資料４５－４－４

非常用ディーゼル発電機の連続運転に関する日本の状況について

令和3年4月14日
技 術 基 盤 課

第43回技術情報検討会において、非常用ディーゼル発電機（以下「EDG」という。）の火災に関する報告[1]がなされた際、以下の問題提起がなされた。

○ 技術レポート「ATENA19-ME01 国内原子力発電所における非常用ディーゼル発電機不具合の傾向と改善策について」[2]には、DG の故障の主原因は、部品の経年劣化と人的過誤とされている。しかし、システムとして据え付けた後、長時間（例えば1週間）動作するか確認するための試験を、日本では実施していないがそれでよいのか。

これに関し、技術基盤課が事業者の見解を聴取する事となったため、面談において別添の資料を受領し、説明を受けた。説明の概要は以下のとおり。

○ 現状のメンテナンスにより、EDG の健全性は確保できており、24 時間の連続運転を実施する必要はない。

○ 一方、長時間運転に関する実績は必ずしも多くないため、現状のメンテナンスの妥当性を確認及び運転実績の蓄積を目的に24 時間運転を実施する。

○ なお、実施時期については、プラントの運転計画（プラント停止時に実施）や連続運転の実施に必要な体制を整備する期間等を考慮の上、2021 年度～2022 年度で完了できるように検討する。

このため、事業者の行う試験の実施状況、結果について、今後フォローすることとしたい。

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[1] 原子力発電所の非常用ディーゼル発電機（EDG）の24 時間連続運転試験を行った後に、EDG 室天井部の排気管貫通部付近で小火が発生した事例（IRS8769）について、追加調査を行い、報告したもの（第43回技術情報検討会資料４３－２－２－２参照）。
[2] https://www.atena-j.jp/report/2019/11/atena-19me01rev1.html#000108

（別添）

2021年2月19日
北海道電力株式会社
東北電力株式会社
東京電力ホールディングス株式会社
中部電力株式会社
北陸電力株式会社
関西電力株式会社
中国電力株式会社
四国電力株式会社
九州電力株式会社
日本原子力発電株式会社
日本原燃株式会社

EDGの連続運転時間について

1． EDGに期待される連続運転時間について

- 実用発電用原子炉及びその附属施設（再処理施設）の位置、構造及び設備の基準に関する規則の解釈より、保安電源設備の容量に対する要求事項は以下の通り。

  第三十三条（保安電源設備）第７項（再処理施設は、第二十五条（保安電源設備）第５項）

非常用電源設備及びその附属設備は、多重性又は多様性を確保し、及び独立性を確保し、その系統を構成する機械又は器具の単一故障が発生した場合であっても、運転時の異常な過渡変化時又は設計基準事故時において工学的安全施設及び設計基準事故に対処するための設備がその機能を確保するために十分な容量を有するものでなければならない。

  解釈（再処理施設は、第５項）

第７項に規定する「十分な容量」とは、7日間の外部電源喪失を仮定しても、非常用ディーゼル発電機等の連続運転により必要とする電力を供給できることをいう。非常用ディーゼル発電機等の燃料を貯蔵する設備（耐震重要度分類Ｓクラス）は、７日分の連続運転に必要な容量以上を敷地内に貯蔵できるものであること。

- 新規制基準適合炉の原子炉設置（変更）許可申請書における有効性評価においても、複数のシナリオでEDGによる７日間の電力供給を想定している。
- EDGに対する設備設計仕様上の要求事項は「定格負荷で連続運転可能」であり、そもそも連続定格運転で使用することを前提とした機器である。

２．　米国の状況

- 米国の EDG 試験時間が 24 時間となっている理由を調査した結果、2009 年 12 月 10 日の NRC 資料にて以下概要の通りとされている。
（別紙１参照）
  - 米国では、７日毎の燃料補給も考慮した 30 日の運転を想定し、定期検査時の試験時間としては最大 24 時間を推奨している。
  - EDG の故障履歴をレビューした結果、8 時間以下の試験では検知できなかった故障を、24 時間の耐久試験を実施するプラントでは検知できた。検知できた故障とは、EDG 排気管貫通部のスリーブが可燃性の建屋材と接触していたため、屋根材が発火したものであった。
→その他に検知できた故障は、施工不良や一般的な経年劣化のようにメンテナンス不備が起因の故障である。

３．　火災に至る発生の可能性の評価

- EDG は、起動、運転により機関他が温度上昇するが、排気管周りの高温部には保温材を施しており、専用の空調が作動することにより、EDG 本体、室内ともに有意な温度上昇はなく、火災に至ることはない。
- スウェーデンで発生した EDG の火災は、EDG 室天井部の排気管貫通部付近に木材を使用していたことが原因であった。また、NRC の見解として、2.項の通り EDG 排気管近傍の建屋材の火災等を 24 時間の推奨根拠として示している。
- 国内の EDG 排気管近傍の建屋材の状況を確認した結果、EDG の排気管は保温材により外側にあるスリーブの温度を有意に上昇させることはない。
また、何らかの原因で排気管の熱がスリーブに伝わったとしても、スリーブ周辺の建屋材には可燃物を使用していないため、火災に至ることはない。

４．　国内の EDG のメンテナンスの状況他

- EDG の選定について
EDG は、プラントメーカにおいて、船舶向けのディーゼル機関をベースとし機種選定がされており、選定において 24 時間以上の試運転を行い耐久性に問題ないことを確認している。
- EDG のメンテナンスについて
EDG のメンテナンスは、保安規定８章（再処理施設は、５章）施設管理に基づき以下の保全を実施している。

(1) 保全／点検計画の策定について

EDG の保全計画は、下記項目を踏まえ EDG 機能確保のために必要な点検メニューを抽出し、策定している。

a.運転実績、事故および故障事例などの運転経験
b.使用環境および設置環境
c.劣化、故障モード
d.機器の構造等の設計的知見
e.科学的知見

EDG の保全方式は、安全上重要設備であることを踏まえ「予防保全／時間基準保全」を選定しており、定期検査時の負荷試験を加味したメンテンナンスを計画している。

(2) 保全の実施について

上記(1)を踏まえ定期検査時に EDG の保全を実施しており、主な点検内容は、下表の通りである。

<table>
<tr><th colspan="2">項　目</th><th>保 全 内 容</th></tr>
<tr><td rowspan="3">各機器点検</td><td>ディーゼル機関</td><td>各部点検
シリンダ開放点検
主軸受開放点検</td></tr>
<tr><td>発電機</td><td>各部点検
絶縁抵抗測定
軸受開放点検
発電機開放点検（固定子・回転子点検）</td></tr>
<tr><td>付属設備
（燃料系統、冷却水系統、空気系統、電気系統、潤滑油系統）</td><td>外観点検・分解点検・計器校正・制御回路点検・系統状態確認（タンク,ポンプ,配管,弁,計器，制御盤等）</td></tr>
<tr><td>EDG 試運転</td><td colspan="2">負荷試験（添付資料参照）
（負荷を段階的に上昇させ、冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度等のパラメータが安定していることを確認）</td></tr>
</table>

- 各機器の点検では、劣化・故障モード等を踏まえ点検を実施し、各機器の健全性を確認している。
- 毎定期検査時の分解点検後の EDG 試運転では、まず、起動前確認事項として燃料系統、冷却水系統、空気系統、潤滑油系統の各系統に問題ないことを確認し、その後、EDG を起動し、負荷を段階的に上昇させ、本体および付属系統の圧力・温度等の各種パラメータが安定する

までの確認※により、EDG の系統全体の健全性を確認している。（約 2 時間）

※：EDG は連続定格運転で使用することを前提とした設備であり、EDG 起動後、各パラメータが安定した段階で設備の健全性に問題ないことが確認できれば、それ以降は有意な変化は生じない設計である。また、施工不良等の経年劣化管理ができない故障要因は管理面で発生防止を図ることになるが、それらの影響も基本的には各パラメータが安定するまでの間で顕在化するものと考えている。

なお、国内原子力発電所においては、24 時間以上の EDG 連続運転実績があるが、何れも問題なく連続運転できている。

【国内運転実績例】

ａ．東通原子力発電所
（年月日）2011 年 3 月 11 日～13 日
（時間×出力）A：約 46 時間（負荷は実負荷に合わせて変動）

ｂ．福島第一原子力発電所 6 号機
（年月日）2011 年 3 月 11 日～22 日
（時間×出力）約 268 時間（負荷は実負荷に合わせて変動）

ｃ．東海第二発電所
（年月日）2011 年 3 月 11 日～15 日
（時間×出力）2D：約 67 時間（負荷は実負荷に合わせて変動）
HPCS：約 85 時間（負荷は実負荷に合わせて変動）

ｄ．敦賀発電所 2 号機
（年月日）1998 年 9 月 24 日~25 日
（時間×出力）A：約 33 時間（負荷は実負荷に合わせて変動）

ｅ．日本原燃㈱再処理施設
（年月日）2011 年 3 月 11 日～13 日
（時間×出力）A:約 55 時間（負荷は実負荷に合わせて変動）
B:約 56 時間（負荷は実負荷に合わせて変動）

ｆ．日本原燃㈱使用済燃料受入貯蔵施設
（年月日）A：2011 年 3 月 11 日～14 日
B：2011 年 3 月 11 日～15 日
（時間×出力）A:約 81 時間（負荷は実負荷に合わせて変動）
B:約 87 時間（負荷は実負荷に合わせて変動）

以上より、現状のメンテナンスにより、EDG の健全性は確保できており、24 時間の連続運転を実施する必要はない。

一方、長時間運転に関する実績は必ずしも多くないため、現状のメンテナンスの妥当性を確認及び運転実績の蓄積を目的に24時間運転を実施し、その結果は、各社適切に、施設管理PDCAのインプットとする。また、実施台数については、メンテナンス体制毎に代表を選定する観点から、24時間運転実績がある社を除き、各社1台以上とする。

なお、実施時期については、プラントの運転計画（プラント停止時に実施）や連続運転の実施に必要な体制を整備する期間等を考慮の上、2021年度～2022年度で完了できるように検討する。

5．24時間連続負荷運転を実施する際に考慮すべきその他の事項

(1) 系統に接続した状態での長時間運転のため、系統事故に起因するEDGのトリップリスクを考慮し、実施時期を設定する。
(2) 24時間連続負荷試験を実施することで累積運転時間が増加することに対する現状保全の見直し要否評価。
(3) EDGの深夜運転に伴う騒音や排ガス等の発生への配慮。
(4) 24時間連続負荷運転に必要な燃料油調達計画の変更。
(5) 大量の燃料油の消費に伴うCO_2やSO_Xの排出に伴う環境負荷の増加。

以　上

別紙：EMERGENCY DIESEL GENERATOR TECHNICAL SPECIFICATIONS SURVEILLANCE REQUIREMENTS REGARDING ENDURANCE AND MARGIN TESTING: SUMMARY REPORT

添付資料：非常用ディーゼル発電機　定期事業者検査毎の運転確認について

December 10, 2009

MEMORANDUM TO: Patrick Hiland, Director
Division of Engineering
Office of Nuclear Reactor Regulation

FROM: George A. Wilson, Chief ***/RA/***
Electrical Engineering Branch
Division of Engineering
Office of Nuclear Reactor Regulation

SUBJECT: EMERGENCY DIESEL GENERATOR TECHNICAL SPECIFICATIONS SURVEILLANCE REQUIREMENTS REGARDING ENDURANCE AND MARGIN TESTING: SUMMARY REPORT

On June 2, 2008, the U.S. Nuclear Regulatory Commission (NRC) issued Temporary Instruction (TI) 2515/176, "Emergency Diesel Generator Technical Specification Surveillance Requirements Regarding Endurance and Margin Testing" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML080420064). This TI had the following purposes:

- Assess the adequacy of nuclear power plant emergency diesel generator (EDG) endurance and margin testing, as required in plant-specific technical specifications (TS).

