

JAMAICA PUBLIC SERVICE COMPANY LIMITED

**TECHNICAL SPECIFICATIONS
POLE MOUNTED SINGLE PHASE
DISTRIBUTION TRANSFORMER**

JPS SPECIFICATION NO. 6939-S-16

Prepared by: Engineering & Construction Department
April 27, 2016

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The "Technical Specifications, General Requirements" forms a part of this specification.

1. **SCOPE**

- 1.1 This specification covers single phase distribution transformers, overhead pole type, with Primary taps, with/without primary arresters and overload protective device; for use on JPS fifty (50) Hertz Distribution system, complete with insulating oil and spare parts.

2. **GENERAL REQUIREMENTS**

2.1 **INFORMATION**

- 2.1.1 Refer to "Submittal of Information" Section 2 paragraph 2.1 of "Technical Specification, General Requirements".

2.2 **DRAWINGS ETC. BY SUPPLIER**

- 2.2.1 Refer to "Submittal of Information" Section 3 of "Technical Specifications, General Requirements".
- 2.2.2 Manufacturer shall provide drawings of transformers showing principal dimensions and weight of components.
- 2.2.3 All information requested in this specification shall be supplied at the time of tendering.

3. **STANDARDS AND SERVICE CONDITIONS**

3.1 **STANDARDS**

- 3.1.1 Refer to "Codes and Standards" Section 3 of "Technical Specifications, General Requirements".
- 3.1.2 Applicable parts of the following standards shall be observed in the design, manufacture, performance and tests.
- 3.1.2.1 "NEMA" Standards publications No. TR-1
- 3.1.2.2 "ANSI" C57.12.00 General Requirements for Distribution Power and Regulating Transformer.
- 3.1.2.3 "ANSI" C57.12.20 Requirements for Overhead type Distribution Transformers 67 kV and below, 500 kVA and smaller.
- 3.1.2.4 "ANSI" C57.12.70 Terminal Markings and Connection for Distribution and Power Transformers.

- 3.1.2.5 "ANSI" C57.12.80 Transformer Terminology.
- 3.1.2.6 "ANSI" C57.12.90 Test Code for Distribution Power and Regulating Transformer.
- 3.1.2.7 "ANSI" C57.91 Guide for loading Mineral-oil-Immersed Transformers.
- 3.1.2.8 "ANSI" Z55.1 Gray finishes for Industrial Apparatus and Equipment.
- 3.1.2.9 "ASTM" B117 Salt Spray Test
- 3.1.2.10 "ANSI/IEEE" C62.11 1993
- 3.1.2.11 "ANSI/IEEE" C62.22
- 3.1.2.12 "NEMA" publication No. LA1

3.1.3 **CONFLICTS**

In the event of any conflicts between referenced standards/specification mentioned herein and this specification, the more stringent specification shall have precedence and shall govern. In addition, the bidder shall outline these conflicts in their bid at the time of tendering.

3.2 **SERVICE CONDITIONS**

- 3.2.1 Refer to "Geographic Conditions" Section 4 of "Technical Specifications, General Requirements".
- 3.2.2 Transformers are required for operation in an environment as noted in 3.2.1 and in addition, will be installed between 24m and 1.6km from the sea. The transformers may also be installed in close proximity to industrial plants emitting atmospheric pollutants in the form of acidic or alkaline dusts and corrosive fumes. These plants may include those manufacturing Caustic Soda, Cement or processing Bauxite and Limestone.

Transformers require special paint finishes (See Section 4.5.6.2) and special Primary Bushings (See Section 4.5.5.1) and as per ASTM B117-85E1 and ASTM D165-79A.

4. **DETAILED REQUIREMENTS**

4.1 **TYPE**

- 4.1.1 Oil immersed, self-cooled, outdoor, two primary high voltage bushings, direct mounting, pole-type transformer, with/without primary and/or secondary protective device, and with two (2) 2 1/2% primary taps above and below normal voltage.

Transformer shall be Primary rated 13800/23900V GRD Y and is required for operation on either a 13800V Delta or 13800/23900V Grounded Wye, solidly multi-grounded Primary Distribution system.

Secondary rated voltage: 120/240 Volts.

- 4.1.2 Oil immersed, self-cooled, outdoor, two primary high voltage bushing, direct mounting, pole-type conventional transformer, with/without primary and or secondary protective device, and with two (2) 2 1/2% primary taps above and below normal voltage.

Transformer shall be primary rated 13800/23900V GRD Y X 6900/11950V GRD Y and is required for operation on either a nominal 13800V Delta or 13800/23900V or 6900/11950 Grounded Wye, solidly multi-grounded primary distribution system.

