

## ANNEX F: SUBSTATION DETAILS

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**AIS vs GIS Fact Sheet - Safety-Security Reliability Maintenance**



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**Fact Sheet for Indoor Gas Insulated Substations (GIS)  
Safety/Security, Reliability and Maintenance Factors**

<b>Service Factor</b>	<b>Safety/Security</b>
Personnel Safety	GIS substations provide a higher degree of personnel safety. This is due to the fact that there are no exposed "live parts" in the substation that can come in contact with operations and maintenance personnel.
Public Safety	GIS substations provide a higher degree of public safety. Since the GIS is contained within a securely locked and monitored enclosure or building, the potential for accidental or intentional public access is greatly reduced. Secondly, if an unqualified person or persons were to gain access to the GIS enclosure or building, then since there are no exposed "live parts" in the substation; the potential for injury due to high-voltage (1000 volts or above) contact is significantly reduced if not totally eliminated.
Physical Security	GIS substations provide a higher degree of physical security. Since the substation is located within an enclosure or building and since the enclosure or building are positioned within a significantly smaller fenced area than an AIS, then the ability to monitor the substation with surveillance equipment is more easily done and less expensive. Likewise, elaborate perimeter security barriers may not even be needed based on the enclosure or building design. GIS located in an enclosure or building is inherently projectile resistant.



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George W. Becker, PE





**Fact Sheet for Indoor Gas Insulated Substations (GIS)  
Safety/Security, Reliability and Maintenance Factors**

<b>Service Factor</b>	<b>Reliability</b>
Climatic conditions and wildlife	GIS substations are less affected by climate conditions and weather events. Since the GIS substation is located within an enclosure or building, then the effects of wind, snow, ice, tropical storm rain etc. are significantly reduced. Additionally, the probability of outages due to wildlife contacting "live parts" is extremely low.
Extreme and Severe Weather Events	GIS substations are less affected by extreme and severe weather events because of compact equipment configurations and completely enclosed "live parts," except for AIS interfaces (i.e. gas-to-air bushings). This is especially true where extreme or severe weather events generate tomadic activity, high straight-line winds, hail, flying projectiles or ice formation and heavy rains. Since GIS is very compact with a low center of gravity and much smaller reactive moments on the equipment, it is inherently better suited to withstand these types of extreme and severe weather situations. Since GIS is generally located within a fortified enclosure or building, the GIS and its associated local control cabinets (LCC's) can enjoy additional protection from extreme and severe weather events.
Pollution	GIS substations are inherently resistant to the effects of air pollutants and naturally occurring contaminants such as salt spray, acids, scales etc. Since all live parts and operating mechanism live parts are completely sealed and insulated by SF <sub>6</sub> gas, then there are no possibilities of these parts coming in contact with pollutants.
Corrosion	GIS substations are inherently corrosion resistant. Since the GIS is located within a climate-controlled enclosure or building, the probability of contamination and ultimately corrosion of equipment is significantly reduced. Additionally, GIS equipment is designed to be installed indoor or outdoor, so the design of the operating mechanisms, linkages, electrical connector, cables and seals are already corrosion resistant.
Availability	Based on Average Availability Factors calculated across the electric utility industry by GIS manufacturers and by IEEE, it is estimated that GIS has a 99.8% availability factor as compared to AIS having a 91.2% availability factor, over the predetermined life cycle of the equipment being 30 years.