- Evaluate the tests to ensure that the EDG can support load profiles (including automatic loads, as well as any manual loads identified in operating procedures and plant modifications) calculated by licensees for events such as design-basis accidents; shutdown requirements related to plant fires (Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979," to Title 10 of the *Code of Federal Regulations* Part 50, "Domestic Licensing of Production and Utilization Facilities"; and station blackout.

- Evaluate EDG loading conditions in the voltage and frequency range allowed by the TS, in view of recent inspections indicating design deficiencies associated with EDG loading calculations.

- Assess EDG failures and correlate them with endurance testing.

Specifically, the NRC issued TI 2515/176 to do the following:

- Evaluate the EDG testing methodologies to develop the most efficient means to address inconsistencies and deficiencies and determine the significance of issues.

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301-415-4057

- Ensure that testing and monitoring programs verify the ability of the EDG to support the safe shutdown of plants under the most onerous conditions postulated under plant design bases and implemented through plant procedures.

The staff of the Electrical Engineering Branch has reviewed the information provided by the NRC's licensees. Based on the review, the staff noted that plant modifications have reduced design margins in EDG capability to support accident loads. The staff also noted that some licensees have not accounted for variations in voltage and frequency that can potentially increase EDG loading and further reduce operating margins. In addition, operating experience indicates that EDG system modifications and maintenance activities can introduce new failure modes that can only be detected during extended EDG operation. Also, some licensees have not implemented testing requirements that envelope the maximum postulated accident loads as well as include parameters such as power factor.

The enclosed report discusses the details of this review.

Enclosure:
As stated

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DATE	12/ /09	11/19/09	12/3/09	12/10/09

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EMERGENCY DIESEL GENERATOR TECHNICAL SPECIFICATIONS SURVEILLANCE REQUIREMENTS REGARDING ENDURANCE AND MARGIN TESTING SUMMARY REPORT

1.0 INTRODUCTION

On June 2, 2008, the U.S. Nuclear Regulatory Commission (NRC) issued Temporary Instruction (TI) 2515/176, “Emergency Diesel Generator Technical Specification Surveillance Requirements Regarding Endurance and Margin Testing” (Agencywide Documents Access and Management System (ADAMS) Accession No. ML080420064). This TI had the following purposes:

- Assess the adequacy of nuclear power plant emergency diesel generator (EDG) endurance and margin testing, as required in plant-specific technical specifications (TS).
- Evaluate the tests to ensure that the EDG can support load profiles (including automatic loads, as well as any manual loads identified in operating procedures and plant modifications) calculated by licensees for events such as design-basis accidents (DBAs); shutdown requirements related to plant fires (Appendix R, “Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979,” to Title 10 of the *Code of Federal Regulations* Part 50, “Domestic Licensing of Production and Utilization Facilities”); and station blackout.
- Evaluate EDG loading conditions in the voltage and frequency range allowed by the TS, in view of recent inspections indicating design deficiencies associated with EDG loading calculations.
- Assess EDG failures and correlate them with endurance testing.

Specifically, the NRC issued this TI to do the following:

- Evaluate the EDG testing methodologies to develop the most efficient means to address inconsistencies and deficiencies and determine the significance of issues.
- Ensure that testing and monitoring programs verify the ability of the EDG to support the safe shutdown of plants under the most onerous conditions postulated under plant design bases and implemented through plant procedures.

2.0 BACKGROUND

On August 29, 2005, the staff at an NRC regional office submitted a request to the Office of Nuclear Reactor Regulation (NRR) to assess the adequacy of the EDG testing procedure at a specific plant. In response, the NRR staff concluded that the EDG endurance test performed by the particular plant was not consistent with the intent of the TS surveillance requirements (SRs) for establishing EDG operability, since the loading of the EDGs during testing did not envelop the predicted design-basis event (DBE) loading. NRC inspectors have subsequently identified this inconsistency at other sites. When reviewing license amendment requests to correct the endurance and margin testing acceptance criteria, the NRR staff also identified issues related to test loading requirements, peak design-basis loading values and durations, and EDG ratings. Therefore, the NRR staff issued TI 2515/176 to assess the extent of these issues and to evaluate the adequacy of EDG testing, as prescribed in plant-specific TS and design bases.

ENCLOSURE

The EDG endurance and margin test (Standard TS (STS) SR 3.8.1.14, in NUREG-1430 through NUREG-1434[1]) is normally performed every 18 to 24 months to demonstrate the ability of the EDG to handle the predicted accident loads with a single active failure of a redundant EDG. The EDG loading is generally designed for a concurrent loss of offsite power (LOOP) and loss-of-coolant accident (LOCA). The concurrent LOOP and large-break (LB) LOCA loading profile is generally bounding; however, at some sites, the calculated load values for the LOOP, coincident with a small-break (SB) LOCA or a main steam line break (MSLB), were greater than the LOOP/LBLOCA load values.

STS SR 3.8.1.14 specifies that the EDGs be operated for 24 hours, 2 hours of which will be at 105 to 110 percent of the continuous rating, with the remaining 22 hours at 90 to 100 percent of the continuous rating. EDGs are rated at different power (kilowatt (kW)) levels for certain durations. These are generally referred to as the continuous rating and the short-time rating, as defined in Institute of Electrical and Electronics Engineers (IEEE) Standard 387, "IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations." However, some nuclear power plants have EDGs that have 2,000-hour, 200-hour, 4-hour, 2-hour, and 0.5-hour ratings and may have been allowed to operate or test at these ratings, depending on how the plant was licensed.

The rating of an EDG can be affected (derated) by factors such as the EDG loading, the engine coolant outlet temperature, or the air intake (combustion air) temperature. In addition, variations in frequency and voltage and the accuracy of the EDG governor and voltage regulator systems can affect the EDG loading. These factors are critical in determining the worst-case EDG loading and testing acceptance criteria, especially if the proposed testing or design-basis loading profile is approaching the EDG rating limits. The NRC inspectors have identified instances in which the EDG loading calculations failed to account for the increased electrical load resulting from EDG operation at the maximum frequency allowed by the TS. The operation of rotating equipment at higher frequency and voltage could result in increased EDG loading under accident conditions. Other factors that could affect EDG loading include motor efficiency, cable losses, and pump runout conditions. The STS also specify that the endurance test be performed at the design-load power factor (PF), if grid conditions allow. The PF requirement is meant to simulate the reactive loading of the EDG during a DBE.

The NRC staff issued guidance for EDG design and testing in Safety Guide 9, "Selection of Diesel Generator Set Capacity for Standby Power Supplies," issued March 1971; Regulatory Guide (RG) 1.108, "Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants"; and RG 1.9 (Revisions 1 through 4), currently titled "Application and Testing of Safety-Related Diesel Generators In Nuclear Power Plants." The NRC withdrew RG 1.108 with the issuance of Revision 3 of RG 1.9 in July 1993. RG 1.9 indicates that IEEE Standard 387 is acceptable for meeting the requirements of the principal design criteria, qualification testing, and periodic testing of EDG units as onsite electric power systems subject to the regulatory positions and exceptions stated in the RG. NRC Information

[1] These NUREGs, issued June 2004, are as follows: NUREG-1430, "Standard Technical Specifications—Babcock and Wilcox Plants"; NUREG-1431, "Standard Technical Specifications—Westinghouse Plants"; NUREG-1432, "Standard Technical Specifications—Combustion Engineering Plants"; NUREG-1433, "Standard Technical Specifications—General Electric Plants (BWR/4)"; and NUREG-1434, "Standard Technical Specifications—General Electric Plants (BWR/6)."

Notice (IN) 1991-13, “Inadequate Testing of Emergency Diesel Generators (EDGs),” dated March 4, 1991, and IN 2008-02, “Findings Identified During Component Design Bases Inspections,” dated March 19, 2008, provide additional information related to the adequacy of EDG design and testing.

3.0 APPLICABLE REGULATORY REQUIREMENTS

10 CFR 50.65(a)(1) states the following:

> Each holder of a license to operate a nuclear power plant…shall monitor the performance or condition of structures, systems, or components…in a manner sufficient to provide reasonable assurance that these structures, systems, and components…are capable of fulfilling their intended functions.

In Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50, General Design Criterion (GDC) 4, “Environmental and Dynamic Effects Design Bases,” states that “Structures, systems, and components important to safety shall be designed to accommodate the effects of and be compatible with the environmental conditions associated with normal operation….”

GDC 17, “Electric Power Systems,” requires onsite electric power systems to have sufficient independence, capacity, capability, redundancy, and testability to ensure that (1) specified acceptable nuclear fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents, assuming a single failure.

GDC 18, “Inspection and Testing of Electric Power Systems,” states the following:

> Electric power systems important to safety shall be designed to permit appropriate periodic inspection and testing of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components. The systems shall be designed with a capability to test periodically (1) the operability and functional performance of the components of the systems, such as onsite power sources, relays, switches, and buses, and (2) the operability of the systems as a whole and, under conditions as close to design as practical, the full operation sequence that brings the systems into operation, including operation of applicable portions of the protection system, and the transfer of power among the nuclear power unit, the offsite power system, and the onsite power system.

In Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” to 10 CFR Part 50, Criterion XI, “Test Control,” states the following:

> A test program shall be established to assure that all testing required to demonstrate that structures, systems, and components will perform satisfactorily in service is identified and performed in accordance with written test procedures which incorporate the requirements and acceptance limits contained in applicable design documents.

Criterion XVI, "Corrective Action," states the following:

> Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition.

These regulations require that EDGs be capable of performing their safety function when needed to support the safe shutdown of the power plant following DBEs and transients. The licensees should have surveillance testing and monitoring programs to demonstrate that the capability and availability of EDGs are not degraded during plant operation and maintenance activities.

