ENGINEERING STANDARD

FOR

PERFORMANCE GUARANTEE

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0. INTRODUCTION

The Standard Practice Manuals titled as "Fundamental Requirements for the Project Design and Engineering" is intended for convenience of use and a pattern of follow-up and also a guidance.

These Standard Engineering Practice Manuals , also indicate the check points to be considered by the process engineers for assurance of fulfillment of prerequisitions at any stage in the implementation of process plant projects.

It should be noted that these Iranian Petroleum Standards (IPS), as Practice Manuals do not profess to cover all stages involved in every project, but they reflect the stages that exist in general in process projects of oil, gas and petrochemical industries of Iran.

These preparation stages describe the following three main phases which can be distinguished in every project & include, but not be limited to:

Phase I) Feasibility Studies, Process Evaluation and the Basic Design Stages (containing six Standards).

Phase II) Detailed Design, Engineering and Procurement Stages (containing three Standards).

Phase III) Start-up Sequence and General Commissioning Procedures (containing two Standards).

The process engineering standards of this group include the following Standards:

STANDARD CODE	STANDARD TITLE
I) Manuals of Phase I (Numbers 1-6)	
IPS-E-PR-150	"Basic Design Package and Recommended Practice for Feasibility Studies"
IPS-E-PR-170	"Process Flow Diagram"
IPS-E-PR-190	"Layout and Spacing"
IPS-E-PR-200	"Basic Engineering Design Data"
IPS-E-PR-230	"Piping & Instrumentation Diagrams (P&IDs)"
IPS-E-PR-250	"Performance Guarantee"
II) Manuals of Phase II (Numbers 7-9)	
IPS-E-PR-260	"Detailed Design, Engineering and Procurement"
IPS-E-PR-300	"Plant Technical and Equipment Manuals (Engineering Dossiers)"
IPS-E-PR-308	"Numbering System"
III) Manuals of Phase III (Numbers 10-11)	
IPS-E-PR-280	"Start-up Sequence and General Commissioning Procedures"
IPS-E-PR-290	"Plant Operating Manuals"

This Engineering Standard Specification covers:

"PERFORMANCE GUARANTEE"

1. SCOPE

This Engineering Standard Specification sets forth the content and the extent of the performance guarantee concerning processes and equipment. The requirements outlined herein are supplementary to the guarantees listed on the individual job specification/duty specification/data sheet.

In the event of a conflict among the various documents, the order of precedence shall be as follows:

Individual job specification/duty specification/data sheet.

Iranian Petroleum Standard (IPS), "Engineering Standard for Performance Guarantee," IPS-E-PR-250.

If conflict is discovered between the items listed it shall be the responsibility of Contractor/Vendor to call attention to the conflict.

It should be noted that for performance guarantee of Licensed processes, the Licensor determines the items, figures and analytical methods, therefore they are not covered by this Standard.

Due consideration must also be given to air pollution, noise control, waste water control and other control measures which are regulated by laws, regulations, national standards, etc. For the plant waste water and the plant solid-waste systems reference is made to Engineering Standards IPS-E-PR-725, IPS-E-PR-730 and IPS-E-PR-735 respectively.

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor/Consultant/Contractor:

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

- Test Method ASTM D-86
- Test Method ASTM D-93
- Test Method ASTM D-1160
- Test Method ASTM D-323
- Test Method ASTM D-156
- Test Method ASTM D-1500
- Test Method ASTM D-155
- Test Method ASTM D-130
- Test Method ASTM D-97
- Test Method ASTM D-976
- Test Method ASTM D-189
- Test Method ASTM D-2500
- Test Method ASTM D-2709
- Test Method ASTM D-1522
- Test Method ASTM D-2163
- Test Method ASTM D-2420
- Test Method ASTM D-70
- Test Method ASTM D-5
- Test Method ASTM D-36
- Test Method ASTM D-113
- Test Method ASTM D-6
- Test Method ASTM D-92
- Test Method ASTM D-4

- Test Method ASTM D-445
- Test Method ASTM D-2788
- Test Method ASTM D-1522

IP (THE INSTITUTE OF PETROLEUM)

- Test Method IP-170
- Test Method IP-57
- Test Method IP-21
- Test Method IP-71

IPS (IRANIAN PETROLEUM STANDARDS)

- E-PR-200 "Basic Engineering Design Data"
- E-PR-725 "Process Design of Plant Waste Water Sewer Systems"
- E-PR-730 "Process Design of Plant Waste Water Treatment & Recovery Systems"
- E-PR-735 "Process Design of Plant Solid-Waste Treatment & Disposal Systems"

NIOC (NATIONAL IRANIAN OIL COMPANY)

- Job Specifications for Arak Refinery Project
- Arak Refinery Engineering and Construction Contract, Arak Refinery

API (AMERICAN PETROLEUM INSTITUTE)

"API Technical Data Book", Petroleum Refining, 4th. Ed., Copyright 1983

3. DEFINITIONS AND TERMINOLOGY

3.1 Company/Employer/Owner

Refers to one of the related affiliated companies of the petroleum industries of Iran such as National Iranian Oil Company (NIOC), National Iranian Gas Company (NIGC), National Petrochemical Company (NPC), etc., as parts of the Ministry of Petroleum.

3.2 Contractor

Refers to the persons, firm or company whose tender has been accepted by the Employer and includes the Contractor's personnel representative, successors and permitted assigns.

3.3 Defects

All items which require replacement or repair but could not have been replaced or repaired before take over and in no way hinder or affect the requirements for substantial completion.

3.4 Engineer

The Employer's representative appointed by the Employer from time to time to supervise execution of the project.

3.5 Licensor(s)

Licensor means a company duly organized and existing under the laws of said company's country and as referred to in the preamble to the contract.

3.6 Provisional Acceptance

Provisional Acceptance means that operability test has been satisfactorily completed with the system operating at the capacity as defined in the contract for a continuous period of seven (7) days. Substantial completion shall be evidenced by issuance of a Provisional Acceptance Certificate per contract.

3.7 Specifications

Drawings, Specifications, bills of materials and any other technical documents, whatever they may be, issued with the contract documents including any revisions or additions from time to time to the drawings, specifications, bill of material and any other technical documents.

3.8 Sub-Contractor

Any person, firm or company (other than Contractor) named in the contract for any part of the works or any person to whom any part of the contract has been sub-let with the consent in writing of the Engineer and the legal personal representatives, successors and assigns of such person.

3.9 Unit or Units

One or all Units and facilities as applicable, to form a complete operable oil and/or gas refinery and a pertrochemical complex and/or distribution depot as defined in the scope of work of the contract except those items listed in the scope of work as to be designed and constructed by others.