George W. Becker, PE



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**Fact Sheet for Indoor Gas Insulated Substations (GIS)  
Safety/Security, Reliability and Maintenance Factors**

<b>Service Factor</b>	<b>Maintenance</b>
Maintainability	GIS substations are more easily maintained than AIS substations. This is because the preventive maintenance of GIS as compared to AIS does not require maintenance of “live parts” unless a significant short circuit event occurs. AIS equipment requires more frequent preventive maintenance of “live parts” as compared to GIS. This is because the AIS equipment is exposed to climate conditions, wildlife, pollution and corrosion.
Meantime of maintenance and maintenance cost	GIS substations require major maintenance of switching equipment only after a significant short circuit event occurs or after 50 years. AIS substations require major maintenance of switching equipment other than circuit breaker internal components every 6-8 years based on electric utility practices.
Mean time of maintenance or repair	GIS substations will require a longer time to maintain a specific component than AIS substations, but the extent of the outage will be less impactful. This is due to the fact that when AIS is maintained and/or repaired the electrical clearance areas in the substations are greater due to the required observation of “minimum approach distances” by personnel. It is entirely possible that an entire substation would have to be de-energized to repair a single switch in an AIS substation depending on the design.
Life Cycle Cost	Based on the fact that the average life of transmission and substation assets in North America is approximately 50 years, the Total Life Cycle Cost of GIS is less than AIS of the same electrical design. This is primarily due to the following factors: <ol style="list-style-type: none"> <li>1. Land acquisition costs are greater for AIS substations due to the greater overall area required, including required buffers, aesthetics and possible remediation concerns.</li> <li>2. Physical security of AIS is costlier as compared to GIS due to the requirement of much more extensive barriers, barrier heights and surveillance area.</li> <li>3. Scheduled maintenance of AIS occurs earlier and more frequently in the total Life Cycle of the substation than it does for GIS.</li> <li>4. Re-investment for the replacement of individual components of AIS due to wear, corrosion and exposure to environment occurs earlier and more frequently in the total Life Cycle of the AIS substation than it does for GIS.</li> </ol>



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F - 2  
New Butwal Substation General Arrangement