4.0 SUMMARY AND ANALYSIS OF RESPONSES

As defined in RG 1.9 (Revision 4), the EDGs used as the onsite electric power system should be able to (1) start and accelerate a number of large motor loads in rapid succession, while maintaining voltage and frequency within acceptable limits, (2) provide power promptly to engineered safety features if a LOOP and a DBE occur during the same time period, and (3) supply power continuously to the equipment needed to maintain the plant in a safe condition, if an extended LOOP occurs. Typically, the mission time of the EDG is considered to be 30 days. The endurance and load margin test demonstrates this capability of the EDG at continuous rating and worst-case PF. The preferred duration of an endurance run is 24 hours. Of this period, 2 hours should be at a load equal to 105–110 percent of the EDG's continuous rating, and 22 hours at a load equal to 90–100 percent of the EDG's continuous rating. The test process should verify that frequency and voltage requirements are maintained.

To evaluate the performance capabilities defined above, the staff reviewed responses from 65 nuclear power plant sites that included 104 reactor units with a total of 239 Class 1E EDG units.

I. Questions 1a. and 1b.

1a. Provide the name of the manufacturer, make, and model for the following:

- EDG unit
- governor system
- voltage regulator system

1b. Provide all available EDG ratings (e.g., the continuous, 2,000-hour, short-time/term, 2-hour, and 0.5-hour ratings (kilovolt-ampere (kVA), kW, and PF). Verify that these ratings are consistent with the specifications of the EDG vendor or manufacturer. Note any constraints.

Discussion

The NRC staff asked its licensees to provide the manufacturers and nameplate ratings of the EDGs used at various nuclear plants. It intended to use this information, in conjunction with Question 8 relating to recent EDG failures, to identify any weaknesses in the EDG systems or components, based on common manufacturer designs and maintenance activities.

The NRC staff reviewed the data gathered in response to Question 8. The limited scope of questions and failures identified did not yield any conclusive findings about manufacturer-related design weaknesses in EDG systems.

Recommendation

No recommendations are associated with Question 1.

II. Questions 2a. and 2b.

2a. Provide the TS SR loading requirements, in kW, for the endurance-run SR:

- initial 2 hours of the endurance run
- remaining hours of the endurance run

2b. Provide the licensee's procedural requirements for EDG loading, if they differ from the TS SR loading requirements.

Discussion

The TI requested information about the plant-specific TS requirements because requirements vary for different vintages of plants. The NRC resident inspectors reviewed the kW values or range of values provided in the licensees' TS for each time interval of the endurance and margin test.

The data indicates that, at 13 plants, the TS do not specify the endurance run test requirements. The NRC staff also noted that 25 plants have an EDG endurance run of less than 24 hours. The staff reviewed the EDG failure history as noted in response to Question 8 of the TI and as documented in event reports submitted by licensees. It is apparent from these reports that in some cases, plants with 24-hour endurance runs identified degraded component performance resulting from EDG maintenance or system modification deficiencies that would not have been identified by plants with TS testing requirements of 8 hours (or less). Examples include the following:

- At Peach Bottom Atomic Power Station, on August 15, 2006, after 21 hours of a 24-hour endurance run surveillance test of the E-3 EDG, combustible roofing material on the EDG building caught fire near the diesel exhaust pipe penetration (roof stack) area (IN 2007-17). The licensee found that improperly installed roofing materials caused the fire. A review of industry operating experience found two similar events at the McGuire Nuclear Station Unit 1 on April 15, 2003, and June 11, 2003, that involved the EDG "A" building roof. The air gap for the EDG exhaust stack penetration was covered with insulation, which caused excessive heating of the steel penetration sleeve and resulted in the ignition of adjacent roofing materials. The significant issues in this type of degradation are the potential for common mode failure and the unlikelihood that any endurance run of 8 hours (or less) would have identified this deficiency.

- At Fermi 2, the generator outboard bearing of EDG-14 failed approximately 12 hours into a 24-hour endurance run. This event had two primary causes: (1) the design modification control process was improperly used, allowing the EDG oil sight glass piping configuration to be incorrectly modified and left uncorrected, and (2) an inadequate process was used to install oil level operating bands.

- At Quad Cities, on May 1 and 3, 2001, a solenoid valve in the Unit 2 EDG fuel oil transfer system failed to open approximately 12 hours after the start of the EDG endurance test. The failure was caused by the thermal pressurization of an isolated section of the transfer system's pump discharge piping.

- At Waterford 3, on September 29, 2003, at about 1020 hours, EDG "A" was started to perform a surveillance run, in accordance with station operating procedures. At approximately 1309 hours, with the machine running loaded, the left/right bank cross-connect tubing failed. The licensee concluded that, after the last successful surveillance on September 2, 2003, EDG "A" may not have been able to complete a mission run time of 24 hours.

- At Braidwood 1, at 0130 hours on February 21, 2008, 16 hours into a planned 24-hour endurance run, fretting between the air vent line and the fuel supply line resulted in a 1/8-inch stream of fuel oil spraying from the main fuel supply line on the 1B EDG. Small-diameter tubing installed on EDGs is susceptible to vibration-induced failures that could render the EDGs inoperable. The vibration-induced failures may appear as cracking or breaks, as well as holes and wall thinning caused by rubbing of components that contact each other. A similar event was identified at Vogtle 1.

Recommendation

The emerging trend from operating experience of EDG problems identified during testing indicates that maintenance and repair activities have introduced failure modes that can be detected only by extended surveillance runs. Based on the operating experience, the staff recommends that the surveillance test duration be extended to 24 hours consistent with STS (NUREG-1430 through NUREG-1434) to demonstrate that EDGs are capable of performing their safety function (complete its mission time, typically 30 days) with reasonable assurance). This extension also helps to demonstrate that EDG capability and availability are not degraded during plant operation and maintenance activities.

III. Questions 3a. and 3b.

3a. Does the EDG continuous rating envelop the peak design load (kW) expected during a DBE?

3b. Did the licensee account for the worst-case voltage and frequency values to determine the worst-case loading in the EDG loading design calculation?

Discussion

This question is related to the calculated or DBE load profile expected of each EDG. The licensees are required to have calculations for a LOOP/LBLOCA, a LOOP/SBLOCA, and a LOOP/MSLB worst-case loading with a single failure of one EDG. The EDG loading calculation should account for derating caused by design limitations and frequency and voltage variations caused by setpoint variations. The NRC staff has identified instances in which the EDG kW loading was affected by operation at the high end of the allowed frequency band, which is critical when the EDG loading is close to the EDG rating. EDGs operating at the higher end of allowable voltage and frequency will affect the horsepower of running motors and directly increase the load on the EDG. On the other hand, if the EDG is operating at the lower end of

the allowable frequency, the motors with marginal capacity may not meet their design bases requirements. Licensees for approximately 50 percent of the plants have evaluated the existing band for voltage and frequency allowed by their TS. Some evaluations performed by the licensees resulted in TS changes, and in some cases, the available design margins accommodated the tolerances. However, the staff has not verified the licensees' evaluations.

The NRC issued Generic Letter 88-15, "Electric Power Systems—Inadequate Control Over Design Processes," dated September 12, 1988, to inform the licensees of problems associated with diesel engine load-carrying capability and diesel generator voltage regulating systems unable to maintain voltage at a level sufficient to permit continued operation of safety-related equipment. No specific action or written response was required by this letter.

Recommendation

The NRC staff should consider generic communications to clarify staff's expectations regarding validation of performance capabilities of EDGs and emergency core cooling systems to meet their design and licensing basis requirements.

IV. Question 4

4. Do testing load profiles envelop worst-case DBE load profiles?

Discussion

This question required licensees to verify that the DBE load values and durations are consistent with their TS SRs or, in accordance with plant test procedures, to verify that the EDGs can achieve design loading.

The NRC staff evaluated a total of 239 EDGs under the TI. Review of the data showed that 110 EDGs, or 46 percent, may be loaded above their continuous rating (or 2,000-hour rating).

A further evaluation of the maximum calculated loading versus the maximum EDG loading during surveillance runs (typically, the 2-hour period of the load run) indicates that a significant number of EDGs are not tested at or above the potential maximum loads. This may be the result of non conservative TS, plant modifications, procedural changes, or staff-approved TS that may not have been evaluated for all DBEs.

The staff has issued several INs identifying inadequacies in EDG testing. Specifically, IN 1991-13 details examples where some EDG testing has not adequately verified the capability of the EDG to carry its maximum expected loads. The IN delineates the intent of the required surveillance testing as ensuring that the EDG can dependably carry its accident loads. It is important that licensees consider the worst-case conditions (frequency, voltage, PF, and environment) when testing the EDG.

The intent of the TS SR is to demonstrate the ability of the EDG to support a safe plant shutdown under worst-case electrical loading. At the onset of an event such as an LBLOCA or MSLB, primary or secondary system pressures may result in pumps operating at runout conditions that are well in excess of the nominal rating. This requires pump motors to deliver higher horsepower, which in turn imposes a higher load on the EDG. The 110–percent, 2-hour load run demonstrates the ability of the EDG to cope with this short-term overload condition. Industry operating experience with EDGs operating at 105–110 percent indicates that improper

governor or motor-operated potentiometer (MOP) settings can result in voltage, power, or frequency fluctuations. As an example, on June 10, 2009, during a 2-hour run at 110-percent load, operators at the Fitzpatrick plant observed some increase in load after adjusting the MOP for the voltage regulator from the control room. On occasion (about four times during the 2-hour run), after adjusting kW load up using the MOP, operators observed an additional “drift” increase in load. Operators then decreased the load and noted a response. The Fitzpatrick staff concluded that the EDG MOP was operating correctly. However, the EDG hydraulic actuator response at higher EDG loadings was somewhat “sluggish.” That is, for a change in input from the MOP, the actuator response to adjust the fuel racks was slower than when the actuator was operating at 100-percent load and lower. The slow responding actuator could potentially degrade the EDG capability to support accident loads at the onset of the event.

Recommendation

The EDG component replacement, environmental changes, load changes, and gradual degradation of support systems can erode EDG margins. Licensees should validate their testing methods to ensure that the EDGs are tested to the loads that envelop the maximum postulated accident conditions to demonstrate their continued capability and reliability to perform the intended functions.

V. Questions 5 and 6

5. Do the TS require testing to a Power Factor (PF) limit?

6a. Does the PF value envelop the worst case?

6b. Do procedures verify grid conditions?

6c. If grid conditions do not permit testing, is a justification provided?

Discussion

These questions solicited information on PF testing and methods used by licensees to demonstrate the EDG ability to operate under varying grid conditions that can affect plant bus voltages and therefore preclude adequate testing.

An EDG consists of two major systems, the engine/governor and the generator/voltage regulator. Testing the EDG at unity PF verifies the engine/governor capabilities but does not adequately verify the generator/voltage regulator capabilities. However, inadequate maintenance practices or improper exciter or voltage regulator settings can result in degraded output for reactive power. The electrical load at nuclear plants consists largely of motors that require significant reactive power during starting and operation during a DBA. The EDGs are designed to supply reactive power for large motor loads, and these performance capabilities need to be verified by testing at the postulated PF of the EDG loads. IN 1991-13 informed licensees about PF testing. Some licensees changed their procedures to include power factor testing during the endurance run.

Recommendation

Additional NRC communications to the industry may be needed to ensure that the EDG tests simulate the worst-case design bases loading (both kW and kVar) requirements.

