thoroughly set the bolts shall be tightened. For further information see Instructions for Installing Centrifugal Pumps in Centrifugal Pump Section of the Standards of the Hydraulic Institute.	W	Comply: The horizontal centrifugal fire pumps at Donald C. Cook Plant are set level.
142	**Alignment.**		Title
142a	A horizontal pump with driver is correctly aligned on bedplate before shipment. This alignment, however, usually is disturbed during transit or by incorrect leveling of bedplate on foundation. The pump manufacturer's instructions on alignment should be carefully followed.		Information Only
142b	Any baseplate, no matter how heavily it is built may be slightly sprung in shipment, or may be distorted by an uneven support on the foundation, or by uneven tightening of the foundation bolts, or by the pull from the pipe connections. It is necessary to be careful when installing the pump to secure perfect alignment of the coupling. **A flexible coupling will not compensate for misalignment.** Inaccurate alignment of the coupling results in rapid wear of the coupling bushings, heating of the bearings and loss of efficiency. Therefore, after the pump is fastened on the foundation it is necessary to see that the shaft of the pump and of the prime mover are in one line. If the prime mover and pump are direct connected up to its piping and the base plate then leveled up and adjusted to position so as to bring the two halves of the coupling into perfect alignment.		Information Only

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142c	With a pair of inside calipers or a wedge, check the distance between the coupling halves at four points and repeat after revolving both halves 180 degrees.		Information Only
142d	Both suction and discharge pipes should be independently supported near the pump so that when the flange bolts are tightened no strain will be transmitted to the pump casing.	W	Comply: Suction and discharge pipes are independently supported.
143	Suction Connections.		Title
143a	The size of suction pipe should be determined from Fig. 143a (Appendix C). These curves include an allowance for velocity and friction loss through elbows and foot valves.		Comply: The size of the suction pipe is such that with the pump(s) operating at 150% of rated capacity the suction head available at the suction flange will be a positive NPSH. Technical Data #42
143b	Suction pipe should be of the same pressure rating as the yard piping and installed in accordance with the Standard for Outside Protection, NFPA No. 24. For short pipe well-supported, flanged cast iron pipe with rubber gaskets should be used. In special cases steel pipe having flanged or screwed joints (flanged joints with flanges welded to the pipe are preferred) may be used above ground in the pump room provided it is galvanized or painted on the inside, prior to installation, with a paint recommended for submerged surfaces. Thick bituminous coatings applied at the plant should not be used. The exterior of steel pipe should be kept painted. Cement asbestos pipe may be used when the pump takes suction under a head at all times.	W,D	Comply With Intent: This section of the code is only a recommendation; the Donald C. Cook Plant is not required to meet this section of NFPA 20. The steel suction pipe installed within the pump rooms has proven to be reliable. In addition, no excessive friction loss or leakage has been experienced due to corrosion. It is felt that at this time painting the inside of the steel pipe which has been in service for many years is unnecessary. Technical Data #12, 42

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
143c	Avoid an excessive length of suction pipe to a pump room under lift by providing a suction well close to the pump. The well can be fed by gravity through a large pipe from the suction source.	D	Does Not Apply: The horizontal pumps do not take suction under lift. Technical Data #2, 14, 20, 31
143d	Provide independent suction pipes where more than one pump is supplied under lift from the same intake or suction well. In special cases where a single suction pipe supplies more than one pump under head, the piping layout at the pumps must be symmetrical so that each pump will receive its proportional supply. The size of the suction pipe should be such that with all pumps operating at overload capacity the total operating suction lift will not exceed 15 feet.	W,D	Comply: The water to the low demand and Unit 1 high demand electric driven fire pumps is provided from the same supply pipe. This pipe is of adequate size to supply water to both pumps. The total operating suction lift will not exceed 15 feet. Technical Data #14, 20, 21, 22, 31, 42
143e	When the suction supply is under sufficient pressure to be of material value without the pump, the pump should be installed with a by-pass (Fig. 143e, Appendix C).	W,D	Does Not Apply: The suction supply provides insufficient pressure to warrant a by-pass. Technical Data #2, 14, 20, 23, 31
143f	Suction pipes involving a lift must be carefully laid to avoid air leaks and air pockets, either of which may seriously affect the operation of the pump. Lay a suction pipe involving a lift so that it will have a constantly ascending grade from the water supply to the pump (Fig. 143f, Appendix C).	W,D	Does Not Apply: See comments from Section 143C.
143g	Lay suction pipe below the frost line. Pay special attention where pipe enters streams, ponds, or reservoirs to prevent freezing either underground or under water (Fig. 100b, Appendix C). Avoid horizontal elbows near the pump.	W,D	Comply: De-icing capabilities to the intake cribs is provided. Horizontal elbows near the pumps are avoided. Technical Data #24

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143h	All pump suction pipe, except short lengths between above-ground suction tanks and pumps, should be hydrostatically tested in accordance with the tests for yard mains given in the Standard for Outside Protection (NFPA No. 24) before back filling.	D	Open Item: No documentation could be found proving that this recommendation has been met. Justification: It is known that excessive leakage has not been a problem in the supply piping. In addition, over the years, the supply piping has proven to be reliable.
143i	When the suction pipe and pump suction connection are not of the same size, connect them with an eccentric tapered reducer in such a way as to avoid air pockets (Fig. 143f, Appendix C).	W,D	Comply: Eccentric tapered reducers exist when the suction pipe and the pump suction flange are not of the same size. Technical Data #15, 16, 25
143j	Equip suction pipes which may at any time involve a lift with approved foot valves except when two completely independent exhaust-type priming methods are provided. Piping should be arranged to permit removing foot valves for inspection and cleaning. Combination foot valves and strainers should not be used.	D	Does Not Apply: The pumps will not at any time involve a lift. Technical Data #11
143k	Provide an approved O.S. & Y. or approved indicator type gate valve in the suction pipe if the pump is ever supplied under a head. NOTE 1: If suction pressure comes from city or service water mains, the gate valve should normally be located at the suction flange on the pump. (Item 6A in Figure 100a.)	W,D	Comply With Intent: The intent of this section of NFPA 20 is to assure that valves with excessive friction loss are not installed in the supply piping. The butterfly valves installed in the supply piping have not proven to cause excessive friction loss. Past performance testing has indicated that the pumps meet all

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	NOTE 2: If suction pressure comes from a stored water container, the gate valve should normally be located at the outlet of the container. (Item 6 in Figure 100a.)		flow and pressure requirements. This butterfly valve has not proven detrimental to the fire protection system. Technical Data #15, 16, 25, 26, 30, 41, 42
143l	Suction inlets should be at least 24 inches below minimum water level to prevent pumps from drafting air and at least 12 inches above the bottom of sump or suction well to avoid obstruction (Fig. 100 b and Fig. 143l, Appendix C).	D	Does Not Apply. The horizontal centrifugal fire pumps do not take suction from a pit or a well. Technical Data #11, 14, 20, 31, 23
143m	Provide double removable intake screens (Fig. 100b, Appendix C) having an effective net area of openings below minimum water level of one square inch for each gallon per minute of 150 per cent of rated pump capacity at suction intakes where it is necessary to prevent the passage of materials which might clog the pump. Screens should be so arranged that they can be cleaned or repaired without disturbing the suction pipe. A brass or copper wire screen of one-half inch mesh and No. 10 B. & S. gage wire secured to a metal frame sliding vertically at the entrance to the intake, makes a serviceable arrangement, and permits ready cleaning and overhauling. The over-all area of this particular screen is 1.6 times the net screen opening area. In some localities, suction supply for fire pumps from public water mains may require the installation of an approved strainer to prevent foreign material from passing through the pump into the system piping.	W,D	Comply: Traveling screens with a 3/8" mesh are installed in the circulating water supply. The fire protection water supply for the electric driven fire pumps is from the NESW system which is supplied from the circulating water system. Technical Data #2, 11, 28, 29
143n	When pump and suction supply are on separate foundations with rigid interconnecting piping, the piping should be provided with strain relief. (See Fig. 100a, Item 5.)	W,D	Comply: Flanged expansion joints are installed to provide strain relief. Technical Data #14, 20

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	CHAPTER 200 - VERTICAL SHAFT TURBINE-TYPE PUMPS.		Title
210	General.		Title
211	**Suitability.** The deep well turbine-type pump is particularly suitable for fire pump service when the source of water is located below the surface of the ground and it would be difficult to install any other type of pump below the minimum water level. It is a vertical shaft centrifugal pump with rotating impellers suspended from the pump head by a column or eduction pipe which also serves as a support for the shaft and bearings. It was originally designed for installation in bored wells, but may also be used to lift water from lakes, streams, open sumps, and other sub-surface sources. Oil-lubricated enclosed line shaft or water-lubricated open line shaft pumps will be acceptable.		Information Only
212	**Maximum Depth.** Wells should not be considered as a source of supply for fire pump service where the water level when pumping at 150 per cent capacity exceeds 200 feet from the surface of the ground. In all applications where the water level is expected to exceed 50 feet the authority having jurisdiction shall be supplied with data on the draw-down characteristics of the well and the pump performance to determine the available discharge pressure at the discharge flange of the vertical pump.		Does Not Apply: The vertical fire pumps installed at Donald C. Cook Plant do not take suction from wells.

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213	**Acceptable Drive.** These pumps may be operated by vertical shaft electric motor or, when equipped with a suitable right angle gear drive, they may be operated by an internal combustion engine or a steam turbine. Careful consideration must be given in each case to the dependability of the source of power.		Information Only
214	**Supervision of Installation.** Satisfactory operation of vertical turbine-type pumps is dependent to a large extent upon careful and correct installation of the unit; therefore, it is recommended that this work be done under direction of a representative of the pump manufacturer.		Information Only
215	**Performance.** Pumps shall furnish not less than 150 per cent of rated capacity at a total head of not less than 65 per cent of the total rated head. The shut-off total head shall not exceed 140 per cent of total rated head (Fig. 1, Appendix C).	D	Comply: Pumps perform as designed and the pumps were designed to meet this criteria. Technical Data #2, 6
220	**Water Supply.**		Title
221	**Source.**		Title
221a	The water supply shall be acceptable to the authority having jurisdiction. Stored water supplies from reservoirs or tanks supplying wet pits are preferable. Lakes, streams and ground water supply may be acceptable where investigation shows that they can be expected to provide a suitable and reliable supply.	W,D	Comply: The water supply was accepted prior to installation or construction. Technical Data #1

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221b	The acceptance of a well as a source of water supply shall be dependent upon satisfactory development of the well and the making of a preliminary test to determine hydraulic conditions. The history of the water table should be carefully investigated. The number of wells already in use in the area and the probable number that may be in use should be considered in relation to the total amount of water available.	D	Does Not Apply: Fire protection pumps do not take suction from a well. Technical Data #11
222	Pump Submergence.		Title
222a	Proper submergence of the pump must be provided for reliability of operation of the fire pump unit.	D	Comply: Proper submergence is in accordance with 222b.
222b	**Wet Pit Installations.** The minimum submergence should be such that the second impeller from the bottom of the pump bowl assembly will be below the lowest standing water level in the open body of water supplying the pit (Fig. 200b, Appendix C). The minimum submergence shall be increased by one foot for each 1000 feet of elevation above sea level.	D	Comply: The second impeller from the bottom of the pump bowl assembly is below the lowest pumping water level. Technical Data #2, 32, 33
222c	**Well Installations.** Submergence of the second impeller from the bottom of the pump bowl assembly should be 10 feet below the pumping water level at 150 per cent of rated capacity. (See Figure 200a, Appendix C.)	D	Does Not Apply: Fire protection pumps do not take suction from a well. Technical Data #11
223	Well Construction.	D	This entire section has been omitted since fire protection pumps installed at Donald C. Cook Plant do not take suctions from wells. Technical Data #11

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224	Unconsolidated Formations.	D	This entire section has been omitted since fire protection pumps installed at Donald C. Cook Plant do not take suctions from wells. Technical Data #11
225	Consolidated Formations.	D	This entire section has been omitted since fire protection pumps installed at Donald C. Cook Plant do not take suctions from wells. Technical Data #11
226	Developing a Well.	D	This entire section has been omitted since fire protection pumps installed at Donald C. Cook Plant do not take suctions from wells. Technical Data #11
227	Test and Inspection of Well.	D	This entire section has been omitted since fire protection pumps installed at Donald C. Cook Plant do not take suctions from wells. Technical Data #11
230	Pump.		Title
231	**Discharge Head.** The discharge head should be of the aboveground type (Fig. 200a and b, Appendix C). In every case the discharge head shall be designed to support the driver, the pump column and the oil tube tension nut or packing container. The discharge head shall also act as a water passage to direct the water from the column into the discharge fittings.	W,D	Comply: The discharge heads are installed above ground and support the driver, pump column and oil tube tension nut or packing container. Water from the column discharges into the discharge piping. Technical Data #14, 20, 32

<table>
<tr><th>Code Section No.</th><th>Code Section</th><th>Information Obtained By: W-Walkdown D-Document</th><th>Summary of Results</th></tr>
<tr><td>232</td><td>Pump Column.</td><td></td><td>Title</td></tr>
<tr><td>232a</td><td>The column shall be furnished in sections not exceeding a nominal length of 10 feet, shall be of minimum weight conforming to specifications in Table 232, and shall be connected by threaded sleeve type or flange type couplings. The ends of each section of threaded pipe shall be faced parallel and machined with threads to permit the ends to butt so as to form accurate alignment of pump column. All column flange faces shall be parallel and machined for rabbet fit to permit accurate alignment.
<table>
<tr><th>Nominal Size (ID) Inches</th><th>Outside Diameter Inches</th><th>Weight per Foot (Plain Ends) lbs.</th><th>Nominal Size (ID) Inches</th><th>Outside Diameter Inches</th><th>Weight per Foot (Plain Ends) lbs.</th></tr>
<tr><td>6</td><td>6.625</td><td>18.97</td><td>10</td><td>10.750</td><td>31.20</td></tr>
<tr><td>7</td><td>7.625</td><td>22.26</td><td>12</td><td>12.750</td><td>43.77</td></tr>
<tr><td>8</td><td>8.625</td><td>24.70</td><td>14*</td><td>14.000</td><td>54.57</td></tr>
</table>
*OD</td><td>D</td><td>Comply: The pump column has been designed to meet this section of NFPA 20.
Technical Data #2, 5, 34, 44</td></tr>
<tr><td>232b</td><td>Open line shaft water-lubricated columns shall not be used where the distance from the pump head to the static water level exceeds 50 feet.</td><td>D,W</td><td>Comply: The distance from the pump head to the static water level at worse case is 22 feet.
Technical Data #2, 14, 20, 33</td></tr>
</table>

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
232c	If the pump is to be of the enclosed line shaft oil lubricated type the shaft enclosing tube shall be furnished in interchangeable sections not over 10 feet in length of extra strong pipe. An automatic sight feed oiler shall be provided on a suitable mounting bracket with connection to the shaft tube for oil lubricated pumps.	D	Does Not Apply: This type of pump is not installed at Donald C. Cook Plant. Technical Data #2, 5
233	**Bowl Assembly.**		Title
233a	The pump bowl shall be of close-grained cast iron or bronze, and provided with bronze wearing rings or other suitable material in accordance with the chemical analysis of the water and experience in the area, as per Paragraph 224b.	D	Comply: The pump bowl is of cast iron and past performance of the pump indicates that the wearing rings are of suitable material. Technical Data #35, 36, 42
233b	Impellers shall be of bronze of the enclosed or semi-open type.	D	Comply with intent: More recent versions of NFPA 20 do not require bronze impellers. It is felt that the stainless steel impellers are better suited for the conditions at Donald C. Cook Plant.The stainless steel impellers installed at Cook are within the current guidelines of NFPA 20. Technical Data #37
234	**Suction Strainer.**		Title
234a	A cast or heavy fabricated type of non-ferrous cone or basket type strainer shall be attached to the suction manifold of the pump. The suction strainer shall have a free area of at least four times the area of the suction connections and the openings shall be of such size to restrict the passage of a 1/2 inch sphere.	D	Comply With Intent: There are 3/8" mesh traveling screens upstream from the fire pump suction manifold. Installation of a 1/2" mesh suction strainer is not practical or necessary. The 3/8" mesh traveling screens combined with the intake bar

