NATIONAL REPORT PRESENTED BY THE UNITED MEXICAN STATES TO MEET THE REQUIREMENTS OF THE CONVENTION ON NUCLEAR SAFETY 2019-2021

August 2022

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ABBREVIATIONS AND DEFINITIONS

AC	Alternating Current
ACI	American Concrete Institute
ACM	Acoustic Circuit Model
ADS	Automatic Depressurization System
ADYR	Radioactive Waste Storage Facilities
ALARA	As Low As Reasonably Achievable
AMAC	Storage for Radioactively Contaminated Materials
AMP	Ageing Management Programs
AMR	Ageing Management Review
ANS	American Nuclear Society (ANS Standards)
ANSI	American National Standards Institute
APQO	Asia Pacific Quality Organisation
ASME	American Society of Mechanical Engineers
ASSET	Assessment of Safety Significance Events Team
ATS	On-site Temporary Storage
ATWS	Anticipated Transient Without Scram
AVS	Anti-Vibration System
BFF	Backwash Flow Filter
BOP	Balance of Plant
BRAC	BWR Radiation Assessment and Control
BTP	Branch Technical Position
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners Group
BWRVIP	Boiling Water Reactor Vessel and Internals Program
CAP	Corrective Action Programme
CAPG	Corrective Action Programme Group
CAQs	Conditions Adverse to Quality
CAS	Central Alarm Station
CAV	Cumulative Absolute Velocity
CENAPRED	National Centre for Prevention of Disasters
CFE	Federal Electricity Commission
CFR	Code of Federal Regulations
CLIMSS	Educational Platform of the Mexican Institute of Social Security - IMSS
CNSNS	National Commission for Nuclear Safety and Safeguards
Co	Cobalt
CONAGUA	National Water Commission
CONASUPO	Mexican state trader in agriculture
Constitution	Political Constitution of the United Mexican States

COPERE	External Radiological Emergency Planning Committee
COVID	Coronavirus Disease
CQAP	Construction Quality Assurance Plan
Cr	Chromium
Cs	Cesium
CST	Condensate Storage Tanks
DBE	Design Basis Earthquake
DC	Direct Current
DCV	DC voltage
DECON	Method of Decommissioning (Decontamination)
DEHC	Digital Electro Hydraulic Control
DG	Diesel Generator
DICONSA	Department of Food Distribution to Remote, Marginalized Areas
DID	Defence in Depth
DN-III	National Emergency Plan
ECCS	Emergency Core Cooling System
ECS	Emergency Coordinator on Site
EDMG	Extensive Damage Mitigation Guidelines
EHC	Electro Hydraulic Control
ELAP	Extended Loss of AC Power
EMA	Mexican Accreditation Authority
EMG	Emergency Management Guide
ENSREG	European Nuclear Safety Regulators Group
EOP	Emergency Operating Procedure
EPG	Emergency Procedure Guidelines
EPRI	Electric Power Research Institute
EPU	Extended Power Uprate
EQ	Environmental Qualification
EREP	External Radiological Emergency Plan
EREPC	External Radiological Emergency Plan Committee
ERO	Emergency Response Organization
ESAG	Emergency Severe Accident Guidelines
ESREG	European Nuclear Safety Regulators Group
FEIR	Final Environmental Impact Report
FIV	Flow Induced Vibration
FLEX	Diverse and Flexible Coping Strategies (Post-Fukushima Actions)
FORO	Hispanic Forum of Radiological and Nuclear Regulatory Bodies
FSAR	Final Safety Analysis Report
FUNDIBEQ	Ibero-American Foundation of Quality
FWCS	Feedwater Control System
GEAS	Generic Environmental Impact Statement

GEV	State Government of Veracruz
GPEA	Global Performance Excellence Award
HIC	High Integrity Container
HPA	Human Performance Analysis
I	Iodine
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IDR	Important Deficiency Report
IEEE	Institute of Electrical and Electronic Engineers
IEP	Internal Emergency Plan
IFT	Federal Institute of Telecommunications
IGSCC	Intergranular Stress Corrosion Cracking
IMS	Integral Management System
IMSS	Mexican Institute of Social Security
INEGI	National Institute of Statistics and Geography
INES	International Nuclear and Radiological Event Scale
INFCIRC	Information Circulars
INFOMEX	Mexican Federal Government web-based application to provide information to the public
ININ	National Institute for Nuclear Research
INPO	Institute of Nuclear Power Operations
IORC	Independent Operations Review Committee
IRRS	IAEA Integrated Regulatory Review Service
IRRT	IAEA International Regulatory Review Team
ISFSI	Independent Spent Fuel Storage Installation
ISI	In-Service Inspection
ISO	International Organization for Standardization
IVVI	In Vessel Visual Inspection
IWB	Requirements for ASME Code Section XI Class 1 Components
IWC	Requirements for ASME Code Section XI Class 2 Components
IWD	Requirements for ASME Code Section XI Class 3 Components
km	kilometre
kV	kilovolt
LED	Light Emitting Diodes
LER	Licencee Event Report
LOCA	Loss of Coolant Accident
LOOP	Loss of off-site Power
LPCS	Low Pressure Core Spray System
LTS	Leadership Team in Site
LVNPS	Laguna Verde Nuclear Power Station
MCC	Motor Control Center
MCP	Multipurpose Canisters

MCR	Main Control Room
MELCOR	Methods for Estimation of Leakages and Consequences of Releases
Mn	Manganese
MPH	Maximum Probable Hurricane
mR/h	Milli-Roentgen/hour
MSR	Moisture Separator Reheater
mSv	Milli Sievert
MWe	mega Watt electrical
MWt	mega Watt thermal
NACN	National Advisory Committee of Normalization
NCC	Nuclear Corporate Coordination
NCQI	National Commission of Quality Infrastructure
NEA	Nuclear Energy Agency
NEDO	General Electric Licencing Topical Report
NMX	Mexican Standard
NOM	Mexican Official Standard
NRE	Notification of Reportable Event
NSCI	Nuclear Safety Cooperation Instrument
NSCMP	Nuclear Safety Culture Monitoring Panel
NSSS	Nuclear Steam Supply System
NSW	Nuclear Service Water
Nuclear Law	Regulatory Law on Nuclear Matters of Article 27 of the Constitution
NUPIC	Nuclear Procurement Issues Committee
NUREG	USNRC Document Series
OBE	Operating Basis Earthquake
ODCM	Off-site Dose Calculation Manual
OECD	Organisation for Economic Co-Operation and Development
OHSAS	Occupational Health and Safety Assessment Series
OSART	Operational Safety Assessment Review Team
PASS	Post Accident Sampling System
PCB	Polychlorinated biphenyl
PCP	Process Control Programme
PEIA	Preliminary Environmental Impact Assessment Report
PEMEX	Mexican Oil Company
PGA	Peak Ground Acceleration
PhD	Doctoral Degree
PMH	Probable Maximum Hurricane
PMP	Probable Maximum Precipitation
PMSC	Panel for Monitoring Safety Culture
PRIS	Power Reactor Information System

PRODESEN	Development Programme of the National Electric System
PROFEPA	Federal Attorney for Environmental Protection
PSA	Probabilistic Safety Analysis
PSAR	Preliminary Safety Analysis Report
PSR	Periodic Safety Review
PSTG	Plant Specific Technical Guidelines
QA	Quality Assurance
QAP	Quality Assurance Programme
QMS	Quality Management System
RAI	Requests for Additional Information
RASCAL	Radiological Assessment System for Consequence Analysis
RCIC	Reactor Core Isolation Cooling
Rem	Roetgen Equivalent Man
RG	Regulatory Guidelines
RHR	Residual Heat Removal
RO	Reactor Operator
ROP	Reactor Oversight Process
RPS	Reactor Protection System
RPV	Reactor Pressure Vessel
RRC	Reactor Recirculation System
RTP	Rated Thermal Power
RWCU	Reactor Water Cleanup System
SAG	Severe Accident Guidelines
SAMG	Severe Accident Management Guidelines
SARCoN	Systematic Assessment of the Regulatory Competence Needs
SARS-CoV2	Severe Acute Respiratory Syndrome - Coronavirus 2
SAST	Workplace Health and Safety Administration System
SAT	Systematic Approach to Training
SAWA	Severe Accident Water Addition
SAWM	Severe Accident Water Management
SBO	Station Black Out
SC	Safety Culture
SCAMB	Safety Culture Ambassadors
SCART	Safety Culture Assessment Review Team
SCCIP	Safety Culture Continuous Improvement Process
SCRAM	Sudden Control Rod Action Movement
SCT	Secretariat of Communications and Transport
SDH	Standard Design Hurricane
SDP	Significance Determination Process
SED	Safety Engineering Department
SEDENA	Secretariat of National Defence

SEMARNAT	Secretariat of Environment and Natural Resources
SENEAM	Mexican Airspace Navigation Services
SENER	Secretariat of Energy
SESVER	Secretariat of Health – Government of Veracruz
SETECO	Technical Secretary of EREPC
SFP	Spent Fuel Pool
SHCP	Secretariat of Finance and Public Credit
SM-AR	Secretariat of Mexican Navy - Army
SORC	Site Operations Review Committee
SPC	Secretariat of Civil Protection
SPDS	Safety Parameter Display System
SRCM	Storage for Radioactive Contaminated Materials
SRI	Statement of Regulatory Impact
SRNM	Startup/Intermediate Range Neutron Monitoring
SRO	Senior Reactor Operator
SRV	Safety Relief Valve
SS	Secretariat of Health
SSC	Structures, Systems and Components
SSE	Safe-Shutdown Earthquake
SSEFPS	Safe Shutdown Earthquake Fire Protection System
STPS	Secretariat of Labor and Social Welfare
Sv	Sievert
TEDE	Total Effective Dose Equivalent
TEVA	Evaluation Card for Performance Operators
THCNS	Traits of a Healthy Culture of Nuclear Safety
TLAA	Time Limited Ageing Analysis
TLD	Thermo Luminescent Dosimeter
TMI	Three Mile Island
TMVB	Trans Mexican Volcanic Belt
TOMO	Observation Card for Operation Manoeuvres
TS	Temporary Storage
TS	Technical Specifications (Standard Technical Specifications)
TÜV	TÜV Anlagentechnik Gmbh
U1	Unit 1
U2	Unit 2
UMU	Units of Measurement and Updating
UNAM	National Autonomous University of Mexico
USA	United States of America
USNRC	United States Nuclear Regulatory Commission
UTM	Universal Transverse Mercator
WANO	World Association of Nuclear Operators

WENRA	Western European Nuclear Regulators Association
Zn	Zinc

INTRODUCTION

PREPARATION AND SCOPE OF THE NATIONAL REPORT

National policy for nuclear activities

National policy regarding nuclear activities is embodied in The Regulatory Law of the Constitutional Article 27 on Nuclear Matters (hereinafter called “Nuclear Law”). The principle of this Nuclear Law is that nuclear energy must be used only for peaceful applications and that nuclear and radiation safety, and physical security receive the highest priority for all activities, including: siting, design, construction, operation, modification, definitive shutdown and decommissioning of the facility.

Nuclear programme of the United Mexican States

The Federal Electricity Commission (hereinafter called “CFE”) is the operator and authorization holder of the Laguna Verde Nuclear Power Station (LVNPS) Units 1 and 2. At the cutoff date of this National Report, LVNPS is authorised to operate up to 2,317 MWt, which is 120% of the originally licenced rated thermal power (RTP) of 1,931 MWt.

In March 2015, the CFE requested for LVNPS the renewal of operating authorizations for an additional 30 years from the expiration dates of the authorizations it held. On July 24, 2020, the Ministry of Energy (SENER), based on the favorable technical opinion of the National Nuclear Safety and Safeguards Commission (CNSNS), granted the renewal of Unit 1, so it currently operates with an Extended Period that expires until July 2050. Regarding Unit 2, its operation renewal is still in the process of regulatory evaluation.

Preparation, structure and main characteristics of the National Report

In accordance with Article 5 of the IAEA Nuclear Safety Convention, this document summarizes the measures taken from January 1, 2019 to December 31, 2021, in relation to LVNPS Units 1 and 2; the only existing nuclear installation in the United Mexican States (hereinafter indistinctly called “Mexico”) as far as the IAEA Nuclear Safety Convention is concerned. A description of LVNPS’s main characteristics is presented in Table 6.1 in Article 6.

This report is self-contained and organised according to the structure of the 19 Articles of the Convention. The report was prepared upon request of the Secretariat of Energy by the National Commission for Nuclear Safety and Safeguards (hereinafter called

"CNSNS"), the Mexican regulatory body in nuclear matters, as coordinator, and the Nuclear Corporate Coordination of CFE, responsible for the safe operation of LVNPS.

Declaration of the Contracting Party to the Convention, including a summary of the principal safety issues included in the National Report

The government of Mexico fully recognizes, through this report and its annexes, the commitment to continue pursuing all the fundamental principles of nuclear and radiation safety, and security in the Mexican nuclear facilities, in order to maintain and increase their safety level.

The most important safety issues in this report are presented in the following articles:

Article 6 describes the main features of the existing nuclear plant in Mexico. Safety-related issues are discussed, including the events that occurred in the past three years, as well as the projects and measures planned for continuing to improve safety. Also an outline of the Post-Fukushima actions is made.