3.10 Writing

Any manuscript type written or printed statement under seal or hand .

4. SYMBOLS AND ABBREVIATIONS

A/D	Analog/Digital.
API	American Petroleum Institute.
ASTM	American Society for Testing and Materials.
bb1/sd	Barrels Per Stream Day.
BL	Battery Limit.
BOD	Biological Oxygen Demand.
CCR	Continuous Catalyst Regeneration.
COD	Chemical Oxygen Demand.
DAF	Dissolved Air Flotation.
DCS	Distributed Control System.
EP	End Point.
Eq	Equation.
FBP	Final Boiling Point.
FI	Flow Indicator.
FIC	Flow Indicator Controller.
FP	Flash Point.

FQ	Flow Totalizer.
HPS	High Pressure Steam.
IP	The Institute of Petroleum.
IPS	Iranian Petroleum Standards.
LPS	Low Pressure Steam.
mass ppm	Parts per million by mass, (mg/kg).
MCR	Maximum Continuous Rating.
MPS	Medium Pressure Steam.
NFPA	National Fire Protection Association.
Nm^3	Normal cubic meters, (at 101.325 kPa and 0°C conditions).
NPSH	Net Pressure Suction Head.
PSA	Pressure Swing Adsorption.
RVP	Reid Vapor Pressure.
Sm^3/d	Standard cubic meters per day (at 101.325 kPa and 15°C conditions).
T/D	Turn Down.
TDS	Total Dissolved Solids.
WWT	Waste Water Treatment.

5. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

6. GUARANTEE ITEMS AND FIGURES

The performance guarantee is classified into the following three categories:

1) Process performance guarantee.
2) Utility guarantee.
3) Equipment guarantee.

6.1 Process Performance Guarantee

The Contractor shall guarantee that when each non-licensed Unit or facility is operated during a performance test in accordance with the designed conditions, the facility constructed will be capable of producing the designed guaranteed quantity and quality of product.

The Contractor shall guarantee that when non-licensed process or Utility Units are correctly operated at their respective design feed rates it will not be necessary to operate pumps or compressors installed as spares simultaneously with the normally operating equipment in the Units or in Offsite Units.

The Contractor shall guarantee that the basic and detailed design work (except design made by Licensers) which is performed for all Units and facilities will be such that the lines, control valves, relief valves and instrumentation and all other parts of the plant shall be capable of handling the quantities specified in the process design.

The items and figures pertaining to process performance guarantee are listed in Table A.1 of Appendix A. Process performance test runs which may be conducted independently or simultaneously with other units, are to be conducted to compare and confirm their performance with the guarantees of respective process. The items and figures applicable to the performance guarantee of utility systems are listed in Table B.1 of Appendix B.

6.1.1 Plant capacity

The plant shall process 100% of the design basis charge, the turn down ratio specified in the design basis shall also be guaranteed.

6.1.2 Product yield

It shall be guaranteed that the plant will produce 100% of the design basis products.

6.1.3 Product specifications

It shall be guaranteed that the plant will produce the products with the specifications indicated in the design basis. All the products guarantees are based on the relevant feed characteristics/compositions presented in original contract documents. In case that discrepancies appear at the time of the performance test run, necessary adjustments shall be made to the guranteed figures upon agreement between the two parties (Contractor and Company) in accordance with actual feed characteristics.

6.1.4 Raw material

In the case of chemical plants designed to synthesize chemical products, there shall be a guarantee with regard to the quantity of synthesized products and the quantity of required raw materials. This means that it is necessary to guarantee the selectivity in terms of yields of reaction, which is closely associated with catalyst performance and catalyst life. In such cases a guarantee figure of 105% (as maximum) of raw material with respect to the design basis shall be considered.

6.1.5 Catalyst performance and life

Since the performance and life of a catalyst are factors that may influence process performance to a large extent, for cases where the Contractor develops process and provides catalyst and offers them to the Company, the Contractor and/or the catalyst manufacturer shall guarantee the performance and life of the catalyst. Aside from above-mentioned cases, Licensor and/or the catalyst manufacturer shall guarantee the performance and life of the catalyst.

6.1.6 Chemical consumption

Chemical consumption is also a factor that may influence process performance to a large extent and it is sometimes related to the performance of a catalyst. It shall be guaranteed that 105% by mass (as maximum) of chemical with respect to the design basis will be consumed.

6.2 Utility Consumption Guarantee

6.2.1 Guarantee items

Utility requirement may vary depending upon the process, the scope of the Contractor’s work and many other factors. The guaranteed utility consumption items will generally consist of:

- Steam [High Pressure Steam (HPS), Medium Pressure Steam (MPS) and Low Pressure Steam (LPS)].
- Electrical power.
- Fuel (fuel gas or fuel oil).
- Cooling water.

6.2.2 Guarantee figure

Utility consumption of a Unit means the imported utilities from other Unit(s). The guranteed figure should be the average utility consumption of continuously operating equipment. These data are at the design throughput of the Unit (utilities required for lighting, ventilation, air conditioning and instrumentation are not included in the consumption). Guaranteed figures of utility consumption for summer condition and winter condition shall be developed with the understanding that one or the other will be demonstrated during the performance test run depending upon the period during which the test will be carried out.

The utility consumption tests for the performance guarantee will consist of the following two tests:

1) Process Unit

The utility consumption of each process Unit at its design capacity is observed during the process performance test. The Units subject to utility consumption guarantee are those mentioned in contract documents.

In the case of licensed processes, Licensers will not usually guarantee utility consumption of a process plant. Accordingly, the Contractor must make allowance for heat loss and utility consumption which must be calculated by himself. Regarding guarantee figures for utility consumption, 5% over and above the calculated values which include the heat losses is allowed.

2) Utility Unit and Offsite Unit

After the performance/utility consumption guarantee test of all process Units, utility consumption (for the Utility Units and the Offsite Units) shall be checked at the contractual capacity of the whole complex at an operation mode in accordance with the complex block flow diagram.

In the event that the Contractor fails to meet the combined total daily cost guaranteed for the consumption of fuel, electric power and steam in the Unit or Units set out in the contract, the Employer accepts a financial settlement in lieu of corrective measures in the event of failure to meet guarantee. Such settlement shall be the amount by which the cost of the utilities based on the consumption determined from the performance test exceeds the guaranteed daily cost both calculated for a period of 1000 days and valued in accordance with the actual costs.

6.3 Equipment Guarantee

Equipment guarantee shall be specified individually in the relevant equipment specification.