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			racks have proven to provide adequate protection to the pumps. Technical Data #28
234b	This suction strainer shall be required in addition to intake screen, specified under Paragraph 143m.	D	Comply With Intent: See comments from 234a.
235	**Fittings.**		Title
235a	The following fittings to be furnished by the pump manufacturer shall be required for attachment to the pump. (Some shown in Fig. 200a, Appendix C.)		
	Discharge tee or elbow.	W,D	Comply: Discharge elbows have been provided. Technical Data #14, 20
	Hose valve head (separable type), Section 44.		See Referenced Section.
	Hose valves, Section 44.		See Referenced Section.
	Automatic air release valve and fittings, Paragraph 235b.		See Referenced Section.
	Discharge gage conforming to Section 45.		See Referenced Section
	Relief valve and discharge cone, when required by Section 43.		See Referenced Section
	Water level testing device, Paragraph 235c.		See Referenced Section

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235b	A 1 1/2 inch or larger automatic air release valve is required to vent air from the column and discharge head upon starting the pump and also to serve to admit air to the column to dissipate the vacuum when the pump is stopped. This valve shall be located at the highest point in the discharge line between the fire pump and the discharge check valve.	W,D	Comply: A 2 inch automatic vent and vacuum breaker has been installed between the fire pump and the discharge check. Technical Data #14, 20
235c	Each pump installed in a well must be equipped with a suitable water level detector. The air line method (Section 236) is considered as a satisfactory method of determining depth of water level. This device should be permanently installed.	D	Does Not Apply: The fire pumps installed at Donald C. Cook Plant do not take suction from a well. Technical Data #11
236	Air Line Method of Water Level Detection.		This entire section has been omitted since fire protection pumps installed at Donald C. Cook Plant do not take suction from wells. Technical Data #11
240	Installation.		Title
241	Pump House. The pump house should be of such character as will offer the minimum obstruction to the convenient handling and hoisting of vertical pump parts. Otherwise the requirements of Section 41 and Section 666 should apply.	W	Comply: The pumps are installed so that minimum obstructions to the convenient handling and hoisting of vertical pump parts occurs. This includes obstructions due to the pump house.
242	Outdoor Setting.		This entire section has been omitted since fire pumps at Donald C. Cook Plant are installed indoors.
243	Foundation.		Title

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243a	The pump foundation for vertical type pumps should be substantially built to carry the weight of the entire pump full of water and the driver. It should be rigid enough to withstand and prevent any vibration. Area of the base of foundation should extend at least 3 inches beyond the pump head base plate on all sides and be of sufficient area and strength so that the load per square foot on concrete does not exceed the ordinary foundation standards, or two I-beams of sufficient length and weight may be used on either side of well.	W,D	Comply: The pump foundations are substantially built and past performances have not indicated any problem with vibration. Technical Data #42
243b	Certified prints can be obtained from the pump manufacturer giving the necessary dimensions.		Information Only
243c	Top of the foundation shall be carefully leveled to permit the pump to hang free in the well.	W	Comply: Pump foundation is level.
243d	Where pump is mounted on I-beam over a pit the right angle gear housing and driver should always be installed parallel to beams, never at right angle.	W	Does Not Apply: Pumps are not mounted on I-beams.
244	**Method of Erecting.**		Title
244a	Several methods of installing a vertical pump may be followed, depending upon the location of the well and facilities available. Since most of the pump unit is underground, extreme care must be used in assembling and installing it and throughly checking the work as it progresses. The installation should be made under supervision of a representative of the pump manufacturer.		Information Only

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244b	The following simple method is the most common.		Information Only
244b1	Construct a tripod or potable derrick and use two sets of installing clamps over open well or pump house. After the derrick is in place the alignment should be checked carefully with the well or suction pit to avoid any trouble when setting the pump.		Information Only
244b2	Attached set of clamps to the suction pipe on which strainer has already been placed and lower onto the well until clamps rest on block beside well casing or on pump foundation.		Information Only
244b3	Attach clamps to pump stage assembly and bring over well and install pump stages to suction pipe, etc., until each piece has been installed in accordance with manufacturer's instructions. Note: A series of drawings illustrating this procedure will be found in Appendix C. See Figures 244b-1, 2, 3 and 4.		Information Only
245	**Setting Impellers.** The setting of the impellers should only be undertaken by a representative of the pump manufacturer. Improper setting will develop excessive friction loss by rubbing of impellers on pump seals with resultant increase in power demand. If adjusted too high there will be a loss in capacity; full capacity is vital for fire pump service. The top shaft nut should be locked or pinned after proper setting.		Information Only
250	**Driver.**		Title

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251	**Method of Drive.**		Title
251a	The pump may be driven by a vertical hollow shaft electric motor or a right angle gear drive or dual drive with internal combustion engine or steam turbine. The driver provided must be so constructed that the total thrust of the pump, which includes the weight of the shaft, impellers, and the hydraulic thrust, can be carried on a thrust bearing of ample capacity so that it will have an average life rating of five-year continuous operation. All drivers must be so constructed that axial adjustment of impellers can be made to permit proper installation and operation of the equipment.	W,D	Comply: Pumps are provided with right angle gear drive. Impeller adjustments can be made from the top of the shaft on the right angle gear drive. Technical Data #2 Open Item: Insufficient documentation could be found to determine if thrust bearings will have an average life rating of five years continuous operation. Justification: Over the years, the thrust bearings have proven to be reliable.
251b	Motors shall be direct connected, of the vertical, hollow shaft type, drip proof, normal starting torque, low starting current, squirrel cage induction type. The motor shall be equipped with an antireverse rachet.	D	Does Not Apply: The vertical shaft turbine type pumps are not driven by electric motors. Technical Data #2, 3, 4, 5
251c	Gear drives must be acceptable to the authority having jurisdiction. Gear drives shall be of the hollow shaft type, permitting adjustment of the impellers for proper installation and operation of the equipment. The gear drive shall be equipped with an antireverse rachet.	W,D	Comply: Pumps are equipped with right angle gear drives of the hollow shaft type which permit adjustment of the impellers. The gear drive is equipped with an anti-reverse racket. Technical Data #2, 3, 4, 5, 46

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
251d	Where internal combustion engines under manual control are used, it shall be the pump manufacurer's responsibility to furnish a coupling of suitable design which will prevent undue strain on either the engine or pump by reverse operation. Automatic starters are equipped with an anti-dieseling device which serves to prevent reverse operation from self ignition during compression.	D	Does Not Apply: The internal combustion engines installed to drive the vertical fire pumps are automatically controlled. Technical Data #2, 3
251e	If dual drive is used, all equipment shall be of approved type and shall include approved free-wheeling clutches (see Paragraph 623.b).	W,D	Does Not Apply: The vertical fire pumps installed at Donald C. Cook Plant are not equipped by dual drive. Technical Data #2, 3, 11
252	Controls. The controls for the motor, steam turbine or internal combustion engine shall comply with the sections of this standard which cover these controls.		Information Only: See Chapter 700.
260	**Tests.**		Title
261	**Field Acceptance And Subsequent Tests.**		Title
261a	When the installation is completed, with wells and pumping equipment all in place, and necessary adjustments and connections made, an operating test shall be made in the presence of the customer, pump manufacturer and representative of the authority having jurisdiction. Requirements regarding field acceptance tests in Article 910 should be followed insofar as they apply, excepting that for well installations the test shall include a continuous run long enough to satisfy the authority having jurisdiction that the permanent pump performs are required, but in no event shall the test be for less than one hour.	D	Open Item: No documentation could be found to verify that a field acceptance test was performed in the presence of the pump manufacturer. Justification: Although no documentation could be found to verify a field acceptance test, records have shown that the pumps have performed up to their designed level. The pre-operational test combined with required Technical Specification and regular insurance company testing

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	[illegible]
			have proven the pumps [illegible] Technical Data #42, 53
261b	A yearly inspection and test at 150 per cent rated capacity to determine water level and condition of pump should be made.		Comply With Exception: Fire pumps are tested at 150% rated capacity on an eighteen month interval as required by the Tech Specs. The authority having jurisdiction (NRC) has approved this test schedule. Additionally, the 18 month interval is the frequency given in the Westinghouse Standard Tech Spec issued by the NRC. The yearly test, stated in this section, is only a recommendation by the NFPA 20 committee. Technical Data #42, 53
270	Operation and Maintenance.		Title
271	Operation.		Title
271a	In starting the unit for the first time after installation it is advisable to check over all electrical connections to the motor and also the discharge piping from the pump. Then momentarily operate the motor to see that the pump shaft rotates in a counter-clockwise direction when viewed from above.		Information Only
271b	With these precautions taken the pump may be started and allowed to run. Observe the operation for vibration while running and also any heating of the motor.		Information Only

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
272	**Vibration.**		Title
272a	Pumping units are checked at the factory for smoothness of running and performance and should operate satisfactorily on the job. If excessive vibration is present several conditions may cause the trouble - a bent pump or column shaft, impellers not properly set within the pump bowls, pump not hanging freely in the well, or strain transmitted through the discharge piping.		Information Only
272b	If vibration develops later the unit should not be continued in operation. The pump manufacturer should be requested to service the installation and to place it in proper running condition.		Information Only
273	**Excessive Motor Temperature.** This condition is generally caused either by a maintained low voltage of the electric service, or when the impellers are not properly set within the pump bowls.		Information Only
274	**Repair.**		Title
274a	Manufacturer's instructions must be carefully followed in making repairs, taking apart and reassembling the pumps. This work should only be undertaken by someone familiar with their design.		Information Only
274b	In ordering spare or replacement parts use the pump serial number stamped on the name plate fastened to the pump head.		Information Only
	Chapter 300 - Special Fire Service Pumps.	D	This entire chapter has been omitted since special fire service pumps are not utilized at Donald C. Cook Plant. Technical Data #11

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
	Chapter 600 - Internal Combustion Engine Drive.		Title
610	**General.**		Title
611a	**Recommended Use.** Selection of internal combustion engine type fire pump equipment for each situation should be based on careful consideration of factors of the most reliable type of control, ignition and fuel (including fuel supply), the starting operation and the running operation of the internal combustion engine.		Information Only
611b	The compression ignition diesel engine is one of the most dependable sources of power for driving fire pumps. Spark ignition type engines are advised as supplemental units with natural gas and gasoline as acceptable fuels in that order for preference.		Information Only
620	**Engines.**		Title
621	**Approval.** Engines shall be specifically approved for fire pump service.	D	Comply With Intent: At the time of installation, the Allis Chalmers engine was a larger capacity engine with greater capacity for continuous duty rating and permitted greater allowance for wear and tear than engines offered with a U.L. label. Besides its reliability, this engine offered nearly all requirements of the fire pump code (with minor exceptions noted within this chapter). Approval of this engine for fire pump service was granted by NELPIA (ANI) at the time of its installation. Technical Data #30, 41, 59

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
622	Ratings.		Title
622a	The engine shall have a bare engine brake horsepower rating at least 20 per cent greater than the maximum brake horsepower required to drive the fire pump at rated revolutions per minute of the pump unit. Note: The 20 per cent excess power takes account of the fact that new production engines are permitted to run as low as 5 per cent under the official bare engine horsepower curve and that up to 5 per cent may be needed for operation of accessories, allowing at least 10 per cent reserve power for reliability of performance and for normal depreciation of the engine with age and use.	D	Comply: The pump curve brake horsepower is 240 while the horsepower rating of the Allis Chalmers 25000 Mark II engine is 325 which exceeds the 20% greater requirement. Technical Data #9, 38, 47
622b	A deduction of 5 per cent of the power shown on the curve of the engine, having a standard sea level compression ratio, shall be made for each 1,000 feet rise in altitude above sea level. This correction should be made prior to any other power deductions or rating correction factors.	D	Does Not Apply: The plant is not located at an elevation greater than 1,000 feet above sea level. Technical Data #1
622c	When the authority having jurisdiction permits the use of gear drives between the pump and its drive, (see 623a.) the horsepower requirement of the pump should be increased to allow for power losses.	D	Comply: Adequate horsepower is supplied to the pump to offset the additional power losses due to the use of gear drives. See comments from 622a. Technical Data #9, 38, 47
622d	Engines listed for fire pump service by a nationally recognized testing laboratory may be accepted for horsepower ratings established by the laboratories.		Information Only

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
623	Connection to Pump		Title
623a	Except where otherwise permitted by the authority having jurisdiction the engine shall be directly connected to a horizontal pump by means of a flexible coupling of suitable design. Vertical shaft turbine-type pumps shall have the engine connected to the right angle drive with suitable universal joints.	D,W	Comply: The vertical shaft turbine type pumps have the engine connected to the right angle drive by a suitable universal joint. Technical Data #2, 3, 4, 5
623b	Dual drive units are not recommended. The use of separate pumps provides greater flexibility and reliability. Where dual drive is used, the coupling should be of an automatic type acceptable to the authority having jurisdiction and the engine drive shall be equipped with an approved freewheeling clutch. If the other drive is an electric motor, it too shall be equipped with an approved freewheeling clutch.	D	Does Not Apply: Dual drive pumps are not installed at Donald C. Cook Plant. Technical Data #2, 3, 4, 5
624	Instrumentation and Control.		Title
624a	Governor. An adjustable governor shall be provided for the engine to regulate the speed within a range of 10 percent between shutoff and maximum load conditions of the pump. It shall be set to maintain rated pump speed at maximum pump load.	W,D	Comply: A governor with 10% tolerance is provided for the engine. This governor is set for the rated pump speed at maximum pump load. Technical Data #38
624b	Emergency Governor. An emergency governor shall be provided for a diesel engine. It should be arranged to shut down the engine at a speed approximately 20 percent above rated engine speed. The emergency governor shall be arranged for manual reset.	W,D	Comply: An emergency governor is installed and is set at 2100 rpm which is approximately 17% above rated engine speed. Manual reset is required before the engine can be started again. Technical Data #38

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
624c	**Tachometer.** A tachometer shall be provided to indicate revolutions per minute of the engine. It shall be of the totalizing type or an hour meter shall be provided to record total time of engine operation.	D,W	Comply: A tachometer is provided indicating revolutions per minute. An hour meter is also provided. Technical Data #38
624d	**Oil Pressure Gage.** An oil pressure gage shall be provided to indicate engine lubricating oil pressure.	D,W	Comply: The engine assembly is equipped with an oil pressure gauge Technical Data #38
624e	**Temperature Gage.** A temperature gage shall be provided to indicate engine cooling water temperature.	W,D	Comply: The engine assembly is equipped with a water temperature gage. Technical Data #38
624f	**Control Panel.** All instruments of control such as gages, switches, indicators and coils should be placed on a suitable board secured to the unit at a suitable point.	W,D	Comply: An operating control and instrument mounting board is provided. Technical Data #28
624g	**Factory Wiring - Automatic Controller.** All connecting wires for the automatic controller shall be harnessed or flexibly enclosed, mounted on the engine and connected in an engine junction box to terminals numbered to correspond with numbered terminals in the automatic controller, for ready wiring in the field between the two sets of terminals.	W	Comply: All wires are enclosed in ridged or flex conduit. Wires are terminated in a professional manner on numbered and labeled terminal blocks.
624h	**Main Battery Contactors.** Main battery contactors shall be manually operable in case of control circuit failure.	W,D	Comply: The main battery contactors can be manually operable. Technical Data #38
625	**Starting Methods.**		Title

