Quality Assurance Project Plan (QAPP) for Shipboard testing of BWMS

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NOTICE

This "Quality Assurance Project Plan" shall be applied to the overall shipboard testing of BWMS performed by the KOMERI. This QAPP include test quality management activity and approval sheet with responsibility and authority.

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Revision History

Revision No.	Revision date	Revised Contents
0	2014. 09. 03	Enacted

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Introduction and Background

All laboratories of Korea Marine Equipment Research Institute (KOMERI) comply with the Korean Laboratory Accreditation Scheme (KOLAS) system for laboratory and research organizations as outlined in Korean national regulations, to ensure the consistency and reliability of laboratory testing results.

All testing, analytical procedures and equipments of KOMERI are certified by the KOLAS to KS ISO/IEC 17025 standard (The certification number for KOMERI is KT-190).

Type Approval from the Korean Administration for BWMS is being sought in accordance with the *Guidelines for Approval of Ballast Water Management Systems* (G8) as adopted by Res. MEPC 174(58) (2008) of the International Maritime Organization (IMO) and The Provisional Regulation for Type Approval of Ballast Water Management System (PR. No. 2013-56) by the Ministry of Oceans and Fisheries, respectively.

Part 2, Section 2.1.2 of the G8 requires that the testing process for BWTS should include both a Quality Management Plan (QMP) and a Quality Assurance Project Plan (QAPP). The QMP addresses the overall quality management policies and structures of the testing body, and the QAPP provides the detailed quality assurance arrangements for the actual testing procedures.

Accordingly, Korea Marine Equipment Research Institute (KOMERI) – a Type Approval Test Organization approved by the Ministry of Oceans and Fisheries, Korea (2008) – has developed QMP and QAPP to assure the reliable testing for the BWTS.

As the G8 does not provide any guideline as to the structure, format and content of the required QMP and QAPP (except referring to generic international standards), KOMERI has developed the both documents using the following as the standard for the QMP and QAPP:

- US EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)
- US EPA Guidance for Quality Assurance Project Plans (EPA QA/G-5)
- KOMERI KOLAS Manual, Procedure and direction documents, 2012
-

Scopes of Certificate for Quality Management System of KOMERI are as follows:

- .1 Field sampling
- .2 Sample transit and preservations
- .3 Laboratory and Field analysis
- .4 Measurement and Data acquisition

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No.190 (1/52)

CERTIFICATE OF ACCREDITATION

Name of Laboratory : KOREA MARINE EQUIPMENT RESEARCH INSTITUTE

Representative : Kim, Gi-jung

Address of Headquarters : 1125-22, Dongsam-dong, Youngdo-gu, Busan 606-806, Korea

Address of Laboratory : 1631-10 Songjeong-dong, Gangseo-gu, Busan 618-270, Korea

Duration : January. 4, 2012 ~ January. 3, 2016

Scope of Accreditation
(Scope of Accreditation is described in the accompanying Annex)

This testing laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025 : 2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated 8 January 2009).

Jan. 4, 2012

Huh. Kyung

Administrator,
Korea Laboratory Accreditation Scheme(KOLAS)

Figure 1. Certification of KOLAS Accreditation

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No. 190 (51/52)

9. Biological Test

9.002 Microbiology Test

Test method	Standard designation	Test range or Limits of detection
APHA Standard Method 9215:2005	Heterotrophic plate count	a.-c. (30 ~ 300) CFU/mL d. (20 ~ 200) CFU/filter
APHA Standard Method 10200 C:2005	Concentration techniques	1. 1 mL ~ 1 L 2. Pore diameter 0.45 ㎛ 3. 1000 g for 20 min 4. mesh size depend on volume of filter water and size of organism
EPA 445.0:1997	*In vitro* determination of chlorophyll-*a* and pheophytin-*a* in marine and freshwater algae by fluorescence	· 0.05 (μgchl-*a*)/L and 0.06 (μg pheo-*a*)/L in a solution of 90 % acetone
EPA 1600:2009	Enterococci in water by membrane filtration using membrane-Enterococcus indoxyl-β-D-glucoside agar (mEI)	· (20 ~ 60) CFU/membrane
EPA 1603:2009	*Escherichia coli* (*E. coli*) in water by membrane filtration using modified membrane-thermotolerant *Escherichia coli* agar (Modified mTEC)	· (20 ~ 80) CFU/membrane
UNESCO 4:2003	Estimating cell numbers	· At least 100 cells
APHA Standard Method 2540 D:2005	Total suspended solids dried at 103 °C - 105 °C	· dried residue : (2.5 ~ 200) mg

