SELECTION, OPERATION & MAINTENANCE
OF
FANS, BLOWERS, GEAR BOXES, AGITATORS & MIXERS

OISD-RP-122
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Prepared by
FUNCTIONAL COMMITTEE FOR
REVISION OF STANDARDS ON ROTARY EQUIPMENT

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Preamble

Indian petroleum industry is the energy lifeline of the nation and its continuous performance is essential for sovereignty and prosperity of the country. As the industry essentially deals with inherently inflammable substances throughout its value chain – upstream, midstream and downstream – Safety is of paramount importance to this industry as only safe performance at all times can ensure optimum ROI of these national assets and resources including sustainability.

While statutory organizations were in place all along to oversee safety aspects of Indian petroleum industry, Oil Industry Safety Directorate (OISD) was set up in 1986 Ministry of Petroleum and Natural Gas, Government of India as a knowledge centre for formulation of constantly updated world-scale standards for design, layout and operation of various equipment, facility and activities involved in this industry. Moreover, OISD was also given responsibility of monitoring implementation status of these standards through safety audits.

In more than 25 years of its existence, OISD has developed a rigorous, multi-layered, iterative and participative process of development of standards – starting with research by in-house experts and iterating through seeking & validating inputs from all stakeholders – operators, designers, national level knowledge authorities and public at large – with a feedback loop of constant updation based on ground level experience obtained through audits, incident analysis and environment scanning.

The participative process followed in standard formulation has resulted in excellent level of compliance by the industry culminating in a safer environment in the industry. OISD – except in the Upstream Petroleum Sector – is still a regulatory (and not a statutory) body but that has not affected implementation of the OISD standards. It also goes to prove the old adage that self-regulation is the best regulation. The quality and relevance of OISD standards had been further endorsed by their adoption in various statutory rules of the land.

Petroleum industry in India is significantly globalized at present in terms of technology content requiring its operation to keep pace with the relevant world scale standards & practices. This matches the OISD philosophy of continuous improvement keeping pace with the global developments in its target environment. To this end, OISD keeps track of changes through participation as member in large number of International and national level Knowledge Organizations – both in the field of standard development and implementation & monitoring in addition to updation of internal knowledge base through continuous research and application surveillance, thereby ensuring that this OISD Standard, along with all other extant ones, remains relevant, updated and effective on a real time basis in the applicable areas.

Together we strive to achieve NIL incidents in the entire Hydrocarbon Value Chain. This, besides other issues, calls for total engagement from all levels of the stake holder organizations, which we, at OISD, fervently look forward to.

Jai Hind!!!

Executive Director

Oil Industry Safety Directorate
FOREWORD

The Oil Industry in India is more than 100 years old. As such a variety of practices are in vogue because of collaboration/association with different foreign companies and governments. Earlier, standardisation in design philosophies, selection, operating and maintenance practices at a national level were hardly in existence. This, coupled with feedback from some serious accidents that occurred in India and abroad, emphasised the need for the industry to review the existing state of art in designing, selecting, operating and maintaining oil and gas installations.

With this in view, the then Ministry of Petroleum and Natural Gas in 1986 constituted a Safety Council assisted by Oil Industry Safety Directorate (OISD) staffed from within the industry in formulating and implementing a series of self-regulatory measures aimed at removing obsolescence, standardising and upgrading the existing standards to ensure safer operations. Accordingly OISD constituted a number of functional committees comprising of experts nominated from the industry to draw up standards and guidelines on various subjects.

The present standard on “Selection, Operation & Maintenance of Fans, Blowers, Gear Boxes, Agitators & Mixers” has been prepared by the “Functional Committee for Rotary Equipment”. The earlier title “inspection of Fans, Blowers, Gear Boxes and Agitators” has been modified by the functional committee. This document, based on the accumulated knowledge and experience of industry members and the various national and international codes and practices, is meant to be used as a supplement and not as a replacement for existing codes standards and manufacturers’ recommendations. It is hoped that the provision of this standard, if implemented objectively, may go a long way to improve the safety and reduce accidents in the Oil and Gas Industry. The users of this document are cautioned that no standard can be a substitute for a responsible and experienced engineer. Suggestions are invited from the users after it is put into practice to improve the standard further. Suggestions for amendment, if any, should be addressed to:

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These documents are intended to supplement rather than replace the prevailing statutory requirements.
**FUNCTIONAL COMMITTEE FOR**
**REVISION OF STANDARDS ON ROTARY EQUIPMENT**
(Complete Revision : July, 2008)