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
625a	Compression ignition diesel engines should preferably be equipped with an electric starting device taking current from a storage battery, but may be started by other reliable means.		Information Only
625b	If air starting of diesel engines is used with air pressure in excess of 100 pounds gage pressure, the air tanks shall be so located or guarded as not to be subject to mechanical injury. For air starting there shall be at least two containers each sufficient for six consecutive starts without recharging. There shall be a separate air compressor, suitably powered, or means of obtaining air from some other system shall be installed, independent of any compressor driven by the engine operating the fire pump. Automatic maintenance of air pressure is preferable, but in all cases suitable supervisory service shall be maintained to indicate high and low pressure conditions.	W,D	Does Not Apply: The diesel engines supplied for the vertical fire pumps at Donald C. Cook Plant are not started by air pressure. Technical Data #38
625c	If a gasoline starting engine is used to crank the diesel engine, or gasoline is used in connection with electric ignition, the handling and storage of gasoline shall be as required for gasoline engine driving of centrifugal fire pumps. NOTE: Electric current for ignition may be taken from the storage battery or from a high tension magneto.	W,D	Does Not Apply: The diesel engines supplied for the vertical fire pumps at Donald C. Cook Plant are not gasoline starting. Technical Data #38

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
625d	Gasoline engines shall be equipped with an electric starting device taking current from the storage battery.	W,D	Does Not Apply: See comments from section 625c.
626	**Storage Battery.**		Title
626a	**General.** The battery shall have sufficient capacity, at 40°F, to maintain the engine manufacturer's recommended cranking speed during the following 6 minute cycle (15 seconds crank and 15 seconds rest in 12 consecutive cycles). The fire pump manufacturer shall provide a certification that the battery which was furnished complies with this requirement.	D	Does Not Comply: A discharge test must be performed or existing batteries must be replaced with batteries of known capacity. Note: Batteries are being upgraded in accordance with this code by RFC-12-3028.
626b	**Lead Acid.** Batteries shall be furnished in a dry charge condition with electrolyte liquid in separate container. Electrolyte should be added at the time the unit is put into service. The battery shall then be given a conditioning charge to bring the electrolyte up to its designated specific gravity.	D,W	Comply: Batteries are charged using a trickle type battery charger. Technical Data #38
626c	**Nickel Cadmium.** A nickel cadmium alkaline type battery may be used where desired in place of the lead acid battery described above.	W,D	Does Not Apply: These type batteries are not utilized on the system at Donald C. Cook Plant. Technical Data #38
626d	**Recharging.** Two ways of recharging storage batteries shall be provided. One shall be the generator furnished with the engine. The other shall be an automatically controlled charger taking power from an alternating power source. (Other charging methods must be specified if a reliable alternating power source is not available.)	W,D	Comply: Batteries can be charged by an automatically controlled charger taking power from an A.C. source. They are also charged by the engine generator. Technical Data #38

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
626e	Chargers.		Title
626e1	All chargers shall be specifically approved for fire pump service.	D	Does Not Comply: The battery chargers are U.L. listed, but not for fire pump equipment. Technical Data #55 Justification: This report shows that the chargers do not lower the level of safety of the fire pump system as proscribed by NFPA 20. Satisfactory performance of the chargers has been proven by testing requirements and over fifteen years of successful operation.
626e2	The rectifier shall be of the semiconductor type.	D	Comply: Sealed silicone diodes are are used for rectification. Technical Data #55
626e3	The charger for a lead acid battery shall be of a type which automatically reduces the charging rate to less than 500 milliamperes when the battery reaches a full charge condition.	D	Comply: The charger reduces the charging rate automatically to less than 500 milliamperes when the batteries are fully charged. Technical Data #55
626e4	The control equipment incorporated in an "off-on" type of charger for a lead acid battery shall start the rectifier hourly and automatically shut off when the battery has been fully charged.		Does Not Apply: The charger is not "off-on" type.
626e5	The charger for a lead acid battery shall be capable of delivering a current within the range of 50 to 100 per cent of the 20-hour discharge rate of the battery.		Does Not Comply: Twenty hour discharge rate of the battery is unknown. See Section 626A

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
			Note: Batteries are being upgraded in accordance with this code by RFC-12-3028.
626e6	The above charging rates apply to lead acid batteries and should be modified in accordance with the battery manufacturer's recommendation when nickel-cadmium batteries are supplied.	W	Does Not Apply: Nickel Cadmium batteries are not installed at Donald C. Cook Plant.
626e7	An ammeter of an accuracy of 5 per cent of the normal charging rate shall be furnished to indicate the operation of the charger.	D	Comply: A quality D.C. ammeter with an accuracy of ± 2% is installed on the charger. Technical Data #55
626e8	The charger shall be so designed that it will not be damaged or blow fuses during the cranking cycle of the engine when operated by an automatic or manual controller.	D	Comply: Inherent current limiting excludes the need for engine cranking disconnect relays. Technical Data #55
626e9	A single charger that automatically alternates from one battery to another on an hourly cycle may be used on two battery installations.		Information Only
626e10	A manual charge switch with indicator light shall be provided or in lieu thereof, the charge shall automatically charge at the maximum rate when required by the state of charge of the battery.	D	Does Not Comply: No indicator light exists on the battery charger. The charge will not automatically switch to the maximum rate when required by the state of the battery. Justification: An indicator light is not perceived to be an intregal part of the charger's operations. The level of safety of the fire pump system is not perceived to be significantly lowered by this deficiency.

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
626f	Location. Storage batteries shall be substantially supported, secured against displacement, and located where they will not be subject to excessive temperature, vibration, mechanical injury, or flooding with water, and are readily accessible for servicing. Location at the side of and level with the engine is recommended to minimize battery to starter lead length.	W,D	Comply: Batteries are substantially supported above the floor and stored in a climate controlled environment. Technical Data #10
627	Cooling.		Title
627a	The engine cooling system shall be of the closed circuit type including a circulating pump driven by the engine, a heat exchanger and a reliable engine jacket temperature regulating device ("Fail-Safe" type of thermostat). An opening shall be provided in this circuit for filling the system, checking coolant level, and adding make-up water when required.	W,D	Comply: The engine cooling system on the 25000 Mark II meets this section of the code. Technical Data #38, 48
627b	The cooling water supply for the heat exchanger shall be from the discharge of the fire pump taken off prior to the pump discharge valve. Threaded rigid piping shall be used. The pipe connection shall include a manual shut-off valve, a strainer, a pressure regulating valve, an automatic electric solenoid valve (when required) and a second manual shut-off valve. Provision should be made for a pressure gage to be installed in the cooling water supply system on the engine side of the last control valve.	D,W	Comply: The cooling water supply is taken from the pump discharge and consists of rigid piping, manual shutoff valves, strainer and a process actuated diaphragm valve. NOTE: The strainer is upstream from the cooling water supply piping. No pressure gauges exist, however, it is only a recommendation to install pressure gages in the cooling water supply piping and not a requirement. Technical Data #14

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
627c	A by-pass line with a manual valve shall be installed around the manual shut-off valve, strainer, pressure regulating valve, automatic solenoid valve (when required) and second manual shut-off valve (See Fig. 627.)	D,W	Comply: A bypass line exists around the manual shut off valves and pressure regulating valve. NOTE: The strainer is upstream from the cooling water supply piping. Technical Data #14, 20
627d	An outlet shall be provided for the waste water line from the heat exchanger, and the line shall be at least one size larger than the inlet line. The outlet line shall be short, with the discharge into a visible open waste cone, and no valves shall be used in this line.	D,W	Comply: An outlet line (one size larger than the inlet line) is provided for the waste water from the heat exchanger which meets these requirements. Technical Data #14, 20
627e	A water jacketed (cooled) exhaust manifold shall be used since no fan is available to dissipate heat and to avoid hazard to operators or flammable material adjacent to the engine. This exhaust manifold should be cooled by raw water discharging from the heat exchanger.	D	Comply: A small amount of coolant passes through the heat exchanger to the rear of the water cooled exhaust manifold. Technical Data #38
628	Carburetion.	D	This entire section has been omitted since a carburetor is not needed on these engines. Technical Data #38

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
629	Anti-dieseling Devices.	D	This entire section has been omitted Since no gasoline fired engines are used at Donald C. Cook Plant. Technical Data #11, 38, 40
630	Location.		Title
631	Construction.		Title
631a	While it may not always be possible to locate a fire pump driven by an internal combustion engine in a separate pump house it is in every case highly important that the pump room be wholly cut off by noncombustible construction of a heavy character.	D,W	Comply: The diesel engine fire pumps are installed in separate fire areas. Technical Data #40
631b	Floors should be pitched for adequate drainage of escaping water or fuel away from critical equipment such as pump, driver, controller, fuel tank, etc.	W	Comply: The floors are pitched to drains which are located a reasonable distance from critical equipment.
631c	Where fire pumps constitute the entire water supply or where they constitute the major water supply, gasoline engine driven fire pumps located in the same room with fire pumps driven by other methods should, because of their possible fire hazard, have a heat resistant barrier wall to isolate the gasoline engines from other pumping units.	W,D	Does Not Apply: No gasoline engine fire pumps are used at Donald C. Cook Plant. Technical Data #11

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
632	**Ventilation.**		Title
632a	Means for thorough ventilation shall be provided, adequate for engine air supply and for removal of hazardous vapors.	W,D	Comply: Adequate ventilation exists for supply and exhaust. Technical Data #10
632b	Gasoline engine driven fire pump units should not be installed in depressed pump rooms. Installation shall be such that escaping gasoline vapors cannot accumulate in the pump room or vicinity.	D	Does Not Apply: No gasoline engine fire pumps are used at Donald C. Cook Plant. Technical Data #11
640	**Fuel Supply Arrangement.**		Title
641	**Review of Plan.** Before any system is installed the authority having jurisdiction should be consulted as to the system proposed to the end that the suitability of the system for conditions be determined.	D	Comply: Drawings were all approved by the purchaser prior to installation Technical Data #2, 3, 4, 5
642	**Guards.** A guard or protecting pipe shall be provided for all exposed fuel lines.	W	Comply: Fuel Lines are adequately protected and/or supported.
643	**Diesel.**		Title

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
643a	**Capacity Diesel Fuel Supply.** The capacity of the main diesel fuel supply tank shall be determined by conditions and subject to special consideration in each case by the authority having jurisdiction; minimum storage capacity shall be sufficient to operate the engine for at least eight hours, and a greater capacity should be provided in places where prompt replenishment of supply is unlikely. There shall be a separate fuel line and fuel tank for each engine. Where multiple engine driven pumps are used, the fuel lines shall be interconnected and valved so that all engines may continue to operate even though one or more fuel tanks may be out of service. NOTE: Allow one pint of diesel fuel per horsepower per hour.	D	Does Not Comply: A 275 gallon tank exists for both engines - one tank per unit. This capacity is 92% of the one pint per horsepower per hour requirement. Justification: The tanks can be supplied from the back up heating boiler fuel oil pumps located on site. The tank can also be filled manually from outside the pump room. Technical Data #51, 60
643b	**Location Diesel Fuel Supply.** The tank shall be located in accordance with municipal ordinances, and requirements of the authority having jurisdiction. Means shall be provided for determining the amount of fuel in the storage tank. The tank should have suitable filling and vent connections.	W,D	Comply: Plans and specifications were reviewed and approved prior to installation of the tank. Suitable filling and vent connections exist. A level gage exists for determining the amount of fuel in the tank. Technical Data #50, 51
643c	**Diesel Fuel Piping.** NFPA Standard for the Installation of Oil Burning Equipment (No. 81) may be used as a guide. A suitable flexible connection of approved metallic type shall be provided in the fuel line where it connects to the engine fuel piping. No shutoff valve shall be installed in the fuel return line to the tank. (See Figs. 643a and 643b for suggested arrangements.)	D,W	Comply: Braided metallic hose is used on all connections to the engine. No shutoff valve exists in the return piping to the tank. Technical Data #51

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
644	Natural Gas.	D	This entire section has been omitted since natural gas is not used to drive the internal combustion engines driving the vertical fire pumps. Technical Data #14, 20, 49, 2, 3, 4, 5, 11
645	Gasoline.	D	This entire section has been omitted since gasoline is not used to drive the internal combustion engine driving the vertical fire pumps. Technical Data #14, 20, 2, 3, 4, 5, 11
646	Gasoline Piping.	D	This entire section has been omitted. See comments from Section 645.
650	Exhaust Piping		Title
651	Exhause Piping. Exhaust from the engine shall be piped to a safe point outside the pump room and arranged to exclude water. A seamless or welded corrugated (not interlocked) flexible connection shall be made between the engine exhaust outlet and the exhaust pipe. The exhaust pipe shall be as short as possible and not over 15 feet unless the size of exhaust pipe is increased at least one pipe size, and shall be properly insulated from combustible material. Muffler, receiving vessel or other attachments which may accumulate unburned gases are not recommended, but if used shall not be located in the pump room. Exhaust gases should not be discharged where they will affect persons or endanger buildings, flues or stacks. A free and independent exhaust is essential to reliability of the equipment.	D,W	Comply: Exhaust is piped through the roof. A flexible connection is made at the engine exhaust outlet. The exhaust pipe is as short as possible and the muffler is on the roof. Technical Data #14, 20

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
660	**Maintenance.**		Title
661	**General.** Internal combustion engines necessarily embody moving parts of such design and in such number that the engines cannot give reliable service unless given intelligent care. The manufacturer's instruction book covering care and operation should be preserved and pump operators should be familiar with its contents and should observe in detail all of its provisions.	D	Comply: Copies of the manufacturers instruction books on care and operation of the engines exist in the AEP system. Technical Data #38
662	**Weekly Run.** The engine shall be started at least once a week and run for at least thirty minutes to bring it up to normal running temperature and to make sure that it is running smoothly at rated speed.	D	Comply With Exception: The diesel engines installed at Donald C. Cook Plant are tested monthly as required by the Tech Specs. The authority having jurisdiction (NRC) has agreed to this testing frequency. Technical Data #53
663	**Fuel Tank.** The fuel storage tank shall be kept well supplied. This tank should always be filled through a strainer funnel designed to withold any water or other foreign matter that may be present. Any service tank shall also be kept full. Note: Gasoline deteriorates with age. It is therefore desirable that gasoline storage tanks be drained and refilled with fresh supply at lease once each year. The occasional use of an upper lubricant is desirable for smooth operation of the engine and preventing sticking valves.	W,D	Comply: The fuel tank is kept above 160 gallons as required by the Tech Specs. The authority having jurisdiction (NRC) has agreed to this minimal level of fuel. Filling is done from outside of the pump room or via the back up heating boiler fuel oil pumps. The tank is inspected at least every 31 days per Tech Spec requirements. In addition, the diesel fuel is sampled for quality every 92 days per Tech Spec requirements. Technical Data #53, 50

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
664	Engine Upkeep. The engine should be kept clean, dry and well lubricated, and the proper oil level should be maintained in the crankcase. Oil should be changed in accordance with engine manufacturer's recommendations, but at least annually.	W	Comply: Engine is clean, well lubricated and the oil level is adequate.
665	Storage Batteries.		Title
665a	Storage batteries should be kept charged at all times and tested frequently with a hydrometer to ascertain the condition of the cells and the amount of charge in the battery.	D	Comply: Batteries are checked at least every seven days. Technical Data #53
665b	Distilled water only should be used in storage battery cells and the plates should be kept submerged at all times.	D	Open Item: No documentation could be found to verify this requirement. Justification: This statement is only a recommendation. Past performance testing has determined that the batteries will work when needed.
665c	An automatic battery charger is not a substitute for proper maintenance for the battery and charger. Periodic inspection of the battery and the charger shall be made. This inspection should determine that the charger is operating correctly, the water level in the battery is correct, and the battery shall be checked by means of a hydrometer to show it is maintaining its proper charge.	D	Comply: The fire pump diesel starting battery bank and chargers are demonstrated operable per the plant technical specifications. Technical Data #53
666	Temperature.		Title
666a	Pump room temperatures must be maintained above 40°F. (see 41e)	D	Comply: Pump rooms are maintained above 40°F. Technical Data #10

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
666b	Diesel engines, at temperatures below 70°F, may require some form of starting aid as recommended by the engine manufacturer.		Information Only
666c	Automatically started engines should be installed in enclosed pump rooms where a minimum temperature of 60°F for gasoline engines and 70°F for diesel engines is maintained.	D	Comply With Exception: This statement is only a recommendation. The diesel fire pump rooms at Donald C. Cook Nuclear Plant are kept at a minimum temperature of 60°F. Past performance testing has not determined that this minimum room temperature causes problems with engine starts.
666d	Since fire pump engines must carry full load as soon as started, automatic heaters should be employed to maintain jacket water temperatures of liquid cooled engines at (a minimum of 120°F) or near operating temperatures. This may be accomplished through the circulation of hot water through heating of engine water by electric elements inserted into the block. The benefits to be gained are (1) quick starting, (2) reduction in engine wear, (3) reduced drain on batteries, (4) reduced oil dilution, (5) reduction in carbon deposits, and (6) with gasoline fueled engines it becomes possible to adjust the automatic choke so that the engine is far more likely to start every time.	W	Open Item: This statement could not be verified. Justification: This section of the code is only a recommendation. The pumps have proven to be operable by appropriate plant testing procedures. It is felt that automatic heaters will not significantly increase the reliability of the fire pumps.
667	**Parts.** Spare parts of such portions of the machine as may be expected to give trouble should be kept on hand.	W	Comply: Spare pump parts are maintained in storage at Donald C. Cook Plant.

