

PLENARY

**“Cross – Functional Collaboration Toward Enhancement of
Maintenance Program to Overcome Challenges on
Sustenance of Noise Engineering Control Equipment
Reliability”**



Speaker

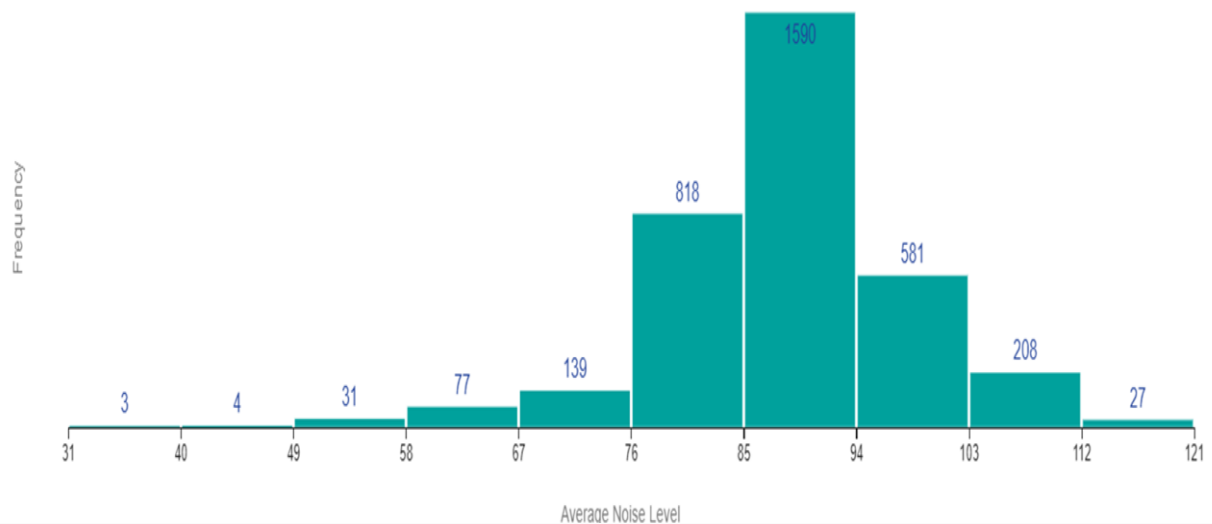
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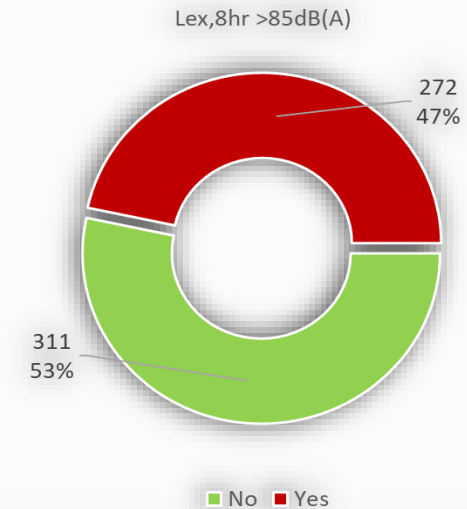
Background

- 75% of noise – generating equipment’s noise sources are above 85dB (A).
- A significant number of personal exposure monitoring results for identified high-risk work units exceed the daily noise exposure limits recorded as of 2020.
 (However, results are below the NEL after considering the noise reduction rating from personal hearing protection worn by workers)

Number of Equipment by Noise Level



Noise Exposure



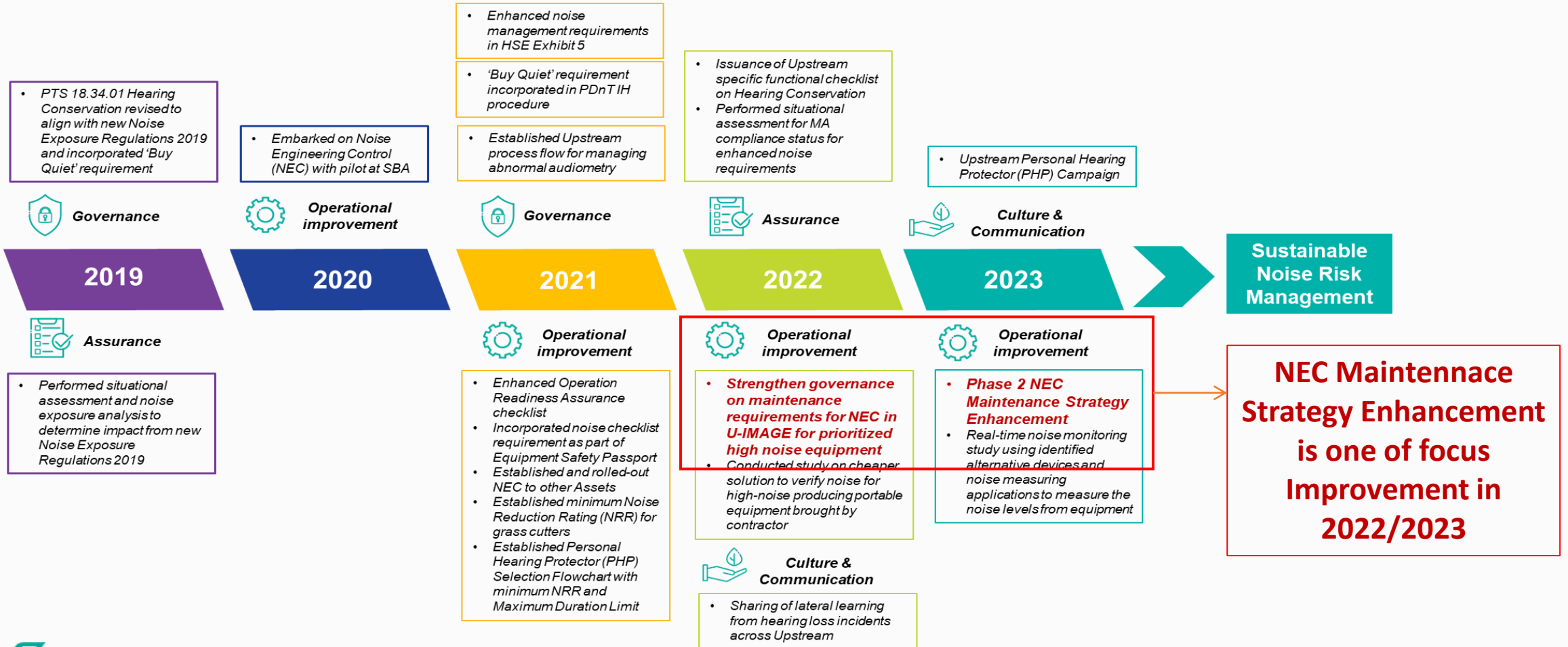


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Collaboration for Sustainable Health in Future of Work

Background

Business journey towards Sustainable Noise Risk Management included various interventions and initiatives to address noise risks for different aspects of the operations and project since 2019.