Secondary rated voltage: 120/240 Volts.

- 4.1.3 Oil immersed, self-cooled, outdoor, one fully insulated primary high voltage bushing, direct mounting, pole-type transformer, with/without primary and/or secondary protective device, and with two (2) 2 1/2% primary taps above and below normal voltage.

Transformer shall be Primary rated 13800/23900V GRD Y and is required for operation on 13800/23900V Grounded Wye, solidly multi-grounded Primary Distribution system.

Secondary rated voltage: 120/240 Volts.

- 4.1.4 Oil immersed, self-cooled, outdoor, one fully insulated primary high voltage bushing, direct mounting, pole-type conventional transformer, with/without primary and or secondary protective device, and with two (2) 2 1/2% primary taps above and below normal voltage.

Transformer shall be primary rated 13800/23900V GRD Y X 6900/11950V GRD Y and is required for operation on a 13800/23900V or 6900/11950V Grounded Wye solidly multi-grounded primary distribution system.

Secondary rated voltage: 120/240 Volts.

- 4.1.5 Oil immersed, self-cooled, outdoor, one fully insulated primary high voltage bushing, direct mounting, pole-type conventional transformer, with/without primary and or secondary protective device, and with two (2) 2 1/2% primary taps above and below normal voltage.

Transformer shall be primary rated 4160/2400V GRD Y and is required for operation on a 4160/2400V Grounded Wye solidly multi-grounded primary distribution system.

Secondary rated voltage: 120/240 Volts.

4.2 **RATINGS ETC.**

- 4.2.1 Number of Phases : Single
- 4.2.2 Primary B.I.L. : 125 kV
- 4.2.3 Secondary B.I.L. : 30 kV
- 4.2.4 Frequency : 50 Hertz
- 4.2.5 Polarity : Subtractive
- 4.2.6 Continuous rated : 3, 5, 10, 15, 25, 37.5, 50, 75, 100, 167 kVA
capacity at 65 °C
temperature rise
- 4.2.7 Taps, full capacity : Two (2) 2.5 percent above and two (2) 2.5 percent below nominal voltage rating. Taps shall operate at both voltage positions for dual voltage transformers
- 4.2.8 Maximum Values : The maximum acceptable losses, weights and dimensions shall be as outlined in Tables 4.2.8 and 4.2.9

Table 4.2.8 Maximum Acceptable Losses for Pole Mounted Distribution Transformers

CATEGORY A - 13.8 kV:120/240 Volts | CATEGORY B - 13.8/6.9 kV:120/240 Volts

LOSSES (WATTS)

SIZE (KVA)	No Load	Full Load (@ 85 ° C)
3	21	51
5	30	60
10	50	89
15	58	161
25	74	283
37.5	94	413
50	110	540
75	156	700
100	186	895
167	370	1150

N.B. Transformer losses shall be tested at the higher voltage level. The values indicated above is a guide and, meeting them does not guarantee an order. Evaluation will be based on Clause 6.1 of specifications.

Table 4.2.9 Maximum Acceptable Weights & Dimensions for Pole Mounted Distribution Transformers

TRANSFORMER SIZE IN KVA	WEIGHT OF TRANSFORMER (KG)	HEIGHT TO TOP OF TANK (mm.)	DIAMETER OF TANK (mm)
3	150	700	480
5	170	750	500
10	204	863	558
15	261	888	584
25	318	914	609
37.5	375	930	640
50	413	939	660
75	580	955	710
100	681	965	736
167	904	1168	762

4.3 **PERFORMANCE**

4.3.1 **Temperature Rise**

4.3.1.1 The temperature rise measured by resistance method shall not exceed 65 degrees C at a maximum ambient of 40 degrees C. The short time overload characteristics shall be such that units can be periodically overloaded without significant loss of life in accordance with applicable ANSI C57.91 Tables.

4.4 **DATA TO BE FURNISHED BY BIDDER**

4.4.1 Bidder must attach to his proposal the "Transformer Data Form" included in the "Schedule of Technical Data" as Exhibit `A' duly completed for each kVA rating of Transformer offered. Any deviations from this specification should be clearly identified/outlined by the bidder. All sections of the data form shall be completed and all information requested in this specification shall be submitted at the time of tendering.