Article 7 describes the primary and secondary legislative framework related to nuclear safety, the licencing processes, evaluation, inspection and enforcement during the period covered by this report. The changes in international treaties, bilateral agreements and official Mexican standards are presented in this article's annexes.

Article 8 presents the legal foundations and statutes of CNSNS, the development and maintenance of its finances, and the means it takes to develop and maintain the competence of human resources, the quality control system, as well as the organisation, position, and level of independence of CNSNS within the governmental structure.

Article 9 describes the legal responsibilities of LVNPS's licence holder with respect to safety and the mechanisms CNSNS has to ensure the licence holder meets that responsibility. The article also describes the mechanisms through which the licence holder maintains open and transparent communication with the public.

Article 10 describes the agreements and regulatory requirements implemented by the licence holder to prioritise safety, such as safety culture programmes, including safety management, self-assessment and international agreements for independent safety evaluations, as well as quality management programmes.

Article 11 presents the financial situation of LVNPS's licence holder in order to guarantee the nuclear facility's safety during operation, decommissioning, and management of spent fuel and radioactive waste from the nuclear facility. The agreements and standards established by CNSNS for regulating the education, training and retraining of employees and contractors are also described.

Article 12 discusses human factors in the design of the nuclear facilities and subsequent modifications. The concept of a “blackboard” is maintained in both LVNPS control rooms, as well as the implementation and adherence to a human performance programme for preventing errors.
Article 13 describes the quality assurance programmes and the quality management systems of LVNPS’s licence holder. Additionally, the regulatory review and control activities performed by CNSNS are described.

Article 13 describes the LVNPS quality assurance programs and quality management systems of the Authorisation Holder. Additionally, the regulatory review and control activities carried out by the CNSNS are described.

Article 14 describes the regulatory provisions and requirements for integral and systematic safety evaluations, including their results, as well as those for verifying safety. Also noted is that the conclusion of the Extended Power Uprate (EPU) regulatory assessment up to 120% thermal power, so the final authorisation was granted. The evaluation of the application for the Renewal of Operating Authorisations and the associated Aging Management Programs is described. A description, in matrix form, of the regulatory inspection programme is included. Also, the Post-Fukushima evaluations are described.

Article 15 covers LVNPS’s authorisation holder’s processes for reducing radiation exposure and for applying the ALARA (As Low As Reasonably Achievable) Principle in all operation and maintenance activities, as well as to the release of radioactive material to the environment. Also, CNSNS’s regulatory review and control activities are described.

Article 16 describes the agreements and regulatory requirements relative for emergency preparedness inside and outside the site, as well as the main elements of the national emergency preparedness plan, including the responsibilities of the regulatory body and other government agencies. In addition, improvements in emergency preparedness and response are presented as a result of the Fukushima event.

Article 17 covers the regulatory provisions and requirements relative to the location and evaluation of nuclear plants, the impact of the plants on the people, the community and the environment, as well as the regulatory reviews to verify compliance with the requirements. Additionally, the re-evaluations made due to the Fukushima event are described.

Article 18 describes the agreements and standards of the Contracting Party concerning the design and construction of nuclear facilities, the implementation of design measures (plant modification and remodelling) including modifications and improvements implemented as a result of LVNPS’s EPU to 120%. Also, the status of the Post-Fukushima actions is presented.

Article 19 describes the regulatory provisions and requirements of the United Mexican States that define the safety limits and establish the operational conditions and limits; the general availability of the engineering and technical support necessary in all safety-related areas of the nuclear installations during construction, operations or cease of operation; the regulatory provisions and requirements of the Contracting Party over the licence holders to collect, analyse and share the operational experience; and finally, the regulatory provisions and requirements of the Contracting Party to manage the on-site spent fuel and radioactive waste.

The conclusion, based on the existing objective evidence, is that Laguna Verde Nuclear Power Station continues to maintain a level of safety similar to nuclear facilities of the same type located in countries with more nuclear experience. Currently, there do not exist any conditions that can be identified as adverse to safe operation, and thus it is not anticipated that the plant will be shut down before the end of its authorized period.

In the opinion of the United Mexican States, it is concluded the commitments of the Convention on Nuclear Safety are fulfilled.

Information to the public

This National Report, like previous reports corresponding to the 1st, 2nd, 3rd, 4th, 5th, 6th, 7th and 8th Review Meetings of the Nuclear Safety Convention, as well as the questions made by the Contracting Parties and the answers provided to them, are public documents in compliance with the Mexican "Federal Law of Transparency and Access to Public Information " and the “General Law of Transparency and Access Information to Public Information”, both with last amendment on May 20, 2021, as well as the recommendations from the Convention contained in the document INFCIRC/572/Rev. 6, dated January 19, 2018.

The National Reports for the Nuclear Safety Convention can be downloaded from CNSNS website (www.gob.mx/cnsns) by following the next link:

https://www.gob.mx/cnsns/documentos/convencion-sobre-seguridad-nuclear

SUMMARY

This document is the ninth National Report of the United Mexican States (hereinafter called “Mexico”) for the Convention on Nuclear Safety. This report addresses Laguna Verde Nuclear Power Station (LVNPS) safety issues and the activities of the Mexican regulatory body, the National Commission for Nuclear Safety and Safeguards (hereinafter called “CNSNS”). It describes how the Mexican government achieves and maintains a high level of nuclear safety through the steps it has taken and is taking at its nuclear installations, supporting international cooperation and complying with all the obligations set by the Convention on Nuclear Safety.

The conclusion from the information presented in this National Report is that both LVNPS units continue to maintain a safety performance level similar to other nuclear plants operating in countries with more nuclear experience. Currently there are no identified conditions that might adversely affect safe operation; therefore, there are no plans to prematurely shut down the installation before the end of its authorized lifetime.

Finally, it is concluded that Mexico has the laws, regulations and means for appropriate inspection and supervision by CNSNS, an independent regulatory body, which ensures that LVNPS operation does not present an undue risk to public health and safety, nor to the environment.

– **Important safety issues that have been identified in or emerged from previous National Reports**

- In relation to the event that occurred at the Fukushima Daiichi plant in Japan on March 11, 2011, Articles 6, 14, 16, 17, and 18 describe how these issues are being addressed by the regulatory body as well as by the Federal Electricity Commission (CFE), the authorisation holder for LVNPS. This information indicates that LVNPS’s site and structures as well as the Mexican organisations are taking the pertinent actions to confront the effects of an event like the one at Fukushima Daiichi.
- Currently, as stated in the Internal Regulations of the Secretariat of Energy (SENER), in Chapter XII, Article 42, fraction XX, issued on October 31, 2014 in the National Gazette, The Secretariat of Energy has delegated to the CNSNS General Director the authority to grant the Authorisations for siting, design, construction, operation, modification, definitive shutdown and decommissioning of nuclear installations. Therefore, and as described in detail in Article 8 (2), although CNSNS is not administratively independent of the organisations responsible for promoting nuclear technology, it behaves with total technical independence.
- In relation to LVPNS’s Extended Power Uprate (EPU) project, regulatory assessment concluded on June 2018, so CNSNS grante two authorisations to

the Federal Commission of Electricity to operate both units LVNPS up to 2317 MWt, maintaining the original expiration dates written stated in the initial licences. The most important issue was the structural integrity of the reactor steam dryer against acoustic loads, which required the installation of reinforcements on this component for both units.

- In June 19, 2019, CNSNS granted the Operating Authorization for the Independent Spent Fuel Storage Installation (ISFSI), which is valid for 40 years. To date, two transfers, called "campaigns"; of fuel, containers from the CNLV Buildings to the ISFSI storage facility have already taken place.
- On July 24, 2020, the Ministry of Energy (SENER), based on the favorable technical opinion of the CNSNS, granted the CFE the Renewal of the Operating Authorization of LVNPS 1 Unit, for an additional period of 30 years, so it currently operates with an Extended Period that expires until July 2050.

– **Future safety related activities and proposed or planned programmes for the period until the next National Report**

- Post-Fukushima actions: The actions planned by CFE for LVNPS will finish in 2023. These actions are the following: Compliance with 10 CFR 50.54(hh)(2), Orders EA-12-049, EA-13-109 and EA 12-051 from USNRC and compliance with Stress test from the FORO (Hispanic Forum of Radiological and Nuclear Regulatory Bodies).
- As indicated in previous paragraphs, SENER granted the Renewal of the LVNPS Operating Authorization, with an expiration date of July 2050. Regarding Unit 2, its Operation Authorization is still in force, so before its expiration date SENER will issue its resolution on the renewal request.

– **Contracting Party’s responses to the results of previous peer reviews, specifically to the suggestions and challenges related to the National Report, as well as any announcement or voluntarily accepted action at previous review meetings**

On the occasion of the 7th Review Meeting of the Convention on Nuclear Safety, Mexico provides the following response:

Challenge 1: Changes to Mexico's regulatory structure to support the licensing and construction of proposed three new nuclear power plants:

- In 2018, the head of the Secretariat of Energy (hereinafter called “SENER”) presented the document “Development Programme of the National Electric System” for the period 2018-2032. This document indicates three new nuclear power units.

- However, at the end of 2019, the SENER updated this document and no new nuclear power units are being planned for the period 2019-2033.

Challenge 2: The establishment of a legislative framework to provide independence between the regulator and the Secretariat of Energy:

- The Secretariat of Energy is empowered to grant authorizations for siting, design, construction, operation, etc. These responsibilities have been delegated to the CNSNS.
- Although the CNSNS is not administratively independent of the organizations responsible for promoting nuclear technology, CNSNS is hierarchically subordinate to this Secretariat and has technical and operational autonomy, as well as executive powers to decide on nuclear matters.
- Furthermore, in June 2018, CNSNS was recognized as a National Safety Instance, so this fact gives more authority to CNSNS Anyway, it is recognized its needed a greater progress to be a complete autonomous body (De Jure).

Challenge 3: The establishment of an adequate level of qualified personnel consistent with the workload, such as LVNPS's license renewal and possible new license applications. Noting that Government has a policy not to increase staff numbers which also applies to the regulatory body:

- Workforce: LVNPS increased the amounts of permanent employees from 1124 (as of February 2016) to 1400 (as of January 2019).

- The CNSNS has sufficient personnel to carry out all its functions.

Challenge 4: The National Commission for Nuclear Safety and Safeguards (CNSNS) raised the need to start a project for directing the control and assessment activities regarding safety culture, and human and organizational factors. However, it was not possible to start this project due to workload associated with the extended power uprate project:

- Despite of the workload, currently CNSNS has in progress a project on Safety Culture. During 2017 and 2019 two workshops were held for the regulatory personnel. It is expected to have a CNSNS self-evaluation in 2021 and the first LVNPS inspection for Safety Culture in the year 2022.

Challenge 5: LVNPS had expected to conclude the extended power uprate project for both units in 2010, however, the completion had been postponed to 2014 due to technical challenges:

- The results of the regulatory evaluations and inspections were concluded and documented by CNSNS in a Safety Evaluation Report that contains a favorable opinion, and finally in June 19, 2018 CFE received from CNSNS two new authorizations to operate LVNPS both units to a maximum power of 2317 MWt, maintaining the original expiration dates: Unit 1: July 24, 2020 Unit 2: April 10, 2025.

Challenge 6: The regulatory body should strengthen the regulatory framework related to nuclear installations.

- Safety objectives for Nuclear Power reactors were reviewed to include Vienna declaration principles. The draft of the General Rules on Nuclear Safety for Nuclear Installations was concluded the year 2019 and currently the draft is being reviewed in preparation to present the draft regulation for public review.

Suggestion 1: Mexico should consider becoming a Contracting Party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

- Mexico signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management on February 2, 2018 and entry into force in May 17, 2018. In addition Mexico presented its first National Report on October 2020.

Suggestion 2: The regulatory body should make a further attempt to convince the government concerning the need for independence. A message from Convention on Nuclear Safety regarding independence can be conveyed to the government.

- CNSNS has made some proposals to have more independence but they have not progressed; however, again emphasized what was described in the response to Challenge 2.

Suggestion 3: It is necessary to continue with use of the knowledge management system in light of resource constraints.

- CNSNS developed a Knowledge Management Strategy with the collaboration of experts of the European Commission under the Nuclear Safety Cooperation Instrument (NSCI) project, but the Knowledge Management Plan is still waiting to be developed. In this Plan will be described the methods to identify the medium and long-term risks of loss of knowledge, as well as how to mitigate these potential losses.

Suggestion 4: The regulatory body needs to implement the Severe Accident Management Guidelines (SAMG) by 2018.

- The Laguna Verde operator (CFE) has developed the Severe Accidents Management Guidelines (SAMG) based on the guidelines for the Emergency Procedure Guidelines / Severe Accident Guidelines EPG / SAG Rev. 3 of the BWR Owners Group. CNSNS is following up within the Post-Fukushima Actions. This will be evaluated within the drills of emergency plans.

– **Measures and strategies adopted by the Contracting Party to address the COVID-19 pandemic and to ensure the continued safe operation of nuclear facilities.**

On March 30, 2020, the General Health Council published in the Official Gazette of Mexican Federation the Agreement declaring the epidemic of disease generated by the SARS-CoV2 virus (COVID-19) as a sanitary emergency due to force majeure, stating that the Ministry of Health would determine all actions that may be necessary to address such emergency.