VI. Question 7

7a. Is the endurance run performed with the EDG aligned parallel to the grid, regardless of the plant mode?

7b. If the answer to Question 7a. is yes, does the licensee declare the EDG inoperable when it is run parallel to the grid?

7c. If the licensee does not declare the EDG inoperable in parallel mode, does the licensee have the necessary analysis to prove that the EDG will not trip and return to standby mode, if it is subjected to transients caused by a LOOP or faults in the upstream system?

7d. What is the response of the EDG to a LOOP or grid voltage fluctuation that occurs during an endurance test run?

Discussion

These questions relate to the performance of the endurance run with the EDG aligned parallel to the grid and the status of the EDG as inoperable or operable.

For a typical EDG, the unit will not trip and return to standby mode if it is subjected to transients caused by a LOOP or faults in the upstream grid system. Some plants may have unique designs, and the licensee may have the necessary analysis to prove that the EDG will not trip and will be available to cope with a LOOP or LOCA event. Industry experience indicates that the EDGs do not trip during grid transients when operating in parallel mode.

- In October 2006, personnel at the Cooper plant discovered that the voltage regulators on both EDGs would not automatically switch from isochronous (voltage droop mode) to synchronous (zero droop mode) if a LOOP were to occur while an EDG was parallel to the grid for surveillance testing. Without this capability, an EDG should be declared inoperable while parallel to the grid, since isochronous operation without the appropriate voltage droop characteristics would prevent the EDG from maintaining the required voltage and frequency range.

- While responding to questions regarding the issues at Cooper, the licensee at River Bend discovered that its EDG would not automatically switch from test mode to emergency mode if a LOOP were to occur while the EDG was parallel to the grid. As a result, the nonemergency trips would not be bypassed, and the fuel racks would not reset, causing the EDG to speed up outside the allowable frequency range if a LOOP were to occur during a surveillance test. Before this discovery, River Bend did not declare its EDGs inoperable during surveillance testing.

Recommendations

Approximately 50 percent of the plants declare the EDGs inoperable when performing endurance tests. The NRC staff position is that the EDGs should be declared inoperable and the limiting conditions of operation entered, in accordance with plant TS, when in test mode operating parallel to the grid. This requires licensees to take compensatory actions to minimize risk to the plant and to preclude the potential unavailability of offsite power sources and other risk-significant systems needed for the safe shutdown of the plant during DBEs.

5.0 CONCLUSION

The responses to this TI indicate that the licensees have analytical evaluations to support the ability of installed EDGs to safely shut down the plants under postulated accident conditions. However, the margins between the continuous rating of the EDGs and the postulated worst-case loading have eroded over the years due to plant modifications, and some licensees have to manage the EDG loads during postulated accident conditions. Therefore, licensees must ensure that the EDGs are rated to handle all required loads with sufficient margins to account for uncertainties needed to mitigate DBEs, including transients, under worst-case loading conditions, assuming a single failure of the redundant EDG. Also, many EDGs are not tested adequately to demonstrate their capability under worst-case loading conditions. In some cases, licensees may have reduced their testing requirements by modifying the surveillance requirements based on selective sections of revisions to RG 1.9 that relaxed testing requirements, assuming there was margin between the nominal rating of the EDG and the required worst-case loading. Several Generic Communications discuss the regulatory requirements and inadequacies of EDG surveillance testing. In view of the reduced margins, it is critical that licensees demonstrate that analytical evaluations of the plants account for factors such as frequency and voltage, which can adversely affect safety-related loads and increase the potential load on the EDGs. Accident analyses assume the mission time of most EDGs to be 30 days. Other events, such as LOOPs caused by hurricanes or other extreme weather, have required the extended operation of EDGs. Furthermore, the reliability of the EDGs was key factor in determining the station blackout duration of plants. Therefore, to demonstrate an EDG's capability for sustained operation for its mission time, most TS require a 24-hour surveillance run. Based on the operating experience, licensees that have less stringent requirements should consider performing surveillance runs for extended duration (up to 24 hours) to verify EDG performance capabilities.

6.0 REFERENCES

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission, Washington, DC.

2. Standard Technical Specifications Surveillance Requirement 3.8.1.14 (NUREG-1430, "Standard Technical Specifications—Babcock and Wilcox Plants"; NUREG-1431, "Standard Technical Specifications—Westinghouse Plants"; NUREG-1432, "Standard Technical Specifications—Combustion Engineering Plants"; NUREG-1433, "Standard Technical Specifications—General Electric Plants (BWR/4)"; and NUREG-1434, "Standard Technical Specifications—General Electric Plants (BWR/6)," all issued June 2004), U.S. Nuclear Regulatory Commission, Washington, DC.

3. IEEE Standard 387, "IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, Piscataway, NJ, 1977, 1984, and 1995.

4. Safety Guide 9, "Selection of Diesel Generator Set Capacity for Standby Power Supplies," U.S. Nuclear Regulatory Commission, Washington, DC, March 1971.

5. Regulatory Guide 1.108, "Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants," Revision 1, U.S. Nuclear Regulatory Commission, Washington, DC (withdrawn).

6. Regulatory Guide 1.9, "Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants," Revision 1 (November 1978), Revision 2 (December 1979), Revision 3 (July 1993), and Revision 4 (March 2007), U.S. Nuclear Regulatory Commission, Washington, DC.

7. Information Notice 1991-13, "Inadequate Testing of Emergency Diesel Generators (EDGs)," U.S. Nuclear Regulatory Commission, Washington, DC, March 4, 1991.

8. Information Notice 2008-02, "Findings Identified During Component Design Bases Inspections," U.S. Nuclear Regulatory Commission, Washington, DC, March 19, 2008.

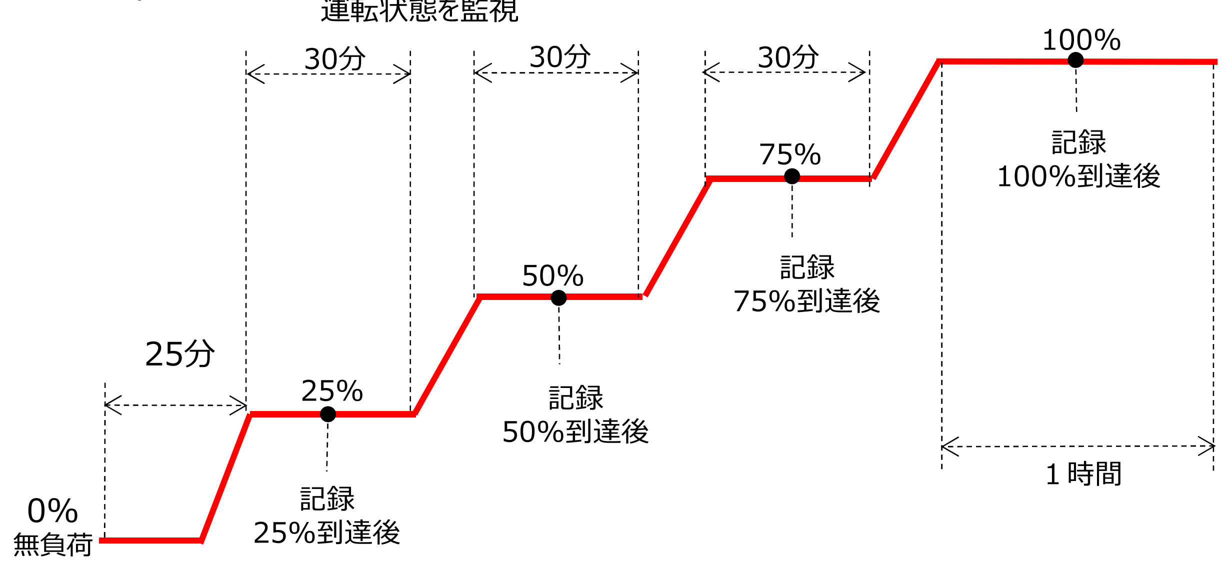
添付資料

非常用ディーゼル発電機　定期事業者検査毎の運転確認について（1／13）

【定期事業者検査（機能性能検査）】　（例：泊3号機)

➢ 定期事業者検査期間中のEDG運転状態確認として試運転を実施するとともに定格容量確認検査を実施。
試運転時は各負荷（25%、50%、75%、100%）で運転状態の確認および記録採取を実施。
各負荷到達後に運転状態確認、記録採取を実施しているが、パラメータは安定しておりバラツキはない。
（冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）

【試運転時の負荷カーブ】
(泊3A号機　2020.4.24　)



測定データ抜粋(泊3A号機)

負荷(%)	目標値	25	50	75	100
潤滑油圧(MPa)	0.5~0.6	0.56	0.5	0.55	0.54
潤滑油温度(℃)	55以下	49	50	51	52