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
	CHAPTER 800 - STEAM TURBINE DRIVE		This entire chapter is omitted since steam turbine drive is not utilized at Donald C. Cook Plant for driving fire pumps.
	PART III - ACCEPTANCE, OPERATION AND MAINTENANCE		
	CHAPTER 900 - TESTS AND INSTRUCTIONS		Title
910	Field Acceptance Tests.		Title
911	Those Present. The pump manufacturer shall have an engineer present at the field acceptance tests when requested by the installing contractor.	D	Open Item: No documentation could be found that states the pump manufacturer was at field acceptance test. Justification: The installing contractor was the plant owner. If the pump manufacturer was not present at the acceptance test, then they were not requested to be there by the installing contractor.
912	The field acceptance test results shall be as good as the manufacturer's certified shop test characteristic curve for the pump being tested within the accuracy limits of the test equipment.	D	Comply: Results were acceptable. Technical Data #6, 7, 8, 9, 54
913	If pump takes suction under a lift, the suction pipe should be drained if possible before tests are started so that the maximum time requried to start the pump with available priming facilities can be determined and conditions remedied if necessary.	D	Comply: Due to the short length of column and shaft from the underside of the discharge head to the bottom of the suction inlet, the water reaches the bearings almost instataneously which eliminates the need for a prelubrication system. Technical Data #52

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
914	Overheating. As installed, at operating speed, the pump shall be able to operate at peak load conditions without objectionable heating of the bearings or of the prime mover. The operating pump speed shall be the speed at which the pumping unit would be expected to operate during a fire, for example:	W,D	Comply: Testing demonstrated proper operation of the pumps. Significant (as stated in Section 624) safety controls exist on the pumps to assure that the pump will not be damaged due to overheating. Technical Data #6, 39, 54
914a	A squirrel cage electric motor has no speed control and would normally drive the pump slightly in excess of rated pump speed at all loads.		Information Only
914b	Combustion engines and steam turbines under manual control (and automatic control where speed adjustment is easily obtained) have their speed adjusted to rated pump speed at maximum (peak) pump load.		Information Only
915	Operating Conditions.		Title
915a	By varying the number and/or size of the discharge outlets in connection with tests (Section 912) the operating conditions under minimum to peak loads shall be determined.	D,W	Comply: Pump tests range from zero flow to 150% rated flow. Technical Data #6, 42, 54
915b	During such test:		Title
915b1	For electric motors at rated voltage (and on a.c. motors at rated frequency), the full load ampere rating should not be exceeded (except as allowed by the service factor stamped on the nameplate) under any conditions of pump load.	W,D	Comply: Rated voltages were recorded during operating conditions of the electric fire pumps. Technical Data #54

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
915b2	For electric motors under conditions of acceptable high or low voltage, the product of the rated voltage (and on a.c. motors at rated frequency) and rated full load current will not be exceeded (except as allowed by the service factor stamped on the nameplate). The voltage at the motor should not vary more than 5 per cent below or 10 per cent above rated (nameplate) voltage during test (see Paragraph 432d).	W,D	Comply: Satisfactory rated voltages and full load currents were obtained for the electric driven fire pumps. Technical Data #54
915b3	An internal combustion engine shall not show signs of overload or stress and its governor shall properly regulate the speed (see Paragraphs 624a and b).	W D	Comply: Suitable safety controls (see Section 624) exist to shut the engine down if it is necessary. The pump performed satisfactorily during pre-operational testing. Technical Data #38, 42, 54
915b4	A steam turbine shall maintain its speed within the limits specified in Paragraphs 822 a, b, and c.	D	Does Not Apply: Steam turbines are not utilized at Donald C. Cook Plant. Technical Data #11
915c	With discharge outlets open (corresponding to the outlets used in test at peak load) pump shall be started and brought up to rated speed without interruption due to opening of circuit breaker or other cause.		Open Item: No information could be found to determine how the pumps were started during initial testing. Justification: Field tests have proven that the capacity of the motors is not exceeded under any condition of pump load.
916	Controllers.		Title

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
916a	Manual controllers for pumps shall be put through not less than ten complete operations.	W	Does Not Apply: Manual controllers are not installed at Donald C. Cook Nuclear Plant.
916b	Combined manual and automatic controllers shall be put through not less than ten automatic and ten manual operations.		Open Item: This statement could not be verified by existing technical data. Justification: It is felt that the rigorous plant testing requirements performed on the fire pumps over the last fifteen years more than prove the controllers will work satisfactorily when needed.
916c	A running interval of at least five minutes at full speed should be allowed before repeating the starting cycle.		Open Item: This statement could not be verified by existing technical data. Justification: This section of NFPA 20 is only a recommendation. The intent of this section is to prevent rapid starting and stopping of the motor as this condition would affect the motor life. It is obvious by the more than fifteen years of successful service that the motor was not effected by the acceptance tests.
916d	Automatic operation of the controller shall start the pump from all the provided starting features, such as pressure switches, deluge valves, etc.		Open Item: This statement could not be verified by existing technical data.

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
			Justification: Automatic operation of the controllers from remote starting features is verified through surveillance test procedures.
916e	Electric motor shall attain rated speed within ten seconds.		Open Item: This statement could not be verified by existing technical data. Justification: Newer versions of the NFPA 20 code no longer require this test to be performed.
917	**Emergency Governor.** On turbines for pumps the emergency governor valve shall be tripped (Hand tripping will be accepted.)	D	Does Not Apply: Turbine fire pumps are not utilized at Donald C. Cook Plant. Technical Data #2, 5, 11, 40
918	**Length of Test.** The pump shall be in operation not less than one hour (total time) during the foregoing tests.		Open Item: No documentation could be found to verify that the pumps ran for one hour during initial testing. Justification: The fire pumps have been in operation well in excess of one hour since their installation at the Donald C. Cook Plant.
921	**At the Alarm.**		Title
921a	When an alarm is given, do not wait to see how serious the fire may be, but get pump started as soon as possible and maintain its rated speed, pumping into sprinkler and hydrant systems.		Information Only

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
921b	Do not be afraid to run a centrifugal fire pump at its full rated speed, even if the demand for water is small. The characteristic curve or the relief valve will usually keep pressures within reasonable limits. NOTE: The best way to prevent a small fire from becoming a large one is to give the sprinklers a liberal high pressure water supply at the start. Fifty open sprinklers may take the full capacity of a 750-gpm pump. Even with a good public water supply the opening of a large number of sprinklers often materially reduces the pressure so that the pumps are needed to reinforce the public supply and insure ample water at good pressure.		Information Only
922	To Start a Centrifugal Pump.		Title
922a	Never start or run a centrifugal pump before priming or first filling case with water; otherwise the interior wearing rings that depend on water for lubrication may be damaged and the pump made inoperative.		Information Only
922b	If pump is primed from a tank or other gravity supply, the pump may be started as soon as water shows at vent cocks. If primed by an exhauster, action of the device will indicate when casing is filled with water.		Information Only
922c	Close attention should be given to the bearings and stuffing boxes during the first few minutes of running to see that there is no heating up or need of adjustment. With water seal supplied with water, a small leak at stuffing box glands is		Information Only

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IMAGE EVALUATION
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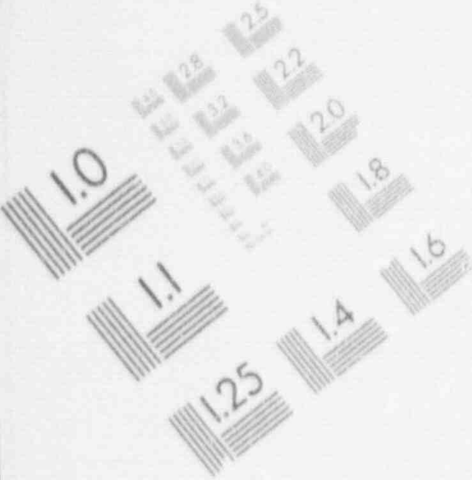

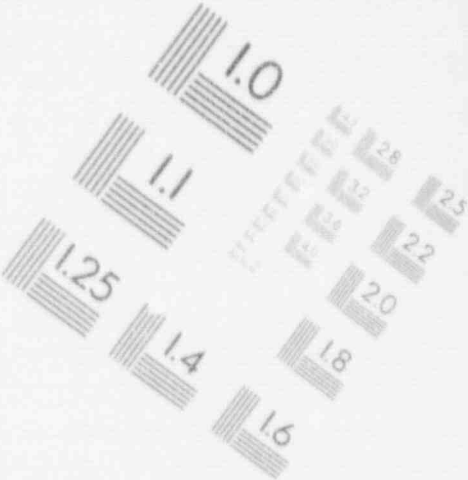

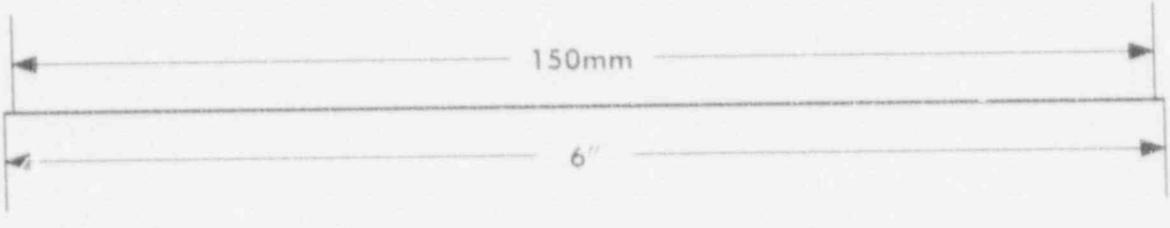

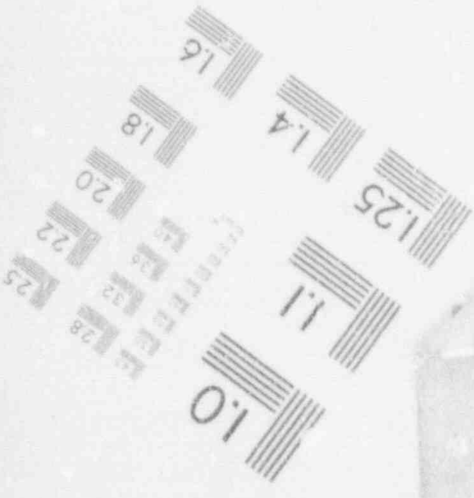

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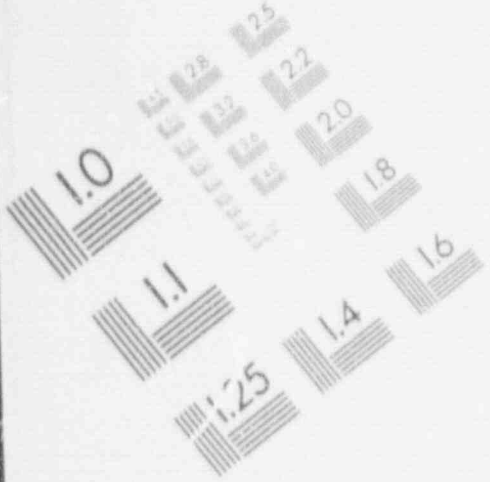