On March 31, 2020, Mexico's Ministry of Health published in the Official Gazette of Mexican Federation, the Agreement establishing extraordinary actions to address the health emergency generated by the SARS-CoV-2 virus, by means of which it ordered the immediate suspension of non-essential activities as of March 30, 2020. In this agreement, the essential activities were specified; specifically, the First Article, Point II e) indicates that they are:

> *Those necessary for the conservation, maintenance and repair of the critical infrastructure that ensures the production and distribution of indispensable services, namely: potable water, electric power, gas, oil, gasoline, turbo fuel, basic sanitation, public transportation, hospital and medical infrastructure, among others that could be listed in this category.*

Given the possibility of the occurrence of a seismic event during the present COVID-19 pandemic, the National Center for Disaster Prevention considers that additional emergencies may occur, so it called on the population to add to the measures already established for earthquakes, the recommendations of distance and the use of mouth covers.

- Regulatory body

  At CNSNS, through a combined home and office-based work scheme, it continued to carry out its regulatory activities of evaluation, authorisation, surveillance and enforcement at the country's nuclear facilities. Although there were several cases of staff infections, work programs and activities suffered minimal disruptions or delays.

- Nuclear facility operator

Within the strategies adopted in the management of acute respiratory diseases related to COVID-19 to confront and mitigate the pandemic caused by SARS-CoV-2, the CNLV established the guidelines described in the Official Gazette of Federation, for which the following points apply, according to specific and general objectives in the case of a large industrial company and the number of personnel in charge, depending on their area and/or department:

1. Health promotion, including constant training, orientation and organization of the workers of LVNPS, granting:

   a) General information on SARS-CoV-2 (COVID-19), the mechanisms of transmission, symptoms it causes, and the best ways to prevent infection and break the chain of transmission to others.

   b) Raise awareness among workers to avoid social gatherings inside and outside the workplace, since it is a precursor to virus transmission.

   c) The importance of not coming to work with symptoms compatible with COVID-19, so as not to be a risk of potential contagion to other people.

   d) Monitoring via remote monitoring of personnel considered as a suspected case of COVID-19, or as a confirmed case, complying with strict isolation for 7 days stipulated in the latest update of the Standardized Guidelines for Epidemiological and Laboratory Surveillance of Viral Respiratory Disease, published on January 12, 2022 by the Secretary of Health of the Government of Mexico.

   e) All personnel working at the Nuclear Corporate Coordination Office are informed of the telephone number of the medical service for the constant monitoring of respiratory symptoms and knowledge of their health status, on a daily basis.

   f) Monitoring of constant hand washing with soap and water or use of 70% alcohol gel solutions.

   g) Insistence on the practice of respiratory etiquette.

   h) Constant disinfection of surfaces and objects of common use in offices, closed places, transportation, meeting centers, among others.

i) Requirement of healthy distance during contacts, meetings, meal times and remembering the importance of the use of personal protective equipment (strict use of mouth covers) at all times.

2. Healt protection.

   a) Safe distance at all times, with delimited and marked spaces at a distance of 1.5 meters, at times of mass entry and exit of personnel.
   b) In confined spaces or meeting rooms, the maximum capacity of persons is delimited and seating is provided maintaining an adequate healthy distance.
   c) Ensure the permanent availability of drinking water, soap, toilet paper, alcohol-based gel and disposable towels for drying hands.
   d) Increase the number of vehicles for personnel, in order to reduce overcrowding and the possibility of contagion.

3. Adherence to Health Protection protocols against COVID-19:

   a) Compliance with the Technical Guidelines for Health Safety in the Work Environment, referred to in the Agreement of the Ministry of Health published in the Official Gazette of the Federation on May 29, 2020, by obtaining the health safety label for a safe return according to the new normality, as a reopening of economic activities.
   b) Accreditation of the course "Training of Monitors for Healthy Return" in the CLIMSS (Educational Platform of the Mexican Institute of Social Security - IMSS), developing the Health Safety Protocol as a strategy to combat the pandemic of COVID-19.
   c) Registration of the Nuclear Corporate Coordination in the New Normality platform of the Ministry of Health of the Government of Mexico.
   d) Obtaining the QR Code for the new normality issued by the Ministry of Health of the State of Veracruz, a provision agreed upon by the Technical Health Committee and the State Health Council (COESA).

As described above, the number of SARS-CoV-2 (COVID-19) infections among the workers of the CNLV's Corporate Nuclear Coordination Unit has been contained in order to ensure the safe and continuous operation of the nuclear facilities.

- **Significant changes in the Contracting Party's nuclear energy and regulatory programmes, as well as any measures adopted to meet the Convention's obligations**

In Mexico there are no significant changes in the regulatory programs, as IAEA's regulations already apply, as well as the rules of the country of origin of LVNPS's nuclear steam supply system. However, these have been complemented with a series of official Mexican standards that are described in Annexes 7.3 and 7.4 of this National Report.

Regarding a possible change in the nuclear energy programmes, the Introduction of this report mentioned that the document called "Development Programme of the National Electric System" or PRODESEN (abbreviation in Spanish) for the period 2018-2032, contemplated three new energy units by nuclear means; however, its update for the period 2021-2035, no longer considers them.

- **Response to the IAEA Generic Safety Observations Report, if provided and if relevant to the particular national situation**

As described in the prior paragraphs, Mexico has:

- Addressed the issues suggested at the Organisation Meetings,
- Responded to the questions presented by other Contracting Parties, and
- Taken action to address the recommendations made at the Review Meetings.

- **Description of policies, plans, and programmes for accepting and following up on feedback from international peer reviews**

The policy of Mexico has been, is, and will always continue to be to welcome the international peer reviews and address their recommendations. This has been made clear in the Secretariat of Energy, the Federal Electricity Commission (operator and licence holder of LVNPS), and the National Commission for Nuclear Safety and Safeguards (the sole regulatory body for nuclear matters).

Mexico has received some international peer reviews and would welcome this type of missions. WANO's latest evaluation of CNLV was held in October 2020.

- **Results of the international peer and IAEA missions to the Contracting Party during the review period; progress made in the implementation of the findings; and plans for follow-up**

  As described in Articles 8 and 11, the regulatory body as well as LVNPS's licence holder have received international reviews and have addressed or are in the process of addressing their observations and recommendations.

- **Measures taken by the Contracting Party to voluntarily share the international peer reviews with the public**

  Mexico's National Reports are available for anyone to download from CNSNS's website (https://www.gob.mx/cnsns/documentos/convencion-sobre-seguridad-nuclear).

- **Incorporating operational experience, lessons learned, and corrective actions taken in response to accidents and events that were significant to the safety of the nuclear installations**

  Derived from the Fukushima-Daiichi event, CNSNS has taken various actions to review LVNPS's actual ability to confront a beyond-design-basis event. Among the actions taken that can be mentioned are:

  - LVNPS has been required to comply with the regulatory requirements issued by the USNRC.
  - CNSNS has required LVNPS to carry out stress test, similar to those required by European regulators.
  - CNSNS has performed various special inspections and has participated in international meetings to exchange operational experience with other countries.

  Thus, it is concluded that the strategies that have been or are in the process of being implemented will contribute to improve LVNPS safety, by increasing Structures, Systems and Components reliability to face beyond-design-basis events like the one occurred at Fukushima-Daiichi and to avoid, as far as possible, damage to the nuclear reactor, thereby protecting the health of the people and environment.

- **Incorporating the lessons learned from emergency drills**

  Internal Emergency Plan (IEP):

  i. The design and implementation of the IEP's health indicators have identified aspects that require attention, generating action plans to improve the key elements of the plan.

ii. The inclusion of critical tasks to training process and to drills has generated observations based on performance and training plans to correct deficiencies.

iii. The process of acquiring materials during an emergency has been distributed to the appropriate personnel and has contributed to strengthening the administration’s perception of the IEP and the importance of its related activities.

iv. The implementation of a replica of the Technical Support Centre in the simulator has increased the realism of simulations, permitting direct interaction with dynamic parameters displayed in the Safety Parameter Display System (SPDS).

External Radiological Emergency Plan (EREP):

During the inspections to the EREP, it has been observed rotation of a significant number of personnel belonging to Task Forces. This is caused by personnel retirement and changes at the state and federal government and the departure of the Ministry of the Interior from the PERE, whose attributions were given to the Ministry of Security and Civil Protection. Therefore, it is necessary to reinforce and systematize the training programs of EREP, as well as the review and modification of the plan's procedures in order to avoid reducing the efficiency of the response in case of a General Emergency at LVNPS.

– **Incorporating the actions taken to improve transparency and communication with the public**

The Mexican laws: “Federal Law for Transparency and Access to Public Information” “Transparency and Access to Public Governmental Information” and the “General Law for Transparency and Access to Public Information” provides guidelines for the classification of governmental information as public, reserved, or confidential. The federal government has the INFOMEX system, through which CNSNS and LVNPS have continued to provide information to the public when requested. This has been done without discrimination, in a transparent and open form.

– **Response to the recommendations adopted at the plenary sessions of the previous review meeting of the Contracting Parties**

The current and preceding National Reports contains the actions that Mexico has adopted and implemented to address the recommendations from the Review Meetings of the Contracting Parties to the Convention on Nuclear Safety.

– Attention to the recommendations of the 7th Review Meeting

Recommendations arisen from the 7th Review Meeting of Convention on Nuclear Safety to be address at the National Report. Document CSN/7RM/2017/08/Final of 7 April 2017.

Topic	Developed in Article or Section
Safety Culture	10
International Peer Reviews	Sections 7(2)(ii), 8(2) and at the Article 10
Legal Framework and Independence of the Regulatory Body	Section 8(2)
Financial and human resources for the Regulatory Body	Article 8
Financial and human resources for LVNPS Licensee	Article 11
Knowledge management for the Regulatory Body	Section 8(1)
Knowledge management for LVNPS Licensee	Article 11
Supply chain	Section 11(1)
Managing the safety of ageing nuclear facilities and life extension	Section 14(2
Emergencies Preparedness	Article 16
Stakeholder Consultation and Communication	Introduction

– Adoption of the three principles of the 2015 Vienna Declaration on Nuclear Safety

The Contracting Parties to the Convention on Nuclear Safety have adopted the following principles to guide them, as appropriate, in the implementation of the objective of the Convention on Nuclear Safety to prevent accidents with radiological consequences and mitigate such consequences should they occur:

1. New nuclear power plants are to be designed, sited, and constructed consistent with the objective of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible releases of radionuclides

causing long-term offsite contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and actions.

Mexico states that the principles will be incorporated in the regulatory framework for new nuclear projects.

2. Comprehensive and systematic safety assessments are to be carried out periodically and regularly for existing installations throughout their lifetime in order to identify safety improvements that are oriented to meet the above objective. Reasonably practicable or achievable safety improvements are to be implemented in a timely manner.

   Mexico has performed and will continue to perform exhaustive and systematic safety assessments, based on IAEA's safety principles, as well as those of the regulatory framework that applies in the country of origin of the reactor, and always considering the experience arising from international events and incidents.

3. National requirements and regulations for addressing this objective throughout the lifetime of nuclear power plants are to take into account the relevant IAEA Safety Standards and, as appropriate, other good practices as identified inter alia in the Review Meetings of the Convention on Nuclear Safety.

   As mentioned in the previous principle, Mexico has performed and will continue to perform exhaustive and systematic safety assessments, based on IAEA's safety principles. Mexico states that it will continue to incorporate and address the points and recommendations that may arise from the Review Meetings of the Convention on Nuclear Safety.

ARTICLE 6. EXISTING NUCLEAR INSTALLATIONS

Obligations

"Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation.

If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shutdown may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact."

– Existing nuclear installations in United Mexican States

As far as the Convention on Nuclear Safety is concerned, there is a single nuclear installation in the United Mexican States called Laguna Verde Nuclear Power Station consisting of two units with Boiling Water Reactors (BWR), with 2317 MWt of thermal power and 817 MWe of net electrical capacity.

The facility is located in the State of Veracruz, on the coast of the Gulf of Mexico, 75 kilometers north of Veracruz City.

Table 6.1 provides the main features of both LVNPS units. In the 2019-2021 reporting period there were no new nuclear installations.

Table 6.1 List of Existing Nuclear Installations

Name	Laguna Verde Unit 1	Laguna Verde Unit 2
Authorisation No.	CNLV-1/2	CNLV-2/2
PRIS Code	MX-1	MX-2
Type	BWR	BWR
Thermal Power (MWt)	2317	2317
Net Electrical Capacity (MWe)	817	817
Operator	CFE	CFE
NSSS Vendor	General Electric	General Electric
Cooling	Open, Gulf of Mexico	Open, Gulf of Mexico
Construction Start Date	1-October-1976	1-June-1977
First Criticality	8-November-1988	6-September-1994
Grid Connection	13-April-1989	11- November-1994
Commercial Operation	24-July-1990	10- April-1995
Authorisation Expiration Date	24-July-2050	10- April-2025

- **Overview of important safety-related issues, including events at nuclear installations during the past three years, and measures taken**

The most important safety issues are listed below:

1. Regarding the Probabilistic Safety Analysis (PSA), new developments that help prevent human errors and improve human-machine interaction (see Article 12).
2. Strategic plans for final disposal of low and intermediate level radioactive waste, construction of a decontamination workshop and development of financial mechanisms to guarantee the decommissioning of the facility at the end of its lifetime.
3. Adequacy of procedures and controls for compliance with the Radiological Safety Regulations and the ICRP-26 by the authorisation holder (see Article 15).