**List of Members**

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<tr>
<th>Name</th>
<th>Organisation</th>
<th>Status</th>
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<tr>
<td>1. Sh. D.K.Puri</td>
<td>Reliance Industries Ltd.</td>
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</tr>
<tr>
<td>2. Sh. S.K.Chatterjee</td>
<td>Hindustan Petroleum Corporation Ltd.</td>
<td>Member</td>
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<td>3. Sh. Deepak Prabhakar</td>
<td>Mangalore Refinery &amp; Petrochemicals Ltd.</td>
<td>Member</td>
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<td>4. Sh. R.C. Agrawal</td>
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<td>Coordinator</td>
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# SELECTION, OPERATION & MAINTENANCE OF FANS, BLOWERS, GEAR BOXES, AGITATORS & MIXERS

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## ANNEXURE

1. TYPICAL INSTALLATION & TEST PROCEDURE-(ITP) 9
1.0 INTRODUCTION

Fans, Blowers, Gearboxes, Agitators and Mixers are widely used equipment in Hydrocarbon Industry. Proper selection, operation and maintenance of these equipment is critical for safety and environment. This document has been developed considering the importance of these equipment in overall safety of the Hydrocarbon Industry.

2.0 SCOPE

This document covers the general considerations in Selection, Installation, Commissioning, Operation, Maintenance and Failure & Root Cause Analysis of Fans, Blowers, Gearboxes, Agitators & Mixers.

3.0 DEFINITIONS

3.1 SHALL
Indicates mandatory requirement

3.2 SHOULD
Indicates recommendation or that which is advised but not mandatory

3.3 FAN
Device used to move large amounts of gas/ air with low increase in pressure.

3.4 BLOWER
A blower is a machine for moving large volumes of a gas/ air with moderate increase in pressure.

3.5 GEAR
Low speed rotor of the gear assembly.

3.6 PINION
High speed rotor of the gear assembly.

3.7 AGITATOR
A dynamic device to impart whirling motion to avoid precipitation for maintaining homogeneity of composite substances.

3.8 MIXER
A dynamic device to prepare homogeneous mixture of soluble elements.

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3.9 ANTI-STATIC

System/device that prevents generation of static electricity or restrict static electricity from causing hazardous effect to the system.

4.0 SELECTION

i. The design shall focus on the parameters that would prevent unsafe condition, fire hazard or adverse effects on health and environment.

ii. The equipment shall conform to the relevant national/international equipment standards and OISD standards. Proven vendor standards can also be accepted where national/international standards do not exist.

iii. Drivers and Auxiliaries shall be suitable for the hazardous area classification of the location as per OISD STD 113.

This section covers the design considerations, general considerations and monitoring & protection systems of all the equipment.

4.1 FANS & BLOWERS

This section covers selection considerations for Fans (such as mixed flow Fans, Axial flow fans like Air Fin Cooler fans and Cooling Tower Fans, etc) and Blowers.

4.1.1 DESIGN CONSIDERATIONS

The factors to be considered are as below:

4.1.1A SERVICE

i. The basic equipment design, materials and the manufacturing processes shall be selected such that machines are suitable for the intended service i.e., process fluid, and other characteristics like the flammability, toxicity, reactivity, contaminant levels, humidity, solid content, etc.

ii. Materials or coating shall be suitably selected considering presence of corrosive elements like acid vapours or presence of abrasive particles in the process fluid.

iii. Casing and sealing design should be such that leakage to atmosphere is negligible.

4.1.1B PRESSURE & TEMPERATURE

i. The basic equipment design and materials shall be suitable for the lowest and highest operating pressures and temperatures.

ii. Casing shall be suitably insulated or lined for hot fluid service.

iii. Insulation should be provided in areas where required.

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iv. Fans and Blowers handling hot gases shall be provided with a deflector plate between shaft seal & bearing housing to prevent impingement of hot gases on bearing housing.

4.1.1.C LOCATION

Equipment design and materials shall be selected considering the location and external operating environment. Location considerations include cooling towers/air-fin coolers applications.

4.1.2 GENERAL CONSIDERATIONS

Forced draft fans shall be provided with suction screen to protect the fan from any external object. The screen material shall be corrosion resistant material as required by the environmental condition.

i. Belts and Couplings shall be suitable for the area and in accordance with OISD STD-123.

ii. Where variable speed drive motors are provided, adequate protection shall be in place to prevent over-speeding.

iii. For air fin cooler fans, appropriate positively secured fan guards shall be provided for the safety of personnel around and also to prevent ingress of external objects.

iv. Lubrication systems shall be as per the OEM requirements or proven vendor standards.