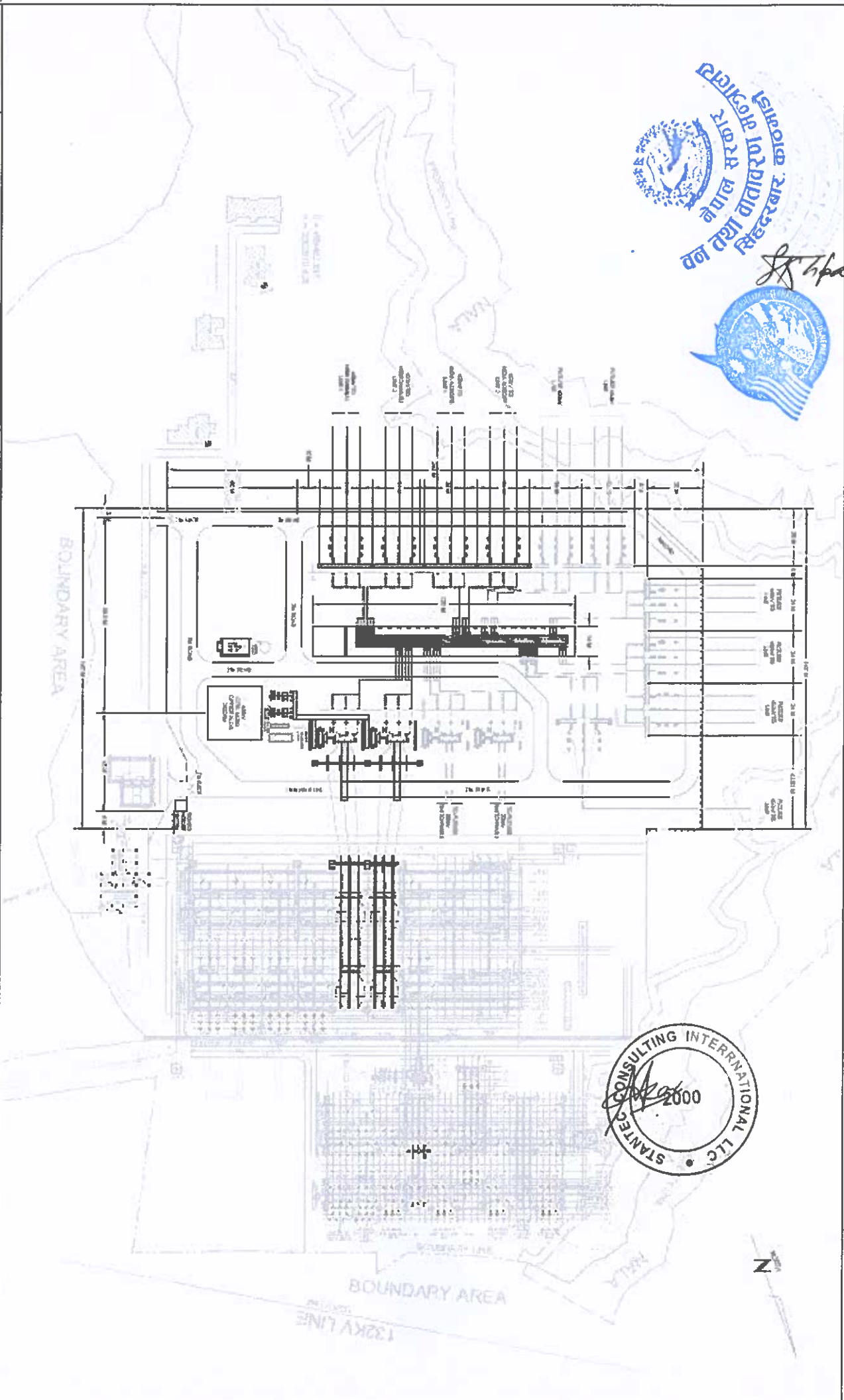




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