4. Maintenance of Environmental Qualification of the equipment and components at the nuclear facility (see Article 14).
5. Tracking of individual and collective radiation doses, contamination of personnel, dry solid waste generation, and unplanned exposure to radiation during refuelling outages.
6. Knowledge management, retirement of experienced and executive personnel in the industry (power plant, research centers) (see Article 11) and CNSNS (see Article 8).
7. CNSNS granted the extension of the LVNPS operating authorisation for the Storage for Radiologically Contaminated Materials (AMAC) No. 1 and 2 (see Article 19).
8. CNSNS granted the extension of the LVNPS operating authorisation to operate "Storage II Area" of the On Site Temporary Storage (see Article 19).
9. CNSNS granted authorisation for the construction of an Independent Spent Fuel Storage Installation (ISFSI) inside LVNPS (see Article 19). In addition, it carried out three special inspections to verify pre-operational tests and training exercises. Through its CNSNS resident inspectors, its behavior was monitored during the first campaigns and during the normal operation of the facility, surveillance was carried out by inspectors from CNSNS headquarters.
10. CNSNS granted the Authorisation for Cease of Operations for the LVNPS "Storage Area for Radioactive Contaminated Materials" called "4 Naves" (see Article 19).
11. CNSNS granted the authorisation to operate LVNPS, Units 1 and 2, at Extended Power Uprate (EPU) conditions up to 2317 MWt. Through the baseline inspection program, CNSNS has monitored the LVNPS performance when operating under this condition.
12. The Corrective Action Programme (CAP) started in 2004, which required the integration of the Corrective Action Programme Group (CAPG). This group began to coordinate the events assessments with increasing emphasis on Root Cause Analysis. Since 2012 the "Tap Root" methodology has been continuously utilized to analyse the events classified as Regulatory Level 1 and Level 2 (Root Cause Analysis). Currently, at least 2 of the following methodologies are used: Task Analysis; Cause and Effect Analysis; Event and Causal Factor Chart Analysis; Tap Root Analysis; Fault Tree Analysis; Change Analysis; Barrier Analysis and Human Performance Evaluation. Depending on the complexity and nature of the events is the methodology used, with the support of the "Event Analysis" procedure, where a summary of the methods is established.
13. A Process Performance Improvement Committee was formed in 2015, with the purpose to continuously improve performance by implementing and monitoring indicators for the most important processes at LVNPS.
14. In 2015, with IAEA support Project RLA9080, started the formation a group of 20 of Safety Culture Ambassadors. This multidisciplinary team will be responsible

for carrying out self-assessments of the safety culture, as well as to provide support to the organisation for implementing the improvements required to influence the safety culture of the Federal Electricity Commission (CFE, Comisión Federal de Electricidad) Nuclear Corporate Coordination (NCC). (see Article10).

15. In 2018, under IAEA project RLA9083, a training workshop was held for Safety Culture Managers and refresher training for the multidisciplinary team of Safety Culture Ambassadors of the LVNPS with the objective of supporting the efforts to continuously strengthen the Safety Culture.

16. CFE delivered to the CNSNS the "LVNPS Radioactive Waste and Spent Nuclear Fuel Management Plan R.2", for the period July 2019- December 2020. The purpose of the plan is to establish guidelines, criteria, implementation deadlines and updated strategies (expansion of storage capacity for dry solid radioactive waste, attention to Findings and Condition Reports, purchase of goods and services to be contracted, volume reduction by incineration, etc.). Likewise, in the management of radioactive waste, residues contaminated with radioactive material and spent nuclear fuel, whatever their level of radioactivity which are generated as a result of the LVNPS's activities, for the short, medium and long term. The CNSNS has followed up on this Management Plan through inspections or meetings with the CFE.

17. In 2021, under the IAEA project RLA9089, a virtual workshop was held at the LVNPS prior to the self-assessment on Safety Culture. The purpose of this workshop was to prepare the Ambassadors and reinforce the evaluation techniques in the evaluation team.

18. In October 2021, the CFE requested authorisation from the CNSNS for the siting of the Radioactive Waste Storage Facilities (see Article 19).

19. In view of the health emergency derived from the COVID-19 pandemic, which has required additional measures to be implemented by the LVNPS, in order to continue with the safe operation of its two nuclear reactors, the CNSNS carried out, among other actions, the surveillance of the availability of the Reactor Operators and Reactor Supervisors. In this regard, the CFE prepared a report to explain the availability of licensed personnel. This report covered the period from April to December 2020 and contains mainly the following topics: a) Protocol established in the LVNPS to avoid infection of licensed and unlicensed personnel; b) Impact of the SARS-CoV2 virus (COVID-19) on the operation of LVNPS Units 1 and 2, and c) Impact of the SARS-CoV2 virus (COVID-19) on the training and retraining of LVNPS licensed personnel. This report mentions that, although there were infections of LVNPS licensed personnel, they were minimal in both units. This means that, there were 4 cases in Unit 1 and only 2 cases in Unit 2, implying that, in order to operate and maintain safety at the LVNPS during the pandemic, there was no significant reduction in licensed personnel.

- **Description of projects and planned measures for continuous safety improvement, on a case-by-case basis, for each type of nuclear installation**

Since 1998, LVNPS has implemented a programme to solve the most important safety issues and it seeks the following five objectives: Safety, Environment, Production, Human Resources, and Costs.

LVNPS has defined as the most important of all five, the improvement of nuclear safety. Topics covered by this programme include, among others, the following:

1. Collective dose reduction (Implemented).
2. Control of Intergranular Stress Corrosion Cracking IGSCC (Implemented).
3. Replacement of the suction filters of the Emergency Core Cooling System (ECCS) to avoid clogging (Implemented)
4. Improving the RPV instrumentation to avoid the degasification problem during the reactor vessel depressurisation (Implemented)
5. Installation of a core instability automatic detection and suppression system (Implemented)
6. Second Level of Low Voltage Protection (Implemented)
7. Replacement of the discharge valves of the Reactor Recirculation Core System, with other valves with improved design (Implemented)
8. Modernization of the LVNPS full scope simulator. The simulator consists of 104 advanced models, new computing platform and new communication interfaces (Implemented)
9. Implementation of an equipment reliability programme (Implemented)
10. Implementation of a programme for obsolete equipment replacement (Ongoing)
11. LVNPS Modernization and Extended Power Uprate (EPU) up to 2317 MWt (Implemented)
12. Programme for Radioactive Waste Reduction (Implemented)
13. Programme for Chemistry Index Reduction (Permanent)
14. Improvement programme based on the World Association of Nuclear Operators (WANO) recommendations (Implemented)
15. Systematic Approach to Training (Implemented)
16. Implementation of a Performance Improvement Process (Ongoing).

17. Levels 1 and 2 Condition Reports of the Corrective Action Programme (CAP) – No Level 1 Expired Actions. It was implemented the evaluation of the characteristics of a healthy safety culture in the root cause analysis process.

18. Installation of anti-vibration systems (AVS) in the Reactor Recirculation Core system, in order to eliminate unstable flow-induced vibration (FIV). Implemented.

19. Chemical decontamination of the Residual Heat Removal (RHR), Reactor Recirculation (RRC) and Reactor Water Cleanup (RWCU) systems of LVNPS, as part of the strategies to reduce the Source Term, with the focus on the reduction of sources of radiation in the primary systems.

20. In June 2019, CNSNS granted the operating authorisation for the Independent Spent Fuel Storage Facility (ISFSI). This authorisation is valid for 40 years (implemented).

21. In July 2020, the Secretariat of Energy granted the Renewal of the Operating Authorisation for LVNPS Unit 1. The expiration date of this authorisation is July 24, 2050 (see Article 14). For the case of LVNPS Unit 2, the regulatory evaluation for the renewal authorisation application is still ongoing.

22. The Succession Plan for middle and senior management positions that perform important functions for safety in the LVNPS has been implemented to ensure the availability of competent management personnel. The first generation filled the positions in 2018; from that date on, managers have been relieved with personnel from the Succession Plan and external talent. With the implementation of this process, LVNPS has the expectation of the continuous coverage of management positions during the entire operating life of the plant.

23. Request for Amendment for the "Storage II Area" of the On Site Temporary Storage Operating Authorisation, for the storage of High Integrity Containers - HIC's with wet solid waste (Under evaluation).

24. Request for authorisation for the temporary storage of drums with mixed waste in the contaminated oil area of LVNPS's Reusable Parts Collection Center - Contaminated Oil Storage (Under evaluation).

Post-Fukushima Daiichi Actions in the Laguna Verde Nuclear Power Station

The actions taken include the following:

CFE in compliance with the CNSNS requirements has implemented mitigation strategies derived from events with extensive damage of 10CFR50.54 (hh) (2), Orders EA-12-049 "Order Modifying Licenses with Regard to Requirements for Mitigation

Strategies for Beyond Design-Basis External Events", EA-12-050 (EA-13-109) "Order to Modify Licenses with regard to Reliable Hardened Containment Vents" and EA-12-051 "Order to Modify Licenses with regard to Reliable Spent Fuel Pool Instrumentation".

To address conditions resulting from events beyond the design basis, CFE implemented the mitigation strategies indicated in 10 CFR 50.54 (hh)(2) complying with the NEI 06-12 Rev.2 "B.5.b Phase 2 & 3 Submittal Guideline". In this way, the LVNPS has developed strategies for inventory makeup and spray to the Spent Fuel Pool (SFP), primary containment spray, inventory makeup in the condenser hot well and Condensate Storage Tanks (CST), inventory makeup to the reactor vessel derived from events with extensive damage, through a portable submersible pump powered by a diesel engine and various sources of makeup water. Additionally, following the guidelines of this NEI 06-12, strategies were developed to depressurize the reactor vessel, maximize the flow of the Control Rod Drive System (CRD), manually isolate the Reactor Water Clean-Up System (RWCU), manually vent the Primary Containment in case of lack of direct current (DC) and control leaks in the Spent Fuel Pool (SFP) in extreme situations derived from events beyond the design basis.

For Order EA-12-049 "Mitigation Strategies for Beyond Design Basis External Events " required by CNSNS, CFE successfully implemented Phases 1 and 2 of the FLEX Strategies in accordance with NEI 12-06 "Diverse and Flexible Coping Strategies (Flex) Implementation Guide". As part of the FLEX Strategies, LVNPS made modifications to connect the Alternate Building Diesel Generators and Portable Diesel Generators to direct current (DC) battery chargers. This was done to address an Extended Loss of AC Power (ELAP) event, thus maintaining the key functions of core cooling, Spent Fuel Pool cooling, and primary containment integrity. In addition, modifications were made to facilitate hose connections to the Residual Heat Removal and High Pressure Core Spray systems to maintain core cooling through a portable diesel pump and multiple makeup water sources.

For the USNRC Order EA-12-050 (EA-13-109), as required by CNSNS, installed a reliable hardened containment venting system for Phase 1, in accordance with NEI Guide 13-02 "Guidance for Compliance with Order EA-13-109". For Phase 2 of Order EA-13-109, LVNPS developed the Severe Accident Water Addition and Management (SAWA/SAWM) methodology, following the guidelines of NEI 13-02.

In accordance with CNSNS requirements for Order EA-12-051 "Reliable Spent Fuel Pool Instrumentation", CFE completed the modification packages on the Diversification of the Spent Fuel Pool Instrumentation at both LVNPS units. This instrumentation is capable of reliably monitoring the Reliable Spent Fuel Pool parameters (level and temperature) during Extended Energy Loss and during accident conditions.

CFE has developed the Emergency Severe Accident Guidelines (ESAG) from the BWR Reactor Owners Group (BWROG) Emergency Procedure Guidelines/Severe Accident Guidelines Rev. 4 (EPG/SAG). The GEAS coordinate the control of key plant parameters under severe accident conditions, and provide guidelines for submerging the core and its slag. In addition, support procedures have been developed for the ESAG, which contain the information to perform the necessary actions to carry out the alignments, connections and disconnections required for ESAG monitoring.

In addition to the ESAG, LVNPS developed the Emergency Management Guide (EMG) based on BWROG documents; this guide serves as a reference for prioritizing available resources and response strategies in the event of an extensive damage event, by coordinating emergency response groups and external support groups.

In conclusion, the overall progress of the Post Fukushima Actions is 98% and is scheduled to be fully completed by the end of 2023.

- **Identification of the installations that were required to shutdown**

  Currently, there are no identified conditions that might adversely affect safe operation; therefore, there are no plans to prematurely shut down the LVNPS installation before the end of its authorized lifetime.

- **A statement on the Contracting Party position regarding the continued operation of nuclear installations, including those that do not comply with the obligations stated in Articles 10 - 19 of the Convention; explaining how safety and other issues were taken into account to achieve this position**

  Based on the information presented in this and other articles of the National Report prepared to meet the commitments under the Convention on Nuclear Safety; it is concluded that Mexico has laws, regulations and means for adequate inspection and supervision by its regulatory body - independent from the exploitation organisms - which ensures that LVNPS operation does not represent an undue risk to public health and safety nor the environment.

  Regarding the specific compliance with the obligations derived from the Convention on Nuclear Safety, the progress and achievements during the reporting period are presented in each of the subsequent articles.

  The conclusion from the existing objective evidence, a summary of which is presented in this report, is that LVNPS continues maintaining a safety performance level similar to other nuclear plants operating in countries with more nuclear experience. Currently, there are no identified conditions that might adversely affect safe operation; therefore, there are no plans to prematurely shut down the installation before the end of its authorized lifetime.