4.1.3 MONITORING AND PROTECTION SYSTEMS

i. For safe operation, the fans and blowers shall have suitable monitoring and protection systems as per provisions of OISD-RP-124 and OISD-RP-126.

ii. For equipment like Cooling Tower Fans and Air Fin Cooler Fans, suitable protection shall be provided to ensure safe shutdown in case of high vibrations.

iii. Process parameters shall be monitored for any abnormality and suitable corrective actions taken to prevent failure of equipment.

4.2 GEAR BOXES

This section covers Gearboxes installed as part of other rotary equipment.

4.2.1 DESIGN CONSIDERATIONS

The factors to be considered shall be as below:

i. The equipment should be manufactured/selected in compliance with the relevant equipment standards and OISD standards depending upon the application. Proven vendor standards can also be accepted on case to case to basis.

ii. Other consideration for selection shall be on the type of prime mover, type of driven equipment and its mode & plane of transmission.

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iii. Sealing devices shall be selected based on the presence of contaminants in operating environment.

4.2.2 GENERAL CONSIDERATIONS

i. Transmission units shall be as per OISD-STD-123

ii. Lubrication systems shall be as per applicable equipment standards.

4.2.3 MONITORING & PROTECTION SYSTEMS

i. For safe operation, gearboxes shall have suitable monitoring and protection systems as per provisions of OISD-RP-124 and OISD-RP-126.

ii. The monitoring and protection system for special purpose gearboxes shall have the following:-
   a) Provision to monitor the various machine conditions like vibrations, bearing metal temperatures, axial displacement, oil pressures and temperatures etc, as applicable
   b) Acceptable limits defined for all machine condition parameters.
   c) Generation of alarms when any machine parameter reaches the pre-set values in order to facilitate evaluation and suitable action.
   d) Provision to trip the machine either manually or automatically, when any parameter exceeds the specified limits.

4.3 AGITATORS & MIXERS

This section covers mechanical agitators/ mixers that are installed in Hydrocarbon Industry in various applications like tank services, chemical handling services, etc.

4.3.1 DESIGN CONSIDERATIONS

4.3.1.A SERVICE

i. Selection of type of agitator/ mixers, material of construction, manufacturing process shall be based on the process fluid characteristics, operating temperature, pressure, corrosiveness, contaminant levels and solid content.

ii. Shaft sealing shall be selected based on considerations of pressure, temperature, flammability and toxicity of the service in accordance with OISD-STD-125.

iii. For shaft seals installed in Hydrocarbon service and for low lubricity liquids and gaseous applications, double mechanical seal with pressurized external fluid shall be provided.

iv. The equipment and sealing systems shall be designed for the minimum and maximum specified pressures, temperatures, and other parameters, like liquid level, specific gravity, viscosity, etc.

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4.3.1.B ORIENTATION AND MOUNTING

i. For agitators/ mixers mounted below the liquid line, a shut-off device shall be provided to isolate leakages. Sealing faces of the shut-off device shall be corrosion resistant.

ii. Provision for draining of accumulated leakage fluid shall be provided in accordance with the environmental regulations.

4.3.2 MONITORING & PROTECTION SYSTEMS

Suitable monitoring and protection systems as per provisions of OISD 124 and OISD 126 shall be provided.

5.0 INSTALLATION

Installation of Fans, Blowers, Gearboxes, Agitators and Mixers shall be carried out in accordance with the provisions mentioned below, as applicable:

i. Equipment erection shall be done in accordance with the approved procedures based on OEM recommendations and International Standards.

ii. Erection Quality shall be ensured with the use of Installation & Test Procedures (ITPs), Stage-wise Inspection and Hold Points. A typical Installation and Test Procedure (ITP) is given in Annexure–1 for reference.

iii. Integrity of foundations shall be verified through quality control checks.

iv. Usage of proper grout and application methods shall be ensured.

v. Equipment erection shall be done with approved lifting tools & tackles under the supervision of competent and skilled rigging person to ensure safety of equipment and personnel.

vi. Tools, tackles and lifting equipment, periodically inspected, calibrated and certified fit for use by competent authority, shall only be used.

vii. Erection of equipment, connected piping, ducts and piping supports shall be such that stress/strain on the equipment nozzles due to piping loads is within acceptable limits.

6.0 COMMISSIONING

Commissioning of equipment shall be ensured with the following activities as a minimum:

6.1 PRE-COMMISSIONING ACTIVITIES

i. Completeness of the system including connections and sub systems.

ii. Verification of erection through checklists.

iii. Readiness of instrumentation and completion of loop checks.

iv. Verification and certification of functioning of alarms & trips/ protections.

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6.2 PREPARATION & COMPLIANCE WITH

i. Equipment Start-up Procedure.

ii. Normal Operation Procedure.

iii. Normal and Emergency Shutdown Procedures.