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*Collaboration for Sustainable
Health in Future of Work*

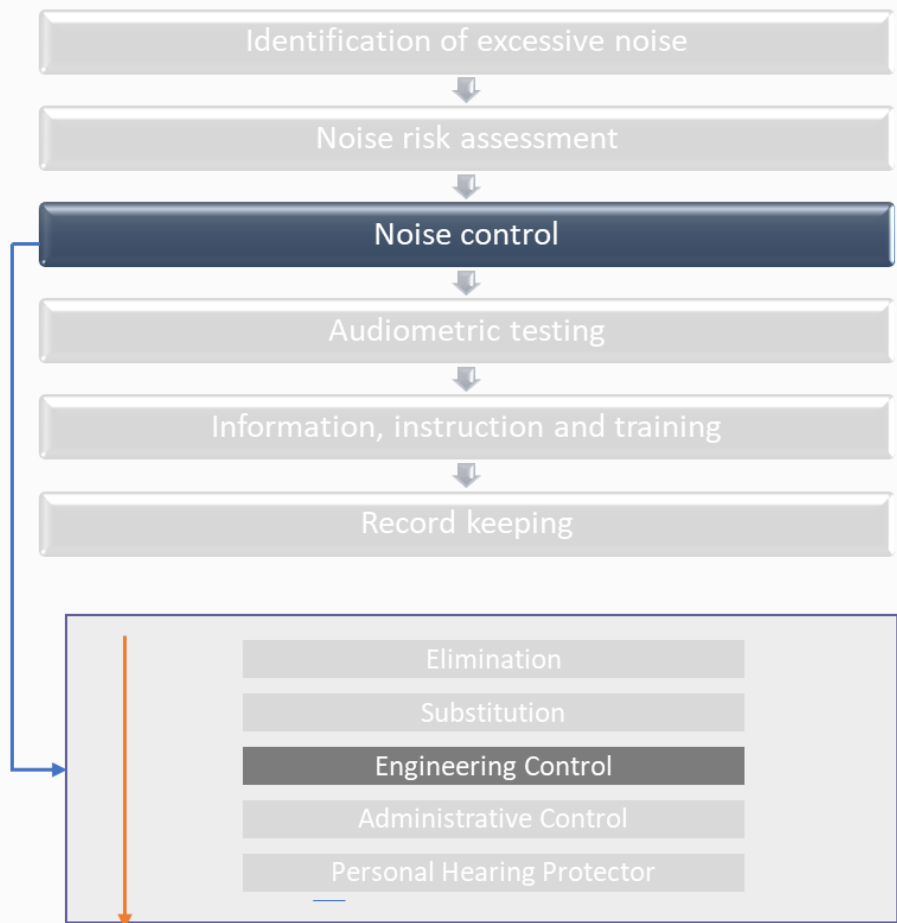


CASE FOR CHANGE



Noise Regulatory & Company Requirements

Components of Hearing Conservation Program



Noise Engineering Control to reduce excessive noise at facilities as 1st control option

(2) Where it appears to an employer that any of his employees is exposed to an excessive noise exceeding the limit specified in subregulation (1) based on the report referred to in subregulation 4(4), the employer shall take such measures to reduce the excessive noise.

(3) The employer shall, before taking the measures under subregulation (2), make an assessment whether it is practicable to reduce such excessive noise by way of engineering control or administrative control.

(4) If upon the completion of the assessment made under subregulation (3) the employer found that—

- (a) it is practicable to reduce such excessive noise by engineering control, the employer shall reduce the excessive noise by such engineering control;
- (b) it is not practicable to reduce such excessive noise by engineering control solely, the employer shall reduce the excessive noise by engineering control together with administrative control;
- (c) it is not practicable to reduce such excessive noise by engineering control together with administrative control, the employer shall reduce the excessive noise by administrative control solely; and
- (d) it is not practicable to reduce such excessive noise by administrative control, the employer shall take other effective measures, which shall include personal hearing protector, to reduce such excessive noise.

(5) The employer shall make a report on the assessment, and shall, upon request in writing from the Director General, give the Director General a copy of that report within thirty days after the request is received.

(6) Where the employer reduces such excessive noise by engineering control specified in paragraphs (4)(a) and (b), the employer shall ensure that such engineering control is maintained in an efficient state and good working order.



Gaps on compliance from Noise Risk Assessment/ Noise Engineering Control

- Recurrent findings related to NEC effectiveness :
 - ✓ Acoustic enclosure was not in good condition
 - ✓ Panel door (act as acoustic enclosure) left open due to overheating
 - ✓ Damage door (acoustic enclosure)
 - ✓ Damage silencer/ muffler at exhaust
 - ✓ air leakage on the existing silencer / muffler
 - ✓ Current silencer/ muffler not able to reduce the noise
 - ✓ High noise emitted from pump due to poor NEC maintenance

- Ineffective maintenance strategy for noise engineering control equipment to mitigate high noise emission from equipment.
- Unclear criteria for noise engineering control equipment maintenance requirement



Damage door (acoustic enclosure)



Air leakage on the existing silencer / muffler



High noise emitted from pump due to poor NEC maintenance



Equipment Criticality Assessment (ECA) and Maintenance Priority

ECA Impact Rating and Descriptors for People Health and Safety

	IMPACT RATING AND DESCRIPTORS				
	Insignificant A	Minor B	Moderate C	Major D	Catastrophic E
People (Health & Safety)	First aid injury or slight health effects not affecting work performance or causing disability, e.g. first aid injury, exposure to non hazardous dusts.	Medical Treatment Case, Restricted Work Case, Lost Time Injury or minor health effects (involving health hazards capable of minor health effects which are reversible, e.g. irritant agents, defatting agents, food poisoning bacteria) affecting work performance, such as restriction to work activities or a need to take a few days to fully recover.	Permanent Partial Disability, significant health effects (capable of irreversible health damage without loss of life, e.g. noise, poor manual handling tasks, hand/arm vibration, chemicals causing systemic effects, sensitizers), exposure to possible human or animal carcinogen, or results of injury/illness in the lower categories (category 1 & 2 above) which affect performance in the longer term such as prolonged absence from work for more than 4 days.	Permanent Total Disability, single fatality from accident or occupational illness or major health effects caused by health hazards capable of irreversible damage with serious disability or death e.g. exposure to corrosives, probable human carcinogens, extreme heat and cold, psychosocial risk factors.	Multiple fatalities or Permanent Total Disability from accident or occupational illness caused by health hazards with the potential to cause multiple fatalities, e.g. chemicals with acute toxic effects (hydrogen sulphide, carbon monoxide), known human carcinogens.