<参考>
なお連続負荷運転に伴う室温の異常な上昇は無く100%負荷時の室温は安定している。（記録は泊3A号機）

負荷(%)	25	50	75	100
室温（℃）	26.8	27.3	27.8	29.1

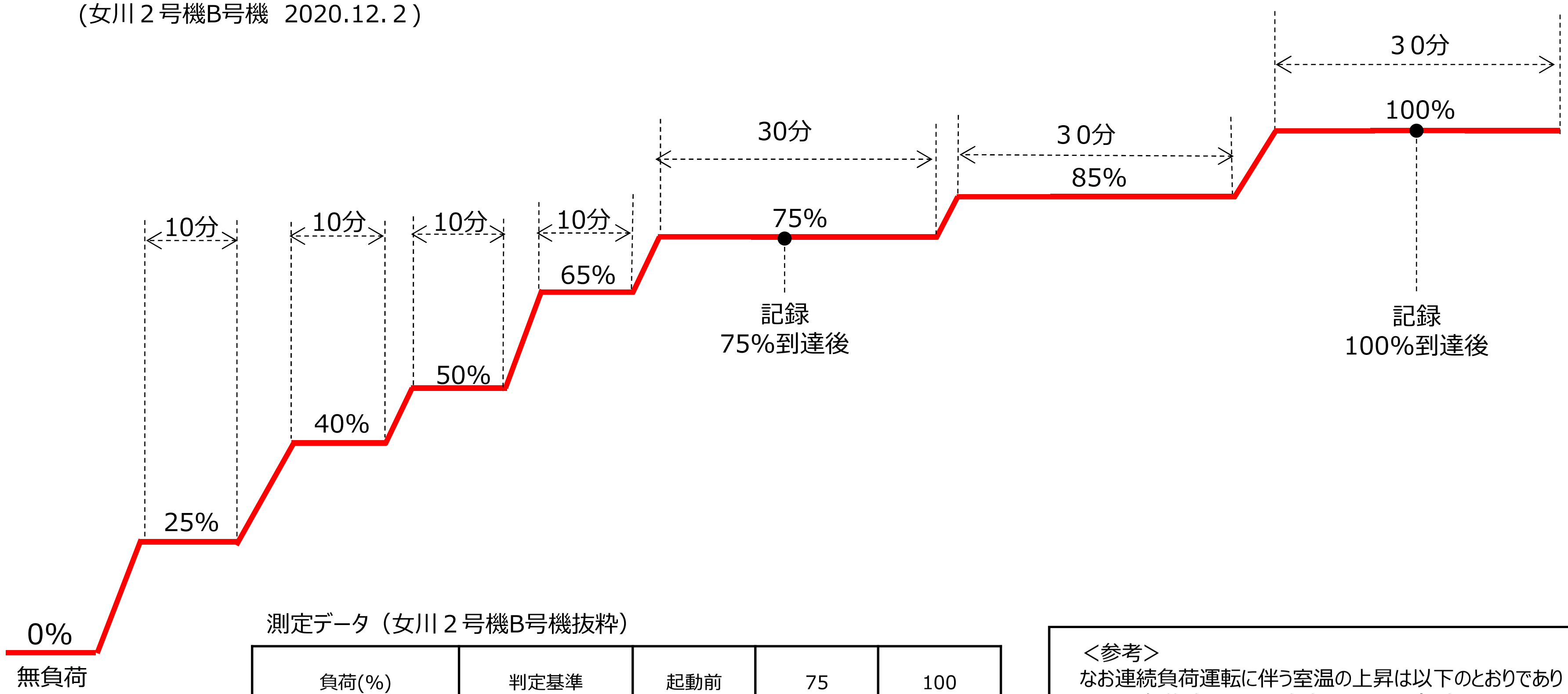
添付資料

非常用ディーゼル発電機　定期事業者検査毎の運転確認について（2／13）

【定期事業者検査毎の機能性能確認】　（例：女川２号機B号機）

➢　定期事業者検査期間中の非常用ディーゼル発電機の運転状態確認として試運転を実施するとともに定格容量確認検査を実施。
試運転時は各負荷（25%,40%,50%,65%,75%,85%,100%）で運転状態の確認を実施。
75%と100%負荷到達後に記録採取を実施しているが、パラメータは安定しておりバラツキはない。
（冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）

【試運転時の負荷カーブ】100%負荷試験時のカーブ
（女川２号機B号機　2020.12.２）



測定データ（女川２号機B号機抜粋）

負荷(%)	判定基準	起動前	75	100
潤滑油圧（主軸受）(MPa)	0.49~0.59	－	0.56	0.56
潤滑油温度（機関入口）(℃)	65未満	40.0	51.5	52.0

<参考>
なお連続負荷運転に伴う室温の上昇は以下のとおりであり100%負荷時の室温は安定している。（記録は，女川2号機B号機）

負荷(%)	起動前	75	100
室温（℃）	22.5	22.5	24.0

添付資料

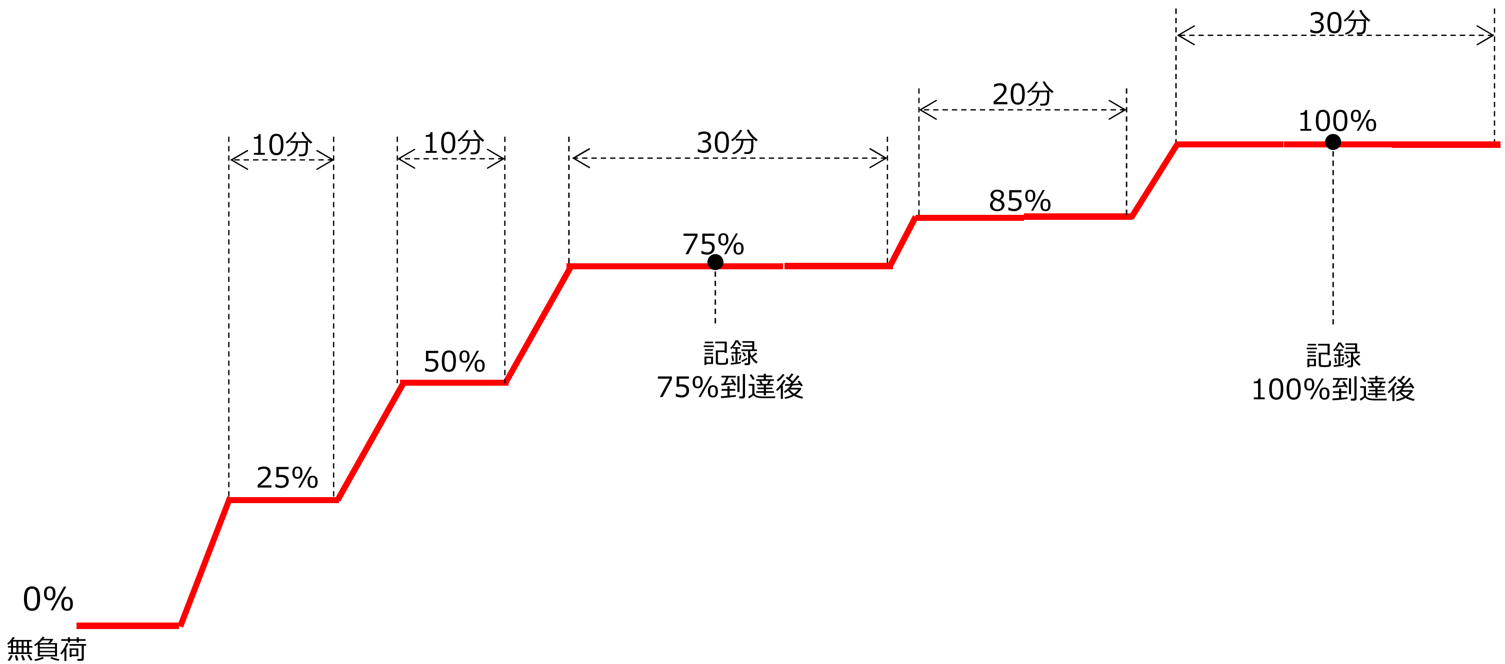
非常用ディーゼル発電機　定期事業者検査毎の運転確認について（3／13）

【定期事業者検査毎の機能性能確認】　（例：柏崎刈羽7号機）

➢　定期事業者検査期間中のEDG運転状態確認として試運転を実施するとともに定格容量確認検査を実施。
試運転時は各負荷（25%、50%、75%、85%、100%）で運転状態の確認および記録採取を実施。
75%と100%負荷到達後に記録採取を実施しているが、パラメータは安定しておりバラツキはない。
（冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）

【試運転時の負荷カーブ】

(柏崎刈羽7C号機　2020.3.27)



測定データ（抜粋）

負荷(%)	判定基準	起動前	75	100
潤滑油圧(MPa)	0.540~0.637	0.170	0.600	0.600
潤滑油温度(℃)	83未満	42.0	63.0	63.0

<参考>
なお連続負荷運転に伴う室温の上昇は無く100%負荷時の室温は安定している。（記録は柏崎刈羽7C号機）

負荷(%)	起動前	75	100
室温（℃）	22.0	16.0	18.0

添付資料

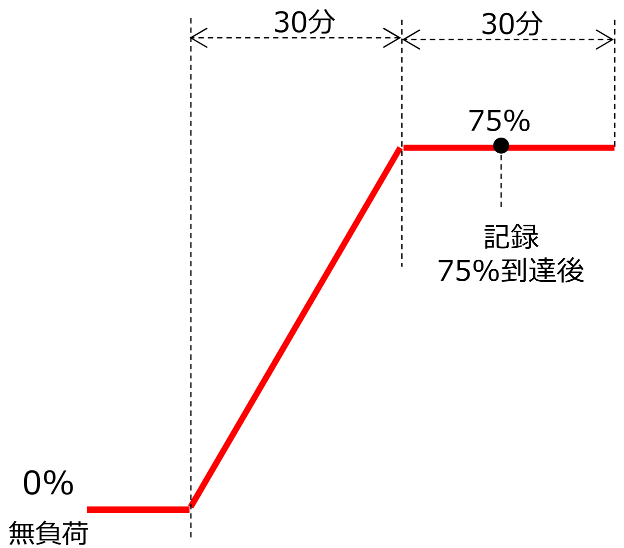
非常用ディーゼル発電機　定期事業者検査毎の運転確認について（4／13）

【定期事業者検査毎の機能性能確認】　（例：浜岡3号機）

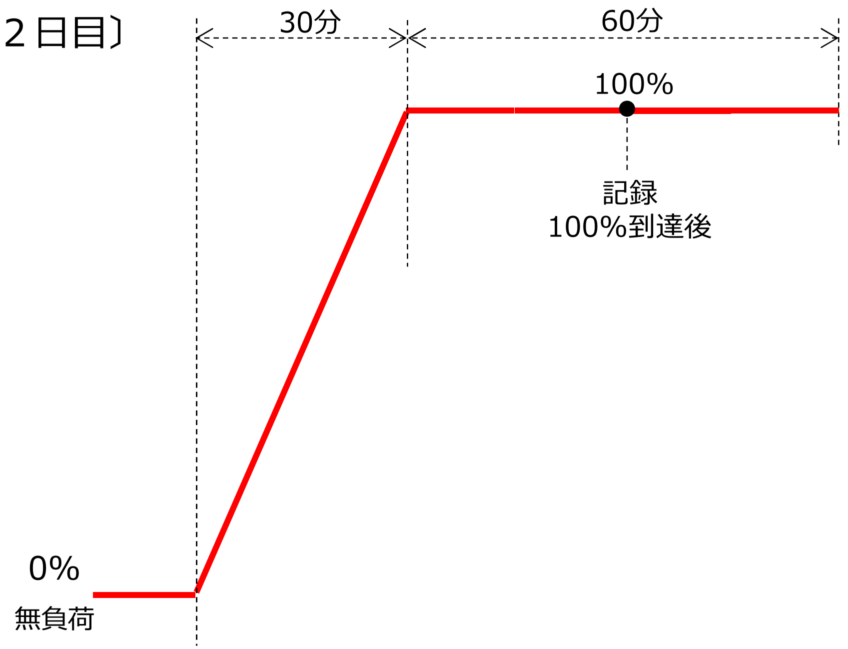
➢ 定期事業者検査期間中のEDG運転状態確認として試運転を実施するとともに定格容量検査を実施。
試運転時は各負荷（75%、100%）で運転状態の確認および記録採取を実施。
75%と100%負荷到達後に記録採取を実施しているが、パラメータは安定しておりバラツキはない。
（冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）

【試運転時の負荷カーブ】
(浜岡３A号機　2020.11.20,21)

〔１日目〕



〔２日目〕



測定データ（抜粋）

負荷(%)	判定基準	1日目 起動前	75	100
潤滑油圧(MPa)	0.41~0.64	0.12	0.60	0.60
潤滑油温度(℃)	55~75	35.0	60.0	62.0