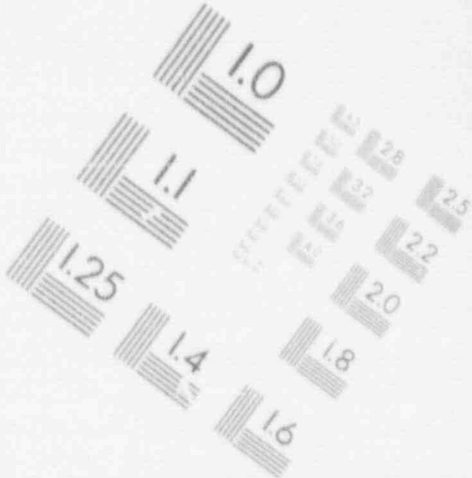

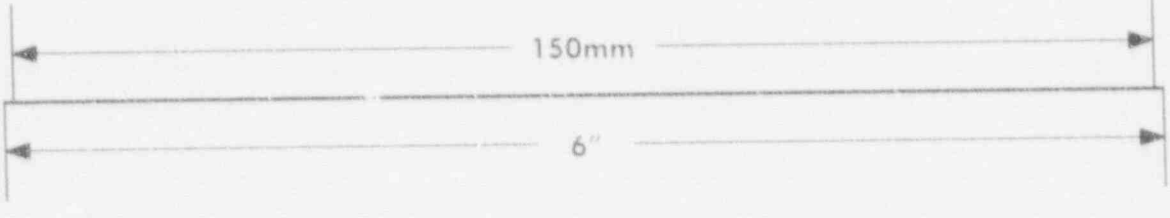

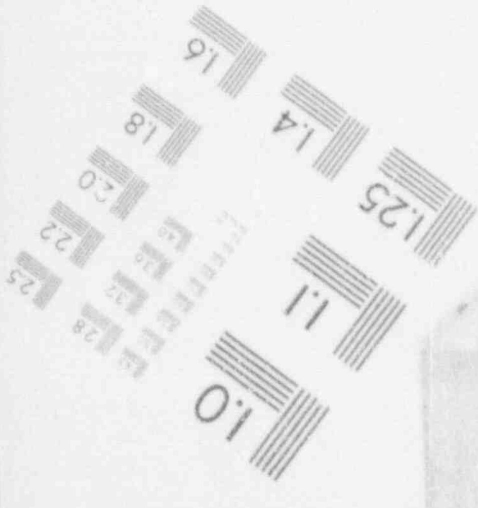

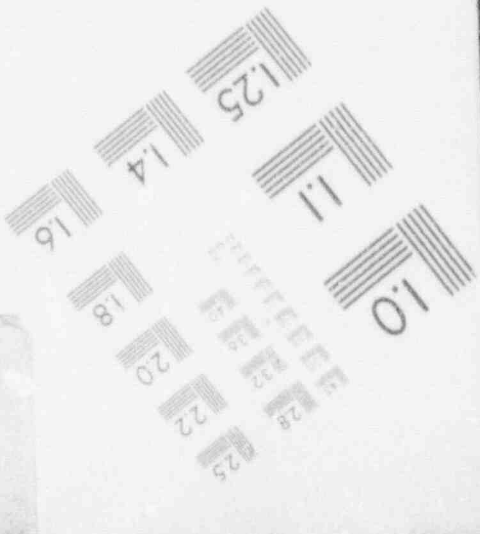

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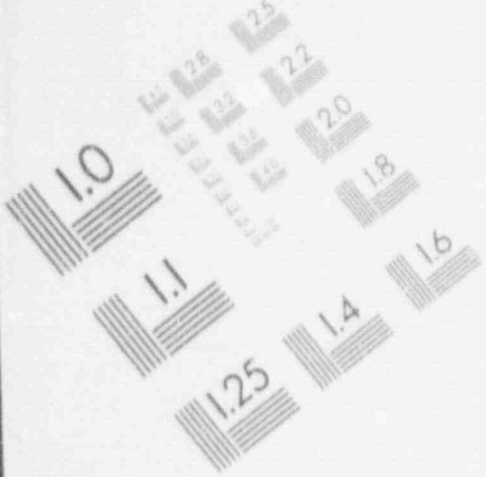
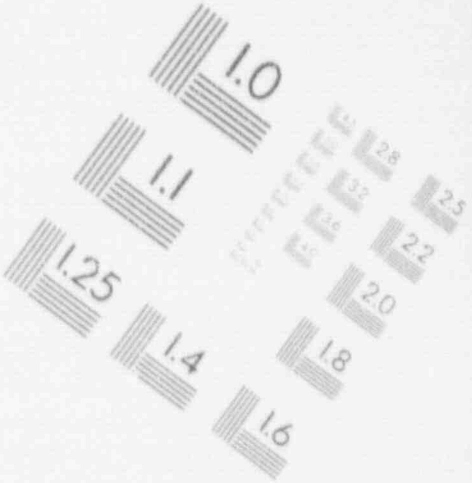
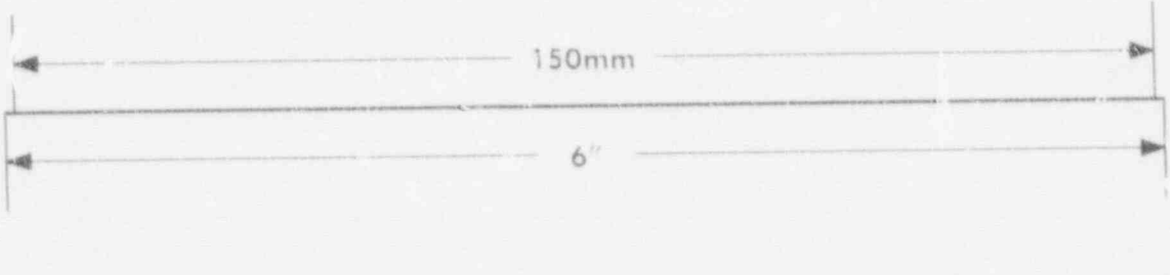
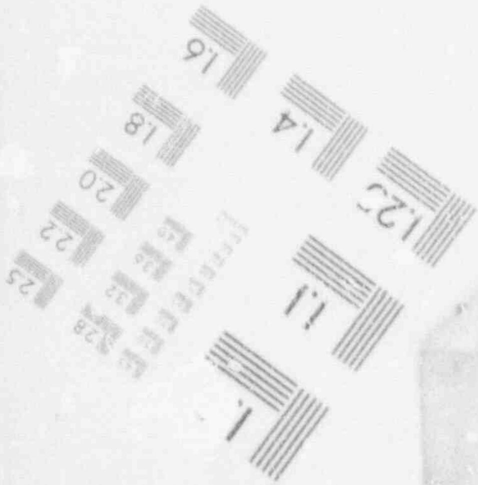
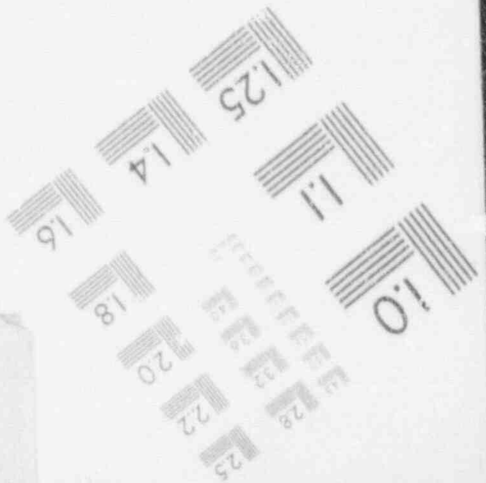
TEST TARGET (MT-3)











Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
	necessary to seal, lubricate and cook the packing. The suction inlet gage as well as the discharge pressure gage should be read occasionally to see that inlet is not obstructed by a choked screen or foot valve.		
923	**Motor-driven Pump.** To start a motor driven pump the following steps should be taken in the order given below:		Information Only
923.1	See that pump is competely primed.		Information Only
923.2	Note that normal voltage is indicated at voltmeter.		Information Only
923.3	Close isolating switch and then close circuit breaker.		Information Only
923.4	Operate starter without undue haste, observing ammeter at each step to avoid excessively large starting currents which may cause circuit breaker to open. NOTE: Circuit breaker tripping mechanism should be so set that it will not operate except when current in circuit is excessively large.		Information Only
924	**Turbine Driven Pump.** To start a steam turbine driven pump, steam should be admitted slowly at first to permit warming up of turbine casing before allowing full head of steam upon the turbine. If the pop safety valve on the casing blows, steam should be shut off and the exhaust piping examined for a possible closed valve or an obstructed portion of piping. Steam turbines are provided with governors to maintain speed at	D	Does Not Apply: Steam turbines are not utilized for the fire pumps at Donald C. Cook Plant. Technical Data #11

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
	a predetemined point, with some small adjustment for higher or lower speeds. Desired speeds below this range may be had by throttling main throttle valve.		
925	**Internal Combustion Engine Driven Pump.**		Title
925a	To start an internal combustion engine driven pump one should familiarize himself beforehand with the operation of this type of engine. The Instruction Book issued by the engine manufacturer should be studied to this end.		Information Only
925b	The storage batteries should always be maintained in good order to insure prompt satisfactory operation of these equipments.		Information Only
925c	Replacement storage batteries shall comply with the performance requirements of Section 626.		Information Only
930	**Care of Pump.**		Title
931	**Weekly Tests.** A centrifugal pump should be operated every week at rated speed with water discharging through some convenient opening. This is desirable to make sure of the condition of the pump, bearings, stuffing boxes, suction pipe and strainers, and the various other details pertaining to the driver and control equipment (see Paragraphs 515d1, 662, 715d1 and 715d5). When automatically controlled pumping units are to be tested weekly by manual means at least one start shall be accomplished by reducing the water pressure either with the test drain on the pressure sensing line or with a larger flow from the entire system.	D	Comply With Intent: This section of NFPA 20 is a recommendation. Plant personnel verify fire pump operability monthly in accordance with Tech Spec requirements. The authority having jurisdiction (NRC) has approved this test frequency.

Code Section No.	Code Section	Information Obtained By: W-Walkdown D-Document	Summary of Results
932	**Yearly Test**. A yearly test at full capacity and over is necessary, to make sure that neither pump nor suction pipe is obstructed.	D	Comply With Intent: This section of NFPA 20 is a recommendation. Plant personnel perform full flow pump test on an eighteen month test frequency per Tech Spec requirements. This frequency has been approved by the authority having jurisdiction (NRC). Technical Data #42
933	Keeping of Pump Room. Pump rooms should be kept clean, orderly, free from miscellaneous storage, well lighted and heated.	W	Comply: Pump rooms are kept clean, orderly and free from storage. The pumps are installed in heated areas which are well lit.
934	Readiness. Always keep the pump ready to start at a moment's notice.	W	Comply: Pumps are always ready to start. The operability of the pumps is maintained through the Tech Spec requirements. When the pumps are determined to be inoperable, the Tech Spec ACTION statements are followed until the pumps are returned to operable status.

Attachment 6.4

NFPA 20 Compliance Evaluation

Electrical Evaluation Section

REFERENCES - (Electrical/Instrumentation & Controls) (Technical Data)

E1	National Electrical Code (NFPA No. 70)	1971
E2	Drawing 1-2-98966	6-18-88
E3	Drawing 1-2-98971	3-14-88
E4	Drawing 1-12002	10-6-86
E5	Drawing 2-12002	10-6-86
E6	Drawing 1-12014	10-6-86
E7	Drawing (Numerous Wiring Diagrams)	
E8	Drawings (Numerous Conduit & Cable Schedules)	
E9	ECP 1-2-Z0-02	7-14-88
E10	Relay Setting Sheets	
E11	Vendor Manual (LA Marche Battery Charges)	
E12	Donald C. Cook Voltage Performance Study	12-XX-85

JDM/cld/2442

CODE COMPLIANCE VERIFICATION CHECKLIST
NFPA 20 - 1969
CENTRIFUGAL FIRE PUMPS

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
PART II - DRIVE AND DRIVE CONTROLLERS FOR PUMP.			
Chapter 400 -- Electric Drive			
410.	GENERAL	D,W	Title Technical Data #E1
411.	ELECTRICAL EQUIPMENT. Electrical equipment shall comply with the National Electrical Code (NFPA No. 70), except as modified or provided herein. NOTE: See Par. 2421 of the NFPA Standard for Installation of Sprinkler Systems (NFPA No. 13) regarding supervision of centrifugal fire pumps constituting the sole sprinkler supply.	D,W	Does not comply: The electrical equipment at Donald C. Cook does not comply with the National Electric Code verbatim. Technical Data #E1 Explanation: Our perception of the intent of the NEC has been met. The deviations that exist with NFPA 70 are perceived to be insignificant to reliability, operation and maintenance.
420.	POWER STATION.		Title
421.	SINGLE POWER STATION. When current is taken from a single power station, the station should be of noncombustible construction, so located or protected as to be free from chances of serious damage by exposure from fire, and the design and arrangement of apparatus within it such that there will be but little chance of interruption of service.		Does not comply. (See comments of article 422.)

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
422.	FROM A SUB-STATION. Where current is taken through a sub-station this sub-station should also meet the requirement of Section 421 and in addition the number and arrangement of cables between the station and the substation should be such as to practically guarantee continuous power at the sub-station.	D	Comply: Backup power from alternate sources are provided at the 4kv supply busses. (The plant electrical distribution system including the 4kv busses and associated equipment are considered as a substation. See Appendix C of NFPA-20, figures and diagrams). Technical Data #E4 and E5 Title
423.	OTHER SOURCES		
423a.	Where service cannot be obtained from a power station or sub-station meeting these requirements, it should be obtained from two or more stations or sub-stations so located and equipped that an accident or fire at one will not cause an interruption of the service supplied by the others.		Does not apply: Service is obtained from a sub-station meeting the specified requirements of art. 422.
423b.	A private generating plant located on the premises served by the fire pump, if in a separate power house or cut off from main buildings, will be considered as a power station, and may be used as one source of current supply.		Does not apply: See comments of 423a.
430.	POWER SUPPLY LINES (See Fig. 430, Appendix C, for Illustrative Diagrams.)		Does not apply: See comments of 423a.

CODE COMPLIANCE VERIFICATION CHECKLIST
NFPA 20 - 1969
CENTRIFUGAL FIRE PUMPS

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
431.	TYPE OF LINES.		Title
431a.	The lines between the power plants and the pump room should be of such number, so arranged and so located that there will be small chance of an interruption of service to the motor, due to accident to the lines.	W	Comply: Power lines run to each pump independently. Circuits are enclosed in conduit and arranged such that there is a low probability of service interruption.
431b.	All wiring in the pump room shall be in approved rigid metal conduit, electrical metallic tubing or liquid-tight flexible metal conduit, or for 600 volts or less may be approved mineral insulated metal sheathed cable (type MI). NOTE: Where the monetary values involved are large and the crippling of this pump service would seriously affect the protection of the property, at least two separate lines from the power plant or plants to the pump installation should be provided. The lines should be run by separate routes or in such a manner that a failure of both at the same time will be only a remote possibility. Where current is taken from an underground Edison 3-wire system it will be considered that two independent lines have been provided if connections are brought into the pump room from two street mains or feeders not terminating directly in the same junction box.	W	Comply: All wiring in pump room is in rigid metal conduit.

CODE COMPLIANCE VERIFICATION CHECKLIST
NFPA 20 - 1969
CENTRIFUGAL FIRE PUMPS

Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
	A complete underground circuit from generating station to pump is strongly recommended and should be obtained when head circuit may be allowed, but that part of the circuit adjacent to the plant or exposing plants should be run with special reference to damage in case of fire. Where the pump room is a part of, or in close proximity to, the plant which the pump is designed to protect, the wires for some distance from the pump room should be underground.		
432.	CAPACITY OF LINES		Title
432a.	Each line between the power plant and pump room shall be of such size that its carrying capacity, as given by the National Electrical Code NFPA No. 70), will not be exceeded.	D	Comply Technical Data #E1 and E8
432b.	The voltage of the motors should not drop more than 5 per cent below the voltage rating of the motors when the pumps are being driven at rated output, pressure, and speed, and the lines between motors and power stations and carrying their peak loads.	D	Comply for all normal operating conditions. Technical Data #E12
432c.	Where squirrel cage motors are used, the capacity of the generating station, the connecting lines and transformers should be ample and such as not to cause the voltage to drop sufficiently to prevent the motor starting (not more than 10 per cent below normal voltage).		Comply: Voltage drop does not prevent motors from starting but voltage drop maybe as low as 14%. (Note: NFPA 20, 1987 Edition (6-3.1.4) allows a voltage drop of 15 percent at the controller).

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432d.	When 208-220 (or 208-220/440) volt motors are used on 208 volt nominal lines, the 5 per cent voltage drop allowed in 432b shall be figured from the 220 volt rating.	D	Does not Apply: 575 volt motors are used. Technical Data #E3
433.	POWER SUPPLY PROTECTIVE DEVICES (Fuses or circuit breakers).		Title
433a.	Such devices when installed in the power supply circuits at utility plants substations, or plant load distribution centers ahead of the fire pump feeder circuits shall hold indefinitely stalled rotor current conditions of the fire pump motor(s) under maximum plant load.	D	Comply: The 300 HP High Demand Fire pumps have power supply protective devices installed ahead of the fire pump feeder circuits which hold indefinitely stalled rotor current conditions of the motor. Technical Data #E3, E4, E5, and E10. Does not comply: The low demand fire pump does not meet this section of NFPA 20 verbatim. Technical Data #E6 and Vendor Information Justification: It is felt that these protective devices are required to hold indefinitely stalled rotor conditions because it is the NFPA commitee's belief that a fire pump is expendable. The intent is that a fire pump shall operate (and pump water) as long as possible in order to keep fighting a fire. The low demand fire pump at Donald C. Cook Plant does not have to keep running in a fire scenario as there are four 2,000 gpm at 152 psi fire pumps backing the low demand pump up. The low demand pump can, therefore, be shut down and no detrimental effects to fire fighting would occur. Therefore, it is felt that while this may be an important

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			feature in a single fire pump application, it is not necessary in our system arrangement due to the redundancy of fire pumps.
433b.	Such devices (fuses not recommended) when installed in the fire pump feeder circuit shall hold indefinitely stalled rotor current of the fire pump motor(s) and other necessary associated fire pump installation electrical accessories. NOTE: Each ungrounded conductor should be protected. See also 514b.	D	Does not comply. To meet this section of NFPA 20 verbatim, the feeder circuit breaker for the two 300Hp motors and the 75Hp motor would have to be replaced with appropriately higher ratings. Technical Data #E3, E4, E5, E6 and Vendor Information Justification: It is believed that the committee on centrifugal fire pumps has included this requirement in NFPA 20 to keep the fire pumps operating until an electrical failure occurs. This would allow the fire pumps to keep operating (and pump water) for as long as possible even if damage from over current may occur to the motor. This situation does not seem necessary at Donald C. Cook due to the redundant fire pumps. It can be said that two of the four high demand fire pumps can arguably extinguish the largest postulated fire. Therefore, while this requirement may be necessary in a single fire pump application, the redundant and independent fire pumps installed at Donald C. Cook Plant present a level of safety far more reliable than a pump in strict compliance with this section.