4.5 **CONSTRUCTION**

4.5.1 **Core**

4.5.1.1 The Transformer shall be Core or Shell type, made from cold rolled, silicone steel with preferred grain - orientation. *Manufacturer shall specify the type and grade of steel used in the construction of the core.* (Any alternative material or design used, and its effect on the transformer shall be clearly outlined in the bid proposal for the purchasers consideration)

4.5.2 **INTERNAL FAULT DETECTION DEVICE**

4.5.2.1 Each transformer shall be equipped with a non-resettable device which detects and provides external indication of internal transformer faults, and also incorporates pressure relief functionality. The specification for the internal fault detection device shall be submitted for review at the time of tendering.

4.5.3 **Tap-Changer**

4.5.3.1 All Tap leads shall be brought to an externally operated Tap-Changer with an appropriate turning handle.

4.5.3.2 Each Tap shall be clearly indicated by a number or letter on the Tap-Changer plate. This designation shall be easily identified with the given Tap Voltage shown on the nameplate. The Tap-Changer will be operated only when the Transformer is de-energized.

A suitable warning decal with black writing on a yellow background shall be affixed to the tank in the vicinity of the Tap- Changer handle, informing Servicemen that the Transformer must be de-energized before the Tap-Changer is operated.

4.5.3.3 All transformers are required to have Tap-Changers and they shall be operable on both voltage positions for dual voltage transformers.

4.5.4 **Overload Protective Device**

No internal overload protective device is required.

4.5.4.2 **Lightning Arrester**

4.5.4.2.1 Transformers shall be fitted with primary gapless type MOV arrester(s) of ratings below to protect the device at its primary operating voltage. The primary arrester shall be suitably attached to the tank to enable replacement. Only one primary arrester shall be fitted to each transformer and it shall be positioned at the H1 bushing.

Transformer Type	Arrester Duty Cycle Rating (kV)	MCOV (kV)
13800/23900V	18	15.3
13800/23900V X 6900/11950V	9	7.65

4.5.4.2.2 When required transformers shall be fitted with secondary MOV arrester of high energy capability so that the unit will be protected from secondary lightning surges. Arrester shall meet ANSI standards and NEMA and UL approved.

4.5.4.2.3 Primary and secondary arresters shall be externally mounted and be of such design that there are visible indications of failures of the devices.

4.5.4.2.4 Provisions for mounting primary arrester should be made on the tanks.

4.5.5 **Bushings**

4.5.5.1 Primary bushing/s shall be cover mounted and located in the segment of the cover according to ANSI C57.12.20 Fig 7 or Fig. 9. Primary bushings shall be equipped with solderless connectors sized according to ANSI C57.12.20 Table 7, suitable for either copper or aluminum conductors.

Primary Bushing/s for all transformers shall have a minimum leakage distance of 762 mm.

4.5.5.2 Secondary bushings shall be side wall mounted type, mounted singly, located according to ANSI C57.12.20 Fig 7 or Fig 9. Secondary bushings for transformers rated 100 kVA and below shall be equipped with solderless connectors sized according to ANSI C57.12.20 Table 9, suitable for either copper or aluminum conductors. Secondary bushings for transformers rated 167 kVA and above shall be equipped with spade terminals according to ANSI C57.12.20 Table 9.

Clamp type terminals, complete with non-ferrous bolts, nuts, washers and lock washers for attaching these terminals to the spade shall be furnished installed, utilizing appropriate joint compound. These clamp type terminals shall be of the "Cable Range" type with maximum range exceeding the ampacity of cable required to continuously carry full load of the Transformer and shall be suitable for either copper or aluminum conductors.

4.5.5.3 Number and arrangement of Secondary bushings shall be as required by ANSI C57.12.20 Table 6.

4.5.5.4 The color of all bushings shall match light gray No. 70 Munsell Notation 5BG 7.0/0.4 as specified in ANSI Z55.1.

4.5.6 **Tank and Finish**

4.5.6.1 Transformer oil preservation system shall be of the sealed tank type and tank shall be welded, construction made of high grade steel plate. The tank shall not be corrugated.

4.5.6.2 The painting process shall be of present day manufacturing process and such that the finish coat form a moisture, salt and abrasion resisting coating.

Transformers shall have "special paint finishes" suitable for use in close proximity to the sea and industrial plants. (See Section 3.2.2 of this

Specification). These paint finishes shall be capable of withstanding the ASTM B117 1500 hrs./ 5% Salt Spray Test without significant loss of adhesion or underfilm corrosion. Manufacturer shall specify paint finishes and provide certified test results that the relevant standards have been met. This information shall be submitted with the bid.

4.5.6.3 The tank finish color shall match light gray No. 70 Munsell Notation 5BG.7.0/0.4 as specified in ANSI Z55.1

4.5.6.4 One (1) set of support lugs shall be provided, located opposite the Secondary terminals. Type of support lugs and their vertical location and spacing shall conform to single - position mounting shown in ANSI C57.12.20 Figure 1.