Equipment shall be commissioned as per start-up procedures and all operating and machine parameters shall be verified for conformance to the design values at various steps. Deviations if any, from design values shall be recorded and corrective measures taken after evaluation.

7.0 OPERATION

Safe and reliable operation of equipment shall be ensured through:

i. Adherence to Standard Operating Procedures (SOPs). Standard Operating procedures shall address start-up, normal operation and emergency shutdown procedures.

ii. Deployment of trained and qualified operators.

iii. Periodic training and validation of operations personnel.

iv. Operation of the equipment within the specified operating system.

v. Review and verification that all the protection systems are in place and functioning. No protections are to be bypassed except those required for start-up with the prior approval from authorized personnel. The by-passing of protection, if any, shall be in accordance with OISD-RP-126.

vi. Continuous monitoring of process & equipment parameters and condition of auxiliary systems, like lubricating oil etc. shall be as defined in OISD-RP-124.

vii. The ‘Normal, Minimum and Maximum’ values of operating parameters shall be defined in the operating procedures or log sheets.

viii. Where toxic or hazardous fluids are handled, proper display boards detailing the properties of process fluid and the precautions to be taken shall be displayed prominently near the equipment.

ix. Measures to ensure that leaks from oil and process systems are minimal.

8.0 MAINTENANCE

8.1 Maintenance systems shall be in place to ensure good health and integrity of equipment. The following shall be considered in finalization of the maintenance program:

i. Condition of the Machine

ii. Type of Machine

iii. Running Hours

iv. OEM recommendations

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v. Opportunity

8.2 Maintenance system should:

i. Adhere to Standard Maintenance Procedures (SMPs)

ii. Comply with requirements of Work Permit System.

iii. Deploy competent and skilled personnel validated through training.

iv. Use of tools, tackles and lifting equipment which are periodically inspected, calibrated and certified fit for use by competent authority.

v. Establish a procedure to carry out monitoring of equipment and process parameters in line with OISD-RP-124.

vi. Detail out a procedure covering type and scope of the predictive and preventive maintenance activities to be done based on standard practices & OISD-RP-124.

vii. Overhaul the equipment based on their condition and as per procedure specified in OEM manual.

viii. Develop a procedure with regard to spare parts to be maintained in the inventory considering the criticality of the concerned equipment.

9.0 FAILURE & ROOT CAUSE ANALYSIS

i. Failure of equipment shall be analysed thoroughly.

ii. Root cause shall be established for each premature failure and necessary corrective actions shall be implemented to improve reliability.

iii. Root cause analysis shall be carried out as per the OISD-RP 126.

10.0 DOCUMENTATION

Proper documentation system shall be available to ensure safe operation of rotary equipment. Documentation shall include the following:

i. Data sheets

ii. Performance curves

iii. Cross sectional & constructional drawings and relevant P&ID

iv. O&M Manuals and Manufacturing Record Books

v. Commissioning Records

vi. Equipment Maintenance History

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11.0 REFERENCES

i. API 673- Standard for centrifugal fans

ii. API- 613 -For special purpose gear transmission system

iii. API 677- For General purpose gear transmission system

iv. API 614 – Lubrication

v. OISD RP 124, 126 – Prédictive maintenance, failure analysis, documentation, spécifique maintenance

vi. API 671- For coupling

vii. Balancing Standards - As per ISO-1940-1986(E), API 684

viii. API RP 686- For Installation & commissioning

ix. AGMA 6010/ 6011 Low speed and High speed drives.

x. OISD-STD-113 ; Classification of Areas for electrical installation at Hydrocarbon Handling Facilities

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### TYPICAL INSTALLATION AND TEST PROCEDURE (ITP)

