
	<p>نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p>							
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طرح نگهداشت و افزایش تولید ۲۷ مخزن

CALCULATION NOTE FOR NGR SIZING

نگهداشت و افزایش تولید میدان نفتی بینک



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IFC: Issued For Comment
IFA: Issued For Approval
AFD: Approved For Design
AFC: Approved For Construction
AFP: Approved For Purchase
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IFI: Issued For Information
AB-R: As-Built for CLIENT Review
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1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.



With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

As a part of the Project, a New Gas Compressor Station (adjacent to existing Binak GCS) shall be constructed to gather of 15 MMSCFD (approx.) associated gases and compress & transfer them to Siahmakan GIS.

GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields CLIENT (NISOC)
PROJECT:	Binak Oilfield Development – Surface Facilities; New Gas Compressor Station
EPD/EPC CONTRACTOR (GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR:	Joint Venture of : Hirgan Energy – Design & Inspection (D&I) Companies
VENDOR:	The firm or person who will fabricate the equipment or material.
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
THIRD PARTY INSPECTOR (TPI):	The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

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2.0 SCOPE

This document covers minimum necessary requirements for the design, selection, manufacture, inspection, testing and delivery of NGR.

It shall be used in conjunction with data/requisition sheets for present document subject.

3.0 NORMATIVE REFERENCES

3.1 CODES & STANDARDS

- IEEE Std 32 Standard Requirements, Terminology, and Test Procedure for Neutral Grounding Devices
- IEEE Std 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems
- IEEE Std 141 IEEE Recommended Practice for Electric Power Distribution for Industrial Plants
- IEEE Std C62.92.4 IEEE Guide for the Application of Neutral grounding in Electrical Utility Systems-Part IV: Distribution

3.2 THE PROJECT DOCUMENTS

- BK-GCS-PEDCO-120-EL-LI-0001 Electrical Load List
- BK-GCS-PEDCO-120-EL-SL-0001 Electrical Overall Single Line Diagram
- BK-GNRAL-PEDCO-000-EL-SP-0018 Specification for NGR
- BK-GCS-PEDCO-120-EL-LI-0002 Electrical Power & Control Cable Schedule



3.3 ENVIRONMENTAL DATA

Refer to "Process Basis of Design; Doc. No. BK-GNRAL-PEDCO-000-PR-DB-0001"

3.4 ORDER OF PRECEDENCE

In case of conflict between requirements specified herein & the requirements of any other referenced document, the most approved stringent requirements of below listed items shall be considered based on the approval given by the owner's representative:

- Purchase order
- Material Requisition
- MTO & Data Sheet
- This Specification

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- Drawing & Other Specification
- Reference Project Specification
- Iranian Petroleum Standard (IPS)
- Reference international Code & Standards

When the term “Authorized”, Authorization”, “Approval”, or “Approved” are used in this specification, it shall mean authorization or Approval from OWNER.

In case of any conflict between the project documents, the most stringent one shall be considered.

4.0 EARTH FAULT CURRENT IMPACTS

The purpose of this section is to present aspects, impact in determination of proper earth fault current level:

4.1 Transient Over Voltage Caused by Earth Fault

By increasing neutral grounding resistor current, the transient over voltage is reduced. According to IEEE 141 standard for controlling the transient over voltage cause by earth Fault, the neutral resistor current should be at least equal to or greater than the system total charging current. So the system total charging current is a limitation for neutral grounding resistor minimum current.



4.2 Hazard of Current Magnitude

Hazard of arc flash and arc blast, which may lead to equipment damage and fatal events for personnel, is increased in proportion to fault current level. So from current magnitude aspect, it's desirable to select ground fault current level as low as possible.

4.3 Appropriate Current Signal for Relays

To protect against earth fault, ground fault level must be high enough. Common practice in earth fault protection of motors is to consider response of relay to the faults occurring in 10% to 100% of motor windings. This is because of the low voltage existed in 10% remaining windings, causes ground short circuit will be rare at. Therefore, to protect mentioned range of windings, ground fault setting must be at 10% of earth fault current, occurred in motor terminal.

On the other hand, to discriminate faulty earthed feeder effectively, the earth fault current must be at least twice the charging current.

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5.0 CAPACITANCE TO EARTH DATA OF EQUIPMENT

The capacitance of equipment is selected based on manufacturer's data from similar projects. So, regarding to the difference between the assumed value and actual value, ten percent (10%) margin will be considered for charging current.

Because of allocating twenty percent spare capacity in power transformers for future extension, accompanied by installation of unforeseen cables and motors in future, the system charging currents is also considered twenty percent higher than calculated value.

5.1 Motor Data

In case of not available any data for capacitance to earth of induction motors, typical values are selected equal to 124pF/kW for 3.3kV motors, correspond to capacitive charging currents presented in Attachment #1 (Refer to "i-Gard Application Guide", www.i-gard.com.)

5.2 Medium Voltage Switchgears & All Auxiliaries

The capacitance to earth of medium voltage switchgears, related bus bars, circuit breakers bushings and connections are negligible

5.3 Transformer Data

The capacitance to earth of power transformers are also according to "i-Gard Application Guide", (www.i-gard.com.)

5.4 Cable Data

The capacitance to earth of Cables is according to ABHAR cable manufactures catalogue.



6.0 NEUTRAL GROUNDING RESISTOR SIZING

6.1 Transient Overvoltage Criteria

In this section the capacitance to earth and residual capacitive current of medium voltage system is calculated. Based on residual capacitive current, it will be possible to calculating medium voltage system total charging current. The neutral grounding resistor fault current is selected based on total charging current to reduce transient overvoltage to acceptable level as stated in 4-1.