4.5.6.5 The kVA rating in Arabic numeral 64 mm high shall be stenciled in black paint on the tank below the Secondary bushings.

4.5.6.6 All Transformers shall be labeled with its voltage rating and serial number on the front of the tank of the transformer so that it is visible from ground level after installation.

4.5.7 **Grounding Terminal**

4.5.7.1 A tank grounding connector of the solderless connector type capable of accepting either aluminum or copper conductor sized and located according to ANSI C57.12.20 Paragraph 6.5.4.3 shall be furnished.

4.5.7.2 A low-voltage grounding connection consisting of an external copper link of adequate size securely connecting the low-voltage neutral terminal to the tank according to ANSI C57.12.20 Paragraph 6.5.4.4 shall be furnished.

4.5.8 **Nameplate**

A nameplate of type, material and location on the Transformer complying with ANSI C57.12.20 Paragraph 6.3.4 shall be furnished. English language and metric system units shall be used. Nameplates shall be bar coded and contain the name of the manufacturer and transformer serial number.

4.5.9 **Accessories**

All standard accessory equipment, type, size, location, etc. according to ANSI C57.12.20 Paragraph 6.2 shall be furnished. A definite means to relieve excess

pressure in Transformer tank resulting from normal operation, shall be provided, meeting requirements of ANSI C57.12.20 Paragraph 6.2.7.

4.5.10 **Transformer Oil**

4.5.10.1 Each Transformer shall be delivered filled with new, unused mineral oil meeting the requirements of ANSI C57.12.00 Paragraph 6.6.1. (1). A Material Safety Data Sheet (MSDS) form shall be provided at the point of tender.

4.5.10.2 The manufacturer shall affix a blue label to each transformer to indicate that the oil is PCB free. The label state that the oil is certified to be PCB free shall have approximate dimensions 50 mm x 70 mm. The label shall be positioned in such a manner as to be easily visible with the transformer installed.

4.5.10.3 The manufacturer shall provide a certificate indicating that the oil used in the batch of transformers to be supplied is PCB free.

4.6 **SPARE PARTS**

The manufacturer shall provide their recommended spare parts list with a recommended quantity for each item. This list shall be priced and its cost shown as a separate item in the bid. The following is a guide as to the purchasers anticipated requirements.

One (1) high voltage bushing with internal conductor for every fifty (50) transformers or fraction thereof each rating purchased.

One (1) low voltage bushing with internal conductor for every fifty (50) transformers or fraction there of each rating purchased.

Spare parts enumerated above (or manufacturer recommended list) shall be individually quoted and priced to be delivered with the quantity of transformers required. However, the Purchaser at time of award may elect to increase or decrease the quantity of spare parts to be ordered or contracted at the unit prices quoted.

5. **TESTS**

5.1 Refer to "Tests" Section 5 of "Technical Specifications General Requirements".

- 5.2 Manufacturer shall invite Purchaser's Representatives (2) at Manufacturers' expense to witness the tests. This invitation shall be extended at least two (2) weeks before commencement of such tests. This condition may be waived at the discretion of the Purchaser. The cost to the purchaser for the witnessing of such tests shall be shown as a separate item in the bid.
- 5.3 Certified test reports shall be provided for each transformer supplied. Test reports shall be in accordance with NEMA standards, in both content and format. (refer to NEMA Pub. No. TR1, TR-7.02 Transformer Test Report). Tests reports shall be provided before delivery of transformers and will be required at the time of inspection by Purchasers representatives.
- 5.4 All transformers which are ready for delivery shall be made available for physical inspection and random selection of samples for testing.

6. **BID COMPARISON AND PRICE ADJUSTMENT**

6.1 **COMPARISON OF BIDS**

Only transformers that have satisfied clauses 4.2.8 and 4.2.9 of specifications will be evaluated.

- 6.1.1 For the purpose of comparing Bids, the Transformer losses will be evaluated on the following basis:-

Evaluated Cost of Transformer:

$$EC = P + 8.245*L1 + 0.748*L2$$

Where, EC is the evaluated cost of transformer in US\$,

P is Price of Transformer in US\$ (CIF Kingston)

L1 is No Load loss in Watts of the "Transformer Data Form".

L2 is Load loss in Watts of the "Transformer Data Form".

- 6.1.2 Bids received in currencies other than US Dollars will for the purposes of comparison, be converted at the Bank of Jamaica's posted selling exchange rates at its opening for business on the day the Bids are opened. (Refer to "Evaluation of Bids" Section 18 of "Instruction to Bidders" for further information).