ARTICLE 7. LEGISLATIVE AND REGULATORY FRAMEWORK

Obligations

1. *"Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.*

2. *The legislative and regulatory framework shall provide for:*
   - *i) the establishment of applicable national safety requirements and regulations;*
   - *ii) a licencing system for nuclear installations and a scheme to prevent the operation of a nuclear installation without a licence;*
   - *iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the licence terms;*
   - *iv) the enforcement of applicable regulations and of the licence terms, including suspension, modification or revocation."*

Article 7 (1) Establishing and maintaining a legislative and regulatory framework

– Overview of the primary legislative framework for nuclear safety, including interfacing national legislation

Introduction

This article presents a summary of the laws, regulations and standards that provide legal support to Mexican institutions related to nuclear and radiation safety, and to the nuclear power plant licencing process overseen by CNSNS. The information cited in this article does not intend to reproduce in their full extent the mentioned laws and regulations. However, at the end of this article, additional information is provided, giving a more complete view of the Mexican regulatory framework.

National requirements and provisions

The legislative and regulatory framework under which the principles and obligations deriving from the Convention on Nuclear Safety is based on the Political Constitution of the United Mexican States (hereinafter called "Constitution") from which a series of laws, regulations and standards are derived.

The Constitution, in its Article 27, establishes that nuclear energy must be used only for peaceful applications and that the use of nuclear fuels for the generation of nuclear energy, as well as the regulation of its application in all areas, falls within the purview of the Mexican State.

In accordance with the Constitution, in its Article 28, the generation of electric power by nuclear means is considered strategic. The public sector is exclusively responsible for such activity, and therefore, the Mexican State has created the organisations and companies necessary for the effective management of such strategic areas under its responsibility.

The Regulatory Law on Nuclear Matters of Article 27 of the Constitution (hereinafter called "Nuclear Law") entered into effect on February 5, 1985, and gives the Federal Electricity Commission (hereinafter called "CFE") exclusively, the right to generate electric power from nuclear fuels. The design and construction of nuclear power plants also falls to the CFE, taking into account the opinion of the National Institute of Nuclear Research (ININ). The Nuclear Law also provides that nuclear reactors that do not produce power shall only be operated by the public sector and the universities, institutes and research centres authorised according to the Law.

CFE is a state owned utility, with its own legal identity and assets, and it has technical, operational and management autonomy, as provided in the Law of the Federal Electricity Commission, which went into effect on August 12, 2014. CFE aims to develop business, economic, industrial and commercial activities in pursuit of its objective, generating economic value and profitability for the Mexican State, with a sense of fairness and social and environmental responsibility.

Likewise, the Constitution in its Article 89, Fraction I empowers the President of the Republic to "promulgate and execute the laws issued by the Congress of the Union, providing the administrative support for allowing its exact observance". Hence the Federal Executive Branch, through the Secretariat of Energy (hereinafter called "SENER") regulates and supervises compliance with the provisions on nuclear safety and safeguards. This attribution is based on Article 33, Fraction XIII of the Organic Law of the Federal Public Administration.

Pursuant to the Article 17 of the Organic Law of the Federal Public Administration, Mexican State Secretariats are authorised to delegate to deconcentrated and subordinated administrative bodies to provide more effective attention and more efficient dispatch of matters of their competency. These organisations (under the Secretariats) shall have specific powers to resolve matters within the territory and competence determined in each case, in accordance with applicable legal provisions.

From the administrative standpoint, this article supports the creation of CNSNS. Being a deconcentrated body under SENER, CNSNS serves as the regulatory body responsible for overseeing nuclear and radiation safety, physical security, and the safeguards within the national territory. By way of SENER's Internal Regulations, these responsibilities have been delegated from the Secretariat of Energy to the Director General of CNSNS.

The Organic Law of the Federal Public Administration empowers SENER to exert the rights of the State on nuclear energy matters, based on the utilization of assets and natural resources, such as radioactive minerals among others, required to generate, transmit, transform, distribute, and supply electricity whose objective is to provide public service and “to conduct and supervise the generation of nuclear energy" (Article 33, Fractions II and III, respectively).

As stipulated in Article 17 of the Nuclear Law, as the nuclear fuel is property of the State, the Federal Executive Branch may only authorise its use under the terms of this Law and always under the surveillance of CNSNS.

The Nuclear Law establishes in its Article 19 that “safety is prime in all activities involving nuclear energy and it should be considered from the planning, design, construction and operation up to the definitive shutdown and decommissioning of nuclear and radioactive installations as well as in the disposal and final destination of all the waste.”

In accordance with this Law, nuclear safety is defined as the “set of actions and measures to prevent the equipment, materials and nuclear installations and their operation from producing undue risks to the population’s health and property, or damage to the environment" (Article 20). It also defines the objective of the radiation safety as: "to protect workers, the population and their property, and the environment in general, by preventing and limiting the effects that could result from exposure to ionizing radiation"(Article 21).

This Law defines two types of installations: nuclear and radioactive. The first one is defined as "one in which nuclear fuel or material is manufactured, processed, used, reprocessed or stored”, and the second as "one in which radioactive material or equipment containing it, is produced, manufactured, stored, used; or radioactive wastes are treated, conditioned or stored" (Article 3, Fractions II and III, respectively).

According to the Nuclear Law, both nuclear and radioactive installations must have systems for nuclear and radiation safety, and physical security that meet the requirements established in other legal and regulatory provisions of the Law (Article 22, second paragraph). Similarly, the Law foresees in Article 27, third paragraph that "nuclear installations shall be staffed with nuclear and radiation safety personnel required, and the head of the corresponding public agency shall be responsible for strict compliance with the applicable regulations."

Regarding to incident notification and management, Article 23 of the Nuclear Law provides that when there is knowledge of an incident involving nuclear materials or fuels, radioactive materials or equipment containing them, or conditions that might cause it, CNSNS shall be notified. In these cases, CNSNS might order or carry out the removal of the equipment, tools or materials that imply some risk, for deposit in places that meet the appropriate safety conditions.

The Nuclear Law establishes the bases for implementing a licencing system for both nuclear and radioactive installations, and for the suspension of licence in case of failure to comply with any established condition. For the granting of any licence it is essential for nuclear and radioactive installations to meet the requirements for the siting (selection, survey and evaluation of the location), design, construction, operation, modification, cease of operations, definitive shutdown, and decommissioning established in the regulatory provisions of the Nuclear Law. These requirements shall reflect the risk associated with operations that involve radioactive material, and depending on the activity and radio-toxicity of the isotopes that are present (Article 25 of the Nuclear Law).

Under the provisions of Article 26 of the Nuclear Law, the current Secretariat of Energy is empowered to grant authorisations for siting, design, construction, operation, modification, definitive shutdown and decommissioning of nuclear and radioactive installations. These responsibilities have been delegated by the Secretariat of Energy to CNSNS according to Article 42, Fraction XVIII of SENER's Internal Regulations.

The authorisations for the construction and operation of nuclear installations will only be granted by presenting relevant information on how the safety objectives will be met and the procedures and methods to be used during the phases of siting, design, construction, operation, modification, cease of operations, definitive shutdown, and decommissioning of the installation, as well as the corresponding radiological emergency plan. Additionally, information on the environmental impact caused by the installation must be included (Article 28 of the Nuclear Law). An authorisation is also required for handling, transport, storage and custody of nuclear materials and fuels, and radioactive materials and equipment containing them (Article 30 of the Nuclear Law).

The Nuclear Law and SENER's Internal Regulations empower CNSNS as the responsible agency for reviewing, evaluating and authorising the bases for the siting, design, construction, operation, modification, cease of operations, definitive shutdown, and decommissioning of nuclear and radioactive installations; as well as everything related to the fabrication, use, handling, storage, reprocessing and transport of nuclear fuels and/or materials, radioactive materials and equipment containing them. Furthermore, everything related to processing, conditioning, dumping, and storage of radioactive wastes; and any disposal of them (Article 50, Fraction III of the Nuclear Law and Article 29, Fraction XVIII of SENER's Internal Regulations) is regulated by CNSNS.

- **Ratification of international conventions and legal instruments related to nuclear safety**

Mexico has committed to implement the safety and health protection measures, as stated in the Informative Circular No. 18/Rev.1, by an agreement with the International Atomic Energy Agency (IAEA) whereby the Agency would assist in the implementation of a project for a nuclear power plant (INFCIRC/203). Thus, Mexico applies and is obligated to comply with the IAEA´s Basic Safety Standards and recommended safety conditions in the corresponding parts of the IAEA's practical guidelines on the "safe operation of nuclear power plants " and the "safe design and construction of reactors"; as well as the IAEA's guidelines on the "organisation of regulatory activities for power reactors", and the "siting of reactors from the point of view of seismic characteristics of the ground".

Additionally, the international treaties that are included in the Mexican legislative framework, once approved by the Mexican Senate, assume the legal status of a Mexican Law. Mexico is signatory of the international treaties listed in Annexe 7.1. Concerning the nuclear matter, Mexico has also signed the bilateral treaties shown in Annexe 7.2.

Article 7 (2) (i) National safety requirements and regulations

- **Overview of the secondary legislation for nuclear safety (ordinances, decrees, etc.)**

Since the inception of Laguna Verde Nuclear Power Station (LVNPS) project, government authorities decided that, in addition to applying the regulations of the International Atomic Energy Agency, the regulations of the Nuclear Steam Supply System (NSSS) supplier's country of origin must be applied. This binding requirement is stated in Conditions No. 3 and No. 4 of the current Authorisations for Commercial Operation for both LVNPS units 1 and 2, respectively. For this reason, Parts 20, 21, 26, 50, 51, 54, 55, 61, 70, 71, 72, 73 and 100 of Title 10 "Energy" of the United States of America Code of Federal Regulations (CFR), and all industry standards and guidelines issued from this title were established as regulatory requirements. Similarly, the Regulatory Guidelines (RGs) issued by the United States Nuclear Regulatory Commission (USNRC) have been adopted, in accordance with the applicability analysis process that is part of CNSNS's internal processes.

Radiation safety matters are regulated based on the General Regulation for Radiation Safety, which entered into force on November 23, 1988. This regulation stipulates requirements for the dose limit system (Title Third) the licence holder, the party responsible for radiation safety and occupationally exposed personnel (Title Seventh); radiological accidents and preventive or safety measures (Title Ninth); approvals, permits and licences (Title Tenth); and administrative procedures (Title Eleventh). The regulations also cover the requirements for inspections, audits and examinations, as well as sanctions and the appeal for reconsideration.

There are also The Regulations for Ground Transportation of Hazardous Materials and Waste, which went into force on April 8, 1993. These regulatory provisions apply for transportation of Class 7 materials "Radioactive Materials". The Secretariat of Infrastructure Communications and Transportation is the competent authority, however, this does not exclude the Secretariat of Energy's authority, through CNSNS, to grant authorisation for transportation of nuclear and radioactive materials.

In 2017, the Regulation for the Safe Transport of Radioactive Material was issued, which came into force on June 9 of that year. This regulation is intended to provide requirements for the safe transportation of radioactive material by land or water. The application of this regulation corresponds to the SENER, through the CNSNS, and when the transport of radioactive material is carried out through bridges, roads or roads of federal jurisdiction, the Secretariat of Infrastructure Communications and Transportation will be equally responsible for the application of this regulation, within the scope of their respective competence.

The Law of Civil Liability for Nuclear Damages is also under the Mexican legislation, and came into force on January 1, 1975. This Law establishes an indemnity financial system for people affected by a nuclear accident. As noted by this Law, the operator (licence holder) is responsible for all damage caused by any nuclear accident occurring in his nuclear installation. For this, the article 15 of Nuclear Law provides that CFE is the sole entity authorised to generate electricity using nuclear fuels.

Besides the Nuclear Law, there is also The General Law of Ecological Equilibrium and Environmental Protection, which came into force on January 29, 1988 and whose decree by which amends, adds and repeals itself, came into force on October 21, 2021. Article 154, Chapter VII "Nuclear Energy", of this Law states that "The Secretariat of Energy and the National Commission for Nuclear Safety and Safeguards, with the participation, if needed, of the Secretariat of Health, will supervise that the radioactive minerals exploration, exploitation and processing, the use of nuclear fuels, nuclear energy applications and in general, and related activities in nuclear and radioactive installations, are conducted in compliance with the official Mexican standards on nuclear and radiation safety, and physical security to avoid human health risks and ensure the ecological equilibrium preservation and environmental protection, corresponding to the Secretariat of Environment and Natural Resources to carry out an environmental impact assessment."

The above-mentioned Law gives the Secretariat of Environment and Natural Resources the authority to perform the environmental impact assessment. However, it is important to mention that the evaluation of the nuclear installations impact on the environment, from the radiation safety standpoint, corresponds to CNSNS.

– Overview of regulations and guides issued by the regulatory body

Standardization is the process of regulating the activities performed by both private and public sectors in different areas, such as nuclear. These instruments can be Mexican Official Standards (hereinafter called "NOM"), Mexican Standards and Reference Standards, which are abided by the provisions of the Law of Quality Infrastructure.

Concerning the Mexican standards on nuclear and radiation safety, during the period covered by this Report, the Mexican government issued the following revisions: NOM-039-NUCL-2020 "Criteria for the exemption of ionizing radiation sources or practices that use them ". A complete list of the applicable standards in nuclear matters can be found in Annexe 7.3 of this National Report.