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440.	TRANSFORMERS		Title
441.	INSTALLATION. Transformers shall be installed in accordance with the requirements of the National Electrical Code (NFPA No. 70). If in the transformer room, there should be access from the outside of the building.	W	Comply: Transformers are installed in accordance with requiremens of NFPA 70. Access from outside of the building is only a recommendation and not a requirement of NFPA 20.
442.	ISOLATION. Transformers supplying current to the lights and motors in the building served by the fire pump may also supply the pump motor, provided all load except the pump motor load can be quickly cut off when necessary. Switches for doing this must be in the pump room unless transformer room is near pump room, in which case they may be in transformer room.	D	Information Only: This section of NFPA 20 is not a requirement; it is only a recommendation. Switches for cutting off other loads are located in a continuously manned control room. Technical Data -- Various Plant Drawings
443.	LOCATION. Room containing transformers installed solely to supply current to a pump motor must be dry and heated in cold weather, or else the transformers must be normally left connected to the supply lines.	D,W	Comply Technical Data -- Plant Drawings

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450	MOTORS		Title
451.	TYPES 600 VOLTS OR LESS. Electric motors are an accepted dependable source of power for operation of centrifugal fire pumps. All fire pump motors shall be rated for continuous duty and shall not be used at voltages in excess of 110 per cent of rated voltage. It is the pump manufacturers responsibility to provide a motor of ample size as specified in Section 453. Only motors wound for 200 or 208 volts shall be used for 208 volt services when the voltage may be less than that determined in accordance with 432d. Direct - or alternating-current motors may be used in accordance with the following requirements:	D,W	Comply: According to nameplates, the motors are rated for continuous duty. Motors are not used at voltages in excess of 110 percent of rated voltage. Technical Data E12
451a.	Direct-current motors shall be either of the stabilized shunt type, or cumulative compound-wound type. The speed of the motor at no load hot shall not exceed the speed at full load hot by more than 10 per cent.		Does not apply: No direct current motors are used for fire pumps.
451b.	Alternating current motors may be of the squirrel-cage induction type with across-the-line type starting equipment unless their starting characteristics would be objectionable to the company furnishing the power, in which case primary resistance primary reactor or auto-transformer type starting may be employed, or a wound rotor type of motor with appropriate starting equipment may be substituted.		Information only

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451c.	Squirrel-cage induction motors should have normal starting and breakdown torque. The locked-rotor current of three-phase, constant-speed, induction motors, measured with rated voltage and frequency impressed with rotor locked shall not exceed the following values: NOTE 1: In the foregoing table the locked rotor currents are for motors rated at 220 or 230 volts. They are approximately six times the full-load current. The corresponding values of locked rotor current for motors rated at other voltages shall be determined by multiplication of the values shown by the following factors: NOTE 2: Code letters of motors rated for 440 or 550 volts shall conform with those shown for 220 volts. Code letters of motor rated for 208 volts, 460 volts, 575 volts and all other voltages shall conform with those shown for 230 volts.	D,W	Comply: Locked-Rotor Indicating Code letter is G for the fire pump motors which meet intent of requirement. Technical Data E1
452.	TYPES -- IN EXCESS OF 600 VOLTS. All fire pump motors shall be rated for continuous duty and shall not be used at voltages in excess of 110 per cent of rated voltage. Voltages above 600 are not recommended for fire pump service, but where it is impracticable to use low voltage, higher voltages may be accepted by the authority having jurisdiction, for motor ratings of approximately 75 horsepower and larger at 2,300 volts and for motor ratings of approximately 100 horsepower and larger at 4,000 volts.	D	Does not apply: Fire pump motors do not exceed 600v. Technical Data #E3, E4, and E5

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453.	CURRENT LIMITS.		Title
453a.	All motors shall be of such capacity that at rated voltage (and on a.c. motors at rated frequency) their full load ampere rating will not be exceeded (except as allowed by the service factor stamped on the name plate) under any conditions of pump load.	D,W	Comply: Field tests confirm the capacity of the motors are not exceeded. Technical Data -- Field Documented Information
453b.	Motors used at altitudes above 3300 feet shall be operated or derated according to NEMA Standard MGI-14.14 (1963).	D	Does not apply: The fire pump motors are not used at an altitude above 3300 feet. Technical Data -- Plant Drawings
454.	MARKING.		Title
454a.	Marking of motor terminals shall be in accordance with the current American Standard C6 for Rotation, Connections and Terminal Markings for Electric Power Apparatus.	W	Comply

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454b.	A name plate shall be provided showing the following information: Direct-Current Motors. -- Manufacturer's type and frame designation. Rated horsepower output. Time rating. Voltage. Temperature rise or class of insulation. Ambient temperature. RPM at full load. Full load amperes. Shunt or compound wound. Alternating-Current Motors -- Squirrel-cage Motors -- Manufacturer's type and frame designation. Rated horsepower output. Time rating. RPM at full load. Frequency. Number of phases.	W	Comply: The nameplates for each motor provide the required information for squirrel-cage motors as specified in art 454b.

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	Voltage. Full load amperes. Code letter. Service factor, if other than 1.0. Temperature rise or class of insulation and ambient temperature.		
	Wound Rotor Induction Motor --		
	In addition to information required in previous paragraph, also show secondary amperes at full load and secondary voltage.		
455.	WATER PROTECTION.		Title
455a.	Open motors which are subject to possible splash of water from hose connections close to the pump, shall be protected against such splashing by some means such as a noncombustible, moisture-resisting partition, furnished by the pump manufacturer, installed between the pump and the motor.	W	Does not apply: motors are drip-proof type.
455b.	Drip-proof motors shall be arranged as described above unless the hose valves are located outside the pump room.	W	Does not apply: Hose connectons are not close to pump. (300 HP. High Demand)
455c.	Splash-proof motors shall be acceptable without splash partition as described above, providing the ventilating inlet and discharge are located so as to prevent impact of dripping or splashing water on windings or other energized mechanisms.		Does not apply: Motors are not splash-proof type.

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455d.	Motors to totally enclosed, fan cooled type shall be acceptable without splash partition. They shall be sealed at the joints and have conduit fittings arranged to prevent the entrance of water. NOTE: See item 19 in Appendix A-Glossary for a description of the various types of electric motors.	W	Comply: Motor is sealed at joints and has conduit fittings arranged to prevent the entrance of water (75 H.P. Low Demand)
456.	OTHER FEATURES.		Title
456a.	Motor shall be equipped with anti-friction ball or roller-type bearings mounted so as to be effectively sealed against dirt and moisture.		Comply with 1988 NFPA 20: More recent versions of NFPA 20 no longer require anti-friction ball or roller-type bearings. It is felt that the sleeve bearings are as reliable and pose no detrimental perils to the pump motor's performance. The pumps are tested at regular intervals, and to this date no problems with the bearings have been identified. In addition, the system as it stands now, is within the current guidelines concerning motor bearings.
456b.	Instructions as to lubrication and care of motor bearings shall accompany each motor.	W	Comply: Instructions are located on plates connected to motor housing.
456c.	The terminal box shall be of a type which can be arranged for attaching conduit at sides, top or bottom. A totally-enclosed fan-cooled motor shall be provided with a watertight conduit box.	W	Comply
456d.	Where unusual moisture or abrasive dust conditions are anticipated, motors shall be of special type or specially insulated to withstand such conditions. Under such conditions high voltage motors shall be totally enclosed.	W	Comply

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457.	CONFORMANCE. Motors furnished for centrifugal fire pump use shall be guaranteed to conform with these specifications.		Comply: The low demand fire pump has been confirmed to be in conformance with NFPA 20 (by Reliance). Does not Comply: The high demand fire pumps do not conform verbatim with NFPA 20. Justification: This report has proven that the high demand fire pump motors installed at Donald C. Cook Plant do not lower the level of safety as prescribed per NFPA 20. The motors and motors' applications meet or exceed the requirements of the specifications called out in Chapter 400 of NFPA 20.

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Chapter 500			
ELECTRIC DRIVE CONTROLLERS			
510.	Requirements for all Controllers.		Title
511.	GENERAL.		Title
511a.	The following specifications cover controlling equipment of the nonautomatic and automatic types for electric motors driving centrifugal fire pumps. Chapter 400 dealing with the electric motor drive also applies insofar as it is appropriate.		Information only
511b.	Automatic-type controllers are recommended for use only where the fire pump takes its water under positive pressure and their use is not recommended where a suction lift is involved.		Information only
511c.	All controllers shall be specifically approved for fire pump service.		Does not comply: The electric drive controllers utilized at Donald C. Cook Plant are NEMA industrial type controllers. Justification: The NEMA rated industrial type controllers utilized are not specifically approved for fire pump service. This report shows that the controllers do not lower the level of safety as prescribed by NFPA 20. Satisfactory performance of the controllers has been proven by testing requirements and over fifteen years of successful operation.

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511d.	The control panel shall be completely assembled, wired, and tested by the manufacturer before shipment from the factory.		Does not comply: The controllers were assembled and tested at the plant. Justification: The control panels were assembled and tested at the plant by qualified personnel. Satisfactory performance of the controllers hac been proven by testing requirements and over fifteen years of successful operation.
511e.	Voltages above 600 v are not recommended for fire pump service, but where it is impracticable to use a low voltage, higher voltages may be accepted by the authority having jurisdiction. High voltage controllers shall be rated at not more than 5000 v. (See Article 520).		Does not apply
511f.	Controllers conforming to this Standard shall be marked "Fire Pump Controller" and shall show plainly the name of the manufacturer, the identifying designation and the complete electrical rating.	W	Does not Comply: The controllers are not labelled as prescribed in NFPA 20. Justification: The label reads "High" (or Low) demand Fire Pump." The word "controller" does not appear on the label, nor is it considered necessary as this should be understood. Our perception of the intent of this section has been met.

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512.	LOCATION.		Title
512a.	The controller shall be located as close to as is practical and within sight of the motor.	D,W	Does not comply: The controllers are not within sight of the fire pump motors. Technical Data -- Plant Layout Drawings Justification: It is believed that the intent of this section is so that an operator is within sight of both the fire pump and the controller during start up of the pump. While an operator will not be able to see both the pump and controller at one time, ample communicating devices exist in the plant so that an operator in each room can confirm proper operation. In addition, the pressure gages and operating lights available in the continuously manned control room provide quick reference for the control room operators (and fire brigade leader) as to whether or not the system is operating normally. It is, therefore, felt that the fire pump system layout does not lower the level of safety as prescribed per this section.
512b.	The controller shall be so locked or protected that it will not be injured by water escaping from the pump or connections. Current carrying parts of the controller shall be not less than 12 inches above the floor level.		Does not comply: Current carrying parts are not greater than 12 inches above the floor. Technical Data -- Plant Drawings

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		D,W	Justification: The controllers are protected (by not being located in pump room) from escaping fire pump water. In addition, the controllers are so located that very little chance of contact with liquid exists. The rooms housing the fire pump controllers are protected with a fixed pipe total flooding CO_2 gas suppression system, and no other liquid filled pipes exist within this room.
512c.	A clearance of not less than 3 1/2 feet shall be provided at the rear of enclosures designed to be inspected and serviced from the rear.	W	Comply
513.	GENERAL CONSTRUCTION.		Title
513a.	EQUIPMENT. All equipment shall be suitable for use in locations subject to a moderate degree of moisture such as a damp basement.	D,W	Comply: Equipment is suitable for the locations installed. Technical Data -- Vendor Information
513b.	MOUNTING. All equipment shall be mounted in a substantial manner on a single, noncombustible supporting structure.	W	Comply: Mounted on seel support structure.
513c.	ENCLOSURE. The structure or panel shall be securely mounted in an enclosure(s) which will protect the equipment against mechanical injury and falling drops of water striking the enclosure from the downward vertical.	W	Comply with intent: Control equipment is located in switchgear, MCC and control room; panels ratings are NEMA Class 1 (general purpose).

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513d.	CONNECTIONS AND WIRING.		Title
513d1.	All bus bars and connections shall be readily accessible for maintenance work after installation of the controller without disconnecting the external circuit conductors.	W	Comply
513d2.	Test Connections. Provision shall be made to allow the use of test meters by one of the methods outlined in the following paragraphs (a) or (b).		Comply: Current monitoring provided.
513d2(a)	Terminals shall be so located and arranged that a clamp-on or such type meter can be safely and conveniently used, or		Comply: Current measuring instruments located on control room panel.
513d2(b)	There shall be provided, as part of the controller, a readily accessible test link or equivalent means for connecting a current measuring instrument in one of the motor circuit conductors without the necessity for disconnecting any conductor which runs outside the equipment enclosures The test link shall be connected between the isolating switch and the circuit breaker.		Comply

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513d3.	Bus bars and other wiring elements of the controller shall be designed on a continuous duty basis, except that conductors which are in a circuit only during the motor starting period may be designed accordingly.	D	Comply: Technical Data -- Vendor Information
513e.	PROTECTION OF AUXILIARY CIRCUITS. Circuits which are depended upon for proper operation of the controller shall not have over-current protective devices connected in them.		Does not comply: The high demand fire pump circuit has over current protective devices. Justification: It is believed that this section of the code is intended to ensure that a fire pump continues to operate (and pump water) as long as possible, even with the ensuing danger of losing the controller from over current. In the event of a fire, the NFPA 20 code committee considers the fire pump controller expendable. Losing a controller does not appear necessary at Donald C. Cook Nuclear Plant since four 2,000 gpm at 152 psi fire pumps are available and any two of them can arguably extinguish largest postulated fire. It is believed that the level of fire safety as a result of the current fire pump arrangement (redundancy and independence) is far greater than what can be achieved by a fire pump installation within strict compliance of this section.

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513f.	EXTERNAL OPERATION. All switching equipment for manual use in connecting or disconnecting, or starting or stopping the motor shall be externally operable as defined in the National Electrical Code (NFPA No. 70). The isolating switch shall meet the requirements of Section 514.		Comply: Switching equipment is externally operable as defined in NFPA-70. However, no isolation switch is used.
513g.	Wiring diagrams and instructions.	W	Title
513g1.	A wiring diagram shall be provided and permanently attached to the inside of the enclosure.	W	Does not comply: Wiring diagrams are not attached to the insides of the fire pump controllers. Justifications: Wiring diagrams for the fire pump controllers are available to plant personnel per plant procedure. Our perception of the intent of this section has been met.
513g2.	All the field wiring terminals shall be plainly marked to correspond with the wiring diagram furnished.	W	Comply: Color code is used to identify field wiring to correspond to terminals provided for field wiring.
513h.	MARKING. Each motor control device and each switch and circuit breaker shall be marked to plainly indicate the name of the manufacturer, his designated identifying number and the electrical rating in volts, horsepower, amperes, frequency, phases, etc., as may be appropriate. The markings shall be so located as to be visible after installation.	W	Comply with intent: Control devices marked per AEP Standards

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5131.	INSTRUCTIONS. Complete instructions covering the operations of the controller shall be provided and conspicuously mounted on the controller. Pump operators should be familiar with these instructions and should observe in detail all of their provisions.	W	Does not comply: Instructions are not mounted on the controllers. Justification: Instructions for the fire pump controllers are available to plant personnel. Our perception of the intent of this section has been met.
514.	COMPONENTS.		Title
514a.	ISOLATING SWITCH. Except as noted in Paragraph 531b for limited service controllers, a manually operated isolating switch shall be provided within the enclosure, connected on the supply side of the circuit breaker with one pole for each branch circuit conductor.	D,W	Does not comply: Separate isolating switches are not used. Circuit breaker operators are used to isolate the pumps. (Isolating switches as indicated would require separate motor control and circuit breakers completely separate and in-addition to the present plant switchgear and MCC's). Technical Data #E3 Justification: It is believed that this section of the code is intended to install a switch to isolate the controller from its source of power. Whereas an isolating switch is not installed, the controllers (circuit breakers) may be serviced by tripping its contacts open and then disconnecting the circuit breaker from the source and line connections by a screw jack assembly. The disconnecting (and subsequent reconnection to restore operability) is accomplished with all enclosure doors closed. The breaker cannot be disconnected or reconnected while its contacts are closed. All work on these breakers are performed by trained professionals in accordance with plant procedures. It is believed that the installation of an isolating switch in complete compliance with this code is not necessary.