6.2 **CONTRACT OR ORDER PRICE ADJUSTMENT**

6.2.1 At the time of witnessing the tests, five percent (5%) (to the nearest integer) of the quantity of transformers from each rating contracted or ordered shall be taken arbitrarily and tested in the presence of the Purchaser's Representatives. An arithmetic average of the actual measured losses for the number of transformers tested for each rating shall be derived. In case the average measured losses exceeds the guaranteed figures, the following amounts will be deducted from the Contract CIF unit price of every rating under test:-

6.2.1.1 US \$8.245 equivalent, for each watt or part thereof if the actual no load losses exceeds the guaranteed no load losses of the "Transformer Data Form".

6.2.1.2 US \$0.748 equivalent, for each watt or part thereof if the actual load losses exceeds the guaranteed load losses of the "Transformer Data Form".

6.2.2 The same currency exchange rates used to evaluate bid (Paragraph 6.1.2) will be used to make any price adjustment for failure to meet guarantees.

7. **PACKAGING AND MARKING**

7.1 All transformers shall be individually packaged in wood crates.

7.2 All spare parts shall be separately packaged in wood crates.

7.3 All crates shall be suitably constructed to offer protection to its contents.

7.4 The transformers and spares shall be shipped in containerized cargoes.

7.5 For "Export Marking" refer to Section 8 of "Technical Specifications. General Requirements".

8. **SHIPMENT**

8.1 Manufacturer shall await written authorization of purchaser before commencing shipment of transformers.

INDEX OF REVISIONS

Revision Number	Date Revision	Of	Revision Made	Checked By
1	6 Feb 1996		Added clause 4.2.10.2, 4.5.10.3	
2	17 May 1996		Revised clause 4.4.1,4.6.6.2 Revised clause 6.1, 6.2.	
3	Jan 1997		3 and 5 kVA size added.	
4	97 May 1		Alternative protective device and overload indicating devices allowed	
5	97 May 12		(clause 4.5.2 and 4.5.4) Primary and secondary arresters added to specification. Losses in tables edited. Clarified arrester requirements	
6	97 Sept 2		Revised clause 4.5.4, 4.5.5.1, 4.5.6.2, 4.5.6.5	
7	97 Oct 22			
8	02 Feb. 22		Added clause 4.1.3 & 4.1.4	
9	06 Jun 30		Added clause 4.1.5	
10	06 Sept 27		Added clause 4.2.8 Category C	
11	10 Jan 15		15, 37.5 and 75 kVA sizes added, arrester specification revised, transformer losses and transformer evaluated cost formula revised.	
12	14 Sep 30		Revised clause 4.5.2 Added clause 4.5.6.6	
13	16 Apr 27		Revised clause 4.5.4.2.1 Revised Transformer Data Sheet	
Revised By: Daniel Tomlinson			April 27, 2016	
<p>Approved By: _____</p> <p style="margin-left: 100px;">Osawaki Wickham</p> <p style="margin-left: 100px;">Manager - Engineering & Construction</p>				

Single Phase Pole-Mounted Transformer Data Sheet

The following submissions are mandatory as part of bid evaluation process:

1. *Completed Data Sheet Below*
2. *Drawings for transformers including dimensions, weights etc*
3. *Transformer Oil MSDS Sheet*
4. *Drawing & Details of the Internal Fault Detector/Pressure Relief Device*
5. *Documentation showing proof of ASTM B117 Salt Spray Test*
6. *List of Companies, Countries and Quantities of Transformers Supplied to date*

Referenced JPS Stock Number	
Manufacturer Name	
Country of Origin	
Type (Single, Three)	
Size (kVA)	
Frequency (Hz)	
Polarity	
Primary Voltage (V)	
Impedance	
Temperature Rise (Over 25°C ambient)	
Number of Primary Bushings	
Primary Bushing Creepage Distance (mm)	
Primary Taps	
Confirm Tap Changers can operate on all voltage positions (For Multi-Voltage Transformers)	
Primary BIL (kV)	
Secondary Voltage (V)	
Secondary BIL (kV)	
Arrester Duty Cycle Rating (kV)	
Arrester MCOV (kV)	
Maximum No Load Loss at 20°C (W)	
Maximum Load Loss at 85°C (W)	
Maximum Total Loss (W)	
Efficiency (%)	
Insulating Fluid	
PCB Level (PPM)	
Core Steel Grade/Type	
Tank Material	
Color of finish	
Internal Fault Detector/Pressure Relief Device Manufacturer & Catalog Number	
Warranty Period	
Exceptions	
Manufacturing Engineer	Name: _____ Signature: _____