Each phase capacitance to earth, residual capacitive current, total system charging current and minimum neutral grounding resistor fault current will be calculated based on the following equations:

$$C_0 = \sum_{i=1}^n C_i \quad (1)$$

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$$X_{C0} = \frac{1}{2\pi f C_0} \quad (2)$$

$$I_{C0} = \frac{V}{\sqrt{3} X_{C0}} \times K_d \quad (3)$$

$$I_0 = 3I_{C0} \times K_F \quad (4)$$

$$I_R \geq I_0 \quad (5)$$

Where:

C_0	Is total capacitance to earth of system (per phase)
C_i	Is each equipment capacitance to earth (per phase)
$f = 50\text{Hz}$	Is the system frequency (Hz)
V	Is the line to line voltage of system in Volt
X_{C0}	Is system-to earth capacitive reactance (per phase) (Ohm)
I_{C0}	Is system one phase to earth capacitive current (Ampere)
K_d	Margin considering the difference between the assumed value and actual value (1.1 for this study)
K_F	Factor considering future extension in power system, i.e. transformers, cables, (1.2 for this study)
I_0	Is total system charging current (Ampere)
I_R	Is neutral grounding resistor limited fault current (Ampere)

If $I_R \gg I_0$ as satisfied in low resistance grounding, following relation can be used to determine resistance value where R is neutral grounding resistor (Ohm).

$$R = \frac{V}{\sqrt{3} I_R} \quad (6)$$

The largest residual capacitance current will be obtained in 3.3kV switchgear of main substation, when the bus-ties are closed and one of the incoming breakers is open. In this condition all switchgear loads are connected to one transformer and related neutral grounding resistor, so the capacitive current of system is the summation of all connected equipment capacitive current.

6.2 Capacitance Charging Current Calculation (3.3KV Network)

Tables 1 to 3 list the equipment capacitance shall be considered in calculation of charging current. Table 4 summarizes the total calculated capacitance for each type of equipment individually. Capacitance to Earth for Induction Motor according to section 5.1 is as follow:



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Table 1: Capacitance to Earth for Induction Motors

Item	Equipment Type	Switchgear	Motor ID	Voltage (KV)	Power (KW)	Motor Cap. (nF)
1	Fire Water Electric Pump	GCS-11-SWG-001B	P-2301A	3.3	300	=124pF×300=37200pF
Total Capacitance (nF):						37.2 nF

Capacitance to Earth for Cable according to ABHAR catalogue is as follow:

Table 2: Capacitance to Earth for Cables

Item	From	To	No. of Run	No. of Core	Cable Size (mm ²)	Cable Length (m)	Cap. To Earth (nF/Km/Run)	Total Cap (nF)
	Equipment No.	Equipment No.						
1	Fire Water Transformer	3.3 Switchgear	1	3	50	50	240	12
3	3.3 Switchgear	P-2301A	1	3	50	150	240	36
Total Capacitance (nF):								48 nF

Capacitance to Earth for MV Transformers is as follow:

According to attachment1, the capacitive current for transformer is 0.05A for each MVA. Therefore the current for 800 KVA transformer is 0.04A. Then based on formula (3):

$$X_{C0} = \frac{V}{\sqrt{3} I_{C0}} \times K_d = \frac{3300}{\sqrt{3} \times 0.04} \times 1.1 = 52394$$



$$C_0 = \frac{1}{2\pi f X_{C0}} = \frac{1}{2 \times 3.14 \times 50 \times 52394} = 60\text{nF}$$

Table 3: Capacitance to Earth for MV Transformers

Item	Equipment Type	ID	Characteristics	Capacitance to Earth (nF)
1	Transformer	GCS-TR-003	11/3.3kV, 0.8MVA	60 nF
Total Capacitance (nF):				60 nF

Table 4: Summary Table

MV Motors	37.2 nF
MV Cables	48 nF
MV Transformers	60 nF
Total 3.3kV network	145.2 nF

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According to table 4 and equations 2 to 4, the system-to-earth capacitive reactance, one phase to earth capacitive current and total system charging current will be as follows:

$$C_0 = 145.2 \text{ nF}$$

$$X_{C0} = 21922 \text{ Ohm}$$

$$I_{C0} = \frac{3300}{\sqrt{3} \times 21922} \times 1.1 = 0.0956 \text{ A}$$

$$I_0 = 3 \times 0.0956 \times 1.2 = 0.344 \text{ A}$$

In order to reducing transient over voltages on system insulation the neutral grounding resistor current shall be selected equal or more than 0.344A ($I_R \geq 0.344A$).

6.3 NGR Sizing

Considering before mentioned criteria, i.e. preventing transient overvoltage and making earth fault current be detectable by protection system, a 100A NGR will be adequate for this purpose.

Withstand duration of 10s is sufficient for the resistor since system protection philosophy is based on high speed over-current protection and also, after fault clearing discharging of trapped charges to earth is almost instantaneously and its thermal impact on NGR is negligible.

As the $I_0 \leq 100A$ condition is satisfied in 3.3kV network, the resistance value could be obtained by equation (6):

$$R = \frac{V}{\sqrt{3}I_R} = \frac{3,300}{\sqrt{3} \times 100} = 19.05 \Omega \quad (7)$$

Short time dissipated energy is calculated as follows:

$$W = RI_R^2 t = 19.05 \times 100^2 \times 10 = 1.9 \text{ MJ} \quad (8)$$

6.4 Conclusion

NGR is selected as 100A, 10s for transformer units. So, it can limit ground fault current to acceptable level. In this situation, sensitivity of protection is not affected and switching overvoltage transients never lead to apparatus failure.

7.0 ATTACHMENT