Moderate C

C

Permanent Partial Disability, significant health effects (capable of irreversible health damage without loss of life, e.g. noise, poor manual handling tasks, hand/arm vibration, chemicals causing systemic

ECA Process Limitation in addressing noise impact to people

- Equipment failure impact to people is tend to be lower compared to Financial (production loss and repair cost) during ECA process
- Hence, noise exposure risk to people was not considered/ addressed during Equipment Criticality Assessment

Less priority on action taken to mitigate any elevated noise level (from baseline)

- Lower failure impact – lower maintenance priority – less stringent timeline to mitigate the equipment failure
- No noise risk impact to people identified – no maintenance plan to be established

Maintenance Timeline identification based on Maintenance Priority

Priority Rating	Ref: Petronas MCF RAM	Description	Timeline*
1-a	E5, D5, E4	Very High MAH	Emergency 24 hours
1-b	C5, B5, A5, D4, E3	High MAH	Urgent 72 hours
2-a	C4, D3, E2	High (non MAH)	2 weeks
2-b	B4, C3, D2, E1	Medium (non MAH)	4 weeks
3-a	A4, B3, A3	Routine - Moderate impact	8 weeks
3-b	C2, B2, A2	Routine - Minor Impact	6 months
3-c	D1, C1, B1, A1	Routine - Insignificant Impact	12 months

*Note: Impact mitigated/ isolated, corrected within stated timeline and/or derate/ reduce /stop process

Table 1.6. Timeline based on Priority rating mapped with Petronas HSE Risk Matrix.

User Data

Email Address:

Consequence Category	A5T	Asset / Production	8
Consequence Class	A52	Asset: Minor Damage	
Probability Class	C	Medium (2 weeks to 3 months)	

Start/End Dates

Required Start: 10:36:52 Priority:

Required End: 9:00:00 Breakdown 10



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Maintenance Philosophy and Strategy Plan for High Noise Producing Equipment

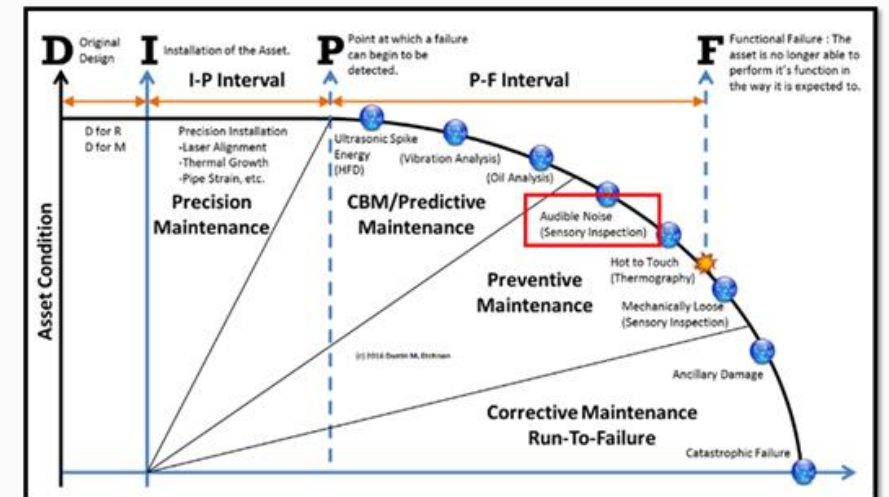
Maintenance Strategy

- Focusing on its intended function
 - e.g. Diesel Generator - focus on ensuring the generator able to generates power.
- Noise is not taken into consideration in defining the function of equipment.
 - No equipment performance standard related to noise e.g. operate within equipment noise design limit/baseline
- No maintenance strategy been established for noise engineering control (NEC) equipment.
 - Understanding of NEC (considered as equipment accessories) design philosophy is Run to Fail
 - NEC issue to be mitigated upon recommended by NRA (corrective maintenance)

Ineffective Equipment Maintenance Program

Unavailability of noise risk evaluation criteria for equipment noise condition assessment

- No specific details on how to evaluate the continuous effectiveness of NEC.
- Requirement to inspect/ maintain/ replace NEC generally as part of equipment's M-plan via sensory inspection