7. EXECUTION OF THE PERFORMANCE GUARANTEE TEST

7.1 Preparation and Preconditions for Test Operation

The following preparations must be made to carry out a preformance guarantee test:

7.1.1 It shall be checked that the plant employs catalysts and chemicals supplied or approved by the Contractor/Company and that such catalysts and chemicals are available in sufficient quantities to conduct the test operation.

7.1.2 It shall be checked that the plant employs feedstocks, raw materials and utilities meeting the specifications set forth in the design basis and that such feedstocks, raw materials and utilities are available in sufficient quantities to conduct the test operation.

7.1.3 It shall be confirmed that the plant has been constructed in accordance with the specifications, drawings and other data furnished by the Contractor/approved by the Company.

7.1.4 It shall be confirmed that the plant is operated and maintained in accordance with the operation manual furnished by the Contractor/approved by the Company.

7.1.5 If it is recognized that exact duplication of design data is improbable under test conditions, operating data obtained during the test operation shall serve therefore as the basis for processing calculations using established and reputable factors and methods. The results obtained in these calculations shall be converted to those which would have been obtained if test conditions had duplicated the design conditions.

7.1.6 The Contractor must prepare test data sheets/log sheets for Company's review. Necessary services such as adequate laboratory testing services, inspection, operating and maintenance personnel and product evacuation, etc. shall be furnished by the Company. The Contractor may witness such laboratory tests.

7.1.7 After the start of the initial operation and before commencing the test operation, the instruments required for the performance guarantees which would seem to have wrong indication shall be calibrated.

7.1.8 Before commencing the performance test, adjustment of operating conditions of the Unit may be required by Contractor to gain a prospect of which the performance guarantees would be met.

7.1.9 Miscellaneous preparatory works shall have been completed such as:

- confirmation of data logging and reading system;
- confirmation of sampling and analysis system;
- confirmation of data collection of electric power consumption.

7.2 Measuring Schedule

7.2.1 Data collection

Operating data to be used for the calculation of the performance guarantee shall be measured by means of instruments provided on the plant and collected by the following method:

1) Shift report printed out on the DCS report printer three times a day (8:00,16:00,24:00).

2) Reading or printing out the data of the tank gaging system every four hours. Tank level measurement shall be adopted as a reference unless otherwise specified, because it is difficult to collect correct data due to erroneous information caused by level fluctuation during tank change and time difference at data collection. Notwithstanding the above when level measurement of a tank is applied, the tank tables shall be made available beforehand.

3) Reading of the local data every four hours. If some hunting on the indicators is found, the averaged value shall be taken for recording.

7.2.2 Measurement of electric power consumption

The electric power consumption shall be measured by reading the total watt-hour meters in the substation, each ampere and volt of running equipment with ampere-meters or clamp-meters and volt meters, as necessary. Reference shall also be made to the respective measuring schedule of detailed performance test of the Units (to be developed by the Contractor).

7.3 Product Sampling and Laboratory Test Schedule

7.3.1 General

Procedures described in this Clause are typical and may be modified in accordance with the discussion between Company and Contractor, according to actual situations and conditions of the parties.

7.3.2 Line sampling for liquid

Samples shall be taken three liters per each sampling time and one sample point every eight(8) hours and be used for the following purposes:

1) One liter to be used for laboratory analysis, the analysis frequency of which is once per eight hours.

2) One liter to be used for making one day composite sample which is a mixture of 3 samples per day and be used for laboratory analysis, the analysis frequency of which is once per day.

3) One liter to be stored for the use of further analysis which might be carried out (such sample is referred to as "retained sample").

7.3.3 Line sampling for gas and LPG

Samples shall be taken one ballon or one bomb per point every eight hours. No retained sample is required.

7.3.4 Tank sampling (if applicable)

1) Samples shall be taken as two liters per point using a sampler at three points in a tank, i.e., upper, middle and lower levels and be used for the following purposes:

- One liter of each point to be used for making a mixture of upper, middle and lower point samples. The mixed sample is to be used for all laboratory analysis required.

- The rest (one liter each) to be stored as retained sample.

2) Samples shall be taken two liters per point at the sample connection on the tank (if provided) and one liter is to be used for all laboratory analysis required and the rest (one liter) is to be stored as a retained sample.

7.3.5 Laboratory test schedule

Reference shall be made to the respective sampling and laboratory test schedule of the detail procedure of each Units (to be developed by the Contractor).

7.3.6 Test equipment

All test equipment required for the laboratory analysis shall be provided by the Company.

7.4 Performance Test Run

7.4.1 Contractor shall notify Company when Contractor judges that a Unit is operating in stable manner and performance test can be done and shall technically observe the operation of each plant/equipment during performance tests.

7.4.2 The performance tests shall be conducted by Company within thirty days after notification of Contractor under the technical advise of Contractor. If Company does not conduct tests within thirty days after Contractor's notification

except for reasons beyond Company's control, the Contractor shall be relieved of the liability of such a performance test. In the event of such enforced delay, the Contractor shall be entitled to be reimbursed for reasonable expenses incurred by it resulting therefrom. If a performance test is not carried out within one hundred eighty days after the date of relevant Completion Certificate for any reason solely attributed to Company, the Contractor shall be relieved of such a performance test.

7.4.3 Malfunctioning of instruments during the test

In case malfunctioning of some instruments is faced during the test period, the test operation shall not be stopped/suspended, provided that the following two conditions are met:

1) Company and Contractor mutually agree that the data required for the performance guarantee could be estimated by calculations or other reasonable methods.

2) The malfunctioning of instruments will not endanger the continuation of the operation.

8. CALCULATION AND EVALUATION OF THE DATA

8.1 Calculation of the Data

8.1.1 The data measured and analyzed for the performance tests shall be arithmetically averaged over the periods of the tests.

8.1.2 The data measured are to be corrected in accordance with the following manner:

1) Feed or product quantities of a unit

The data measured are to be corrected by temperature, pressure and other variables as shown in Appendix C "correction of measured values".

2) Utility consumption

The data measured are to be corrected by temperature, pressure and other variables as shown in Appendix A. Moreover the data are to be corrected by ratio of design to actual flowrate of a Unit charge.

3) Electric power consumption

As individual watt-hour meters are not provided for each equipment/Unit, electric power consumption for the utilities consumption guarantee basis shall be calculated and corrected as follows:

Step 1. Calculation of average electric power consumption from readings of watt-hour meters at start and end of the test run.

Step 2. Calculation of averaged electric power consumption from ampere and voltage measured by ampere meter and voltmeter, for the equipment for which watt-hour meter is not provided.

Step 3. Substraction of expected electric power requirements of the equipment which are not subject to the guarantee.