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514a1.	The switch shall be externally operable (see 513f) and the operating handle shall be provided with a spring latch which will not interfere with the closing of the switch, but shall be so arranged that it requires the use of the other hand to hold the latch released in order to permit the opening of the isolating switch.		Does not comply: see comments of 514a.
514a2.	The ampere rating of the switch shall be at least 115 per cent of the complete current rating of the motor.		Does not Comply: See 514a.
514a3	The following warning shall appear on or immediately adjacent to the isolating switch: WARNING -- DO NOT OPEN OR CLOSE THIS SWITCH WHILE THE CIRCUIT BREAKER (DISCONNECTING MEANS) IS IN CLOSED POSITION.		Does not comply: See 514a.

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514b.	CIRCUIT BREAKER (DISCONNECTING MEANS). Except as noted in Section 532 for limited service controllers, the motor branch circuit shall be protected by a suitable magnetic trip-type circuit breaker, connected directly to the load side of the isolating switch and conforming with the following requirements:	D	Does not comply: The circuit breakers for the high demand fire pumps have solid state trip devices which perform the same as the magnetic type in that they are not thermal replica type circuit breakers. These may be considered equivalent for this purpose. The circuit breaker (molded case) used on the low demand fire pumps is an uncompensated thermal magnetic type which does not meet the requirements of this section. Technical Data #E3 and Vendor Information Justification: The fire pump motor branch circuits are suitably protected. The redundancy and independence of the multi-fire pump system more than compensates for any reduction in reliability that may be envisioned by not providing "magnetic trip-type" circuit breakers.
514b1.	No other overcurrent protective devices shall be in the motor circuit on the load side of the circuit breaker. NOTE: See Article 433 for rating and setting of overcurrent devices in the circuit on the line side of the circuit breaker. See National Electrical Code (NFPA NO. 70) for the number of overcurrent units required for circuit protection devices.	D	Does not comply. The 300 HP High Demand Pump motors have additional overcurrent relays (type 51) and the 75 HP Low Demand pump motor has thermal overload relays (type 49). Technical Reference #E3 Justification: The redundancy and independence of the multi-fire pump system more than compensates for any reduction in reliability that may be envisioned by providing overcurrent protective devices in the motor circuit on the load side of the circuit breakers.

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514b2.	It shall have one pole for each ungrounded branch circuit conductor.	D	Comply Technical Reference #E3
514b3.	It shall be externally operable (see 513f).		Comply
514b4.	It shall trip free of the handle.		Comply
514b5.	Its rating shall not be less than 115 per cent of the rated full load current of the motor.		Comply
514b6.	It shall permit normal starting of the motor without tripping.		Comply
514b7.	It shall provide stalled rotor and instantaneous short circuit protection.		Comply
514b7(a)	For a squirrel cage induction motor, it shall be of the time delay type and have a time delay of not over 20 seconds at locked rotor current (this is 600 percent of rated full load motor current for squirrel cage induction motors), and shall be calibrated up to and set at 30 percent of the motor full load current.	D	High demand unit complies, however low demand does not comply in that the range is from 13-30 sec Technical Reference #E3 and Vendor Reference Justification: The low demand fire pump at Donald C. Cook Plant does not have to keep running in a fire scenario as there are four 2000 gpm at 152 psi [illegible] pumps backing the low demand pump up. This [illegible] of tolerance condition of the circuit breaker time delay trip does not affect the low demand fire pump reliability to any great extent.

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514b7(b)	For a direct-current motor and wound rotor alternating-current motor, it shall be of the instantaneous type calibrated and set at 400 percent of the motor full load current.		Does not apply:
514b8.	Its interrupting rating shall be adequate for the circuit in which it is used, and in no case be less than 14,000 amperes (symmetrical).	D	Comply: Technical Reference - Vendor Data
514b9.	The required interrupting rating should be obtained by the purchaser based upon the maximum possible short-circuit current at the pump room. The values, which are approximate, shown in Table 514 may be used as a guide.		Comply:
514b10.	A nameplate with the legend CIRCUIT BREAKER -- DISCONNECTING MEANS in letters not less than 3/8 inch high shall be located on the outside of the enclosure adjacent to the means for tripping the circuit breaker.	W	Comply with intent: Circuit Breakers located in switchgear and MCC's. Legends are per plant stardards however, do not include the exact wording, but plant personnel are trained to location and use.
514c.	MOTOR STARTER. The motor starter shall be of the magnetic type with a contact in each conductor.		Does not comply: Magnetic type motor starters are not used for the high Demand Pumps. The motor starter for the Low Demand Pump is the magnetic type.

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			Justification: The redundancy and independence of the multi-fire pump system more than compensates for any reduction in reliability that may be envisioned by not providing magnetic type motor starters for the two high demand fire pumps.
514c1.	For electrical operation of reduced voltage starters, timed automatic acceleration of the motor shall be provided and the period of motor acceleration shall not exceed 10 seconds.		Does not apply
514c2.	Starting resistors shall be designed to permit one 5 second starting operation in each 80 seconds for a period of not less than 1 hour.		Does not apply
514c3.	The operating coil for the main contactor shall be supplied directly from the main power voltage and not through a transformer for controllers of 600 volts or less.	D	Does not comply. (Power for operating coils for 300 HP High Demand are from 250 V DC plant systems. Power for operating coil for 75 HP Low Demand from 575/220V control transformer). Technical Reference #E3 Justification: The control power to operate the two high demand fire pump controllers is from the plants 250V DC system. This storage battery backed system would seem to be as reliable as control power derived by any other method or source.

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514d.	ALARMS AND SIGNAL DEVICES (ON CONTROLLER). A 6w or 7w candelabra base 115-125 v. pilot lamp shall be connected to a pair of power supply conductors directly on the line side of the motor starter (load side of the circuit breaker) to indicate that the circuit breaker and test link are closed and that power is available at the controller for starting. The lamp shall be accessible for replacement. NOTE: It is recommended that the lamp operating voltage be less than the rated voltage of the lamp to insure long operating life. When necessary, suitable resistors or potential transformers should be used to reduce the voltage for operating the lamp.		Does not comply verbatim: Justification: Only a minor deviation from this requirement exists. 600V bus voltage loss is alarmed and loss of power at the MCC motor starter is indicated. Our perception of the intent of this requirement has been met.
514e.	ALARM AND SIGNAL DEVICES (REMOTE). Where the pump room is not constantly attended, the authority having jurisdiction may require the controller to be equipped with contacts to operate circuits, not exceeding 125 volts, for audible or visual alarms at a point of constant attendance indicating the following:		Information only.
514e1.	Controller has operated into a pump running conditions.		Information Only
514e2.	Trouble on the controller or pumping unit. Unless the power to this alarm circuit is electrically supervised, the controller shall be arranged to start upon failure of this alarm circuit power.		Information Only

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Code Section No.	Code Section	Information Obtained By: W=Walkdown D=Document	Summary of Results
515.	STARTING AND CONTROL		Title
515a.	The following definitions are from the National Electrical Code (1968):		Information Only
515a1.	Nonautomatic: Nonautomatic means that the implied action requires personal intervention for its control. As applied to an electric controller, nonautomatic control does not necessarily imply a manual controller, but only that personal intervention is necessary.		Information Only
515a2.	Automatic: Automatic means self-acting, operating by its own mechanism when actuated by some impersonal influence, as for example, a change in current strength, pressure, temperature, or mechanical configuration.		Information Only
515b.	NFPA No. 20 contemplates that:		Does not apply.
515b1.	Nonautomatic controller shall be actuated by electrical manual and mechanical manual means.	D	Comply Technical Reference #E3

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515b2.	Automatic controller shall be operable as a nonautomatic controller and also by other nonpersonal means such as: low water pressure, tripping of deluge and dry pipe valves, etc.		Information Only
515c.	NONAUTOMATIC		Title
515c1.	Manual Electric Control at Controller: There shall be a manually operated switch on the control panel so arranged that when the pumping unit is started manually, its operation cannot be affected by the pressure switch, and so that the unit will remain in operation until manually shut down, except that an autotransformer reduced voltage type of starter need not have electrical control means for starting the motor.		Comply: Manual Electric Control is provided at the pumps.
515c2.	Manual Electric Control at Remote Station: Additional control stations for causing nonautomatic continuous operation of the pumping unit independent of the pressure actuated control switch may be provided at locations remote from the controller, but such stations shall not be operable to stop the unit.		Comply: Manual Electric Control is provided in the control room.

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515c3.	Manual Mechanical Control at Controller:		Title
515c3(a)	The controller shall be equipped with a handle or lever which operates to close the motor-circuit switching mechanism mechanically for nonautomatic continuous running operation of the motors independent of any electric control circuits or magnets (or equivalent device) and independent of the pressure-activated control switch. Means shall be incorporated for mechanically latching or holding of the handle or lever for manual operation in the actuated position. The mechanical latching shall not be automatic, but at the option of the operator.		Does not comply: Manual mechanical control is not provided. Justification: It is believed that the intent of this section is to provide a means of starting the fire pump even with loss of an electronic control circuit or magnet within the controller. Whereas this would make a single controller for a fire pump somewhat more reliable, the system at Donald C. Cook Plant is one of redundancy and independence. Four independent 2,000 gpm at 152 psi fire pumps exist. It is known that any two of these pumps can arguably put out the largest postulated fire. It is highly unlikely that a component would fail in more than one controller at any given time. It is, therefore, felt that the level of fire safety is not compromised by the lack of a mechanical control at the fire pump controllers.

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515c3(b)	The handle or lever shall be arranged to move in one direction only from off to final position with the exception of the autotransformer reduced-voltage type starter.		Does not comply: See 515c3(a)
515c3(c)	The motor starter shall return automatically to the "off" position in case the operator releases the starter handle in any but the full running position.		Does not comply: See 515c3(a)
515d.	AUTOMATIC		Title
515d1.	Water Pressure Control: An acceptable type pressure switch having independent high and low calibrated adjustments, and which is responsive to water pressure in the fire system shall be provided in the control circuit. NOTE: Test Device: Suitable provision shall be made for relieving pressure to the pressure switch to test the operation of the controller and the pump (Figure 515d.1, Appendix C).	D	Comply: (The intent of the requirement is met by providing adjustable pressure switches with an adjustable dead band. However independent high and low adjustments are not provided.) Technical Reference E3 and Vendor Information

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515d2.	Fire Protection Equipment Control: When the pump supplies special water control equipment (deluge, dry pipe valves, etc) and it is desired to start the pump before the pressure control(s) would do so, the authority having jurisdiction may require the controller to be equipped to start the pump upon operation of the fire protection equipment. The controller shall be equipped with a relay of the drop-out type to start the pump when the fire protection equipment operates. The relay shall be actuated from a normally closed contact on the fire protection equipment. NOTE: Deluge System Operation: Where the pump supplies a deluge system the authority having jurisdiction may require the controller to be equipped [illegible] a relay of the drop-out type to start the pump [illegible] the deluge valve trips. The relay should be actuated from a normally closed contact on the deluge valve.		Information only: Drop-out type relays are only required when the authority having jurisdiction requires that the pump be started immediately upon operation of the fire protection equipment. The authority having jurisdiction has not required the plant to meet this section of the code. In addition, due to the huge capacity of the system, this situation is undesirable. In fact, an extensive logic system of time delays and pressure set points has been set up so that this situation only occurs when it is absolutely necessary.
515d3.	Sequence Starting: Controllers for multiple pump units shall incorporate a sequential timing device to prevent any one pump starting simultaneously with any other pump. If the water requirements are such that more than one pump operates, the units shall start in 5-second intervals or at intervals which will not permit a subsequent starting pump to start until the previous pump has reached full speed. Failure of a leading pump to start shall not prevent subsequent pumps from starting.	D	Comply: Minimum of 5 second interval is provided as determined from analysis of ECP 1-2-70-02 Technical Reference #E9

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515d4.	For sprinkler systems and standpipe systems where an automatically controlled pump constitutes the sole supply or where required by the authority having jurisdiction, the controller shall be wired for automatic start and manual shutdown.	D	Comply Technical Reference #E3
515e.	METHODS OF STOPPING: Shutdown may be accomplished - by either one or both of the following:		Information Only
515e1.	Manual - the control panel shall have means for electrical operation for stopping the motor which in case of automatic controllers will return the controller to full automatic position.	D	Comply Technical Reference #E3
515e2.	Automatic - after starting causes have returned to normal and the pumping unit has operated for the time fixed by the running period timer. NOTE: Whenever the controller is arranged for automatic shutdown, a running period timer set for one minute for each ten horsepower of motor rating, but not to exceed 7 minutes, shall be installed.	D	Does not comply: Running period timer is not used. Technical Reference #E3 Justification: New versions of NFPA 20 no longer require this feature. Hence, the system as installed, is within the current guidelines of this section. No automatic shutdown of the fire pumps exists. Fire pumps have to be reset manually after the starting cause has been returned to normal.
520.	Requirements for Controllers for Voltages in Excess of 600 Volts.		Title
521.	CONTROL EQUIPMENT. Where equipment rated in excess of 600 volts is permissible (see Section 511) the control equipment shall comply with the requirements of Article 510 except as indicated in Sections 522 through 528.	D	Does not apply: Voltage for controllers does not exceed 600 volts, therefore article 520 through 528 are not applicable. Technical Reference #E3

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522.	PROVISIONS FOR TESTING. The provisions of Paragraph 513d.2 shall not apply, but an ammeter with a suitable transfer switch arranged for reading the current in each phase shall be provided on the controller. An indicating voltmeter with scale calibrated to the high voltage supply and deriving its source of power from the control transformer secondary shall also be provided on the controller.		Does not apply: see notes of 521
523.	DISCONNECTING UNDER LOAD. Provision shall be made to prevent opening the isolating switch under load.		Does not apply: see notes of 521
524.	LOCATION OF PRESSURE ACTUATED SWITCH. Special precautions should be taken with regard to the location of the pressure actuated switch called for in Paragraph 515d(1) to prevent any water which may be present due to leakage from coming in contact with high-voltage components.		Does not apply: see notes of 521
525.	LOW VOLTAGE CONTROL CIRCUIT. The low-voltage control circuit shall be supplied from the high-voltage source through a step-down control circuit transformer protected by suitable high-voltage fuses. Its supply shall be interrupted when the isolating switch is in the open position.		Does not apply.
526.	PILOT LAMP. For these controllers Section 514d shall be replaced by the following:		

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	A pilot lamp shall be provided to indicate that power is available. The lamp operating voltage shali be less than the lamp voltage rating to insure long life. The supply for the lamp shall be obtained from the secondary of the control circuit transformer through resistors, if found necessary, or a small capacity step-down transformer to reduce the control transformer secondary voltage to that required for the pilot lamp.		Does not apply.
527.	PERSONNEL PROTECTION FROM HIGH VOLTAGE. The necessary provisions shall be made, including such interlocks as may be needed, to protect the personnel from accidental contact with high voltage.		Does not apply.
528.	INTERRUPTING CAPACITY. The circuit breaker, or the controller where it also performs the function of the circuit breaker, shall have adequate kilovolt ampere interrupting capacity for the intended service.		Does not apply.
530.	Limited Service Controllers.		Title
531.	APPLICATION. This section is applicable to automatic controllers for across-the-line type squirrel cage motors of 30 horsepower or less, 600 volts or less, where such use is acceptable to the authority having jurisdiction. All of the requirements of the preceding sections apply except as indicated in the following:		Does not apply: Motors used are larger than 30 horsepower, therefore articles 530 through 532 are not applicable.