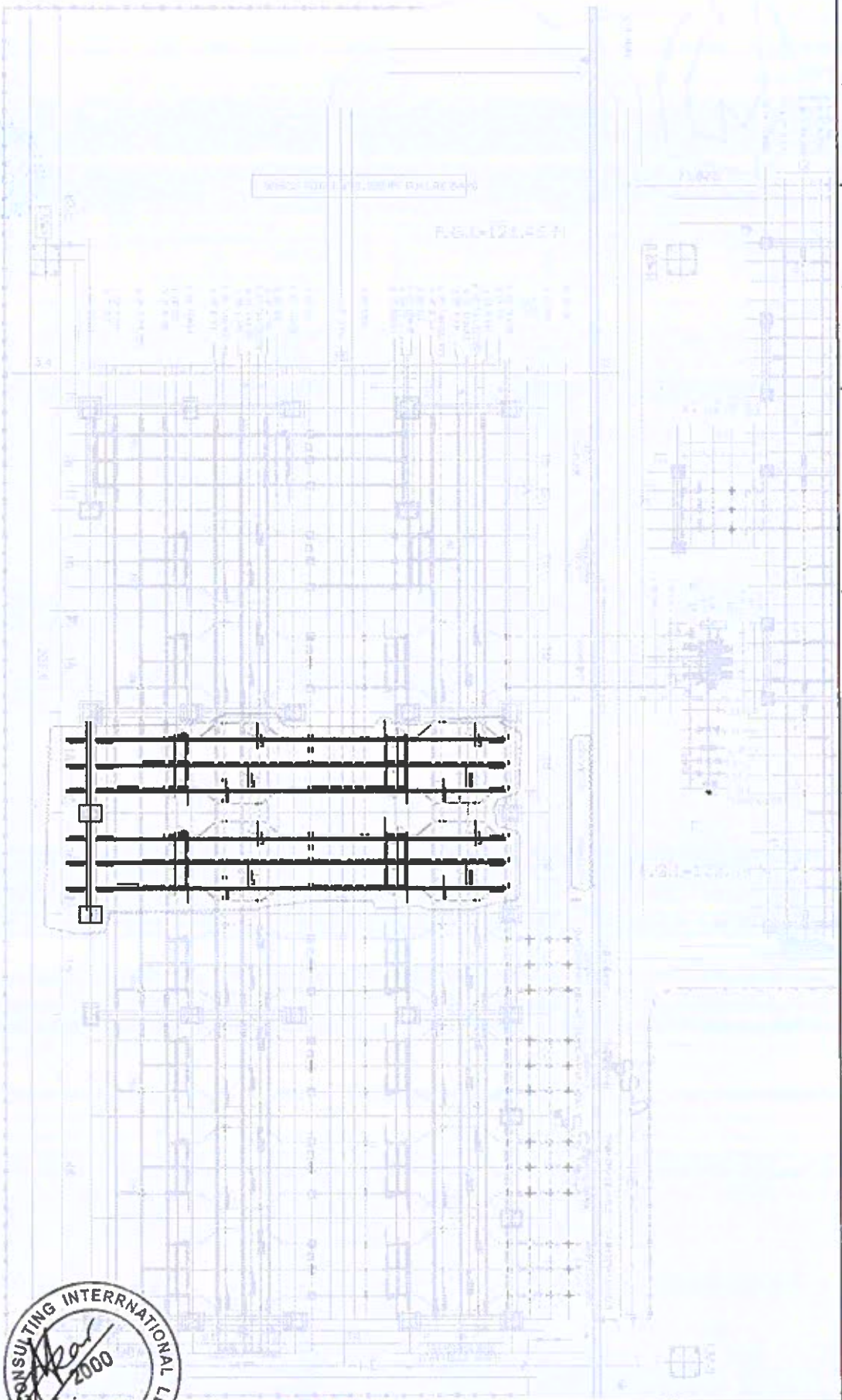
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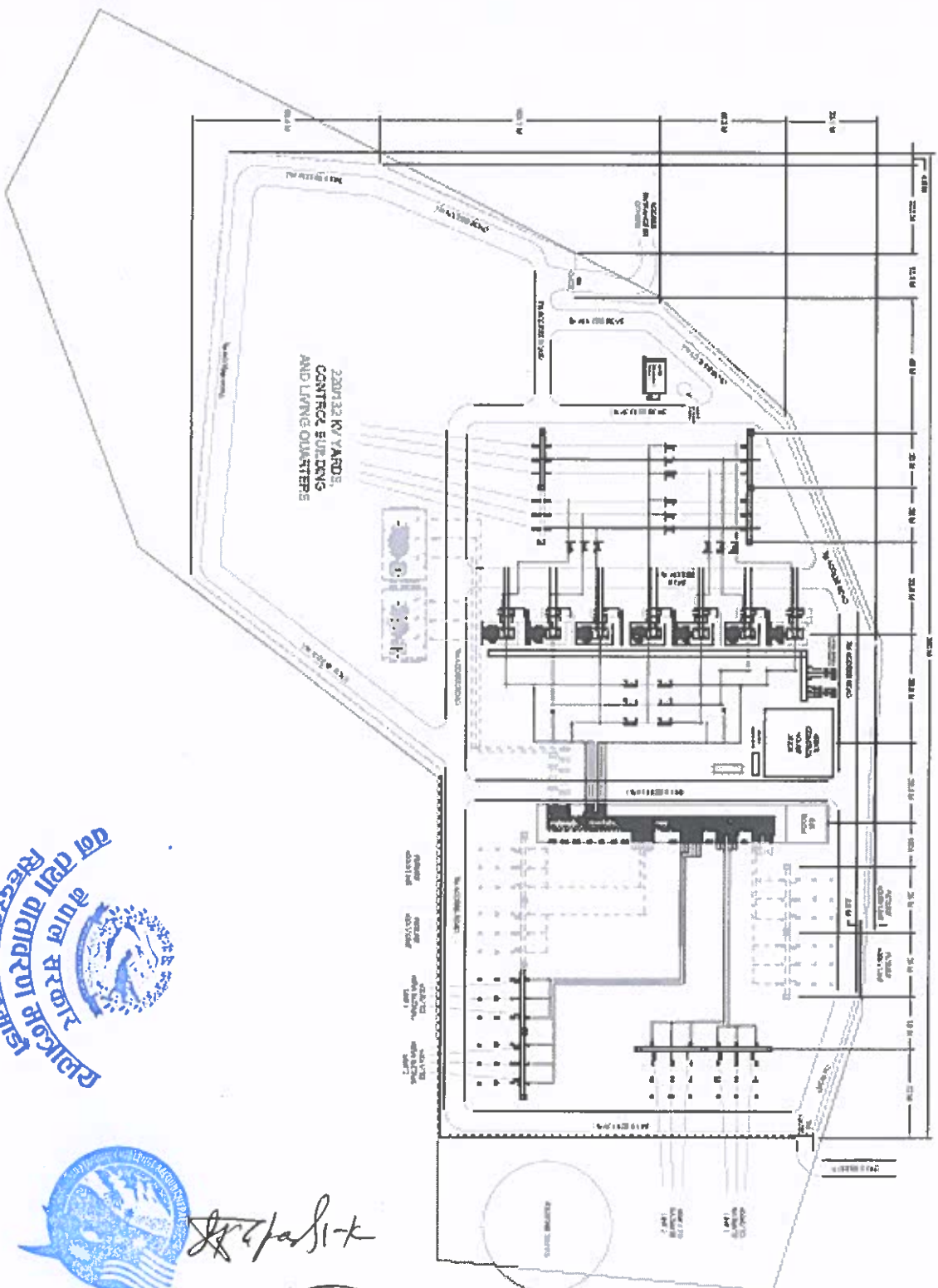
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F - 3  
New Damauli Substation General Arrangement