Figure 1. Continued

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No. 190 (52/52)

9.002 Microbiology Test

Test method	Standard designation	Test range or Limits of detection
APHA Standard Method 9222 B:2005	Standard total coliform membrane filter procedure	· (20 ~ 80) coliform CFU and not more than 200 CFU/membrane
ISO 15705:2002	Water quality-Determination of the chemical oxygen demand index (ST-COD)-Small-scale sealed-tube method	· 6 mg/L for photometric detection at 600 nm, and 15 ng/L for titrimetric detection
APHA Standard Method 5210 D:2005	Respirometric method	· (0 ~ 40) mg/L · (0 ~ 80) mg/L, · (0 ~ 200) mg/L · (0 ~ 400) mg/L · (0 ~ 800) mg/L · (0 ~ 2 000) mg/L · (0 ~ 4 000) mg/L

End.

Figure 1. Continued

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지정번호 제2013-1호
Cert. No.: 2013-1

선박평형수처리설비 형식승인시험기관 지정서
CERTIFICATE OF SHIP'S BALLAST WATER MANAGEMENT SYSTEM TYPE APPROVAL TESTING LABORATORY

명칭(상호) Company	(재)한국조선해양기자재연구원 Korea Marine Equipment Research Institue		
성명(대표자) Name	김기정 KIM, Gi-Jung	사업자등록번호 Registration No.	602-82-06034
주소(사무소) Address	대한민국 부산광역시 영도구 동삼동 1125-22 1125-22, Dongsam-dong, Youngdo-gu, Busan, R.O.Korea 대한민국 부산시 강서구 송정동 1631-10 1631-10, Songjeong-dong, Gangseo-gu, Busan, R.O.Korea		
지정받은 형식승인시험의 종류 Kind of Type Approval Testing Laboratory	환경시험, 육상시험 및 선상시험 Environmental Testing, Land-based Testing and Shipboard Testing		
비고 Remark			

「평형수(平衡水)관리시스템의 형식승인 등에 관한 잠정기준」 제6조 제3항에 따라 형식승인시험기관으로 지정합니다.

This is to certify that above laboratory is designated as Type-Approval Testing Laboratory in accordance with the Interim Regulation for Type Approval of Ship's Ballast Water Management System and IMO MEPC Res 125(53)

2013 년 9 월 25일
September 25, 2013

해양수산부장관 해양수산부장관의 직인

Minister of Oceans and Fisheries

Figure 2. Certification of Type Approval Test Organization

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1 Project management

1.1 Responsibility

To perform reliable testing of BWMS which is provided (delivered) by an applicant, by ensuring an organizational structure and responsibilities and authority of members in the organization during performing a globally certified testing task including BWMS efficacy testing, KOMERI complies with a quality manual of organization (KOMERI-M-01).

Project Director communicates relevant facts to the project to all members through a managers meeting or a business report. Quality Manager backs up a test with a required budget, equipment and facilities, and human and physical resources. Project Manager requests assistance of Quality Manager, if is required after reviewing the budget, equipments, facility, human and physical resources for a test, Quality Manager requests a direct for support. Project Manager will be supervised engaging staffs.

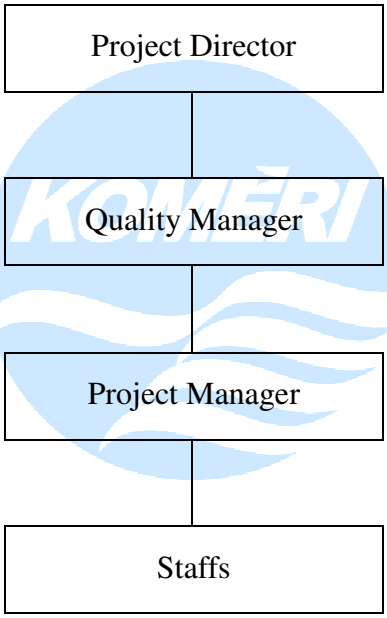

Figure 3. Responsibility structure

Detail task responsibility and contact information of staff engaged in this project will be described in Test Plan.

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1.2 Task

The shipboard testing in accordance with the G8 is composed of the following tasks:

(1) Efficacy testing of BWMS, including collecting ballast water samples from shipboard testing.
(2) Reporting and evaluation of test results.
(3) Notifying to all related organization with the project when the test schedule is changed due to failure, malfunction and unexpected abnormal state of BWMS and/or test facility, a natural disaster and so on.