Asset Degradation Diagram

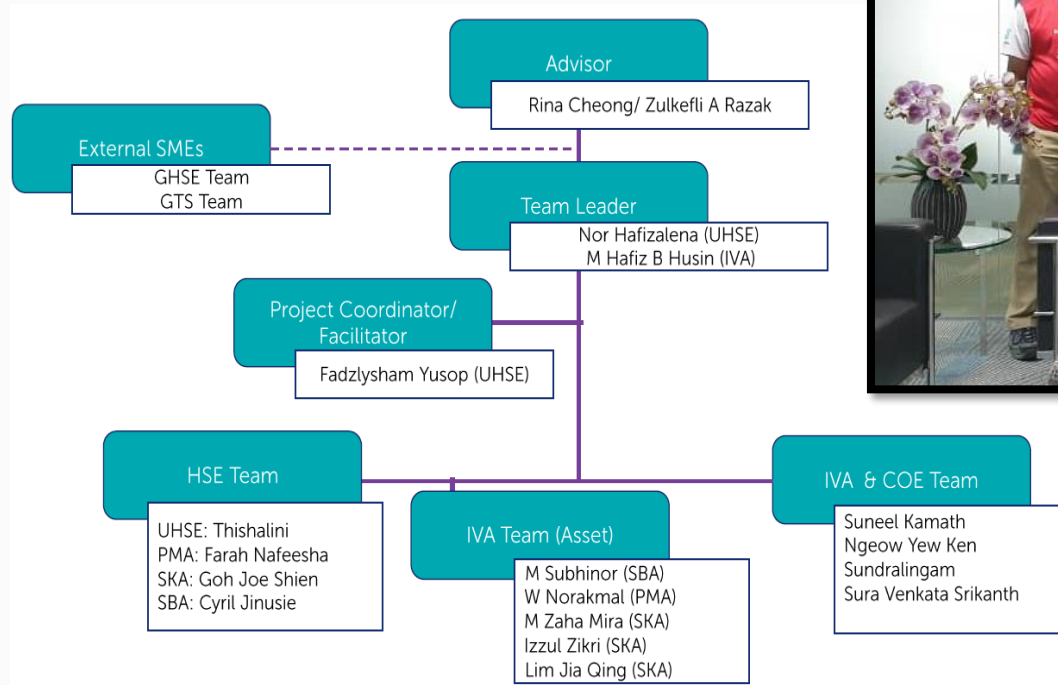


NEC MAINTENANCE STRATEGY ENHANCEMENT



Collaboration Effort

Multi – Discipline Teams including IH, safety , maintenance, reliability, operation and system governance.



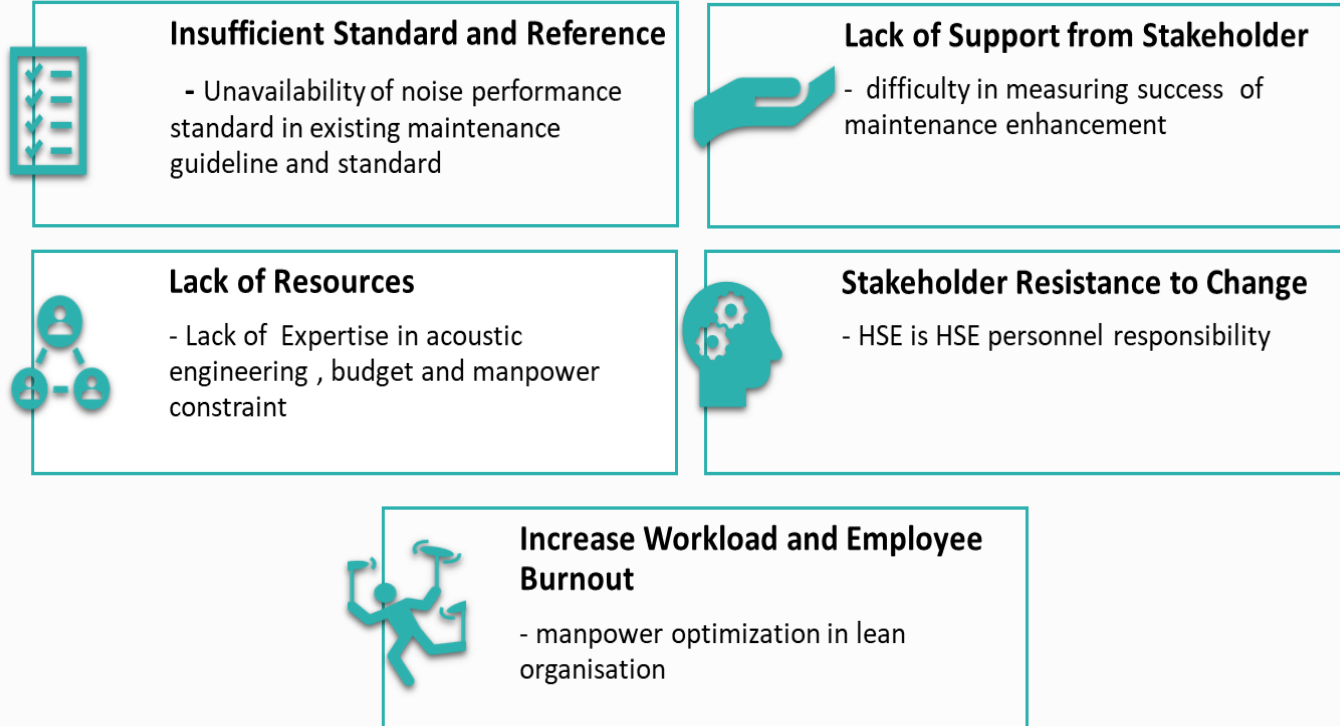
PROPOSED IMPROVEMENT

- Noise Engineering Control Equipment Maintenance Strategy Enhancement through
1. Leveraging existing equipment maintenance management program
 2. Preventive maintenance strategy approach.
 3. Sustainable maintenance practice.



Identify and Overcome Challenges

• Key challenges in Development and Implementation of Maintenance Strategy Enhancement Plan