- **Overview of the process of establishing and revising regulatory requirements, including the involvement of interested parties**

  One of the duties of CNSNS, as an agency of the Federal Public Administration, is to aid in the integration of the National Quality Infrastructure Programme with proposals for Mexican Official Standards (NOM) and issues related to nuclear and radiation safety, physical security, and associated safeguards.

  Mexican Official Standards are mandatory technical regulations, issued by competent agencies, establishing applicable rules, specifications, attributes, guidelines, characteristics or directions for a product, process, installation, system, activity, service or, production or operation method, as well as those relating to terminology, symbols, packaging, labelling and those that relate to their enforcement or implementation.

  The Law of Quality Infrastructure, published in the Official Gazette of the Federation on July 1, 2020 establishes a uniform procedure for the preparation of Mexican Official Standards by the agencies of the Federal Public Administration, which is summarised below:

  1. The topics to be prepared shall be included in the National Programme of Quality Infrastructure.

  2. The competent agency prepares the standard draft along with its Statement of Regulatory Impact (SRI), reviewing if there are other standards related to the subject. If applicable, the corresponding agencies will coordinate the preparation of a single NOM by subject or sector. Also the Mexican and international standards related to the subject of the standard draft will be taken into account.

  3. The standard draft is submitted to the corresponding National Advisory Committee of Normalization (NACN) – the stakeholders are included as part of this committee – for comments.

  4. The agency that developed the standard draft will answer the comments made by the NACN, and will amend the draft, if required. When the agency submitting the project, considers that the comments risen by the NACN are not justified, it may request the NACN chair the approval of the draft without changes.

  5. Once the NACN approves the standard draft, the corresponding agency sends it along with its SRI for its resolution.

6. The agency answers to the National Commission of Quality Infrastructure (NCQI) comments raised about the standard draft and its SRI, incorporating to these documents the pertinent adaptations and modifications until the NCQI issues its final resolution about them.

7. The standard draft ruled is submitted to the NACN for approval for publication in the Official Gazette of the Federation as a NOM project. The stakeholders including the general public may comment on the corresponding NACN within 60 calendar days.

8. After 60 days, the corresponding NACN shall review the comments received and, if appropriate, proceed to modify the project.

9. The Standardization Authorities shall order the publication of the NOM in order to produce legal effects. This order will happen within 45 days after the final resolution of the NACN.

10. Once approved by the corresponding NACN, the NOMs are issued by the competent agency and published in the Official Gazette of the Federation for its implementation.

The NOM must be reviewed every 5 years to confirm its validity, updating or cancellation. The Technical Secretariat of the National Commission for Standardization will be notified about the outcome of this review, otherwise they will no longer be in force.

Article 7 (2) (ii) System of licencing

- **Overview of the licencing system and processes including types of licenced activity and, where appropriate, the procedure for relicencing**

Description of the licencing system and its processes

According to the provisions of the Nuclear Law, Chapter IV Articles 25 and 28, and Chapter VI Article 50 Fractions III, IV, V, VII and XIII, CNSNS has the authority for reviewing, evaluating and authorising the bases for the siting, design, construction, operation, modification, cease of operations, definitive shutdown, and decommissioning of nuclear and radioactive installations; as well as everything related to the manufacture, use, handling, storage, reprocessing and transport of nuclear materials and fuels, radioactive materials and equipment containing them; and the processing, conditioning, dumping, and storing of radioactive wastes; and any disposal of them.

During the siting authorisation, CNSNS reviews the most important aspects related to the site where the installation will be built, including the parameters that may affect the design, including: the site seismology, severe weather (probable maximum hurricane) and other aspects of interest. Information concerning the current and future distribution of the population is also reviewed.

Subsequently, in accordance with the provisions of the United States of America 10 CFR 50 for the licencing process, two stages have been established. The first one starts with the formal delivery of the Construction Permit Application including a description of the characteristics of the installation and essentially of the safety systems provided to ensure that installation would not represent an undue risk. The documents submitted to CNSNS by CFE to support LVNPS application, are the following: (1) Preliminary Safety Analysis Report (PSAR) and (2) Preliminary Environmental Impact Assessment Report (PEIA).

During this stage, CNSNS reviewed the design criteria (structural, system and component – SSC - characteristics, nuclear analysis, etc.) and particularly all the issues related to the impact of the site characteristics on the SSC design of the installation, and the impact of the installation on the environment.

During the review stage, CNSNS may require Request for Additional Information to clarify or to supplement the safety reports. Once the review is finished, a report is prepared containing the CNSNS technical opinion on the Construction Permit application and sent to the Secretariat of Energy. Based on CNSNS opinion SENER may to issue the authorisation for construction. The report includes recommendations and conclusions about the installation's safety.

During LVNPS construction, CNSNS through audits and inspections supervised this phase to assure that the installation was built in accordance with the safety analysis report and the conditions set by the aforementioned authorisation for construction.

Once the detailed design of the installation finalized, the Licence for Commercial Operation can be requested. This requires that another detailed report on the plant's safety be sent to CNSNS. This report is called the Final Safety Analysis Report (FSAR). This document contains the same information as the Preliminary Safety Report (PSAR); however, the information is no longer generic but specific to the installation. Also a Final Environmental Impact Report (FEIR) is prepared, which includes the environmental monitoring programme to be operative during the whole plant lifetime, to monitor the effect that the installation will cause on the environment. All the measurements performed during at least five years prior to the plant´s operation are used as reference.

The FSAR review by CNSNS includes assessing the actual operation conditions. The acceptance criteria for pre-operational testing, start-up testing (as well as its impact on the accident analysis) and during commercial operation (in the preliminary report they were generic) are reviewed also. The proposed Technical Specifications (TS) are also examined which, once approved by CNSNS, are part of the Authortization for Operation to govern the operation of the installation. The scope of activities for the inspection of the major safety components that will be performed during the plant's lifetime (In-Service Inspection) is also evaluated. The adequacy of the training of the installation's operation personnel are verified by examinations.

When the construction progress is such that the safety related equipment and component testing can begin, CNSNS's personnel witness these tests and review the results, to verify that the equipment meets the design criteria.

The FSAR original version reflects the plant's detailed design. The FSAR is continuously updated right up to the start of commercial operation. After that, it is updated on a regular basis to reflect the installation's "as built" condition.

In order to support the granting of the Authorisation for Operation, CNSNS prepares the technical report named "Safety Evaluation Report" which contains recommendations and conclusions. It is submitted to the Secretariat of Energy which, following the recommendations and based on Article 26 of the Nuclear Law, may or may not grant the authorisation.

It should be noted that, currently in accordance with the Internal Regulations of SENER in its Chapter XII, Article 42 fraction XX, published in the Official Gazette of the Federation of October 31, 2014, the Secretary of SENER has delegated to the CNSNS General Director the empowering to grant the Authorisations for Siting, Design, Construction, Operation, Modification, Cease of Operations, Final Closure and the Decommissioning of nuclear installations.

According to the applicability analysis performed to establish a licensing process for a future new nuclear power plant, CNSNS established the Regulatory Framework in March 2016. This updated Nuclear Regulatory Framework was conformed based on the Regulatory Law of Article 27 on Nuclear Matters and, additionally, with the requirements established in 10 CFR 50 and 10 CFR 52. It states that the CNSNS has opted to take as reference the two-step licensing process, considering that, for a site authorisation, the structure of the "Early Site Permit" of 10 CFR 52 will be taken as reference, without overriding the established national regulations.

The licensing process has been elaborated and established in the Preliminary Draft Regulations for Nuclear Facilities, which is still under review by CNSNS. This licensing process has been prepared in accordance with the Safety Guidelines of the International Atomic Energy Agency (IAEA).

Licence Renewal procedure

In March 2015, the licence holder CFE, submitted to CNSNS a licence renewal application for both LVNPS units. The regulatory framework for this task was established by CNSNS and was implemented by the licence holder in its application. CNSNS applied the Regulatory Guide NUREG-1800 Rev. 2. At the time CNSNS and the licence holder developed the technological skills required to carry out such an activity and are continuing to maintain and improve these skills.

The regulatory evaluation process by CNSNS was carried out through Audits and Inspections. The findings of the regulatory assessment were documented in a Safety Evaluation Report and finally, on July 24, 2020, the Secretariat of Energy (SENER), based on the favourable technical opinion of the National Nuclear Safety and Safeguards Commission (CNSNS), granted the Renewal of the Authorisation of Operation for Unit 1.

- **Involvement of the public and interested parties within the Contracting Party**

The Mexican Nuclear Law does not provide for citizen participation in public hearings. However, information related to the licencing system and its processes is available to the public and interested agencies in accordance with the "Federal Law of Transparency and Access to Public Information," and the "General Law of Transparency and Access to Public Information" both amended on May 20, 2021, as well as the recommendations from the Convention included in document INFCIRC/572/Rev. 6, dated January 19, 2018.

- **Legal provisions to prevent the operation of a nuclear installation without a valid licence**

The legal provision to prevent the operation of a nuclear installation without a valid licence is stated in Chapter 4, Article 26 of the Mexican Nuclear Law, which establishes that "The siting, design, construction, operation, modification, cease of operations, definitive shutdown, and decommissioning of nuclear and radioactive installations require the authorisation of the Secretariat of Energy".

Article 7 (2) (iii) System of regulatory inspection and assessment

- **Regulatory strategies**

CNSNS is conducting an integral and systematic safety review of LVNPS through the Reactor Oversight Process (ROP), following the USNRC practice. In this process, the resources and information obtained through the assessment and inspection procedures that CNSNS has set up are taken advantage of.

The Reactor Oversight Process is considered an additional method to the deterministic conventional forms of assessment, review and inspection activities that were taking place previously. The current orientation of these activities by CNSNS is an integration of information obtained from both deterministic and probabilistic methods that contributes to a better safety assessment of LVNPS. This is possible through the Reactor Oversight Process.

– Overview of the regulatory inspection and assessment process with regard to the safety of nuclear installations

The purpose of the inspections conducted is to carry out an independent performance verification of LVNPS and assess the condition of its facilities, and achieve a high degree of confidence that the safety objectives prescribed or approved by CNSNS are met.

The inspection process allows verifying the safety of LVNPS through a review that makes it possible to determine if the licence holder:

1. Complies with all laws, regulations and applicable licence conditions as well as all the pertinent codes, guidelines, specifications and practices.
2. Is staffed with competent and effective management, has a good safety culture and satisfactory self-assessment systems to ensure the safety of the installation and the protection of the workers, the public and the environment.
3. Achieves and maintains the required quality and behaviour regarding both the safety related activities and the installation's Structures, Systems and Components throughout its useful lifetime.
4. Has enough competent personnel to perform its work both safely and efficiently at all times and during all stages of the installation's useful lifetime.
5. Determines, assesses and, at the appropriate time, corrects the deficiencies and the abnormal conditions and, if necessary, they are duly reported to CNSNS.
6. Determines and properly analyses any other safety issue that is not specified in the authorisation nor prescribed in the regulations.

Moreover, the Reactor Oversight Process allows carrying out a safety assessment of LVNPS, using the information of the findings documented by CNSNS, as well as the reportable events, documented condition reports, and the Performance Indicators provided by the licence holder.
The Reactor Oversight Process is a risk-informed, tiered approach of key performance strategic areas linked to safety cornerstones that are logically aligned towards fulfilling CNSNS's Mission. There are three key performance strategic areas: nuclear safety, radiation protection, and physical security; and seven safety cornerstones linked to the key performance strategic areas, covering the essential safety aspects of installation operation. Satisfactory licence holder performance in the seven cornerstones provides reasonable assurance that CNSNS's mission is being

accomplished with no further action required. Otherwise, it is necessary to take the steps described later in the Action Matrix.

The seven safety cornerstones are:

1. Initiating events: Limit the event frequency.
2. Core damage mitigating systems: Availability, reliability and capacity.
3. Barrier integrity: Fuel clad, pressure boundary and containment.
4. Emergency preparedness: Appropriate performance in drills and actual emergencies.
5. Public radiation protection: Liquid and gaseous effluents, inadvertent release of solid radioactive waste, environmental radiation monitoring and transport of radioactive materials within the power plant.
6. Occupational radiation protection: Access control, radioactive materials control and application of ALARA criterion.
7. Physical security: Design basis threat and radiological sabotage.

In addition to the seven cornerstones, there are three "cross-cutting" elements common to all of them.

1. Human behaviour or performance.
2. Safety culture.
3. Corrective Action Programme (CAP)

The Reactor Oversight Process begins by collecting information from two sources: Performance Indicators, which are reported quarterly by CFE to CNSNS, and the inspections, defined in the Baseline Inspection Programme. The set of indicators and the inspections cover the safety cornerstones and the cross-cutting elements. The process continues with the assessment of this information. For the performance indicators, data is compared against prescribed thresholds, and for inspections, the inspection findings are first prioritised and after this the safety determination process is done by using established procedures.

The performance indicator information (data) and the inspection information (findings) are classified using colour codes. A given colour combination results and the cornerstones affected are known. The resulting information allows assessing the licence holder performance in the period of interest. This evaluation identifies five levels (Action Matrix) from best to worst in relation to safety significance. For each level, there is an associated information level and a regulatory response to the licence holder to correct the situation. This response is gradual and relative to the significance that the licence holder performance has on safety. The response includes meetings at different management levels between CNSNS and CFE, surveillances, supplemental inspections and other actions.