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2 Measurement and data acquisition

Detail information about the test activities including sample handling, analysis plan and data management/analysis/reporting to perform BWMS test is described in Test Plan.

2.1 Test process design

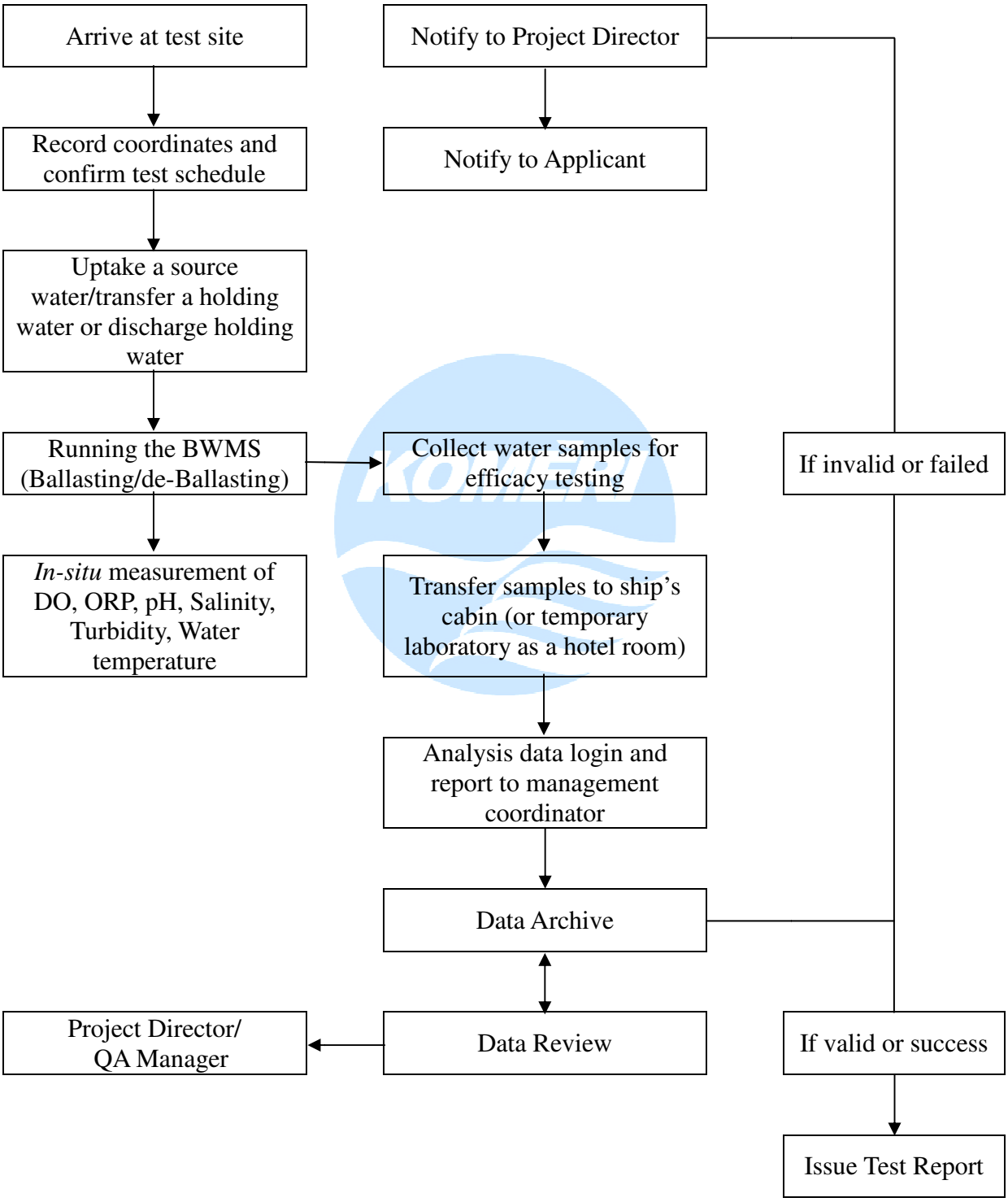

Figure 4. Test activities and data management process

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2.2 Sampling

2.2.1 Sampling methods and sample preservation

Sampling and sample collection plans will be applied during laboratory scale testing. TP will include detailed information on the sample location, sample volume, sampling bottle (container) and the types of samples to be collected. Project Director will apply the sampling and sample collection plan and brief the sampling team on the objectives of the sampling.