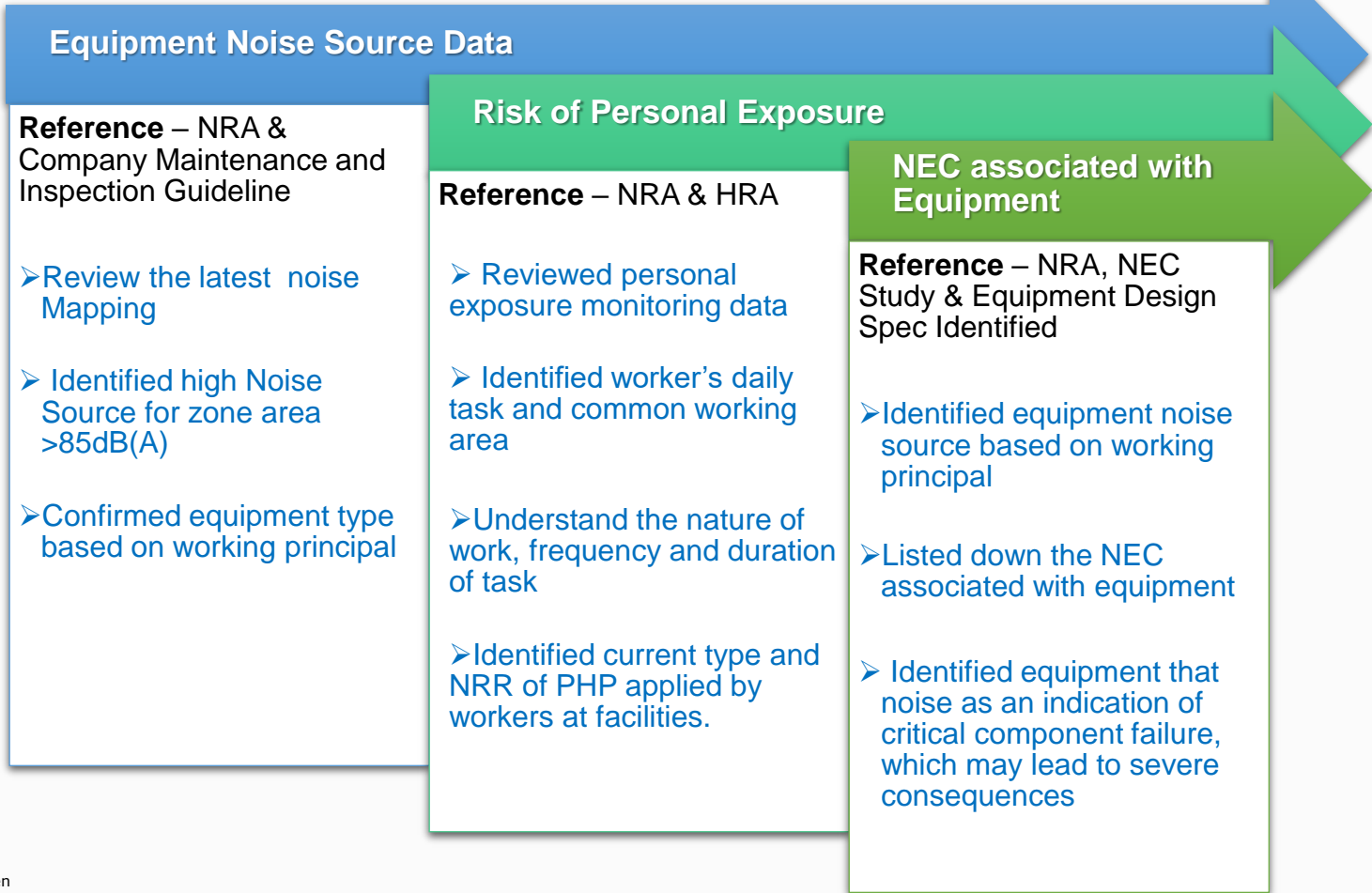
• Overcome Challenges and Move Forward





1. Focus Equipment Establishment

Evaluation of risk exposure to prioritize high noise producing equipment with Noise Engineering Control (NEC)



Equipment Type	Example	Associated NEC
Positive displacement compressor	Air compressor	Enclosure panel Acoustic insulation
	Air dryer package	Muffler/ silencer
	Gas Turbine Generator Skid	Exhaust/ silencer Enclosure panel
Gas Turbine	Gas turbine compressor Skid	Exhaust/ silencer Enclosure panel
	AODD pump (Wilden)	Exhaust pump
Positive Displacement Pump	Injection pump	Extension of CI vent outlet
	Portable water pump	Acoustic insulation
	Chemical Skid pump	
Auxiliary Equipment	Cooling fan- HVAC/ process gas	
Gas/ Diesel engine	Power generation (continuous running unit), Mechanical drive	Insulator
		Exhaust
		Enclosure panel

Prioritization of equipment shall be done with consideration of the following factors:

- ✓ Equipment producing high noise above 85 dBA in the area with high exposure (frequency & duration) to personnel
- ✓ Equipped with Noise engineering control equipment
- ✓ Equipment those that have acceptable baseline noise, and may increase over time, due to degradation.
- ✓ Those that have noise as an indication of critical component failure, which may lead to severe consequences



2. Noise Condition Assessment (NCA) Criteria / Method Establishment

Equipment Noise Baseline

For new plant operation/ equipment:
 ➤ Equipment noise source data from project

For existing equipment / operation
 ➤ Established process flow for baseline development based on existing data

Quantitative Assessment Method

Noise source measurement by using sound level meter as per NRA
 ➤ Pilot the method evaluation at facilities

Why 3dB(A) ?

Increment of >3dBA (50% Dose) will reduce the working duration to half

Qualitative Assessment Method

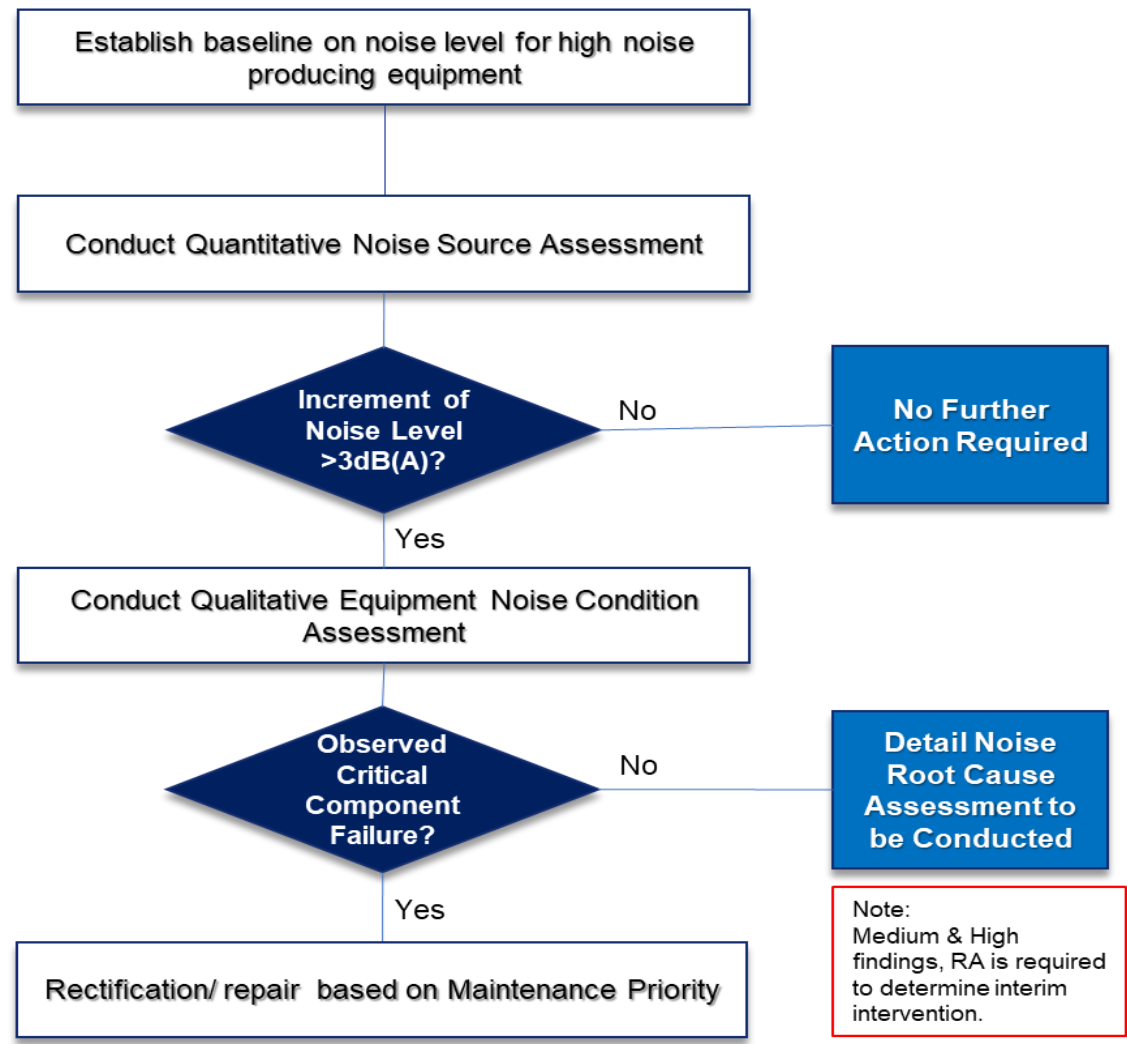
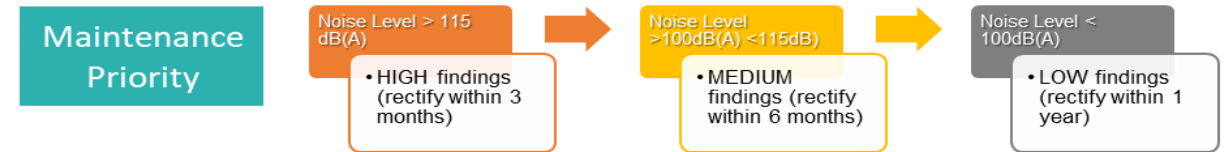
Developed Equipment Noise Condition Assessment Checklist