<参考>
なお連続負荷運転に伴う室温の上昇は無く100%負荷時の室温は安定している。（記録は浜岡3A号機）

負荷(%)	1日目 起動前	75	100
室温 (℃)	27.0	31.0	31.0

添付資料

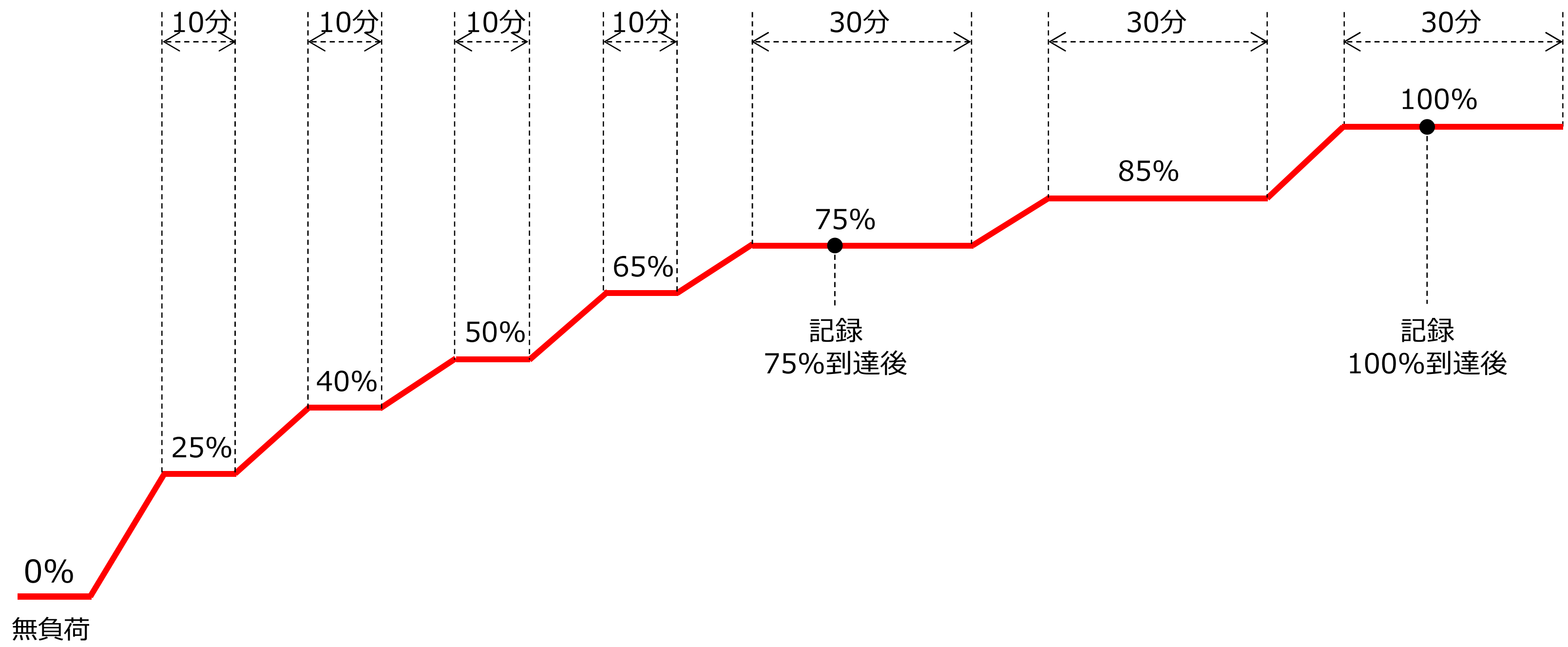
非常用ディーゼル発電機　定期事業者検査毎の運転確認について（5／13）

【定期事業者検査毎の機能性能確認】　（例：志賀1号機)

- EDG運転状態確認の定期事業者検査については負荷試運転時に実施。
  試運転時は各負荷（25%、40%、50%、65%、75%、85%、100%）で運転状態の確認を実施。
  75%と100%負荷到達後に記録採取を実施しているが、パラメータは安定しておりバラツキはない。
  （冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）

【試運転時の負荷カーブ】

(志賀1A号機　2014.6.18)



測定データ（抜粋）

負荷(%)	判定基準	起動前	75	100
潤滑油圧(MPa)	0.54~0.64	0	0.55	0.57
潤滑油温度(℃)	25.0~85.0	33.5	71.0	73.0

<参考>
なお連続負荷運転に伴う室温の上昇は以下のとおりであり100%負荷時の室温は安定している。（記録は志賀1A号機）

負荷(%)	起動前	75	100
室温（℃）	25.0	29.0	30.0

添付資料

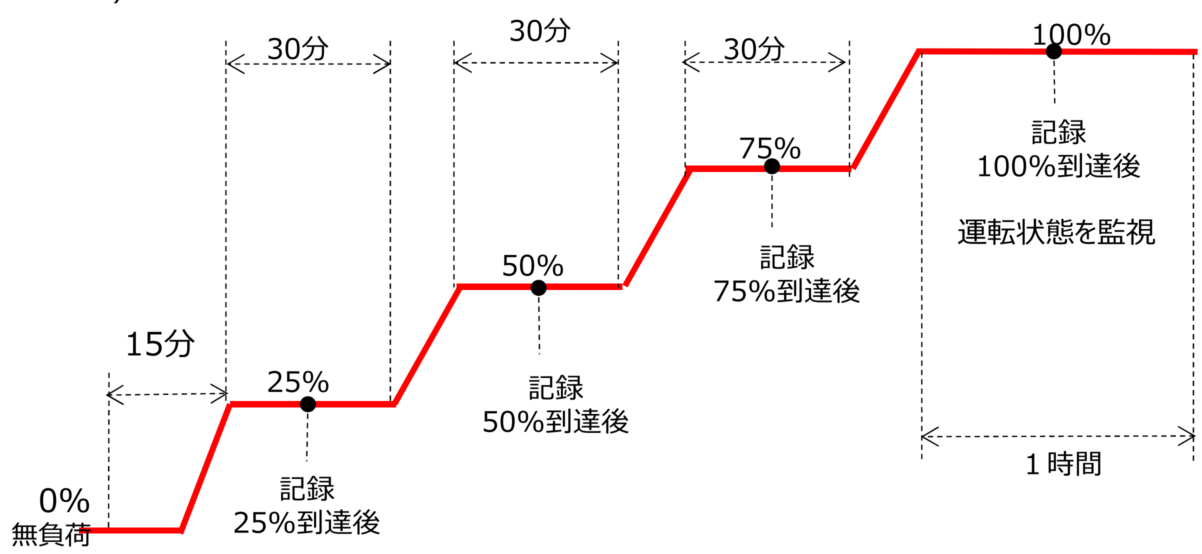
非常用ディーゼル発電機　定期事業者検査毎の運転確認について（6／13）

【定期事業者検査（機能性能検査）】　（例：高浜3号機）

➢ EDG運転状態確認の定期事業者検査については負荷試運転時に実施。
試運転時は各負荷（25%、50%、75%、100%）で運転状態の確認および記録採取を実施。（冷却水温度・圧力、**潤滑油温度・圧力**、シリンダ出口排気温度　etc）
各負荷到達後に運転状態確認、記録採取を実施しているが、パラメータは安定しておりバラツキはない。
※下線部は定事検での採取データ

【試運転時の負荷カーブ】

（高浜3A号機　R2.3.13　）



定期事業者検査（機能検査）記録は試運転時に合せて実施。
各負荷到達後に運転状態確認、記録採取を実施。（機関入口潤滑油圧力、機関出口潤滑油温度）

（記録は高浜3A号機）

負荷(%)	判定基準	25	50	75	100
潤滑油圧(MPa)	0.49~0.54	0.52	0.51	0.51	0.50
潤滑油温度(℃)	50.0~70.0	52.4	54.7	57.1	61.9

<参考>
なお連続負荷運転に伴う室温の上昇は無く100%負荷時の室温は安定している。（記録は高浜3A号機）

負荷(%)	25	50	75	100
室温（℃）	30	31	32	29

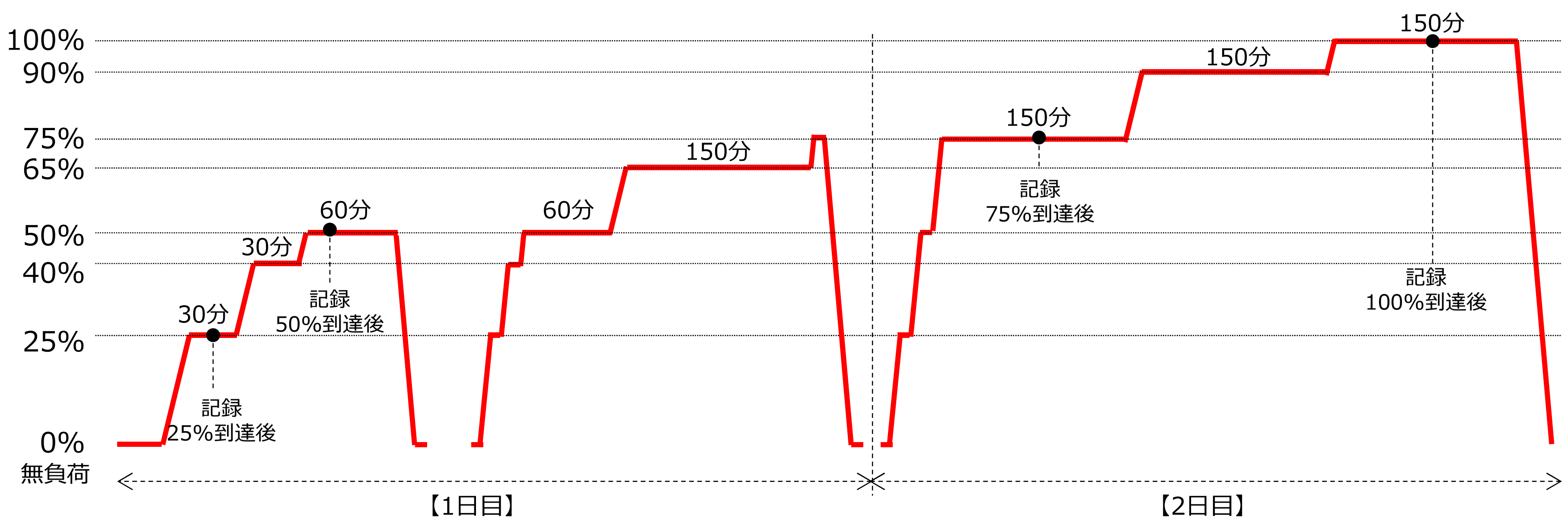
非常用ディーゼル発電機　定期事業者検査毎の運転確認について（7／13）

【定期事業者検査毎の機能性能確認】　（例：島根2号機）

➢ 定期事業者検査期間中のEDG運転状態確認として試運転を実施するとともに定格容量確認検査を実施。
試運転時は各負荷（25%、40%、50%、65%、75%、90%、100%）で運転状態の確認および記録採取（25%、50%、75%、100%）を実施。
各負荷到達後に記録採取を実施しているが、パラメータは安定しておりバラツキはない。
（冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）