Sampling will be performed according to Standard Methods for the Examination of Water and Wastewater (APHA, 2012).

2.2.2 Sample handling and custody

In order to minimize the possibility of contamination and introduction of artifacts, a procedure will be developed to collect, transport and preserve the samples for analysis. Special care will be taken to prevent the volatilization from filtered samples, to prevent adverse temperature-effect on water samples, as well as to prevent contamination of collected samples with ubiquitous gaseous air pollutants.

Specific procedures to ensure the integrity of the collected samples will be outlined in the SOPs developed for each instrument. However these should include the necessary procedures for ensuring sample validity by:

- Preparation of sampling material, including procedures to clean water samples, loading water samples into sampling apparatus, and transport of sampling media to field locations
- Storage of sampling media once removed from sampling location including sealing procedures and temperature requirements for transportation from field locations to place for analysis
- Archiving of sampling material until the analysis can be performed including prevention of photochemical and temperature changes
- Requirement for removing samples from archive for analysis that preserve sample integrity

Sample custody will be documented with sample log sheet for each water sample which will track the lifetime from preparation and cleaning, deployment to the place for analysis.

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2.3 Measurement and analysis methods

Accuracy of measurement and analysis will be assessed for compliance with the criteria established in Korea Laboratory Accreditation Scheme (KOLAS) for efficacy testing. All testing and analysis will be carried out by scientific and technical staff that belongs to KOMERI.
Sample for DOC/POC analysis of basic parameters will be refrigerated at 4 °C in a refrigerator and as soon as possible transferred to Korea Testing & Research Institute (KTR) after entry Korea. The analysis will be conducted by KTR.

Detail methods will be described in the Test Plan.

2.4 Data acquisition

2.4.1 Documentation and records

- **QAPP**

The Master Copy of the QAPP will be kept in electronic copy at a security data server at KOMERI.

The Quality Assurance Manager, Jae-Uk Kang, is the overall Quality Manager for all test of KOMERI in accordance with KOLAS and has responsibility for controlling its currency and ensuring that all staffs listed in Approval Sheet have up-to-date, controlled copies of the document, sent by email as a Read Only (non-changeable) PDF file. Record of Distribution is to be kept as hard copy on file and saved in electronic copy at file directory.

Staff in approval sheet is to be confirmed by email to the Project Director/QA Manager when they receive updated versions of the QAPP, which are to be filed as per paragraph. Such confirmation e-mails are to be printed and filed as hard copy on file and saved in electronic copy at file directory.

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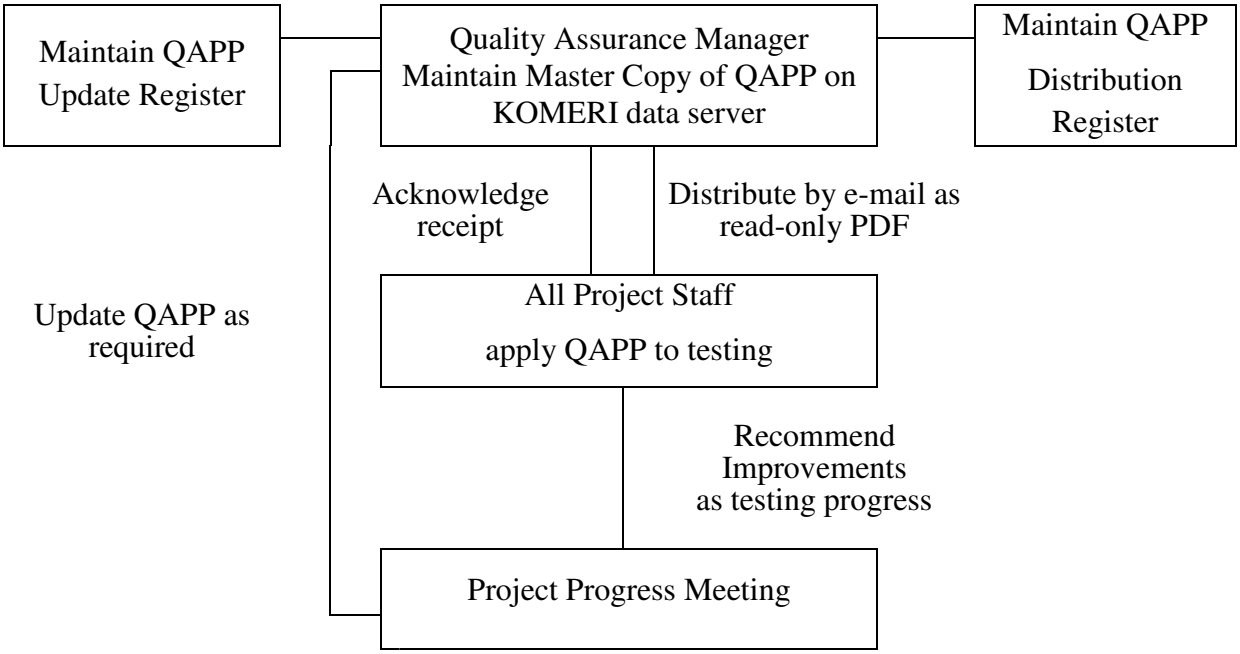