8.1.3 The heating value required for the calculation of calorific values of fuel for the utilities consumption guarantee basis shall be based on the Figures in the API Technical Data Book.

8.2 Evaluation of the Data

8.2.1 Measurement tolerances

To evaluate the values measured by instruments, permissible measurement tolerances pertaining to instruments shall be taken into account. Reference shall be made to Appendix D for these tolerances.

If the differences between the guarantee figure and test result calculated/corrected by using measured values is within the range considering the allowable tolerances of the instruments, the guarantee shall be deemed to be met.

8.2.2 Priority in flow measurement

The priority in evaluating the flow measurement is given below:

Priority 1: Value measured by the positive displacement type flow totalizer (PD meter).
Priority 2: Value measured by other flow instruments.
Priority 3: Value measured by the tank gaging system.

When the measurement of higher priority is not applicable, measurement of the next priority will be adopted.

8.3 Evaluation of Laboratory Analysis Result

8.3.1 As for the precision of obtained results, reproducibility shown in each test method shall be adopted.

8.3.2 When results of laboratory analysis are verified reasonable by Company's and Contractor's authorized personnel, the values shall be deemed acceptable. The priority in evaluating the results is given to those for the composite sample rather than the 8 hours sample if analysis items are duplicated.

8.3.3 If the analyzed values for 8 hours samples seem to be doubtful, the retained sample shall be analyzed. Since there is no retained samples for gas and LPG, additional sample could be taken for analysis if sampling time is not close to that of the next 8 hours. The values verified reasonable by all of the above personnel, shall be deemed acceptable.

8.3.4 In case where the analyzed values are verified incorrect due to the problem on the sampling the above personnel, that sample and the results will become void for evaluation. In this case, the composite sample will not include such sample.

8.3.5 If the analyzed values for the composite sample or mixed sample of a tank seem to be doubtful, the retained samples shall be used for analysis. The values verified reasonable by all of the above personnel, shall be deemed acceptable.

8.3.6 In the event that Company and Contractor cannot agree on the accuracy of any laboratory test, then a sample of the material shall be submitted to a mutually agreed independent laboratory whose findings shall be accepted as final.

9. COMPLETION OF PERFORMANCE TEST

9.1 Reporting

Within ten working days after receipt of all test run data, including laboratory analysis and utilities consumption data, Contractor shall submit the test run results to Company, indicating whether in Contractor opinion the performance guarantees have been met.

9.2 Judgement

As a result should the following have been achieved, the performance guarantees for a Unit shall be deemed to have been met:

1) The process guarantees have been achieved.
2) The utilities consumption guarantees have been achieved.

9.3 Acceptance

Within ten working days after notification by Contractor of the test results, Company shall issue the written acceptance of the performance test, if the test results have been satisfied, or non-acceptance in case of failure. If the required performance guarantees are not met for reasons for which the Contractor and/or his Vendors and Sub-contractors are responsible, the Contractor shall modify the Unit as is considered necessary and the test shall be repeated until the required performance test has been successfully completed or a settlement is reached in lieu thereof in accordance with the contract.

In the event that any Unit has been in operation for so long a time before a performance test is started that the catalyst activity is less than design activity or that fouling in excess of that specified in design has occurred on certain heat exchanger surfaces or will probably occur before a test run of the required duration can be obtained, then the Company shall at its expense replace or regenerate the catalyst and clean the exchanger surfaces.

10. LIQUIDATED DAMAGES FOR PERFORMANCE GUARANTEES

For each entire degree of deviation of each guaranteed parameter of a Unit, the Contractor shall pay to the Employer, as liquidated damages, the corresponding applicable percentage of the defined maximum liability as agreed in the contract.

APPENDICES

APPENDIX A
TABLE A.1 - GUARANTEE ITEMS APPLICABLE TO TYPICAL PROCESS UNITS PERFORMANCE

GUARANTEE ITEM	GUARANTEE FIGURE	OBJECT OF CALCULATION	ANALYTICAL AND MEASURING METHOD
1 CRUDE DISTILLATION UNIT			
1.1 PLANT CAPACITY	CONTRACT VALUE	CRUDE OIL CHARGE RATE	TANK GAGING AND/OR FLOW METER
1.2 PRODUCT YIELD	CONTRACT VALUE	BLENDING NAPHTHA	TANK GAGING AND/OR FLOW METER
		KEROSENE	
		ATMOSPHERIC GASOIL	
		REDUCED CRUDE	
		LIGHT STRAIGHT RUN NAPHTHA	
		HEAVY STRAIGHT RUN NAPHTHA	
		HEAVY DIESEL (LIGHT VACUUM GASOIL)	
		WAXY DISTILLATE	
		VACUUM RESIDUE	
1.3 PRODUCT SPECIFICATION			
1.3.1 FRACTIONATION	CONTRACT VALUE	ATMOSPHERIC COL.	ASTM D-86
GAP BETWEEN THE 95% ASTM DISTIL. TEMPERATURE OF THE LOWER BOILING FRACTION AND THE 5% ASTM DISTIL. TEMP. OF THE HIGHER BOILING FRACTION		OVERHEAD PRODUCT-BLENDING NAPHTHA	
		BLENDING NAPHTHA-KEROSENE	ASTM D-86
		KEROSENE-ATMOSPHERIC GASOIL	ASTM D-86

(to be continued)

APPENDIX A (continued)

GUARANTEE ITEM	GUARANTEE FIGURE	OBJECT OF CALCULATION	ANALYTICAL AND MEASURING METHOD
1.3.2 FLASH POINT (FP)	CONTRACT VALUE	BLENDING NAPHTHA	IP-170
		KEROSENE	ASTM D-93
		ATMOSPHERIC GASOIL	ASTM D-93
		HEAVY DIESEL (LIGHT VACUUM GASOIL)	ASTM D-93
		WAXY DISTILLATE	ASTM D-93
		VACUUM RESIDUE	ASTM D-93
		ATMOSPHERIC RESIDUE	ASTM D-93
1.3.3 DISTILLATION	CONTRACT VALUE	HEAVY STRAIGHT RUN NAPHTHA (5 vol% AND EP)	ASTM D-86
		KEROSENE (20 vol% AND FBP)	ASTM D-86
		ATMOSPHERIC GASOIL (90 vol% AND FBP)	ASTM D-86
		LIGHT VACUUM GASOIL (HEAVY DIESEL, 90 vol% AND EP)	ASTM D-1160
		WAXY DISTILLATE (95 vol% AND EP)	ASTM D-1160
1.3.4 RELATIVE DENSITY (SPECIFIC GRAVITY)	CONTRACT VALUE	HEAVY STRAIGHT RUN NAPHTHA	
		KEROSENE	
		ATMOSPHERIC GASOIL	
		LIGHT VACUUM GASOIL (HEAVY DIESEL)	
1.3.5 SMOKE POINT	CONTRACT VALUE	KEROSENE	IP-57
1.3.6 RVP	CONTRACT VALUE	LIGHT STRAIGHT RUN NAPHTHA	ASTM D-323
1.3.7 COLOR	AS PER CONTRACT	KEROSENE	ASTM D-156
		ATMOSPHERIC GASOIL	ASTM D-1500
		LIGHT VACUUM GASOIL (HEAVY DIESEL)	ASTM D-155
1.3.8 FREEZING POINT	CONTRACT VALUE	KEROSENE	