- Assess any critical component failure on equipment,
 - Any breakage, corrosion, looseness
 - Malfunction NEC
 - Abnormal operation activities

Detail Noise Root Cause Study

Root cause identification /diagnostic

- Further Trouble shooting
- Sound waveform, sound spectrum, vibration analysis, flow study, lube oil analysis, etc





3. Maintenance Strategy Review

Embedment of NEC maintenance requirement during Maintenance Strategy Review (MSR)



Programme	Method	Interval	What Changes	Resources
EBC (Equipment Basic Care)	Walk around- Look listen feel (LLF) NCA checklist	Daily	Details on Abnormal Noise, e.g. for higher than usual noise, specific type of noise, emphasized on noise producing component for specific equipment	Operation Personnel
CBM (Condition Based Maintenance)	Noise level monitoring (based on NCA criteria)	1 yearly (Once 3 years data have been collected, interval can be extended)	Details on Abnormal Noise, e.g. for higher than usual noise, specific type of noise, emphasized on noise producing component for specific equipment.	CBM Personnel, Sound Level Meter
PPM (Plant Preventive Maintenance)	Routine Maintenance	8K / Corrective Maintenance	<ul style="list-style-type: none"> • Visual & performance based • Detailed assessment • Prioritize repair P1 from CBM findings. 	Rotating Team



4. Readiness of System for Sustainable NCA Procedure Implementation



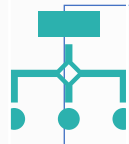
Engagement session with Asset relevant team (CBM & reliability team)



Conducted Cost & Benefit Analysis (CBA)



Embed noise as one of failure mode into Equipment Reliability Study (ERS) to derive appropriate mitigation action. .



NCA Business Process Workflow (BPW) & Procedure Establishment

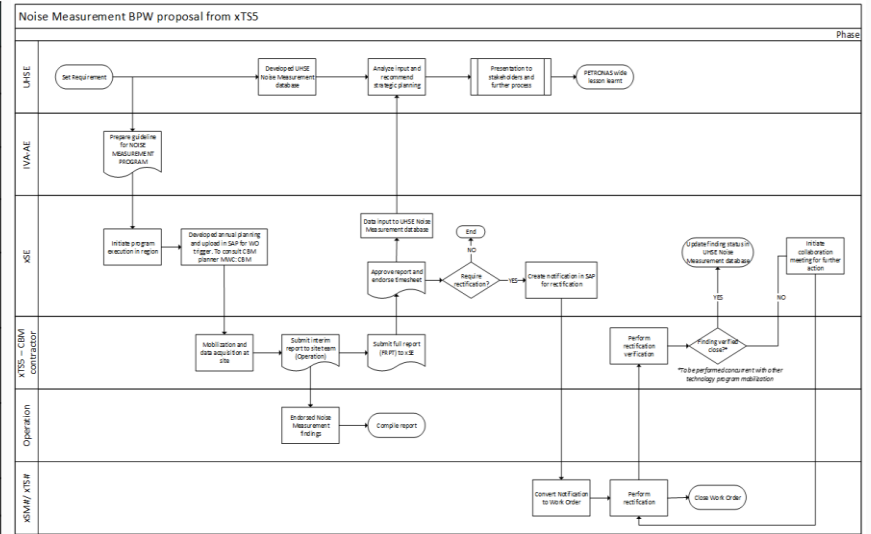


NCA Requirement incorporated into business Inspection and Maintenance Assurance Guideline

Cost and Impact Analysis

COMPETENCY		CBM Optimized	Operation	HSE
Total Cost (MYR)		23,000	157,000	199,300
Manpower		Existing CBM Team – contractual basis	Existing Operation Team	Contractual basis
Total Manhours		328 hrs	328 hrs	328 hrs
COMPETENCY	Noise Quantitative Assessment	Yes	Yes	Yes
	Equipment condition Assessment	Yes	Yes	No
	Preliminary Troubleshooting skills	Yes	No	No
	Total Training session required per asset	1	7	1
Database		Internal database development by HSE		
Benefit Criteria Scoring		73	55	58
Cost/Benefit Ratio		315.07	2854.55	3436.21
Ranking		1	2	3