Figure 5. QAPP document control process

- **Field sample records**

Field sample records are to be accompanied by a Chain of Custody (COC) format at each sampling time, and then bound for keeping. To facilitate the use of data, not only log data record (COC) will be converted as PDF format after scanning but will be transferred to MS-EXCEL format as well.

- **Chain of custody (COC) records**

The transport of all samples from field sampling to the laboratory for analysis is to be accompanied by a COC. The COC is to be completed at each step in the transport chain, with each party in the transport exchange keeping a copy of the Record; which is to be filed by each party for future reference if necessary.

- **Laboratory raw data records**

Analysis raw data log sheets are used for data recording and are to be accompanied by a COC format at each time of analysis, and then bound for keeping.

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2.4.2 Data management

- **Data recording**

Data are transposed from field notebooks and analysis raw data log sheet to an electronic data-base.

- **Data validation**

Data are validated to ensure that the system performs the intended function consistently, reliable, and accurately in generating the data in accordance with KOLAS (ISO/IEC 17025).

- **Data transformation**

It is expected that data transformations made during this investigation will be relatively simplistic and all calculations made during data transformation will be checked 100% prior to dissemination of the transformed information.

- **Data transmittal**

During the transfer of data from one place (field notebook or data report) to another (electronic data spreadsheet) the data will be copied and checked by one individual and then checked 100% by a second individual to ensure accuracy.

- **Data reduction**

Raw data from field measurements are recorded directly in field notebooks or on sample log. If errors are made, results will be legibly crossed out, legibly signed and dated by the person recording the data, and corrected in a space adjacent to the original entry. Logbooks will be periodically reviewed by the Project Director and QA Manager to insure that records are complete, accurate, and legible. Reduction of current water quality test data will be made by entering all field collected data in an EXCEL® computer spreadsheet.

Laboratory data reduction procedures will be performed according to the following protocol. All information related to analysis will be documented in controlled laboratory logbooks, instrument printouts, or other approved forms. All entries that are not generated by an automated data system will be made neatly and legibly in waterproof ink. Corrections will be made by drawing a single red line with personnel signature through the error and entering the correct information adjacent to the cross out. All changes will be legibly signed, dated, and if appropriate, accompanied by a brief explanation. Analysis laboratory records will be reviewed by the Section Supervisors on a regular basis and by the Achieve Personnel periodically, to verify adherences to documentation requirements.

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- **Data analysis**

The data generated during initial test periods in this project will be used to calculate the efficiency of ballast water treatment system during the test periods. Treatment efficiency will be used to calculate charging/discharging to and from the ballast tank, and to verify the system durability and/or stability.

- **Data tracking**

Data will be recorded in the field notebooks and upon return completion of the associated data collection information will be transposed to an electronic spreadsheet or Acrobat Reader (PDF) format. Copies of field data will be made and stored in project file on a daily basis. Laboratory data will also be transposed to an electronic spreadsheet format upon receipt.

- **Data storage and retrieval**

Data will be maintained in electronic format using MS EXCEL for data analysis and presentation purposes. Backup copies of all data files will be made intermittently throughout the project and upon completion of the project, a CD or DVD containing all electronic data will be produced with copies available for distribution.

- **Data release**

Prior to being released as final, laboratory data will proceed through a tiered review process. Each analyst will be responsible for reviewing the analysis and QC data that he/she has generated. As part of this review, the analyst will verify that:

- The appropriate methodology was used,
- Instrumentation was functioning properly,
- QC analysis were performed at the proper frequency and the analysis met the acceptance criteria,
- Samples were analyzed within due time,
- All data were generated within the calibration range,
- Matrix interference problems were confirmed,
- Method-specific analysis requirements were met, and
- Calculations, dilution factors, and detection limits were verified.