(to be continued)

APPENDIX A (continued)

GUARANTEE ITEM	GUARANTEE FIGURE	OBJECT OF CALCULATION	ANALYTICAL AND MEASURING METHOD
1.3.9 CORROSION	CONTRACT VALUE	KEROSENE (3 hours AT 50°C)	ASTM D-130
		ATMOSPHERIC GASOIL (3 hours AT 100°C)	ASTM D-130
		LIGHT VACUUM GASOIL (HEAVY DIESEL, 3 hours AT 100°C)	ASTM D-130
1.3.10 POUR POINT	CONTRACT VALUE	ATMOSPHERIC GASOIL	ASTM D-97
1.3.11 DIESEL INDEX	CONTRACT VALUE	ATMOSPHERIC GASOIL	IP-21
		LIGHT VACUUM GASOIL (HEAVY DIESEL)	IP-71
1.3.12 CETANE INDEX	CONTRACT VALUE	ATMOSPHERIC GASOIL	ASTM D-976
		LIGHT VACUUM GASOIL (HEAVY DIESEL)	ASTM D-976
1.3.13 CARBON RESIDUE	CONTRACT VALUE	ATMOSPHERIC GASOIL	ASTM D-189
		LIGHT VACUUM GASOIL (HEAVY DIESEL)	ASTM D-189
		WAXY DISTILLATE	ASTM D-189
1.3.14 CLOUD POINT	CONTRACT VALUE	ATMOSPHERIC GASOIL	ASTM D-2500
1.3.15 WATER AND SEDIMENT	CONTRACT VALUE	ATMOSPHERIC GASOIL	D-2709
1.3.16 METAL CONTENT	CONTRACT VALUE	WAXY DISTILLATE	
1.3.17 TOTAL NITROGEN	CONTRACT VALUE	WAXY DISTILLATE	
1.3.18 TOTAL SULFUR	CONTRACT VALUE	WAXY DISTILLATE	ASTM D-1522
1.3.19 C_7 INSOLUBLES	CONTRACT VALUE	WAXY DISTILLATE	
1.3.20 C_5 CONTENT	CONTRACT VALUE	LPG	ASTM D-2163
2 LPG UNIT			
2.1 PLANT CAPACITY	CONTRACT VALUE	C_4, C_5 AND LIGHTER STREAMS	TANK GAGING AND/OR FLOW METER
2.2 PRODUCT YIELD (RECOVERY)	CONTRACT VALUE	PROPANE	TANK GAGING AND/OR FLOW METER

(to be continued)

APPENDIX A (continued)

GUARANTEE ITEM	GUARANTEE FIGURE	OBJECT OF CALCULATION	ANALYTICAL AND MEASURING METHOD
		BUTANE	TANK GAGING AND/OR FLOW METER
		PENTANE	TANK GAGING AND/OR FLOW METER
2.3 PRODUCT SPECIFICATION			
2.3.1 FRACTIONATION	CONTRACT VALUE	C_2 vol% IN C_3 PRODUCT	
		C_4 vol% IN C_3 PRODUCT	
		C_3 vol% IN C_4	
		C_5 vol% IN C_4	
		C_4 vol% IN C_5	
2.3.2 H_2S CONTENT	NEGATIVE	C_3	ASTM D-2420
		C_4	ASTM D-2420
3 H_2S REMOVAL AMINE TREATING UNIT			
3.1 PLANT CAPACITY	CONTRACT VALUE	SOUR GAS RATE	FLOW METER
3.2 PRODUCT SPECIFICATION			
3.2.1 H_2S CONTENT	CONTRACT VALUE (HP TREATED GAS SHALL BE SUITABLE AS FEEDSTOCK TO H_2 PLANT)	LOW PRESSURE TREATED GAS	
4 SULFUR RECOVERY UNIT			
4.1 PLANT CAPACITY	CONTRACT VALUE	SULFUR PRODUCT	TANK GAGING AND/OR FLOW METER
4.2 SULFUR RECOVERY	CONTRACT VALUE	SULFUR RECOVERY BASED ON SULFUR INTAKE	
4.3 PRODUCT SPECIFICTION			
4.3.1 PURITY	CONTRACT VALUE	SULFUR PRODUCT	

(to be continued)

APPENDIX A (continued)

GUARANTEE ITEM	GUARANTEE FIGURE	OBJECT OF CALCULATION	ANALYTICAL AND MEASURING METHOD
4.3.2 ASH CONTENT	CONTRACT VALUE	SULFUR PRODUCT	
4.3.3 MOISTURE	CONTRACT VALUE	SULFUR PRODUCT	
4.3.4 ACIDITY AS H_2SO_4	CONTRACT VALUE	SULFUR PRODUCT	
4.3.5 HYDROCARBON	CONTRACT VALUE	SULFUR PRODUCT	
4.3.6 COLOR	AS PER CONTRACT	SULFUR PRODUCT	
4.4 CATALYST LIFE	CONTRACT VALUE	CATALYST ACTIVITY	
5 ASPHALT UNIT			
5.1 PLANT CAPACITY	CONTRACT VALUE (bbl/sd of NIOC 904 AND 920 GRADES)	PRODUCT RATE	TANK GAGING AND/OR FLOW METER
5.2 PRODUCT SPECIFICATION			
5.2.1 RELATIVE DENSITY (SPECIFIC GRAVITY)	1.01-1.06/1.05	904/920 GRADES	ASTM D-70
5.2.2 PENETRATION, 0.1 mm AT 25°C	60-70/10-20	904/920 GRADES	ASTM D-5
5.2.3 SOFTENING POINT,°C	49-56/85-95	904/920 GRADES	ASTM D-36
5.2.4 DUCTILITY AT 25°C, cm	100/1.5	904/920 GRADES	ASTM D-113
5.2.5 DROP IN PENETRATION AFTER HEATING,%	20	904	ASTM D-5 AND D-6
5.2.6 LOSS IN HEATING, mass%	0.2	904/920	ASTM D-6
5.2.7 FLASH POINT, °C	250/255	904/920	ASTM D-92
5.2.8 SOLUBILITY IN CS_2, mass%	99.5/99	904/920	ASTM D-4
5.2.9 SPOT TEST	NEGATIVE	904	
6 SOUR WATER STRIPPER UNIT			
6.1 PLANT CAPACITY	CONTRACT VALUE	SOUR WATER RATE	FLOW METER
6.2 PRODUCT SPECIFICATION			
6.2.1 H_2S CONTENT	CONTRACT VALUE (mass ppm), (mg/kg)		