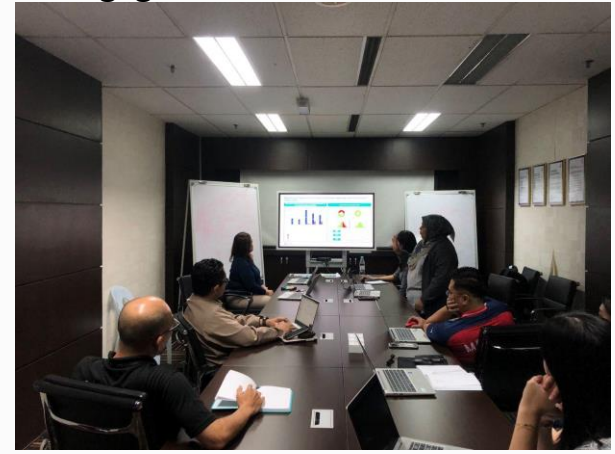
NCA Business Process Workflow (BPW)



Testing NCA Method with Asset



Engagement Session with Asset





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5. Strategise NCA Operationalisation

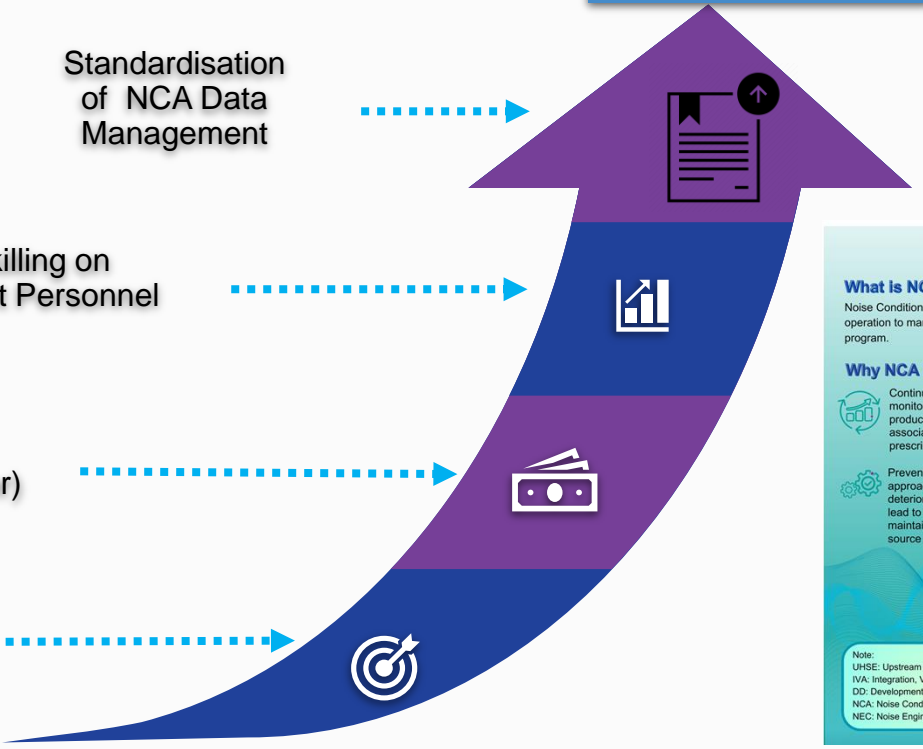


Standardisation of NCA Data Management

Upskilling on Relevant Personnel

Resource Availability (Equipment & Manpower)

Identification of Pilot Location



Brought to you with the collaboration of **UHSE X IVA X DD**

What is NCA ?
Noise Condition Assessment Program serves as a procedure for Upstream operation to manage the facility noise risk through noise level inspection program.

Why NCA is important ?

- Continuous performance monitoring on high noise producing equipment and its associated NEC through prescribed evaluation criteria.
- Preventive maintenance approach to control deterioration process that may lead to failure of system in maintaining equipment noise source within the baseline level.

Value Creation ?

- Safeguarding personnel from over-exposure to excessive noise.
- Improve operation compliance to statutory requirements mainly on NEC maintenance aspects.

Note:
UHSE: Upstream HSE
IVA: Integration, Value & Assurance
DD: Development Division
NCA: Noise Condition Assessment
NEC: Noise Engineering Control

Feedback from Stakeholder Involved in Pilot

Positive Feedback

- Very good initiative to discover the gaps on the NCA
- Good initiatives. To closely monitor the findings closure plan
- looks forward for implementation.

Feedback for Improvement

- Establish/develop BPW for NCA by UHSE
- Team should understand that CBM only perform inspection, rectification by maintenance/eq. Owner
- Propose as discussed to set NEC as SCE. this will manage NEC effectively
- On the reporting and data of noise monitoring , UHSE to relook on existing BPW
- To proceed for revision by COE on UIMAGG and ERS guideline
- To add noise failure mode in ERS.
- Should establish checklist for qualitative assessment with diagram to ensure standardize practices.

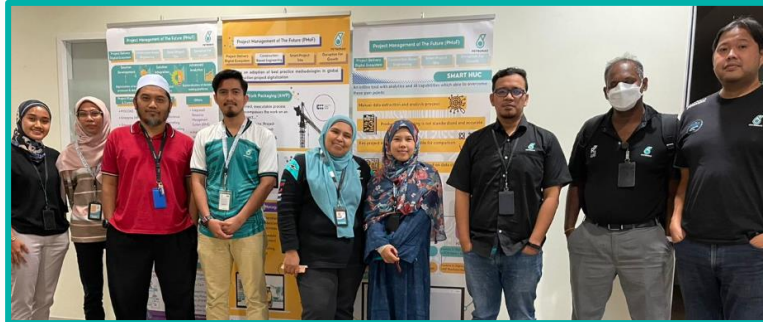


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Outcome of NCA Pilot Implementation at Identified Facility of Malaysia Asset

Day 1:
Conditioning/
upskilling with
Reliability & CBM



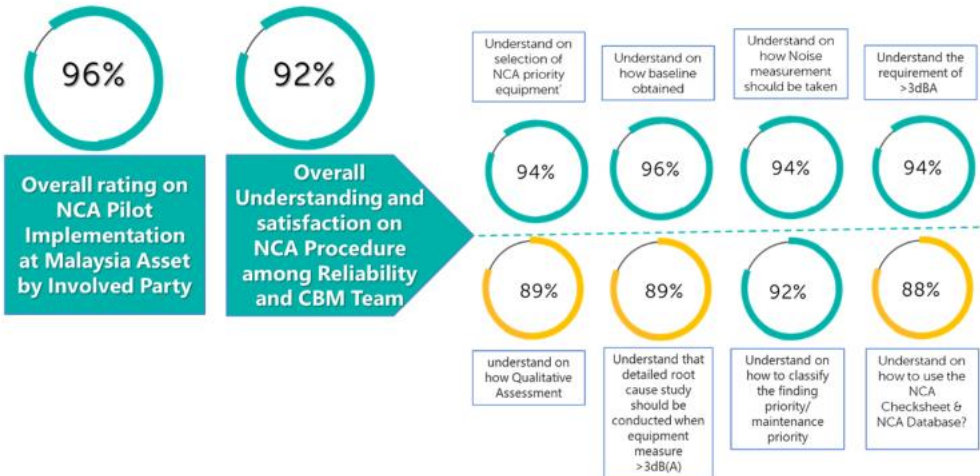
Day 2
"Hands-on" data
collection with
CBM Team