Prior to releasing the final data, the section supervisor will review the data to:

- Verify the appropriate methodology was used,
- Verify QC analysis were performed at the proper frequency and the analysis met the acceptance criteria,
- Verify samples were analyzed within due time,
- Review and document problems encountered during the analysis.

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The final data report will be reviewed and approved by Project Director and QA Manager prior to its release.

2.4.3 Data validation and usability

- **Data review**

Once these goals and objectives are evaluated and approved BWMS, analysis data quality will be assessed to determine if the objectives have been met. In addition, the data will be reviewed by analysis data reviewer for indications of interference of results by sample matrices, cross contamination during sampling, cross contamination in the laboratory, and sample preservation and storage anomalies.

Assessment of the analysis data in the final Test Report will be performed by Analysis Data Reviewer. The overall completeness of the data package will be evaluated. Completeness checks will be administrated on all data to determine whether the deliverables in accordance with the requirements specified in the QAPP are present. Final Test Report will be issued after receiving the confirmation of Analysis Data Reviewer by e-mail or letter.

- **Validation and verification methods**

The procedures used to evaluate field and laboratory analysis data will include checking procedures used in the field, ensuring that field measurement equipment was properly calibrated, checking for transcription errors, and comparing the data to historic data or verifying its 'reasonableness'. Evaluation of field data will be the responsibility of the Project Director or his designee.

(1) Efficacy test

To ensure that the data generated from any test meet the goals of the test, a number of data validation procedures will be performed by members responsible for the generation of the data. Data validation efforts include the completion of QC activities. The data from the test will be evaluated relative to the measurements to ensure that the DQOs are met.

(2) DOC/POC analysis

Accuracy of laboratory analysis will be assessed for compliance with the criteria established in section Calibration and Quality Control Check of the Final Report using the analysis results of method blanks and DOC/POC samples. The percent recovery (%R) for DOC/POC samples will be determined according to the following equation:

$$\%R = [(\text{Amount in spiked sample} \times \text{Amount in sample}) / \text{Known amount added}] \times 100$$

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%R for DOC/POC will be determined according to the following equation:

%R = (Experimental concentration / Known amount added) X 100

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3 Quality assurance system

3.1 Instrument/equipment and reagents

Test equipments are controlled by appointing the person (main and associate) in charge who is accredited according to the internal requirement as test staff. And test equipments are set up in proper place and controlled to keep the degree of precision.

3.1.1 Instrument/equipment maintenance and calibration

All of instruments/equipments related to test are confirmed if the equipment meets the test standard and internal test method.

Periodical inspection is conducted at inspection period specified in equipment manual according to Quality Instruction 'Mid-inspection of Equipment (KOMERI-I-07)'.

Instruments/equipments calibration is periodically requests to an officially recognized national calibration laboratory according to Quality Manual (Document No. KOMERI-M-20, Traceability) and Quality Procedure (Document No. KOMERI-P-20, Measurement traceability and Calibration). And KOMERI comply with the calibration period specified by the calibration report or equipment manual. The staffs who are accredited according to the internal requirement as test staff shall operate test equipments according to the available latest instruction.

However, if instruments/equipments cannot be calibrated by an officially recognized national calibration laboratory and/or calibration result of equipment has great influence on test, KOMERI conduct the internal calibration program by using reference materials and specific standards in accordance with Quality Instruction (Document No. KOMERI-I-05, Self-calibration). Calibrated instruments/equipments and the latest calibration condition including calibration report shall be recorded according to Quality Manual.

Table 1. List of the instrument for calibration

No.	Equipments	Management No.	Model name	Manufacturer
1	Water quality multiprobes	08TA0121	Hydrolab DS5	Hach company
2	Water quality multiprobes	09TA0006	Hydrolab MS5	Hach company
3	Water quality multiprobes	10TA0017	Hydrolab MS5	Hach company
4	Portable turbidimeter	09TA0001	2100P	Hach company
5	Portable turbidimeter	10TA0027	2100P	Hach company
6	Portable turbidimeter	10TA0028	2100P	Hach company

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7	pH meter	10TA0114	S20-K	Mettler Toledo

3.1.2 Inspection/acceptance of supplies and consumables

Calibration instruments or Reference materials are purchased according to Quality Procedure (Document No. KOMERI-P-07, The Service and Item Purchase Procedure).