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531a.	MARKING. Each motor controller shall be marked as specified in Paragraph 511f except that the title will be 'Limited Service Controller.'		Does not apply: see comments of 531
531b.	The manually operated isolating switch mentioned in 514a is not required.		Does not apply: see comments of 531
532.	CIRCUIT BREAKER. The circuit breaker shall conform to 514b with the following changes:		Does not apply: see comments of 531
532a.	It shall be approved for disconnect purposes.		Does not apply: see comments of 531
532b.	It need not be a magnetic trip type. In general, the rating of a direct heated thermal element breaker should be the standard rating at or next below 250 per cent of the motor full-load current, but not smaller than 150 per cent; and the rating of an indirect heated thermal element breaker should be the standard rating at or next above 125 per cent of the motor full load current.		Does not apply: see comments of 531
532c.	The calibration shall be of the fixed type to discourage adjusting and tampering by unauthorized persons.		Does not apply: see comments of 531
532d.	The interrupting rating of the breaker shall be not less than 10,000 amperes.		Does not apply: see comments of 531

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Chapter 700			
ENGINE DRIVE CONTROLLERS			
710.	Requirements for All Controllers.		
711.	GENERAL		Title
711a.	The following specifications cover controlling equipment of the combined nonautomatic and automatic types for internal combustion engines driving centrifugal fire pumps. Chapter 600 dealing with the internal combustion engine drive also applies where appropriate.		Information Only
711b.	Automatic-type controllers are recommended for use only where the fire pump takes its water under positive pressure and their use is not recommended where a suction lift is involved.		Information Only
711c.	All controllers shall be specifically approved for fire pump service.	D	Does not comply. Technical Reference -- Vendor Information Justification: The diesel fire pump controllers are not specifically approved for fire pump service. This report shows that the controllers do not lower the level of safety as prescribed per NFPA 20. Satisfactory performance of the controllers has been proven by testing requirements and over fifteen years of successful operation.

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711d.	The control panel shall be completely assembled, wired and tested by the manufacturer before shipment from the factory.	W	Does not comply: The controllers were assembled and tested at the plant. Justification: The control panels were tested by qualified personnel during plant start up. Satisfactory performance of the controllers has been proven by testing requirements and over fifteen years of successful operation.
711e.	Controllers conforming to this Standard shall be marked "Fire Pump Controller" and shall show plainly the name of the manufacturer, the identifying designation and the complete electrical rating.		Does not comply: Electrical rating is not shown. Justification: All requirements are met with the exception of showing the electrical rating. However, this information is available through the plant's document control centers. Our perception of the intent of this section has been met.
711f.	The services of a representative of the manufacturer may be required for installation and adjustment of the equipment. It shall be the responsibility of the installing contractor to make the necessary arrangements for this service.		Information Only

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712.	LOCATION.		Title
712a.	The controller shall be located as close to as is practical and within sight of the engine.	W	Comply
712b.	The controller shall be so located or protected that it will not be injured by water escaping from the pump or connections.	W	Comply
712c.	A clearance of not less than 2 1/2 feet shall be provided at the rear of enclosures designed to be inspected and serviced from the rear.	W	Comply
713.	GENERAL CONSTRUCTION.		Title
713a.	EQUIPMENT. All equipment shall be suitable for use in locations subject to a moderate degree of moisture such as a damp basement. Reliability of operation shall not be adversely affected by normal dust accumulations. NOTE: In areas affected by excessive moisture, heat may be useful in reducing the dampness.	W	Comply with intent: Equipment in general is suitable for use in the locations. Plant walkdown indicates no deterioration due to moisture or dust accumulation.

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713b.	MOUNTING. All equipment except engine mounted shall be mounted in a substantial manner on a single, non-combustible supporting structure.	W	Does not comply: Equipment mounted on steel supporting structure, but all controlling equipment not in a single structure. Justification: All equipment is mounted on substantial noncombustible supporting structures; however, all equipment is not within a single structure. The different components are connected via substantial noncombustible structures. It is not though that having all equipment in one structure will add to the reliability of the entire system. Our perception of the intent of this section has been met.
713c.	ENCLOSURE. The structure or panel shall be securely mounted in an enclosure(s) which will protect the equipment against mechanical injury and falling drops of water striking the enclosure from the downward vertical.	W	Does not comply verbatim: Justification: All equipment meets the requirements of this section with the exception of the transfer switch. The transfer switch is not protected against water falling from the downward vertical. If we were to lose a fire pump due to a "wet" transfer switch, the other three high demand fire pumps would still be available to extinguish a fire. It has already been said that any two pumps can arguably extinguish the largest postulated fire. It is highly unlikely that more than one pump would be lost at any one time due to a "wet" transfer switch panel.

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713d.	LOCKS: All switches required to keep the controller in the "automatic" position shall be within locked cabinets having break glass panels.	W	Does not comply: Locks do not exist on controllers. Justification: No locks exist; however, rigid controls assure switches are in proper position. In addition, due to the type of facility these panels are installed in, problems with tampering by personnel are very rare. Our perception of the intent of this section is met.
713e.	WIRING DIAGRAMS.		Title
713e1.	A wiring diagram shall be provided and permanently attached to the inside of the enclosure showing exact wiring for this controller including a legend of identifying numbers of individual components.	W	Does not comply: Wiring diagrams are not attached to the inside of the panel. Justification: Wiring diagrams for fire pump controllers are available to plant personnel per plant procedure. Our perception of the intent of this section has been met.
713e2.	All wiring terminals shall be plainly marked to correspond with the wiring diagram furnished.		Comply
713f.	CONNECTIONS AND WIRING.		Title
713f1.	Wiring elements of the controller shall be designed on a continuous duty basis, except that the conductors which are in a circuit only during the engine starting period may be designed accordingly.	W	Comply

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713f2.	Field Wiring. All wiring leading from the panel to the engine and batteries shall have adequate carrying capacity and shall be protected against mechanical injury. Controller manufacturer's specifications regarding distance and wire size shall be followed.	W	Comply
713g.	MARKING. Each operating component of the controller shall be marked to plainly indicate an identifying number referenced to the wiring diagram. The markings shall be located so as to be visible after installation.	W	Comply
713h.	INSTRUCTIONS. Complete instructions covering the operation of the controller shall be provided and conspicuously mounted on the controller. Pump operators should be familiar with these instructions and should observe in detail all of their provisions.	W	Instructions not mounted on controller but available per plant procedures.
714.	COMPONENTS.		Title
714a.	Alarm and Signal Devices (On Controller)		Title
714a1.	A pilot lamp(s) shall be provided in the line side of the starting equipment circuit to indicate that the controller is in the "automatic" position with power available for starting. The lamp shall be accessible for replacement.	D	Comply with intent: Lamp indicating power available is provided. Automatic position not indicated since an automatic switch is not provided. Design of starting equipment accepts an automatic or manual start signal. Technical Reference #E3

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	NOTE: It is recommended that the lamp operating voltage be less than the rated voltage of the lamp to insure long operating life. When necessary, suitable resistors should be used to reduce the voltage for operating the lamp.		
714a2.	A pilot lamp shall be provided in each battery supply to indicate that batteries are connected to the controller and are at least partially charged when the controller is set in the automatic position.	D,W	Comply Technical Reference #E3
714a3.	Pilot lamps and a common bell shall be provided to indicate trouble caused by:	D,W	Comply Technical Reference #E3
714a3(a)	Low oil pressure in the lubrication system.		
714a3(b)	High engine jacket water temperature.		
714a3(c)	Failure of engine to start automatically.		
714a3(d)	Shutdown from overspeed (diesel only).		

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714b.	ALARM AND SIGNAL DEVICES (remote). Where the pump room is not constantly attended, the controller shall be equipped with contacts (open or closed) to operate circuits powered by a source other than engine starting batteries, not exceeding 125 volts, for audible or visual alarms at a point of constant attendance indicating the following:		Information only: See below for specific compliance/noncompliance.
714b1.	Controller has operated into a pump running condition. (separate signal)	D	Comply Technical Reference #E3
714b2.	Controller main switch has been turned to "off" or "manual" position (separate signal).	W,D	Does not apply: Design does not utilize a main switch to turn controller "off" or "manual."
714b3.	Trouble on the controller or engine: (A common signal may be used for trouble indication).	D	Comply Technical Reference #E3
714b3(a)	Items in 714.a.3.		Comply
714b3(b)	Loss of A.C. power to the battery chargers and controller. This may be accomplished through use of a drop-out type of relay. The relay contacts should close on failure of voltage. Unless the power is electrically supervised as above, the controller should be arranged to start upon failure of this power. (See Paragraph 715.d.6)	D	Does not comply. Alarm or signal not provided for loss of A.C. power to battery chargers. Technical Reference #E3 Justification: Although no alarm or signal is provided for loss of AC power to the chargers, the batteries are verified to be charged at least every seven days per Technical Specification requirements. A defective battery charger would

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			be identified by this check. In addition, due to the redundancy and independence of the system, more than enough pumps exist to extinguish the largest postulated fire even if we were to lose a diesel fire pump due to low battery voltage.
715.	STARTING AND CONTROL.		Title
715a.	DEFINITIONS (from the National Electrical Code, 1968 Edition).		Title
715a1.	Nonautomatic - Nonautomatic means that the implied action requires personal intervention for its control. As applied to an electric controller, nonautomatic control does not necessarily imply a manual controller, but only that personal intervention is necessary.		Information Only
715a2.	Automatic - Automatic means self-acting, operating by its own mechanism when actuated by some impersonal influence, as for example, a change in current strength, pressure, temperature or mechanical configuration.		Information Only
715b.	This Standard contemplates that:		
715b1.	Nonautomatic controller shall be actuated by electrical manual means.		Comply

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715b2.	Automatic controller shall be operable as a nonautomatic controller and also by other nonpersonal means such as: low water pressure, tripping of deluge and dry pipe valves, etc.	D	Comply Technical Reference #E3
715c.	NONAUTOMATIC.		Title
715c1.	Manual Electric Control at Controller. There shall be a manually operated switch on the control panel. This switch shall be so arranged that when the pumping unit is started manually, its operation cannot be affected by the pressure switch so that the unit will remain in operation until manually shut down.		Comply
715c2.	Manual Electric Control at Remote Station. Additional control stations for causing nonautomatic continuous operation of the pumping unit independent of the pressure-actuated control switch may be provided at locations remote from the controller, but such stations shall not be operable to stop the unit except through the established operation of the controller.		Comply
715d.	AUTOMATIC.		Title
715d1.	Water Pressure Control. An acceptable type pressure switch having independent high and low calibrated adjustments and which is responsive to water pressure in the fire system shall be provided in the control circuit.	D	Comply: (The intent of this requirement is met by providing adjustable pressure switches with adjustable dead band. However independent high and low adjustments are not provided.) Technical Reference #E3 and Vendor Information

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	NOTE: Test Device. Suitable provision must be made for relieving pressure to the pressure switch to test the operation of the controller and the pump. (Figure 515.d.1. Appendix C.)		Does not comply. Justification: Pumps, controllers. and associated equipment are tested regularly via other methods.
715d2.	Fire Protection Equipment Control. When the pump supplies special water control equipment (deluge, dry pipe valves, etc.) and it is desired to start the pump before the pressure control(s) would do so, the authority having jurisdiction may require the controller to be equipped to start the pump upon operation of the fire protection equipment. The controller shall be equipped with a relay of the drop-out type to start the pump when the fire protection equipment operates. The relay shall be actuated from a normally closed contact on the fire protection equipment with this circuit supplied by the batteries.	D	Comply: Drop-out type relays are only required when the authority having jurisdiction requires that the pump be started immediately upon operation of the fire protection equipment. The authority having jurisdiction has not required the plant to meet this section of the code. In addition, due to the huge capacity of the system, this situation is undesirable. In fact, an extensive logic system of time delays and pressure set points has been set up so that this situation only occurs when it is absolutely necessary. Technical Reference #E2 and E3
715d3.	Sequence Starting. Controllers for multiple pump units shall incorporate a sequential timing device to prevent any one pump starting simultaneously with any other pump. If the water requirements are such that more than one pump operates, the units shall start at intervals which will not permit a subsequent starting pump to start until the previous pump has reached full speed. Failure of a leading pump to start shall not prevent subsequent pumps from starting.	D	Comply: Minimum of 5 second interval is provided as determined from analysis of ECP 1-2-70-02. Technical Reference #E2, E3 and E9

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715d4.	For sprinkler systems and standpipe systems where an automatically controlled pump constitutes the sole supply or where required by the authority have jurisdiction, the controller shall be wired for automatic start and manual shutdown.	D	Comply Technical Reference #E2 and E3
715d5.	Weekly Program Timer. To assure dependable operation of the pumping unit and its controller, the controlling equipment may be arranged to automatically start the unit at least once a week. A solenoid drain valve on the pressure control line shall be the initiating means. Such performance may be automatically indicated on a recording pressure gage.		Information Only
715d6.	Power Failure Start. The controller may be equipped with a power failure relay, which shall be time delayed, to start the unit upon loss of A.C. power to the battery chargers and timers. (See Paragraph 714.a.3(b).)		Information Only
715e.	STARTING EQUIPMENT ARRANGEMENT.		Title
715e1.	Two storage batteries, each complying with the requirements of Section 626, shall be provided and so arranged that manual and automatic starting of the equipment can be accomplished with either battery. The starting current shall be furnished by first one battery and then the other on successive operations of the starter. The changeover must be made automatically, except for manual start.		Comply: (see Section 626).

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715e2.	In the event that the engine does not start after approximately six attempts have been made, or after approximately 1 1/2 minutes of cranking, the controller shall stop all further cranking and operate the trouble lamp and bell.	D	Comply with intent: (cranking continues for 10 seconds more than specified time). Technical Reference #E3
715e3.	In the event that one battery is nonoperative, the control shall lock-in on the remaining battery during the cranking sequence.	D	Comply Technical Reference #E3
715e4.	Circuits shall be provided in the controller to operate chokes or similar devices where required on spark ignited engines.		N/A
715e5.	When dual drive units are used and one or both are under automatic control, see Paragraph 623.b. Breakage or disconnection of any wires that interconnect the electric motor control and the engine control, or failure of either power source and/or controller shall not interfere with the proper operation of the other power source and/or its controller.		N/A
715f.	METHODS OF STOPPING. Shutdown may be accomplished by either one or both of the following:		Comply
715f1.	Manual - by operation of the selector switch on the controller or other shutdown features.		
715f2.	Automatic Shutdown after Automatic Start:		

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715f2(a)	Normal - after starting causes have been returned to normal and the pumping unit has operated for the time fixed by the running period timer. Whenever the controller is arranged for automatic shutdown a running period timer set for at least 30 minutes shall be installed.		Comply with intent. Shutdown is manual but running period timer is not used.
715f2(b)	Emergency overspeed shutdown - When the emergency overspeed governor operates, the controller shall cause the engine to shut down without time delay, and lock out until manually reset.	D	Comply Technical Reference #E3
715f3.	Anti-Dieseling. Circuits shall be provided in the controller to operate anti-dieseling devices where required on spark ignited engine (see Paragraph 629).		Does not apply.
715g.	EMERGENCY CONTROL. Automatic control circuits, the failure of which could prevent starting, shall be completely bypassed for manual control.	D	Comply with intent: (Automatic control circuits are not completely bypassed for manual control. However, almost all conceivable failures of the automatic circuits would not prevent manual control). Technical Reference #E3