22x132 RY YARDS,  
CONTROL BUILDINGS  
AND LIVING QUARTERS

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सिद्धेश्वर, काठमाडौं  
राष्ट्रिय योजना आयोग



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NOT FOR  
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7-3-19

NO.	REVISION	DATE	BY	CHKD	APPD
1	ISSUED FOR PERMIT	17/03/19	...	...	...
2	...	...	...	...	...
3	...	...	...	...	...
4	...	...	...	...	...

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STANTEC CONSULTING SERVICES, INC.  
CONSULTING ENGINEERS  
NEW CHANGI AIRPORT/ DISASTION

NSM 201-1





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F - 4  
Ratmate Substation General Arrangement



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5-15-19

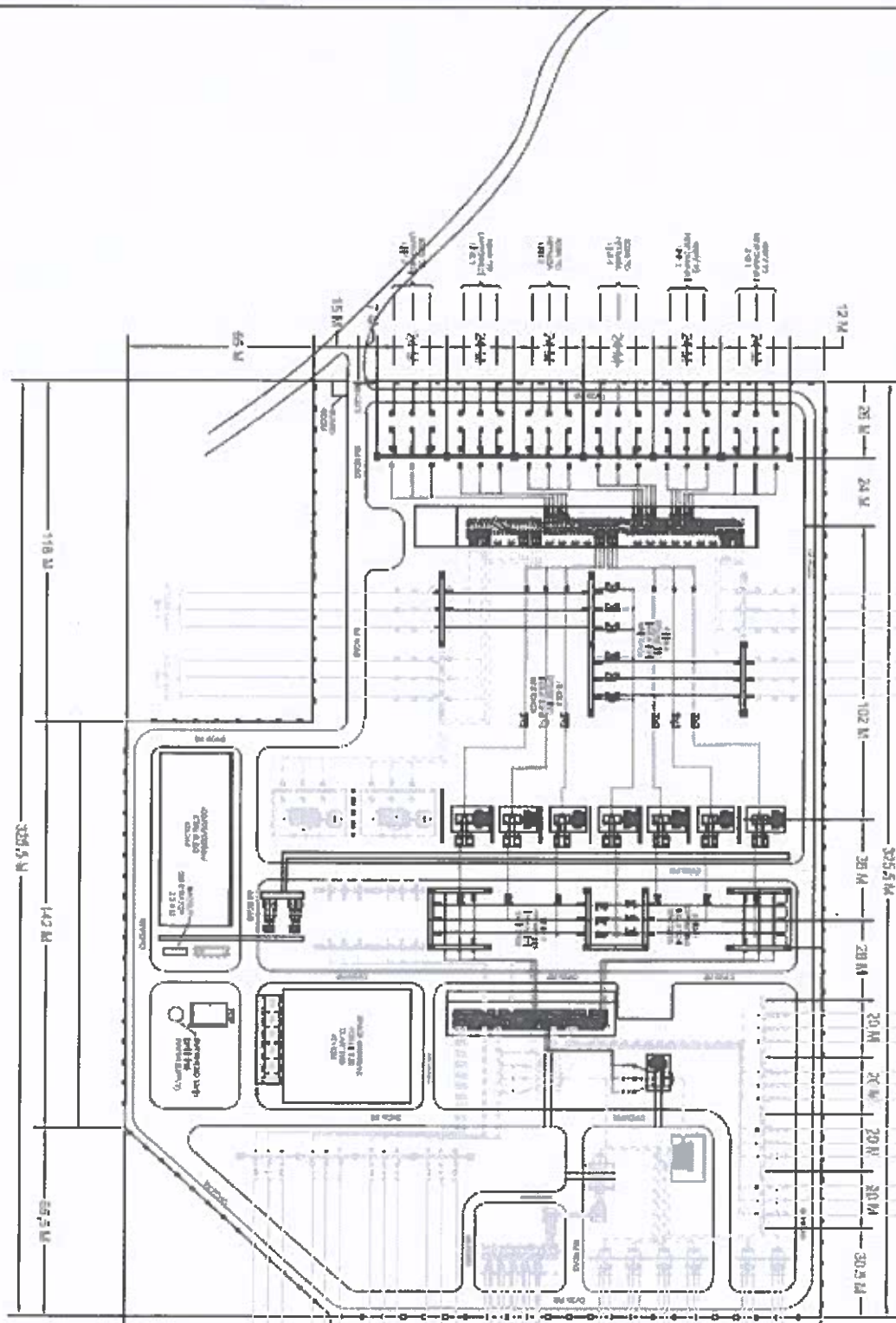
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1	REVISED FOR ROAD 212	5-15-19	A.T.	A.T.	W.A.D.
2	ADDITION OF TRUCK FLTS	5-15-19	A.T.	A.T.	W.A.D.
3	REVISED FOR APPROXIMATE	5-15-19	A.T.	A.T.	W.A.D.
4	REVISED FOR ROAD 212	5-15-19	A.T.	A.T.	W.A.D.

NO.	DESCRIPTION	DATE	BY	CHKD.	APPV.
5	REVISED FOR ROAD 212	5-15-19	A.T.	A.T.	W.A.D.



STANTEC CONSULTING GROUP INC.  
GENERAL ARCHITECT  
RUSTWATE ASSESSMENT SUBMITTAL PM

DATE: 05/15/19  
DRAWING NUMBER: RTE-200-1





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F - 5  
New Hetauda Substation General Arrangement