Depending on the verification result about the technical managers, acquire if it passes, and take appropriate measures such as returning to the supplier if it doesn't. And reference materials that passed the corresponding manager's verification are stored in the designated places.

Reference materials are stored in environmental conditions required by the corresponding material and not damaged, deformed, or altered.

All calibration instruments/reference materials are recorded in the Quality Instruction (Do cument No. KOMERI-I-04-01, Calibration Instrument/Reference Material Registration Ca rd) and should be able to secure an adequate stock.

3.2 Quality assurance objectives

Analysis will be carried out 3 replicates for validation of data and analysis data will be calculated the arithmetic average and standard deviation.

Table 2. Quality assurance objectives of basic water parameter

Test item	Unit	Resolution	Concentration range	Accuracy objective
Water temperature	°C	0.01	-5 ~ 50	± 0.1
Salinity	PSU	0.01	0 ~ 70	± 1.0
pH	pH unit	0.01	0 ~ 14	± 0.2
Dissolved oxygen	mg/L	0.01	0 ~ 60	± 0.1 at ≤ 8 mg/L ± 0.2 at > 8 mg/L
ORP	mV	1	-999 ~ 999	± 20
Turbidity	NTU	0.01	0 ~ 1,000	± 2 %

Basic water parameters are measured by a water quality meter (Hydrolab MS5/DS5 sonde, USA) and a turbidity meter (2100P turbidity meter, USA). Calibration records will be kept accordance with KOMERI Quality System (ISO/IEC17025). Suspect calibration information will be highlighted in the field data log sheet upon discovery of the information. Data collected during the period of suspect information will be footnoted as being questionable.

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Table 3. Quality assurance sample types, frequency of use, and types of data generated for basic water parameter

Test item	QA sample type or measurement procedure	Frequency of use	Data generated for calibration and redundancy
Salinity	Certified standard conductivity solution (~ 50 µS/cm)	Every second week	Difference between probe value and standard level
Dissolved oxygen	Water-saturated air calibration	Every second week	Difference between probe value and saturation level
Water temperature	QC check with standard thermometer	Every second week	Difference between probe value and thermometer
pH	QC check with standard buffers	Every second week	Difference between probe value and standard level
Turbidity	Certified standard turbidity solution (0, 10, 100, 1000 NTU)	Every second week	Difference between sample and duplicate
Dissolved organic carbon	QC check with standard (potassium hydrogen phthalate) / Proficiency testing	Each test cycle	Difference between sample and 3 replicates
Total organic carbon	QC check with standard (potassium hydrogen phthalate) / Proficiency testing	Each test cycle	Difference between sample and 3 replicates
Total suspended solid	QC check with 3 replicates	Each test period	Difference between sample and 3 replicates

Table 4. Quality assurance sample types, frequency of use, and types of data generated for efficacy testing

Test item	QA sample type or measurement procedure	Frequency of use	Data generated for calibration and redundancy
≥ 50 µm Organisms	QC check 3 replicates and other identification data	Each test period / species assemblage	Comparison of 3 samples, standard deviation
≥ 10 and < 50 µm Organisms	QC check 3 replicates and other identification data	Each test period / species assemblage	Comparison of 3 samples, standard deviation
Heterotrophic bacteria	QC check 3 replicates and positive and/or negative (blank) sample	Each test period and/or every sample	Comparison of 3 samples, standard deviation
Coliform	QC check 3 replicates and positive and/or negative (blank) sample	Each test period and/or every sample	Comparison of 3 samples, standard deviation
Escherichia coli	QC check 3 replicates and positive and/or negative (blank) sample	Each test period and/or every sample	Comparison of 3 samples, standard deviation
Intestinal Enterococci	QC check 3 replicates and positive and/or negative (blank) sample	Each test period and/or every sample	Comparison of 3 samples, standard deviation
Toxicogenic *Vibrio Cholerae* (O1, O139)	QC check 3 replicates and positive and/or negative (blank) sample	Each test period and/or every sample	Comparison of 3 samples, standard deviation

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Table 5. Data quality objective of efficacy testing