【試運転時の負荷カーブ】

（島根2A号機　2019.12.9-10）



測定データ（抜粋）

負荷(%)	判定基準	起動前	25	50	75	100
潤滑油圧(MPa)	0.440~0.600	0.135	0.599	0.557	0.549	0.542
潤滑油温度(℃)	50.0~60.0	47.0	55.5	55.0	55.0	55.1

＜参考＞
なお連続負荷運転に伴う室温の上昇は無く100%負荷時の室温は安定している。（記録は島根2A号機）

負荷(%)	起動前	25	50	75	100
室温（℃）	24.0	20.5	21.0	22.0	22.0

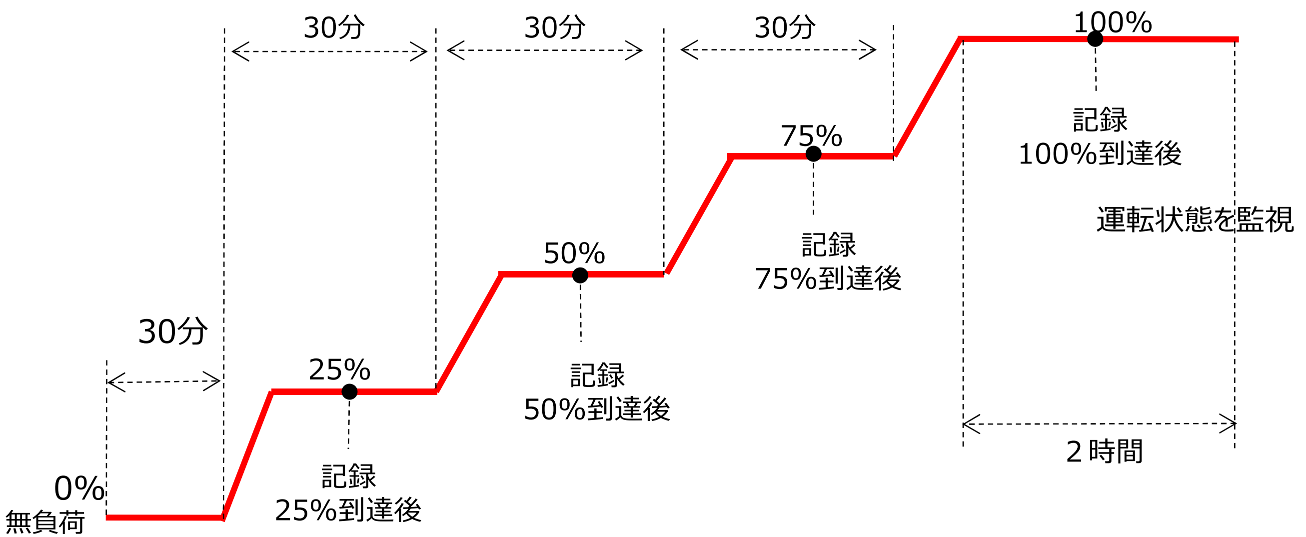
非常用ディーゼル発電機　定期事業者検査毎の運転確認について（8／13）

【定期事業者検査（機能性能検査）】　（伊方3号機）

➢　EDG運転状態確認の定期事業者検査については負荷試運転時に実施。
試運転時は各負荷（25%、50%、75%、100%）で運転状態の確認および記録採取を実施。（冷却水温度・圧力、**潤滑油温度・圧力**、シリンダ出口排気温度　etc）
各負荷到達後に運転状態確認、記録採取を実施しているが、パラメータは安定しておりバラツキはない。
※下線部は定事検での採取データ

【試運転時の負荷カーブ】

(伊方3A号機　R2.3.20　)



定期事業者検査（機能検査）記録は試運転時に合せて実施。
各負荷到達後に運転状態確認、記録採取を実施。（機関入口潤滑油圧力、機関出口潤滑油温度）

(記録は伊方3A号機)

負荷(%)	判定基準	25	50	75	100※
潤滑油圧(MPa)	0.49~0.59	0.56	0.55	0.55	0.540
潤滑油温度(℃)	50.0~70.0	55.9	58.2	60.4	64.0

※定事検での採取データ

＜参考＞
なお連続負荷運転に伴う室温の上昇は無く100%負荷時の室温は安定している。（記録は伊方3A号機）

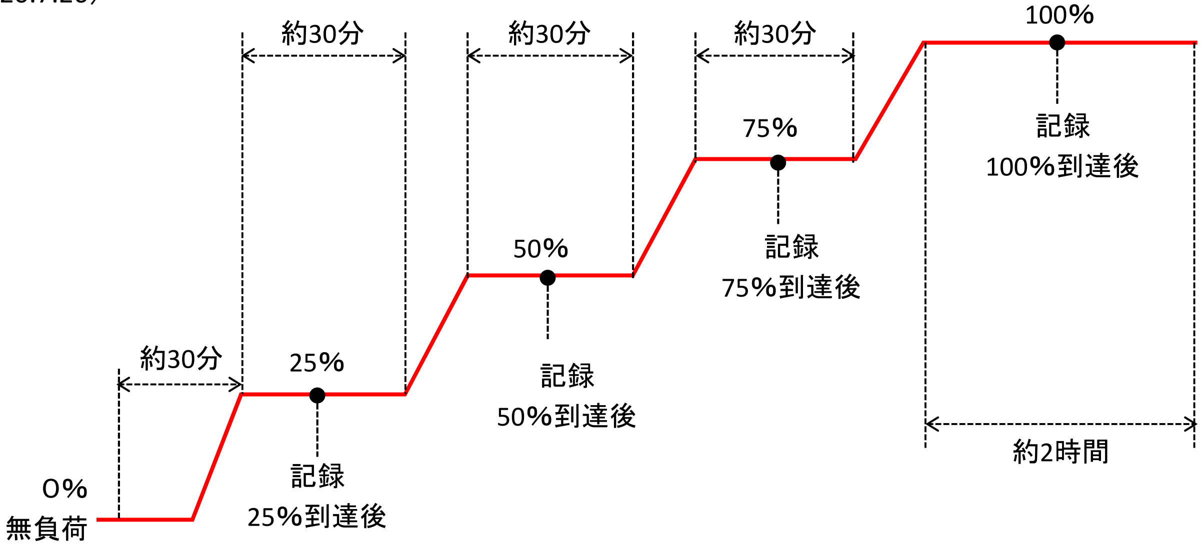
負荷(%)	25	50	75	100
室温（℃）	24	24	24	25

非常用ディーゼル発電機　定期事業者検査毎の運転確認について（9／13）

【定期事業者検査毎の運転状態確認】（例：川内1号機）

➢定期事業者検査期間中にEDGの運転状態を確認するため試運転を実施。
試運転時は各負荷（25%、50%、75%、100%）で運転状態の確認および記録採取を実施。（冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）
各負荷到達後に運転状態確認、記録採取を実施しているが、パラメータは安定しておりバラツキはない。

【試運転時の負荷カーブ】
（川内1A号機 2020.7.26）



測定データ（抜粋）
（記録は川内1A号機）

負荷(%)	目標値	25	50	75	100
潤滑油圧力（機関入口圧力）(MPa)	0.49～0.54	0.52	0.51	0.51	0.50
潤滑油機関出口温度(℃)	50～70	58	60	63	67

＜参考＞
なお連続負荷運転に伴う室温の上昇は無く100%負荷時の室温は安定している。（記録は川内1A号機）

負荷(%)	運転前	25	50	75	100
室温(℃)	26	28	28	28.5	30

添付資料

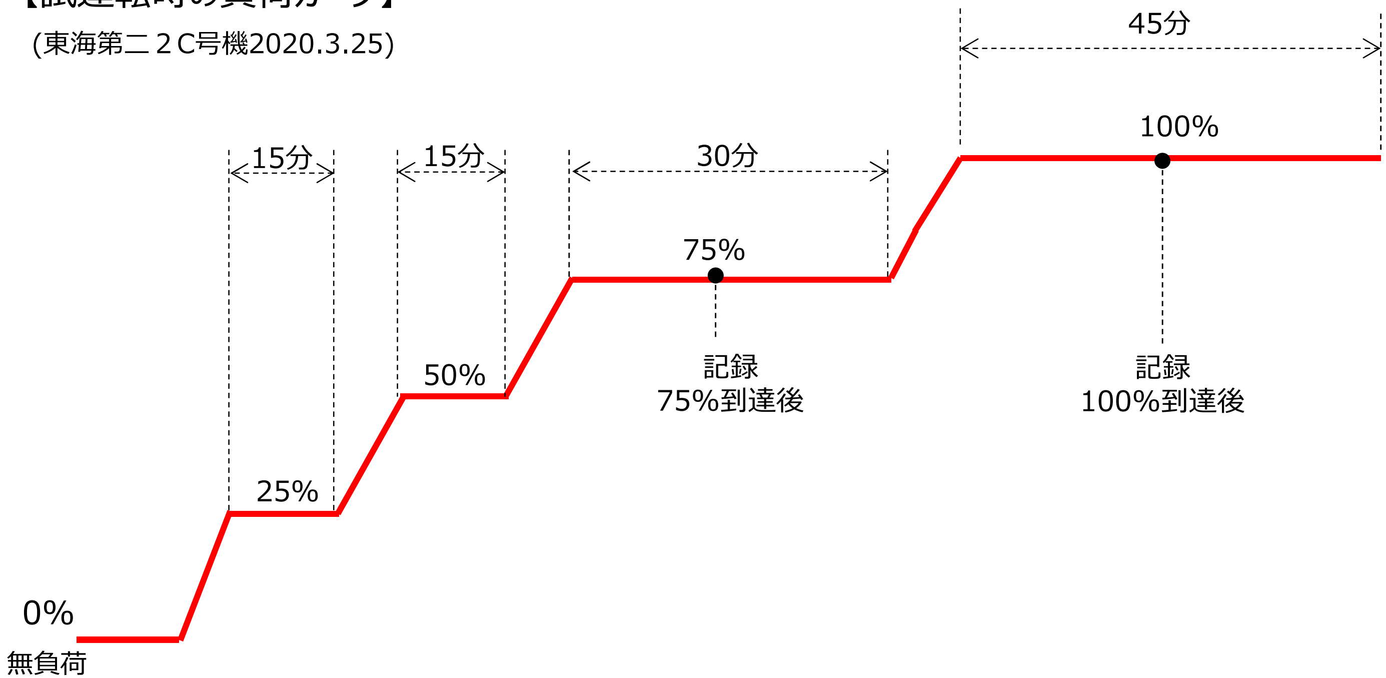
非常用ディーゼル発電機　定期事業者検査毎の運転確認について（10／13）

【定期事業者検査毎の機能性能確認】　（例：東海第二）

- 定期事業者検査期間中のEDG運転状態確認として試運転を実施するとともに定格容量確認検査を実施。
  試運転時は各負荷（25%、50%、75%、100%）で運転状態の確認および記録採取を実施。
  75%と100%負荷到達後に記録採取を実施しているが、パラメータは安定しておりバラツキはない。
  （冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）

【試運転時の負荷カーブ】

(東海第二２C号機2020.3.25)