Day 3
Detail root-cause
& feedback
session



Overall Achievement of NCA Pilot Implementation





Way Forward

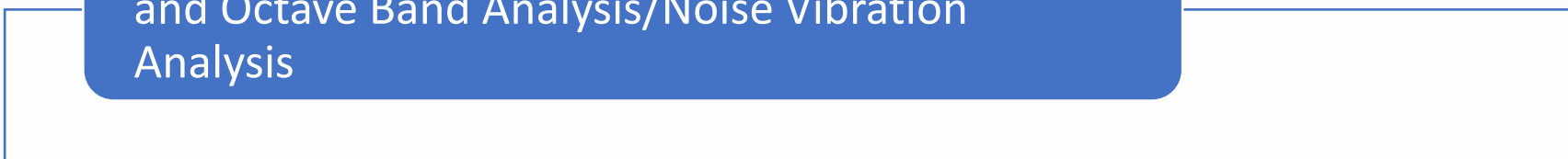
Roll out of NCA Procedure targeted in September 2023



Detail Noise Root Cause Analysis Upskilling for relevant SMEs



Study on linkage between CBM Vibration Analysis and Octave Band Analysis/Noise Vibration Analysis



Take Away



- **Effective collaboration** between industrial hygiene with operation maintenance management team is important to **ensure clear maintenance philosophy and noise evaluation criteria** for equipment preventive maintenance program able to be established effectively **for proactive identification and rectification of noise risk at source.**



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Do Something Today That Your
Future Self Will Thank You For

THANK YOU



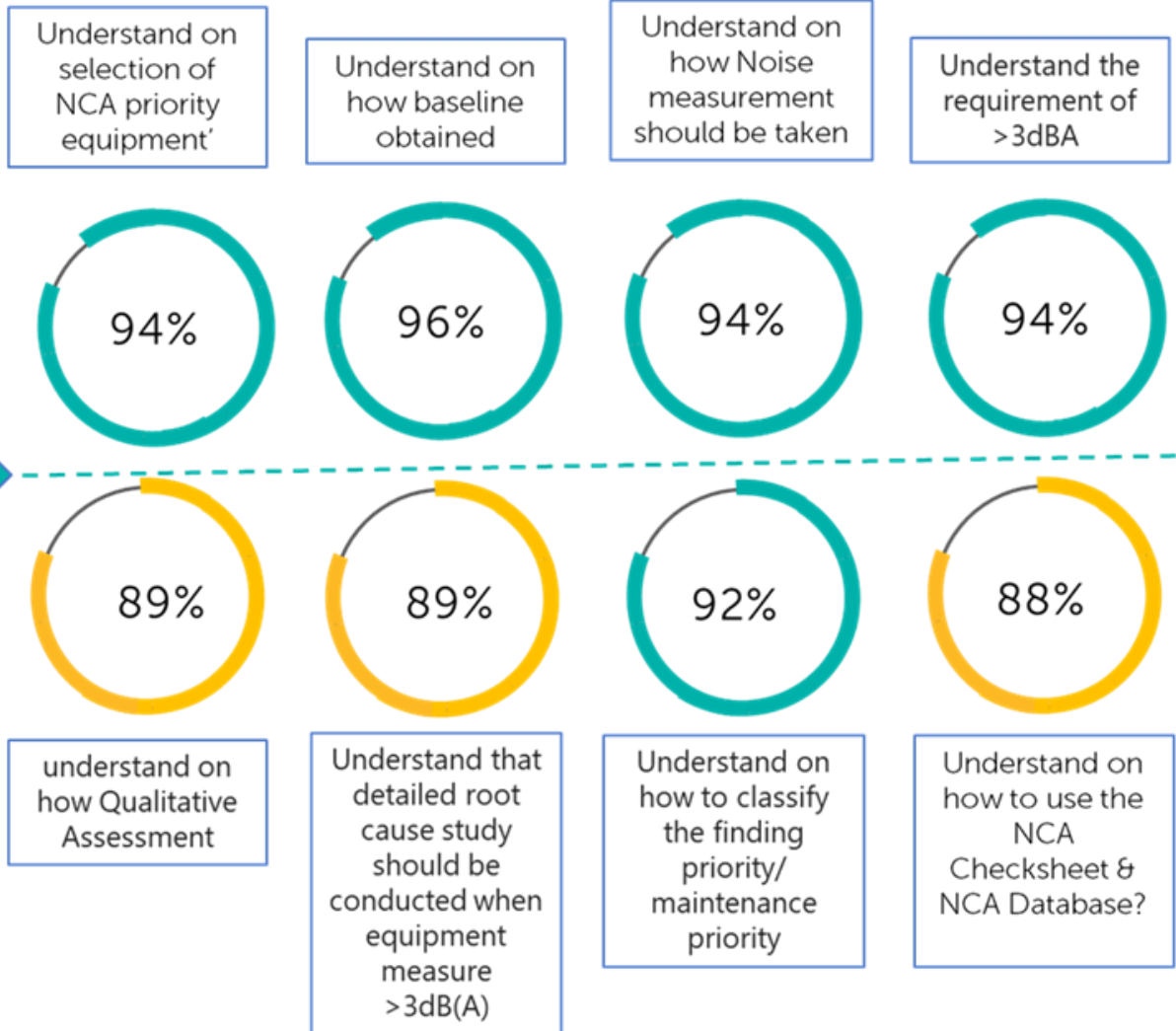
Overall Achievement of NCA Pilot Implementation



Overall rating on NCA Pilot Implementation at Malaysia Asset by Involved Party



Overall Understanding and satisfaction on NCA Procedure among Reliability and CBM Team



Feedback from Stakeholder Involved in Pilot



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