(to be continued)

APPENDIX A (continued)

GUARANTEE ITEM	GUARANTEE FIGURE	OBJECT OF CALCULATION	ANALYTICAL AND MEASURING METHOD
6.2.2 FREE NH_3 CONTENT	CONTRACT VALUE (mass ppm), (mg/kg)		
7 COMBINED UNIFINING AND PLATFORMING UNIT			
7.1 PLANT CAPACITY	CONTRACT VALUE		TANK GAGING AND/OR FLOW METER
7.2 PRODUCT YIELD	CONTRACT VALUE		
7.3 PRODUCT SPECIFICATION	CONTRACT VALUE		
ITEMS 7.1 THRU 7.3 ARE TO BE COMMITTED BY THE LICENSOR, THE CONTRACTOR GUARANTEES THE MECHANICAL AND HYDRAULIC GUARANTEES ACCORDING TO THE SPECIFICATIONS AND OTHER DETAILS SPECIFIED IN THE CONTRACT AND FURNISHED BY THE LICENSOR			
8. HYDROCRACKER UNIT			
8.1 PLANT CAPACITY	CONTRACT VALUE		TANK GAGING AND/OR FLOW METER
8.2 PRODUCT YIELD	CONTRACT VALUE		
8.3 PRODUCT SPECIFICATION	CONTRACT VALUE		
ITEMS 8.1 THRU 8.3 ARE TO BE COMMITTED BY THE LICENSOR, THE CONTRACTOR GUARANTEES THE MECHANICAL AND HYDRAULIC GUARANTEES ACCORDING TO THE SPECIFICATIONS AND OTHER DETAILS SPECIFIED IN THE CONTRACT AND FURNISHED BY THE LICENSOR			
9 HYDROGEN PRODUCTION UNIT			
9.1 PLANT CAPACITY	CONTRACT VALUE	HYDROGEN PRODUCT RATE Sm^3/d	FLOW METER
9.2 PRODUCT SPECIFICATION			
9.2.1 HYDROGEN PURITY	CONTRACT VALUE (mole percent)		
9.2.2 CO+CO_2 CONTENT	CONTRACT VALUE (mole ppm)		
9.3 CATALYST LIFE	CONTRACT VALUE	CATALYST ACTIVITY	
10 VISBREAKER UNIT			
10.1 PLANT CAPACITY	CONTRACT VALUE	FEED CHARGE RATE	TANK GAGING AND/OR FLOW METER
10.2 PRODUCT YIELD	CONTRACT VALUE	VISBREAKER RESIDUE	TANK GAGING AND/OR FLOW METER
10.3 PRODUCT SPECIFICATION			
10.3.1 VISCOSITY AT 100°C	CONTRACT VALUE	VISBREAKER RESIDUE	ASTM D-445

(to be continued)

APPENDIX A (continued)

GUARANTEE ITEM	GUARANTEE FIGURE	OBJECT OF CALCULATION	ANALYTICAL AND MEASURING METHOD
10.3.2 FLASH POINT	CONTRACT VALUE	VISBREAKER RESIDUE	ASTM D-93
10.3.3 RVP	CONTRACT VALUE	VISBREAKER NAPHTHA	ASTM D-323
11 SOLVENT DEASPHALTING UNIT			
11.1 PLANT CAPACITY	CONTRACT VALUE	FEED CHARGE RATE	TANK GAGING AND/OR FLOW METER
11.2 PRODUCT YIELD	CONTRACT VALUE	DEASPHALTED OIL	TANK GAGING AND/OR FLOW METER
11.3 PRODUCT SPECIFICATION			
11.3.1 COLOR	CONTRACT VALUE	DEASPHALTED OIL	ASTM D-1500
11.3.2 SOFTENING POINT	CONTRACT VALUE	ASPHALT	ASTM D-36
11.3.3 PENETRATION	CONTRACT VALUE	ASPHALT	ASTM D-5
11.3.4 METAL CONTENT	CONTRACT VALUE	DEASPHALTED OIL	ASTM D-2788
11.3.5 SULFUR	CONTRACT VALUE	DEASPHALTED OIL	ASTM D-1552

APPENDIX B
TABLE B.1 - GUARANTEE ITEMS APPLICABLE TO TYPICAL UTILITY SYSTEMS PERFORMANCE

GUARANTEE ITEM	GUARANTEE FIGURE	OBJECT OF CALCULATION	ANALYTICAL AND MEASURING METHOD
1 STEAM GENERATION SYSTEM			
1.1 BOILER CAPACITY (EACH)	CONTRACT VALUE (AT MCR)	STEAM PRODUCTION RATE	FLOW METER
1.2 STEAM CONDITION AT BOILER BL (e.g., AT DESUPERHEATER OUTLET)	CONTRACT VALUE	PRESSURE AND TEMPERATURE	
2 POWER GENERATION SYSTEM			
2.1 ELECTRIC POWER (GENERATOR OUTPUT)	CONTRACT VALUE	MW AT GENERATOR TERMINAL AT SITE CONDITION	
3 DEMINERALIZER UNIT			
3.1 TREATED WATER CAPACITY PER CYCLE	CONTRACT VALUE	CUBIC METERS OF TREATED WATER, (m^3)	TANK GAGING AND/OR FLOW METER
3.2 OPERATING CYCLE	CONTRACT VALUE	CYCLE TIME (hours)	
3.3 WASTE WATER QUANTITY PER CYCLE	CONTRACT VALUE	CUBIC METERS OF WASTE WATER (m^3)	
3.4 CHEMICAL CONSUMPTION	CONTRACT VALUE	CHEMICAL CONSUMPTION PER CYCLE AND PER 1000 CUBIC METERS EFFLUENT WATER, (1000 m^3)	
3.5 RESIN LOSSES	CONTRACT VALUE		
3.6 DEMINERALIZED WATER QUALITY			
3.6.1 TOTAL DISSOLVED SOLIDS (TDS)	CONTRACT VALUE	mg/kg (mass ppm) OF TDS	
3.6.2 TOTAL HARDNESS	CONTRACT VALUE	mg/kg (mass ppm) OF $CaCO_3$	
3.6.3 SILICA	CONTRACT VALUE	mg/kg (mass ppm) as SiO_2	
4 CONDENSATE COLLECTION SYSTEM			
4.1 CONDENSATE RECOVERY	CONTRACT VALUE	CONDENSATE RECOVERY (vol%)	
5 COOLING WATER SYSTEM			
5.1 TOTAL CIRCULATING WATER RATE	CONTRACT VALUE		