測定データ（抜粋）

負荷(%)	判定基準	75	100
潤滑油圧(MPa)	0.49~0.59	0.58	0.58
潤滑油温度(℃)	60以下	38	42

＜参考＞
なお連続負荷運転に伴う室温の上昇は無く100%負荷時の室温は安定している。（記録は東海第二２C号機）

負荷(%)	75	100
室温（℃）	19	20

添付資料

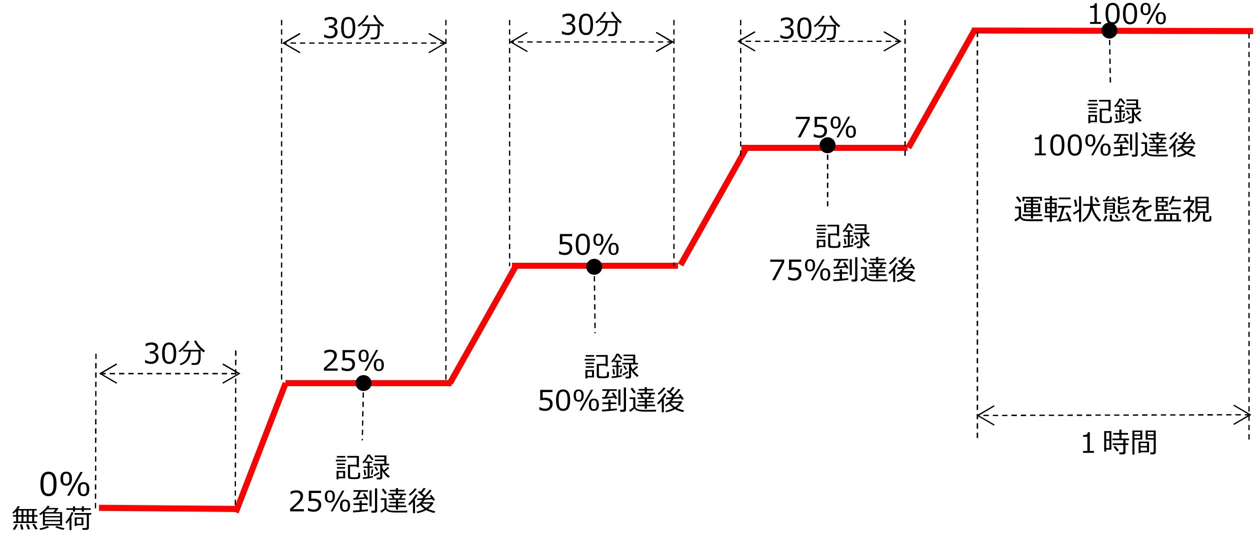
非常用ディーゼル発電機　定期事業者検査毎の運転確認について（11／13）

【定期事業者検査毎の機能性能確認】　（例：敦賀２号機）

- 定期事業者検査期間中のEDG運転状態確認として試運転を実施するとともに定格容量確認検査を実施。
  試運転時は各負荷（25%、50%、75%、100%）で運転状態の確認および記録採取を実施。
  各負荷到達後に記録採取を実施しているが、パラメータは安定しておりバラツキはない。
  （冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）

【試運転時の負荷カーブ】

(敦賀２B号機　2019.12.20　)



(記録は敦賀２B号機)

負荷(%)	判定基準	25	50	75	100
潤滑油圧(MPa)	0.49~0.54	0.52	0.51	0.51	0.51
潤滑油温度(℃)	50~70	55	58	62	64

<参考>
なお連続負荷運転に伴う100%負荷時の室温は安定している。（記録は敦賀２B号機）

負荷(%)	25	50	75	100
室温（℃）	32	35	36	19

添付資料

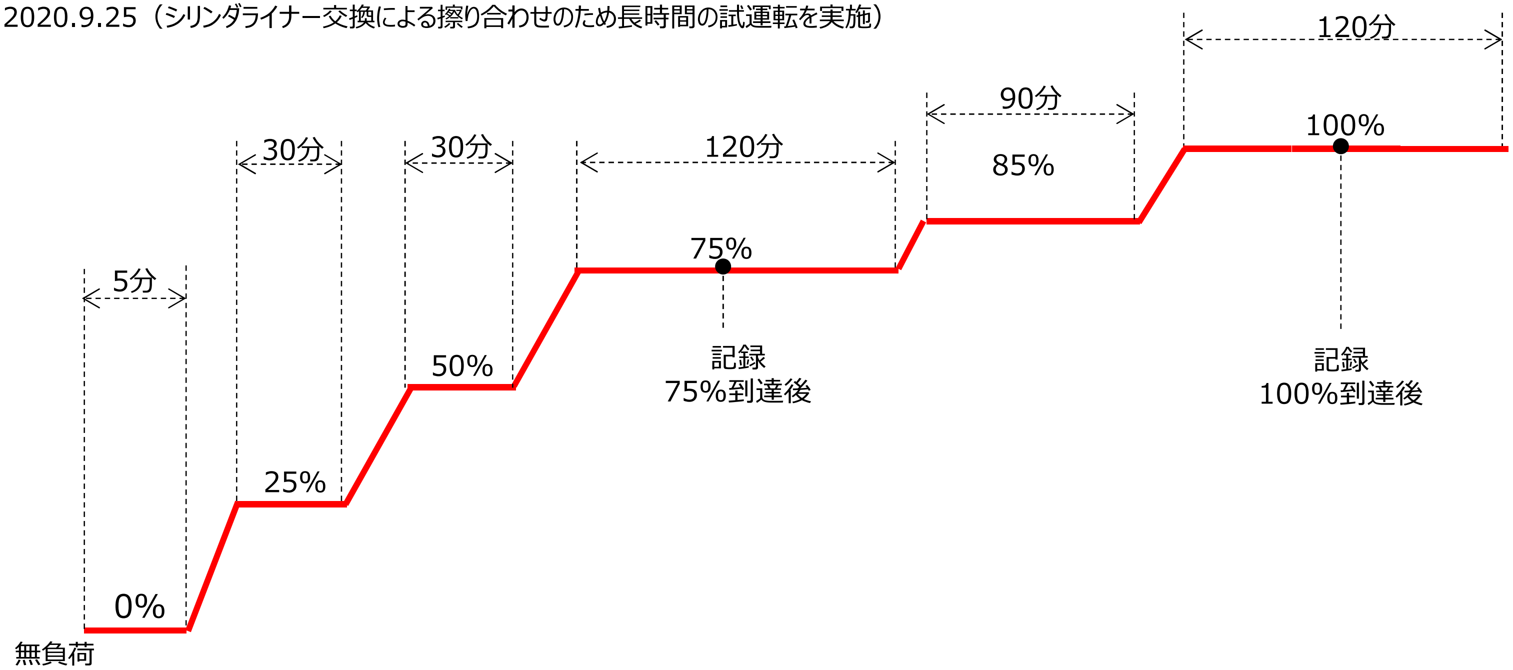
非常用ディーゼル発電機　定期事業者検査毎の運転確認について（12／13）

【EDG定期点検後の負荷試運転】（例：日本原燃　第１非常用ディーゼル発電機）

- EDGの運転状態確認としてEDG定期点検後の負荷試運転時に実施。
  試運転時は各負荷（25%、50%、75%、85%、100%）で運転状態の確認を実施。
  75%と100%負荷到達後の採取データ（抜粋）を示すが、パラメータは安定している。
  （冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）

【試運転時の負荷カーブ】

Ｂ号機　2020.9.25（シリンダライナー交換による擦り合わせのため長時間の試運転を実施）



採取データ（抜粋）

負荷(%)	判定基準	75	100
潤滑油圧力(MPa)	0.55~0.65	0.55	0.55
潤滑油温度(℃)	35.0~85.0	73.5	74.8

<参考>
なお連続負荷運転に伴う室温の上昇は無く100%負荷時の室温は安定している。（Ｂ号機）

負荷(%)	75	100
室温（℃）	29	29

添付資料

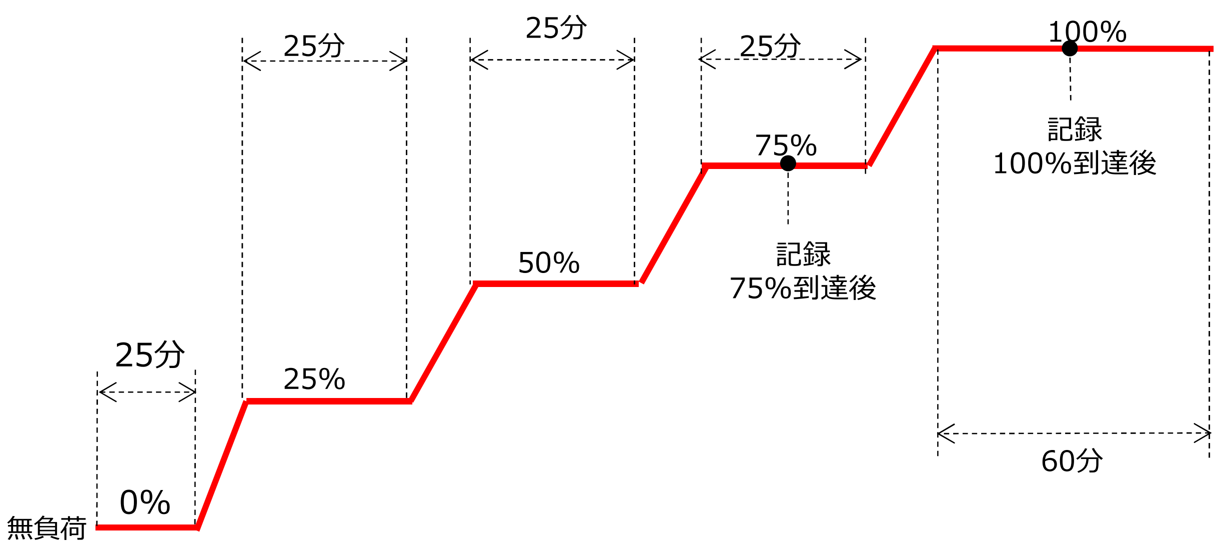
非常用ディーゼル発電機　定期事業者検査毎の運転確認について（13／13）

【EDG定期点検後の負荷試運転】（例：日本原燃　第２非常用ディーゼル発電機）

- EDGの運転状態確認としてEDG定期点検後の負荷試運転時に実施。
  試運転時は各負荷（25%、50%、75%、100%）で運転状態の確認を実施。
  75%と100%負荷到達後の採取データ（抜粋）を示すが、パラメータは安定している。
  （冷却水温度・圧力、潤滑油温度・圧力、シリンダ出口排気温度　etc）

【試運転時の負荷カーブ】

A号機　2020.7.17



採取データ（抜粋）

負荷(%)	判定基準	75	100
潤滑油圧力(MPa)	0.44～0.59	0.53	0.54
潤滑油温度(℃)	50～80	61	65

＜参考＞
なお連続負荷運転に伴う室温の上昇は無く100%負荷時の室温は安定している。（A号機）

負荷(%)	75	100
室温（℃）	32	34