	Data Quality Indicator	Evaluation process	Performance measure	Data Quality Objective
≥ 50 µm Organisms (Zooplankton)	Precision	Analyze three samples in the Bogorov counting chamber from uptake water sample upon ballasting.	Coefficient of Variation (% CV)	≤ 20 % CV
	Completeness	Calculate percentage of valid samples analyzed out of the total number of samples collected.	Percent Completeness (%C)	≥ 90 %C
≥ 10 and < 50 µm Organisms (Phytoplankton)	Precision	Analyze three samples in the Sedgewick-Rafter chamber from uptake water sample upon ballasting and control water sample upon de-ballasting.	Coefficient of Variation (% CV)	≤ 30 % CV
	Completeness	Calculate percentage of valid samples analyzed out of the total number of samples collected.	Percent Completeness (%C)	≥ 90 %C
Bacteria	Precision	Analyze three samples from every sample collected except for *E. coli* and intestinal enterococci.	N/A[a]	N/A
	Completeness	Calculate percentage of valid samples analyzed out of the total number of samples collected.	Percent Completeness (%C)	≥ 90 %C

[a] Not appicable

3.3 Quality control procedures

Three types of internal quality control samples, blank sample and/or duplicates sample are routinely used at the laboratory.

A field duplicate is a sample which is collected immediately after the regular sample at the same location. This type of co-located field duplicate is estimated precision of the whole sampling process including inherent variability at the field site.

The quality control samples used are:

- A synthetic water quality control check sample is analyzed at least twice in each run of pH, salinity, water temperature, oxidation-reduction potential, dissolved oxygen and turbidity samples.
- In case of plankton, two sets of the dyed and undyed samples are prepared.
- For the analysis of bacteria, the routine analysis of positive and negative controls, filter sterility checks, method blanks and media sterility checks are required.

3.4 Training

In order to assure test data quality, all staffs including Project Director, Quality Manager, and

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Project Manager are must be completed ISO/IEC 17025 training course (Quality System, Uncertainty/GUM Guide). And renewal training course must be completed every three years.

Furthermore, all engaged staffs are university qualified marine biologists who have formal training in field sampling, laboratory testing and analysis techniques and equipment.

While, all field sampling staffs are experienced more than 3 years in accordance with standard protocols for sampling water and bacteria using the equipment identified within this QAPP that are relevant to the US EPA microbiological manual (1978); and according to KOLAS (ISO/IEC 17025) accreditation.

The quality guarantee plan is established at the start of every year and the plan must be included the following contents. Skill level programs and comparison proficiency tests between test centers approved by the KOLAS must be participated at least one time per three years, and if the corresponding year has arrived, it must be reflected in the quality guarantee plan. Until participating in the next skill level program, the quality of the test results must be guaranteed through comparison test with testers every year. The subjects for comparison test between testers must be more than 3 including test agents and the technical manager.

Internal quality management, that use authorized standard materials and calibration equipments are regularly conducted according to Quality Procedure (Document No. KOMERI-P-20, Measurement traceability and Calibration) and Quality Instruction (Document No. KOMERI-I-05, Self-calibration).

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4 Assessment/oversight

4.1 Assessments and corrective actions

The laboratory as part of their QA program will conduct laboratory performance and system audits. System audits will be done on an annual basis at a minimum and will include an examination of laboratory documentation on sample receipt/log-in/storage/chain-of-custody, procedures, sample preparation and analysis, instrument operating records, etc.

Field audits will include examination of field sampling records/screening results/instrument operating records, sample collection, handling, and packaging in compliance with the established procedures, maintenance of QA procedures, chain-of-custody, etc. Follow-up audits will be conducted to correct deficiencies, and to verify that QA procedures are maintained through the investigation. The audits will involve reviews of field measurement records, instrumentation calibration records, and sample documentation.

The corrective action is the process of identifying, recommending, approving, and implementing measures to counteract unacceptable procedures or out-of-limit QC performance that can affect data quality. Corrective actions can occur during field activities, laboratory analysis, data validation, and data assessment. Corrective actions should only be implemented after approval by the Project Director or his designee.

For non-compliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the Project Director.

4.2 Reports to management

The results of assessments conducted under this QAPP will be reported to the Project Director and QA Manager after shipboard testing in accordance with the process outlined in Figure 5 in section 2.4.

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Reference

ISO 8245. 1999. Water quality-Guidelines for the determination of total organic carbon (TOC) and dissolved organic carbon (DOC). 2nd Ed.

Standard Methods. 2005. In: A.D Eaton, L.S Clesceri, E.W Rice, A.E Greenberg (eds), *Standard Methods for the Examination of Water and Wastewater*. Baltimore, Maryland. APHA, AWWA and WEF. pp

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