(to be continued)

APPENDIX B (continued)

GUARANTEE ITEM	GUARANTEE FIGURE	OBJECT OF CALCULATION	ANALYTICAL AND MEASURING METHOD
5.2 TEMPERATURE RANGE	CONTRACT VALUE		
6 PLANT AND INSTRUMENT AIR SYSTEM			
6.1 AIR COMPRESSOR (EACH)			
6.1.1 CAPACITY	CONTRACT VALUE	Nm^3/h OF AIR	
6.1.2 DELIVERY PERSSURE	CONTRACT VALUE		
6.2 INSTRUMENT AIR DRIER			
6.2.1 CAPACITY	CONTRACT VALUE	Nm^3/h OF AIR	
6.2.2 DEW POINT	CONTRACT VALUE		
6.3 PLANT AIR DRIER			
6.3.1 CAPACITY	CONTRACT VALUE	Nm^3/h OF AIR	
6.3.2 DEW POINT	CONTRACT VALUE		
7 FUEL OIL SYSTEM			
7.1 CAPACITY	CONTRACT VALUE	FUEL OIL SUPPLY RATE	
7.2 FUEL OIL TEMPERATURE	CONTRACT VALUE	AT PROCESS HEATERS/BOILERS	
8 NITROGEN PLANT			
8.1 CAPACITY	CONTRACT VALUE	m^3/d OF LIQUID AND m^3/h OF GAS SIMULTANEOUSLY	
8.2 N_2 QUALITY			
8.2.1 PURITY	CONTRACT VALUE	vol% NITROGEN	
8.2.2 O_2 CONTENT	CONTRACT VALUE	ppm vol OF O_2	
8.2.3 CO_2 CONTENT	CONTRACT VALUE	ppm vol OF CO_2	
8.2.4 CO CONTENT	CONTRACT VALUE	ppm vol OF CO	
8.2.5 WATER CONTENT	CONTRACT VALUE	ppm vol OF H_2O	
8.2.6 HYDROCARBONS	CONTRACT VALUE	ppm vol OF HYDROCARBONS	
8.3 DELIVERY PRESSURE	CONTRACT VALUE		
9 WASTE WATER TREATMENT UNIT			

(to be continued)

APPENDIX B (continued)

GUARANTEE ITEM	GUARANTEE FIGURE	OBJECT OF CALCULATION	ANALYTICAL AND MEASURING METHOD
9.1 CAPACITY	ALL PROCESS WASTE WATER STREAMS ORIGINATED FROM SOUR WATER STRIPPER WATER, CRUDE DESALTER EFFLUENT WATER, SANITARY WATER		
9.2 TREATED WATER QUALITY	CONTRACT VALUE	WATER TO BE SUITABLE TO BE REUTILIZED AS MAKE UP WATER FOR COOLING TOWERS	
10 CONDENSATE POLISHING SYSTEM			
10.1 TREATED CONDENSATE CAPACITY	CONTRACT VALUE	EFFLUENT RATE	TANK GAGING AND/OR FLOW METER
10.2 OPERATING CYCLE	CONTRACT VALUE	CYCLE TIME (hours)	
10.3 CHEMICAL CONSUMPTION	CONTRACT VALUE	CHEMICAL CONSUMPTION PER CYCLE AND PER 1000 m^3 OF EFFLUENT CONDENSATE	
10.4 RESIN LOSSES	CONTRACT VALUE		
10.5 TREATED CONDENSATE QUALITY	CONTRACT VALUE	CONDUCTIVITY (micro-simens/centimeters at 25°C), (µS/cm)	
10.6 MAXIMUM DIFFERENTIAL PRESSURE OF THE SYSTEM	DESIGN VALUE		
11 CONDENSATE OIL REMOVAL SYSTEM			
11.1 TREATED CONDENSATE CAPACITY	CONTRACT VALUE	EFFLUENT CONDENSATE RATE	
11.2 TREATED CONDENSATE QUALITY	CONTRACT VALUE	OIL CONCENTRATION (mg/kg) or (mass ppm)	GRAVIMETRIC TEST
11.3 MAXIMUM DIFFERENTIAL PRESSURE OF THE SYSTEM	DESIGN VALUE		

APPENDIX C
CORRECTION OF MEASURED VALUES

The following measured values shall be corrected as follows:

C.1 Level of Tank

1) V = [V(2) . K (2) - V (1) . K (1)]/T **(Eq. C.1)**

V: Averaged hourly flow rate (m³/h at 15°C)

Where:

V (1),(2)	are volumes converted from R(1)/R(2) (reading of tank levels on the tank gaging system) and the tank table. (m³ at actual temperature);
K(1), K(2)	is correction factor converted from actual temperature to specified temperature (15°C) in accordance with ASTM/IP Petroleum Measurement tables (Metric Edition);
T	is hours from start to end of measurement interval.

C.2 Flow Instrument

C.2.1 Differential pressure type

1) Shift average data

$$V = \left[\sum_{i=1}^{n} V(i).K(i) \right] = n \qquad \textbf{(Eq. C.2)}$$

Where:

V is averaged hourly flow rate

(Liquid: m³/h at 15°C)
(Gas: Nm³/h)
(Steam: kg/h or tonne/h);

n is number of data to be averaged;

K(i) is correction factor.

When the operation data and the fluid composition are deemed to be stable, the averaged correction factor K can be used. In this case, corrected flowrate V is expressed as follows:

$$V = K.\left[\sum_{i=1}^{n} V(i) \right] = n \qquad \textbf{(Eq. C.3)}$$

Where:

K is averaged correction factor.

(to be continued)

APPENDIX C (continued)

2) Local flow instrument.

$$V = S \sum_{i=1}^{n} R(i) \cdot K(i)^2 \cdot^3 = n \qquad \textbf{(Eq. C.4)}$$

Where:

V	is averaged hourly flow rate;
R	is reading of flow instrument;
S	is scale factor;
n	is number of data to be averaged;
K(i)	is correction factor.

When the operating data and the fluid composition are deemed to be stable, the averaged correction factor K can be used. In this case, corrected flow rate V is expressed as follows:

$$V = K \cdot S \sum_{i=1}^{n} R(i)^2 \cdot^3 = n \qquad \textbf{(Eq. C.5)}$$

Where:

K	is averaged correction factor.