- **Basic features of inspection programmes**

The CNSNS's base inspection programme includes a set of inspections scheduled and supplemental inspections according to the facility performance, throughout the lifetime of the nuclear installation, and inspections to other relevant areas of both LVNPS and its contractors to ensure compliance with regulatory requirements. Inspection methods include the review and assessment of the installation, procedures, records and documentation; supervision by the licence holder, as well as staff interviews; and tests and measurements. Regulatory inspections are conducted by their resident inspectors and non-resident subject matter expert inspectors from CNSNS's headquarters. The findings of these inspections are documented in inspection reports prepared by CNSNS's inspecting staff. These reports include the objective, areas inspected, description of the activities conducted, findings and observations, inspection timeline, and conclusions. There is also a semi-annual supervision and a follow-up programme of the inspection reports, in order to provide feedback to the Inspection Process.

As indicated in Article 14 (2) of this National Report, the inspection frequency depends on the type of activity and its significance for the installation's safety. The baseline inspection programme indicates the minimum number of scheduled inspections to be performed during the period in which the installation has an acceptable level of performance. Additionally, the Baseline Inspection Programme includes some inspections to verify: (1) the quality-related areas, (2) supervising groups and (3) the cross-cutting elements.

It should also be noted that sometimes, there might be a need to conduct special inspections focused on: (1) Safety related emerging generic issues; (2) a specific objective when the licence holder performs major manoeuvres, such as functional testing after power changes or replacement of major components; (3) to respond to the results arisen from the performance analysis developed for the Performance Indicators and the findings of scheduled inspections; (4) the response to operational events which should be evaluated on a case by case basis; and (5) the activities related with the Application for Renewal of the Authorisation of Operation.

Article 7 (2) (iv) Enforcement of applicable regulations and terms of licences

– Power for legal actions

In accordance with the provisions of the Nuclear Law, Chapter IV Articles 34, 35, 36, 37, 38, 39 and 40, and Chapter VI Article 50, Fraction XII, CNSNS has the authority to apply preventive and safety measures, impose fines, execute enforcement actions and decree administrative sanctions.

– Overview of enforcement measures available to the regulatory body

In cases of danger or imminent risk to the personnel of a nuclear or radioactive installation, or to the society in general, the articles of The Regulatory Law of the Constitutional Article 27 on Nuclear Matters indicated in the preceding paragraph, grant the CNSNS the authority necessary to order and execute preventive and safety measures, such as: the temporary, partial or total closure of nuclear and radioactive installations, as well as contaminated immovable properties, setting the deadlines to correct deficiencies or anomalies. In the event that the deficiencies or anomalies are not corrected within the term granted, the CNSNS may proceed to the final closure, with support in the corresponding technical report.

The suspensions, cancellations or revocations of granted authorisations, as well as the fines and safety measures imposed by the CNSNS, will be made based on the results of the inspections, audits or verifications carried out and taking into account the evidence and allegations of the interested parties.

Non-compliance with the regulatory framework, regardless of whether they are grounds for suspension, cancellation or revocation of the authorisations granted, will be sanctioned with a fine of five to five thousand Units of Measurement and Updating (UMU). This Unit of Measurement and Update is the economic reference in National currency (named “pesos”) to determine the amount of payment of the obligations and assumptions foreseen in the federal laws of the federal entities, as well as in the legal dispositions that emanate from all the previous ones. The value of the UMU changes every year and is assigned by the National Institute of Statistics and Geography (INEGI Abbreviation in Spanish).

For the quantification of fines, the severity of the committed infraction will be taken into consideration; the economic conditions of the offender, and the recurrence, if any.

To determine the severity of a violation, the CNSNS has the document "Guideline for Assessing the Impact on Safety of Noncompliance or Violations of the Regulatory Framework at National Nuclear Installations,” which establishes the criteria that govern the process of Evaluation of the Safety Impact, as well as two procedures. The first one assigns a significance level based on the evaluation of four factors (actual consequences, potential consequences, impact to the regulatory process, and intentionality). The second procedure uses the Significance Determination Process

(SDP) to determine the risk significance. The SDP assigns a colour of green, white, yellow or red, depending on the risk significance. Green corresponds to the lowest risk and red to the highest.

Moreover, CNSNS has a third procedure which describes the preparation and conduct of Investigation Visits to the national nuclear installations. This procedure establishes the steps to be taken to collect on the site the information related to the infringements or violations occurred in a nuclear installation, and to document it appropriately in accordance with the Federal Law of Administrative Procedure, which governs the actions of the national administrative authorities in his acts and resolutions

– Experience with legal actions and enforcement measures

In December 2017, the CNSNS carried out an on-site inspection to the LVNPS and at the beginning of 2018 the corresponding Opinion was prepared, which documented seven specific non-compliances. The CNSNS evaluation of the response prepared by CFE determined that the information presented did not undermine nor justify any of these non-compliances. Subsequently it was determined that only four had a Low to Moderate severity. In this regard, the CNSNS Directorate of Legal and International Affairs was requested to initiate an Administrative Sanction Procedure for these violations, which began and concluded in 2019 with a fine imposed on CFE.

In the first semester of 2018, CNSNS conducted the first Investigation Inspection to LVNPS. The respective Opinion documented eleven specific non-compliances. The evaluation of the LVNPS's response determined that the information presented did not undermine nor justify any of the aforementioned non-compliances, except for two items out of four of a specific non-compliance. The safety impact assessment of these infringements, determine that eight of them merited the imposition of an administrative sanction, so, in 2019 the CNSNS Directorate of Legal and International Affairs was requested to initiate an Administrative Sanction Procedure for these violations. In the 2019 – 2021 period, a joint review was carried out with the Directorate of Legal and International Affairs to prepare the official notice of the sanctioning procedure to the CFE, obtaining a final version of the document. During the first part of 2022, the CFE will be notified of the initiation of this procedure.

In December 2018, the CNSNS conducted the second Investigation Inspection. The respective Opinion documented eleven specific non-compliances. The evaluation of the CFE response determined that the information presented did not disprove nor justify any of the non-compliances. The evaluation of the safety impact of these non-compliances determined that nine of them are susceptible to imposition of an administrative sanction, so in 2019 the Directorate of Legal and International Affairs was requested to review the official draft notice to initiate the corresponding Administrative Sanction Procedure. At the end of 2021, a new draft version was sent to the Directorate of Legal and International Affairs, which was accompanied by the original file of the aforementioned inspection. In this regard, it is expected that this sanctioning procedure will begin in 2022.

Annexe 7.1 International Treaties Signed by Mexico on Nuclear Matters Applicable to CNSNS

International Atomic Energy Agency

Name	Date of signature	Date of entry into force	Notes
International Atomic Energy Agency (IAEA) Statute	December 7, 1956	April 7, 1958	The signing of this statute makes Mexico an IAEA member state. It contains an amendment to Article VI, adopted in Vienna on September 28, 1970, that is in force and to which Mexico is a party
Agreement on the privileges and immunities of the International Atomic Energy Agency (IAEA)	July 1, 1959	October 19, 1983	The representatives of the member states will accept the privileges and immunities for IAEA officials and experts
Treaty for the proscription of nuclear weapons in Latin America	February 14, 1967	September 20, 1967	As stated in Article 14, Mexico commits itself to submit semi-annual reports on the application of safeguards to nuclear materials in the country
Treaty on the non-proliferation of nuclear weapons	July 1, 1968	January 21, 1969	This Treaty obliges Mexico to keep an accounting and control system of nuclear materials subjected to IAEA safeguards
Agreement for the application of safeguards related to the Treaty for the Proscription of Nuclear Weapons in Latin America and the Treaty on the Non-Proliferation of Nuclear Weapons	September 27, 1972	September 14, 1973	Article 7 obliges Mexico to establish and maintain an accounting and control system of all nuclear materials subject to safeguards. Article 63 obliges Mexico to report changes in the inventory of nuclear materials and report the nuclear material balance

Name	Date of signature	Date of entry into force	Notes
Subsidiary arrangements relating to the Agreement for the application of safeguards related to the Treaty for the proscription of nuclear weapons in Latin America and the Treaty on the non-proliferation of nuclear weapons	September 17, 1972	September 14, 1973	Under these Arrangements Mexico is obliged to provide the following: information on facilities and nuclear material located outside them; reports on accounting and changes in the inventory; materials balance, together with the corresponding physical inventory report; and the transfer of nuclear material from or to México
Additional Protocol to the Agreements between Mexico and the IAEA for the application of safeguards	March 29, 2004	March 4, 2011	Mexico is obliged to submit information to the IAEA on nuclear installations and those outside them. Mexico shall prepare a report on the research and development activities related to the nuclear fuel cycle, safeguards operational activities in installations and locations outside the facilities where nuclear material is routinely used. Mexico is obliged to make annual declarations about exports and imports of nuclear material subject to safeguards (basic materials which did not reach the composition suitable for fuel fabrication) and material which is exempted from safeguards, and dual use equipment and non-nuclear material
Vienna Convention on Civil Liability for Nuclear Damages	April 25, 1989	July 25, 1989	The Convention obliges our country to cover the damage caused by an accident at a Mexican nuclear installation.

Name	Date of signature	Date of entry into force	Notes
Convention on physical protection of nuclear materials	April 4, 1988	May 4, 1988	The Convention obliges Mexico to take appropriate measures, under its national legal framework and in accordance with international law, to ensure that the nuclear materials are protected during their transportation, use and storage
Amendments to the Convention on physical protection of nuclear materials	Not applicable	August 1, 2012	These amendments update various items included in the Convention, extending coverage to nuclear installations and transportation of nuclear material
Convention on prompt notification of nuclear accidents	September 26, 1986	June 10, 1988	This Convention obliges Mexico to be prepared to address radiological and nuclear emergencies, to facilitate the exchange of information with the IAEA and the signatory countries; in addition to provide information to the IAEA about any radiological or nuclear accidents. Mexico is also obliged to establish points of contact for the help and participate in IAEA exercises
Convention on Reciprocate Assistance in the Event of Nuclear Accident or Radiological Emergency	September 26, 1986	June 10, 1998	The Convention's objective is to provide and / or receive assistance in case of a nuclear or radiological accident. Mexico is obliged to establish points of contact for the help and participate in IAEA exercises
Convention on Nuclear Safety	November 9, 1994	October 24, 1996	Mexico is obliged to prepare the triennial report on the nuclear safety implemented in nuclear power reactors, participate in meetings of the Contracting Parties and to answer the questions posted by other Contracting Parties

Name	Date of signature	Date of entry into force	Notes
Comprehensive Nuclear-Test-Ban Treaty	September 24, 1996	December 27, 1999	CNSNS was designated as a national technical counterpart to this treaty, taking over control of the installation of seismic stations, radionuclide detection and hydroacoustics. Moreover, in the near future, administration of the national data centre
Cooperation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean	May 11, 1999	September 5, 2005	Through this agreement, Latin American countries develop technical cooperation projects under the auspices of the International Atomic Energy Agency (IAEA)
International Accord for the Repression of Nuclear Terrorism Acts	January 12, 2006	July 7, 2007	Nuclear crimes are established, requiring states to establish jurisdiction over such offences, as well the exchange of information and assistance between countries
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management	February 2, 2018	May 17, 2018	Mexico is obliged to prepare a national report on the national policy for this matter. Besides, Mexico has to participate in the annual meetings of this Convention
Treaty on the Prohibition of Nuclear Weapons	September 20, 2017	January 22, 2021	Each State Party undertakes never under any circumstances to develop, test, produce, manufacture, acquire, possess, transfer to any recipient, receive the transfer of, use or threaten to use nuclear weapons or other nuclear explosive devices

Annexe 7.2 Bilateral Agreements Signed by CNSNS

Name	Date of signature	Date of entry into force	Notes
Australia: Agreement between the governments of Mexico and Australia for cooperation in the peaceful uses of nuclear energy and nuclear material transfer	February 28, 1992	Exchange of diplomatic notes	None
Australia: Administrative arrangement on safeguards between the Secretariat of Energy, Mines and Parastate Industry (currently Secretariat of Energy) and the Australian safeguards office.	May 26, 1994	May 26, 1994	CNSNS is obliged to submit annual reports on nuclear materials imported from Australia
Canada: Agreement between the governments of Mexico and Canada for cooperation in the peaceful uses of nuclear energy.	November 16, 1994	February 24, 1995 Exchange of diplomatic notes	CNSNS is obliged to submit annual reports on nuclear materials imported from Canada
Canada: Administrative Agreement between the Canadian Nuclear Safety Commission and CNSNS on import and export of radioactive sources	Exchange of notes on February 6, 2009 and March 25, 2009	March 25, 2009	Through this agreement the parties exchange information about the sending and receiving of category I radioactive sources

Name	Date of signature	Date of entry into force	Notes
Cuba: Agreement of cooperation on nuclear and radiation safety between the Secretariat of Energy and the Ministry of Science, Technology and Environment of the Republic of Cuba on nuclear and radiation safety	May 24, 1996	May 24, 1996	As part of this Agreement, several international cooperation actions took place
Spain: Agreement of technical cooperation between CNSNS and the Nuclear Safety Council of Spain.	March 8, 1994	March 8, 1994	As part of this Agreement, several international cooperation actions took place.