<table>
<thead>
<tr>
<th>UNIT:</th>
<th>SERVICE:</th>
<th>LOCATION:</th>
<th>ITEM DESCRIPTION:</th>
<th>SYSTEM No:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI No:</td>
<td>Activity Description</td>
<td>Controlling Document</td>
<td>Acceptance Criteria</td>
<td>Verifying Forms</td>
</tr>
<tr>
<td>1</td>
<td>Centrelines and elevation marking on foundation (incl. Coordinates). Check foundations release note.</td>
<td>GA Drawing/ Civil drawing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Pocket depth, size &amp; centre to centre distance of pockets.</td>
<td>Civil drawing</td>
<td></td>
<td>Contractor record</td>
</tr>
<tr>
<td>3</td>
<td>Check foundation top surface micro-chipping and jack bolts.</td>
<td>Visual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Packer plates / shims condition under base plate.</td>
<td>Visual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Base plate/ casing erected and aligned with foundation centre line.</td>
<td>GA drawing/ Civil drawing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Assembly of equipment and check assembly and bearing.</td>
<td>Vendor manual</td>
<td>Visual</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Base plate/Bearing housing levelled properly - Foundation bolts tightened.</td>
<td>GA Drawing/ Civil drawing</td>
<td>Level &amp; shim within specification</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Check pocket clean and dried with dry air prior to pocket grouting.</td>
<td>Visual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Pocket grouting with specified grouting material (Remove jackscrews after grouting is cured).</td>
<td>Visual</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<p>| 10 | No loose items (tubing, oil cup, level glass etc) mounted on the equipment. | Visual | W | S | S |
| 11 | Nozzle and all opening covered/ blinded/plugged. | Visual | W | W | S |
| 12 | Check availability of shim (at least 2mm) under motor. | | W | W | S |
| 13 | Measure shaft's DBSE and record reading. | Vendor manual, Contractor record | W | W | DR |
| 14 | Levelling and alignment check (without ducting) Record reading. | Contractor record | W | W | DR |
| 15 | Check final grouting of Base-plate with specified grout and tightened Base plate bolts after curing of Grout. | Relevant Specification/Procedure | W | W | S |
| 16 | Dowelung of legs. | Visual | W | W | S |
| 17 | Check Erection of all auxiliaries, tubing, cooling water piping, Air filters, Flow glass and Breather. | GA Drawing &amp; P &amp;ID | Visual, Checklist | W | S | S |
| 18 | Check Erection of all instruments like Instrument panel, Pressure gauges/switches, Temperature gauges/switches, Orifices, sight glass and Limit switches (if any) | P &amp; ID | Visual, Instrumentation Check list | W | W | S |
| 19 | Bearing housing clean before first fill. | | | | | H |
| 20 | Lube oil system installed &amp; filled with proper lubricant. | As per Vendor manual | Visual | H | H | S |
| 21 | Adjustment of trip setting. | As per Vendor manual | Visual | W | W | S |
| 22 | Check parallelism of suction and discharge ducting/ piping | Vendor manual &amp; G A Drawing | Visual, Contractor record | W | W | S |</p>
<table>
<thead>
<tr>
<th></th>
<th>Activity Description</th>
<th>Source</th>
<th>Method</th>
<th>S</th>
<th>W</th>
<th>W</th>
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<tr>
<td>23</td>
<td>Check the availability/installation of name plate on motor and equipment and directional arrows on equipment, motor, valves.</td>
<td>P.O. Datasheet / P &amp; ID</td>
<td>Visual</td>
<td></td>
<td>W</td>
<td>W</td>
</tr>
<tr>
<td>24</td>
<td>Check fit up of coupling and coupling guard.</td>
<td>Visual</td>
<td></td>
<td></td>
<td>W</td>
<td>W</td>
</tr>
<tr>
<td>26</td>
<td>Placement of lower half of casing &amp; bearing pedestals (D.E &amp; N.D.E)</td>
<td>Vendor Manual</td>
<td>Level &amp; alignment as per vendor</td>
<td></td>
<td>W</td>
<td>W</td>
</tr>
<tr>
<td>27</td>
<td>Blue matching of bearing pedestals &amp; Plumber blocks</td>
<td>Vendor Manual</td>
<td>Visual</td>
<td>W</td>
<td>W</td>
<td>S</td>
</tr>
<tr>
<td>28</td>
<td>Blue matching of sleeve bearing lower half &amp; Plumber block</td>
<td>Vendor Manual</td>
<td>Visual</td>
<td>W</td>
<td>W</td>
<td>S</td>
</tr>
<tr>
<td>29</td>
<td>Placing of rotor assembly on the lower half of casing &amp; levelling</td>
<td>SMP</td>
<td>Reverse dial gauge method</td>
<td>W</td>
<td>W</td>
<td>S</td>
</tr>
<tr>
<td>30</td>
<td>Blue matching of shaft and bearing</td>
<td>Relevant Specification</td>
<td>Visual</td>
<td>W</td>
<td>W</td>
<td>S</td>
</tr>
</tbody>
</table>

**Note:** All activities shall be performed wherever applicable

**Legend:**
- S - Surveillance only
- W - Witness Inspection Point Review
- W% - 10% min Witness point
- DR - Document

<table>
<thead>
<tr>
<th>Contract</th>
<th>Execution Engineer</th>
<th>Client</th>
<th>Third Party Inspection</th>
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</thead>
<tbody>
<tr>
<td>Date</td>
<td>Name</td>
<td>Signature</td>
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