C.2.2 Positive displacement type flow totalizer (PD meter)

$$= [R(E) - R(S)] \cdot Kt / Kd \qquad \textbf{(Eq. C.6)}$$

Where :

V	is Total flow, (m³ at 15°C);
R (E)	is reading at end ;
R (S)	is reading at start;
Kt	is density at actual flowing temperature;
Kd	is density at 15°C.

C.2.3 Correction factor

1) Volumetric liquid flow

$$K(i) = [S(ai) / S(b)]^{1/2} \times \frac{\text{Design density at 15/4°C (water)}}{\text{Operating density at 15/4°C (water)}} \qquad \textbf{(Eq. C.7)}$$

Where:

S(b)	is density at design flow temperature;
S(ai)	is density at actual flowing temperature.

(to be continued)

APPENDIX C (continued)

$$K = [S(ai)/S(b)]^{1/2} \times \frac{\textit{Design density at 15/4°C (water)}}{\textit{Averaged operating density at 15/4°C (water)}} \qquad \textbf{(Eq. C.8)}$$

Where:

S(ai) is averaged density at actual flowing temperature.
S(ai) is converted by averaged operating temperature (T(ai)) and averaged operating density at 15/4°C (water).

$$\overline{T(ai)} = \left[\sum_{i=1}^{n} T(ai)\right] = n \qquad \textbf{(Eq. C.9)}$$

Where:

n is number of data to be averaged.

$$\textit{Averaged operating density at 15/4°C(water)} = \left[\sum_{i=1}^{n} \textit{Operating density (ai) at 15/4°C (water)}\right] = n$$

2) Gas flow

$$K(i) = \left[\frac{P(ai)}{P(b)} \cdot \frac{T(b)}{T(ai)} \cdot \frac{M(b)}{M(ai)}\right]^{1/2} \qquad \textbf{(Eq. C.10)}$$

Where:

P(b), T(b), M(b) are actual pressure, absolute temperature and molecular mass for design respectively;
P(ai), T (ai), M(ai) are Actual absolute pressure, actual absolute temperature and actual molecular mass respectively.

$$K = \left[\frac{\overline{P(ai)}}{P(b)} \cdot \frac{T(b)}{\overline{T(ai)}} \cdot \frac{M(b)}{\overline{M(ai)}}\right]^{1/2} \qquad \textbf{(Eq. C.11)}$$

$$\overline{P(ai)} = \left[\sum_{i=1}^{n} P(ai)\right] = n \qquad \textbf{(Eq. C.12)}$$

$$\overline{T(ai)} = \left[\sum_{i=1}^{n} T(ai)\right] = n \qquad \textbf{(Eq. C.13)}$$

$$\overline{M(ai)} = \left[\sum_{i=1}^{n} M(ai)\right] = n \qquad \textbf{(Eq. C.14)}$$

(to be continued)

APPENDIX C (continued)

Where:

n is number of data to be averaged.

3) Mass liquid flow and steam flow

$$K(i) = [D(ai)/D(b)]^{1/2} \quad \textbf{(Eq. C.15)}$$

Where:

D(b) is density at design flow condition;
D(ai) is density at actual flowing condition.

$$K = [D(ai)/D(b)]^{1/2} \quad \textbf{(Eq. C.16)}$$

Where:

D(ai) is averaged density at actual flowing condition.

For liquid flow:
D(ai) is converted by averaged actual flowing

temperature ***(T(ai))*** and averaged operating density at 15/4°C (water).

For steam flow:
(P(ai)) is converted by averaged actual flowing pressure
(P(ai)) and temperature ***(T(ai))***

P(ai) is averaged actual flowing pressure

$$= \left[\frac{1}{n}\sum_{i=1}^{n} P(ai)^2\right]^{1/2} \quad \textbf{(Eq. C.17)}$$

Where:

T(ai) is averaged actual flowing temperature

$$= \left[\frac{1}{n}\sum_{i=1}^{n} T(ai)^2\right]^{1/2} \quad \textbf{(Eq. C.18)}$$

Where:

n is number of data to be averaged.

APPENDIX D
ALLOWABLE INSTRUMENT TOLERANCES

The allowable tolerance range of the measurement system is as follows:

D.1 Flow Instrument

1) Orifice type FIC/FI/FQ for mounting in control room

The maximum allowable tolerance for each set of the above instruments shall be as follows:

Orifice & lead pipe	= ±2.0% of full scale
Transmitter	= ±1% of full scale
DCS signal conversion (Conditioner, A/D Converter)	= ±½% for at least 7% of full span
Recorder	= ±1% of full scale

The expected total allowable tolerance for indication and recorder shall be ±2.3% of full scale.

2) Orifice type local flow instrument

The allowable tolerance for each of the instruments shall be as follows:

Orifice & lead pipe	= ±2.0% of full scale
Indicator	= ±1.0% of full scale

The excepted total allowable tolerance for indicators shall be ±2.3% of full scale.

3) Positive displacement type flow totalizer (PD meter).

The expected total allowable tolerance shall be ±0.25%.

D.2 Level Instruments

The allowable tolerance shall be as follows:

- Accuracy of indication of field tank gage = ±2 mm
- Total accuracy of indication of tank gaging system = ±2 mm

D.3 Temperature Indicators on Control Room

The allowable tolerance for each of the instruments shall be as follows:

Thermocouple element	= ±1% of full scale
DCS signal conversion (Conditioner, A/D converter)	= ½% for at least 70% of full span

The expected total allowable tolerance for indicators shall be ±1% of full scale.

D.4 Pressure Indicator on Control Room

The maximum allowable tolerance for each set shall be as follows:

Transmitter = Within ½ of 1% of the range of instrument
DCS signal conversion = Within ½ of 1% of the range of instrument (Conditioner, A/D converter)

The expected total allowable tolerance for indicators shall be ±0.5% of full scale.

(to be continued)

APPENDIX D (continued)

D.5 Field Pressure and Temperature Indicators

The allowable tolerance for each of the instruments shall be ±1.0% of full scale.

D.6 Capacity Scale

(Catalyst regeneration section of CCR platformer)

The allowable tolerance will be shown in Vendor's instructions.

D.7 Watt-Hour Meter

The allowable tolerance for each watt-hour meter shall be ±2% of reading.

D.8 Clamp-Meter

The allowable tolerance for each clamp meter shall be ±3% of reading.

D.9 Ampere Meter

The allowable tolerance for each ampere meter shall be ±2% of reading.

D.10 Volt Meter

The allowable tolerance for each volt meter shall be ±2% of reading.