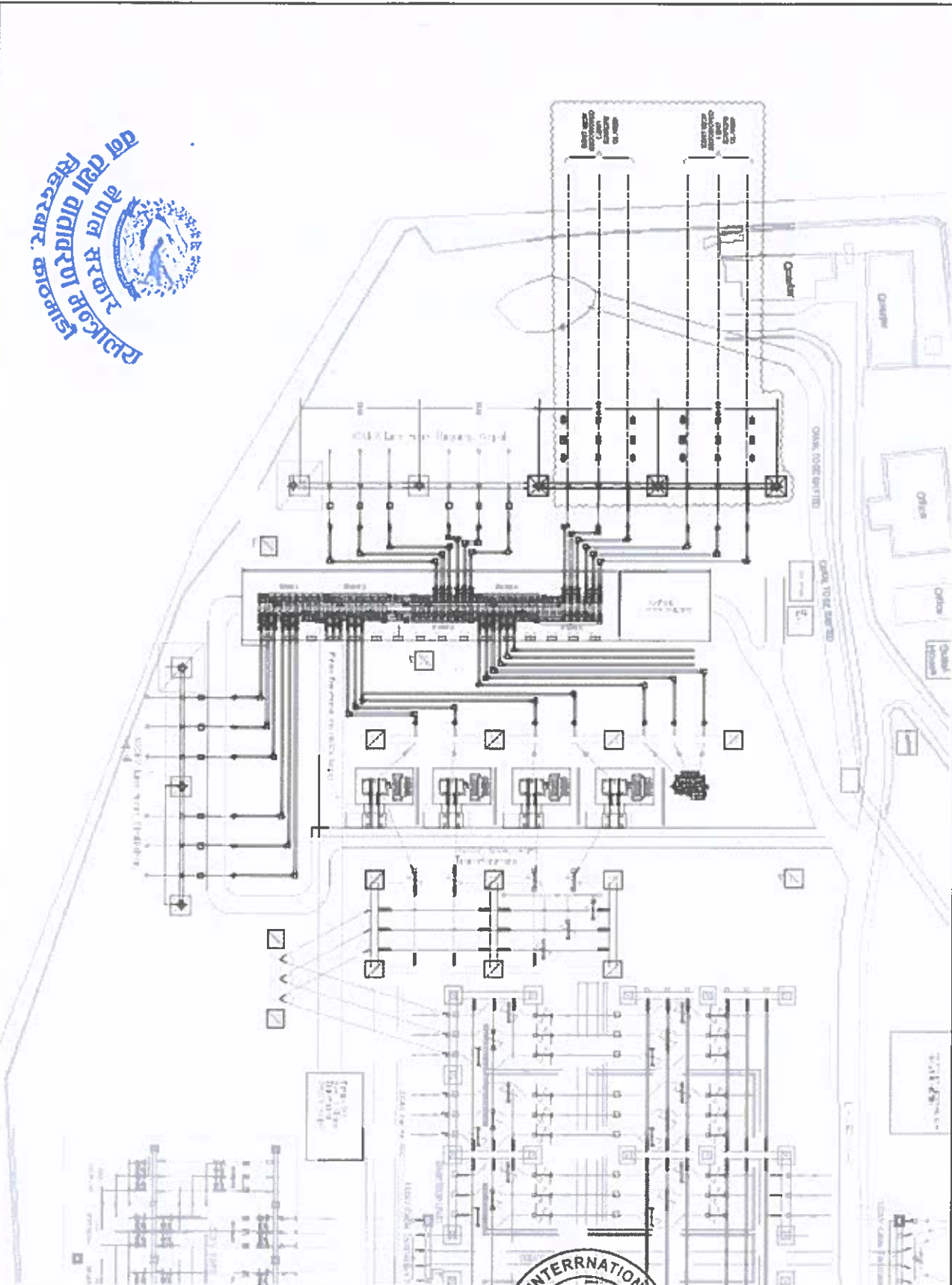
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सिद्धेश्वर, काठमाडौं

NOT FOR  
CONSTRUCTION  
7-3-19

NO.	REVISION	DATE	BY	CHKD	APPD
1	ISSUED FOR CONSTRUCTION	04.11.18	AL	AL	AL
2	ISSUED FOR CONSTRUCTION	04.11.18	AL	AL	AL

SCALE	1:1
DATE	11/03/19
PROJECT	100% & 50%

STATTEC CONSULTING SERVICES INC.  
GENERAL AGREEMENT  
NEW NEPALON AIRPORT GROUND STATION  
HEI-200-1



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F - 6  
Lapsiphedhi Substation General Arrangement