Name	Date of signature	Date of entry into force	Notes
United States of America: Agreement of cooperation between CNSNS and the USNRC on exchange of technical information and cooperation on nuclear reactor safety and research	September 18, 2012	September 18, 2012	As part of this Agreement, several international cooperation actions took place.
United States of America: Memorandum of cooperation between CNSNS and the USNRC on import and export of some radioactive sources	September 1, 2017	September 1, 2017	Both parties are obliged to confirm radioactive sources delivery and receipt, particularly categories I and II
Guatemala: Agreement of cooperation between CNSNS and the General Directorate for Nuclear Energy of Guatemala on Radiation Safety	February 26, 1996	February 26, 1996	As part of this Agreement, several international cooperation actions took place
France: Agreement of cooperation between the governments of Mexico and France for the development of peaceful uses of nuclear energy	July 30, 2014	August 1, 2015	The parties will develop activities of technical and scientific cooperation in the use of nuclear energy for peaceful purposes

Name	Date of signature	Date of entry into force	Notes
Russia: Agreement between the governments of Mexico and Russia for cooperation in the field of peaceful use of nuclear energy	December 4, 2013	September 28, 2015	Together they will develop and strengthen cooperation in the field of peaceful use of nuclear energy
South Korea: Agreement between the governments of Mexico and South Korea for cooperation in peaceful uses of nuclear energy	June 17, 2012	July 14, 2013	Through the framework of this agreement various actions to foster and promote cooperation in the peaceful use of nuclear energy were developed, in accordance with the respective applicable laws and regulations
Argentina: Agreement between the governments of Mexico and Argentina for cooperation in peaceful uses of nuclear energy.	July 4, 2002	July 4, 2002	This agreement has as objective to promote the cooperation for the development and application in peaceful uses of nuclear energy and motivate the commercial cooperation, in accordance with necessities and priorities of the nuclear programs
United States of America: Agreement for cooperation in peaceful uses of nuclear energy	May 7, 2018	Non applicable	Pending for approval by the Mexican Chamber of Senators

Annexe 7.3 Summary of Mexican Official Standards Applicable to Nuclear Facilities

Standard	Title	Publication date
NOM-001-NUCL-2013	Dose equivalent calculation factors	Dec-6-2013
NOM-002-NUCL-2015	Leak and tightness tests for sealed sources	Oct-26-2015
NOM-004-NUCL-2013	Classification of radioactive waste	May-7-2013
NOM-008-NUCL-2011	Radioactive contamination control	Oct-26-2011
NOM-012-NUCL-2016	Requirements and operation criteria to be fulfilled by ionising radiation monitors and direct lecture dosimeters	Jan-16-2017
NOM-018-NUCL-1995	Methods to determine activity concentration and total activity in radioactive waste packages	Aug-12-1996
NOM-019-NUCL-1995	Requirements for low level radioactive waste packages for their definitive storage near the surface	Aug-14-1996
NOM-021-NUCL-1996	Lixiviation tests for solidified radioactive waste specimens	Aug-4-1997
NOM-022/1-NUCL-1996	Requirements for a facility for the near-surface, permanent storage of low-level radioactive waste. Part 1. Site	Sep-5-1997
NOM-022/2-NUCL-1996	Requirements for a facility for the near-surface, permanent storage of low-level radioactive waste. Part 2. Design	Sep-5-1997
NOM-022/3-NUCL-1996	Requirements for a facility for the near-surface, permanent storage of low-level radioactive waste. Part 3. Construction, operation, closing, post-closing and institutional control	Jan-14-1999
NOM-026-NUCL-2011	Medical surveillance from occupationally exposed personal to ionising radiation	Oct-26-2011
NOM-028-NUCL-2009	Radioactive waste handling in radioactive facilities that use open sources	Aug-4-2009
NOM-031-NUCL-2011	Requirements for the qualification and training of the occupationally exposed personal to ionising radiations	Oct-26-2011

Standard	Title	Publication date
NOM-034-NUCL-2016	Selection, qualification and training requirements of personnel in nuclear power plants	Dec-2-2016
NOM-035-NUCL-2013	Criteria for the disposal of radioactive waste	May-7-2013
NOM-036-NUCL-2001	Requirements for facilities for treatment and conditioning of radioactive waste	Sep-26-2001
NOM-039-NUCL-2020	Specifications for exemption from some or all regulatory conditions for practices and sources within a practice that use ionizing radiation sources	Dec-9-2020
NOM-041-NUCL-2013	Annual limits on incorporation and their concentrations in releases	May-6-2013

Annexe 7.4 Summary of Mexican Official Standards applicable to nuclear facilities but outside CNSNS's competence

Standard	Title	Publication date
NOM-002-STPS-2010	Safety conditions - prevention, protection and fire fighting in the workplace	Dec-9-2010
NOM-005-STPS-1998	Health and safety conditions in the workplace for handling, transportation and storing of dangerous chemical substances	Feb-2-1999
NOM-010-STPS-2014	Chemical contaminants in the work environment – recognition, evaluation and control	Apr-28-2014
NOM-011-STPS-2001	Health and safety conditions in workplaces where noise is generated	Apr-17-2002
NOM-012-STPS-2012	Health and safety conditions in the workplace relating to the manufacturing, use, handling, storing or transportation of ionizing radiation sources	Oct-31-2012
NOM-017-STPS-2008	Selection, use and handling of personal protective equipment in the workplace	Dec-9-2008
NOM-018-STPS-2015	Harmonized system for the identification and communication of risks and hazards from dangerous chemicals in the workplace	Oct-9-2015
NOM-052-SEMARNAT-2005	The characteristics, the identification procedure, classification and hazardous waste listings	Jun-23-2006
NOM-053-SEMARNAT-1993	Procedure to perform the extraction test to determine the components that could make a waste hazardous based on their toxicity to the environment	Oct-22-1993

Standard	Title	Publication date
NOM-054-SEMARNAT-1993	Procedures to determine the incompatibility between two or more wastes considered hazardous by the Mexican official standard NOM-052-SEMARNAT-1993	Oct-22-1993
NOM-133-SEMARNAT-2015	Environmental protection - polychlorinated biphenyls (PCBs) - handling specifications	Feb-23-2016

ARTICLE 8. REGULATORY BODY

Obligations

1. *"Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities."*

2. *"Each Contracting Party shall take appropriate steps to ensure effective independence between the regulatory body functions and any other body or organization concerned with the promotion or utilization of nuclear energy."*

Article 8 (1) <u>Establishment of the regulatory body</u>

– Legal foundations and statute of the regulatory body

Legal bases

The Mexican regulatory body regarding nuclear safety, radiation safety and safeguards areas is the National Commission of Nuclear Safety and Safeguards (CNSNS), which was established and created by the Regulatory Law on Nuclear Matters of Article 27 of the Constitution (or Nuclear Law), on January 26, 1979. As mentioned in Article 7 (1), the following articles of the Nuclear Law dated February 4, 1985 (which substitute to the nuclear law dated Jan 26, 1979), give support to CNSNS's functions: Articles 13, 17, 18, 19, 23, 28, 29, 32, 33, 34, 35, 36, 37 and 50.

Statutes

CNSNS does not have statutes because it was created by law as a deconcentrated body under the Secretariat of Energy; so as deconcentrated, CNSNS does not have assets or legal personality of its own.

– Mandate, mission and tasks

Mandate

CNSNS was created by the Nuclear Law. Article 50, Fraction I of this law states that it is a deconcentrated body under the Secretariat of Energy, which serves as the regulatory body responsible for overseeing nuclear and radiation safety, security, as well as safeguards within the Mexican national territory.

Mission

CNSNS's mission is: Regulate the nuclear and radiation safety, security and safeguards for the pacific use of nuclear energy to protect the health of the population and the environment.

Tasks

The main tasks carried out by CNSNS are: review and assessment, authorisation, inspection, development of regulations and guidelines, and enforcement. CNSNS also performs other supplemental tasks, such as: emergency preparedness, examination and licencing of nuclear facility control room operators; issuing licences and import permits for the use, transport, and storage of radioactive materials; participation in technical assistance and international cooperation agreements; and independent execution of research and development projects or in association with other regulatory agencies or research centres, or academic institutions.

– Attributions and responsibilities

Attributions

The primary attributions of CNSNS are to propose and enforce the application of nuclear and radiation safety, security, and safeguards standards and regulations for the operation of nuclear and radioactive installations, as well as the use, handling, transportation and possession of nuclear and radioactive materials.

Responsibilities

CNSNS's responsibility is setting the bases and preparing the technical opinion, and is empowered to grant the licences for nuclear and radioactive installations. It is also responsible for conducting audits, inspections and verifications to nuclear and radioactive installations, including physical security and safeguards. CNSNS has the authority, by law, to decree sanctions to the installations that do not comply with the regulatory framework. Similarly, for the licencing of nuclear installations operators, CNSNS performs the evaluation of candidates through written and simulator-based operational examinations, and grants the operator's licences.

Additionally, according to the General Law of Ecological Equilibrium and Environmental Protection, CNSNS is responsible for reviewing the environmental radiological information contained in the licence applications of future plants, and the periodic reports submitted by operating plants during their operation, both in order to avoid undue risks to human health and ensure the preservation of ecological equilibrium and environmental protection. However, the Secretariat of the Environment and Natural Resources reviews the environmental impact assessment. In addition, CNSNS carries out an environmental monitoring independent from the one done by the licence holder, through an isotopic analysis of environmental samples collected periodically in LVNPS's vicinity and finally these samples are processed at CNSNS laboratory. The surveillance results allow verifying the consistency of the periodic reports submitted by the licence holder.

- **Organisational structure of the regulatory body**

Figure 8.1 shows CNSNS's organisation, which has four Coordinator Directors and a Finance and Administration Director, which report to the Director General and have the following objectives:

Coordinator Directorate of Nuclear Safety, responsible for proposing the regulations on nuclear and radiation safety, as well as verifying their compliance at nuclear installations.

Coordinator Directorate of Radiation Safety, responsible for proposing the regulations on radiation safety and verifying their application in radioactive installations.

Coordinator Directorate of Environmental Radiation Monitoring, Physical Security, and Safeguards, responsible for proposing the regulations and operate the national system of environmental radiation monitoring and for maintaining the national system of safeguards and physical security at nuclear installations.

Coordinator Directorate of Technology, Regulation, and Services, responsible for updating and adapting the regulatory framework and providing technical support on nuclear and radiation safety, physical security, and safeguards required by CNSNS staff. It manages the information and communications technology system.

Directorate on Finances and Administration, responsible for managing the human, financial and material resources allocated to CNSNS, in accordance with applicable regulations and policies. It handles or provides the services that are generally required for the maintenance and conservation of the facilities and assets.

CNSNS also has the Directorate of Legal and International Affairs, the Nuclear Contingency Organisation and the Radiological Contingency Organisation, all of them report to the Director General.

– Development and maintenance of human resources over the past three years

CNSNS currently has the following authorized staff, permanent and temporal:

General Organisation Structure	Number of Positions			
	2019	2020	2021	Difference
Director General Office	6	6	6	0
Coordinator Directorate of Nuclear Safety	46	46	46	0
Coordinator Directorate of Radiation Safety	53	53	53	0
Coordinator Directorate of Environmental Radiation Monitoring, Physical Security, and Safeguards	23	23	23	0
Coordinator Directorate of Technology, Regulation, and Services	30	30	30	0
Directorate on Finances and Administration	37	37	37	0
TOTAL	**195**	**195**	**195**	**0**

For this total number, 29 are temporal personnel.

– Measures to develop and maintain competence

In order to ensure the acquisition of appropriate skills, as well as the achievement and maintenance of adequate levels of competence, CNSNS carries out planning and programming actions for the training of its personnel, which on average, exceeds the 40 hours of training per person per year established by the Regulations of the Law of the Professional Career Service in the Federal Public Administration.

In order to achieve this objective, CNSNS relies on the following measures:

1.- General training; connected with public service.

2.- Specialised technical training; oriented to carry out its functions

3.- Establishment of an annual training programme.

In order to homologate the knowledge of graduates coming from different colleges and curricula, CNSNS has developed a basic training programme. This programme includes fundamentals of radiological and nuclear safety, nuclear reactor technology and an introduction to the areas and duties that are CNSNS's responsibilities.

Another action taken to develop and maintain the staff's competence is the personnel participation in training programmes of other regulatory bodies. Such is the case of the United States Nuclear Regulatory Commission (USNRC), which has provided training to CNSNS staff on Boiling Water Reactors (BWRs) technology, among others, at the Technical Training Centre in Chattanooga, Tennessee, and at the Professional Development Centre in Bethesda, Maryland. Also, through international agreements, CNSNS's personnel have received training from organisations and centres in France, Germany, Argentina, Japan, Brazil, Bulgaria, and the Philippines, among other countries. More recently, CNSNS also has benefitted from the European Commission's Nuclear Safety Cooperation Instrument (NSCI) created to foster a higher level of nuclear safety and radiation protection in the member countries of the European Union and in other regions of the world, mainly benefiting developing countries.

During the reporting period, derived from the prevailing epidemiological worldwide conditions, technical training from bilateral and multilateral agreements with the IAEA, the USNRC and the European Commission was sensibly reduced; technical training by national, public and private institutions was also reduced. In contrast, in 2021 the CNSNS with its resources provided more hours of technical training (on radiation protection and nuclear reactor technology topics) than in the entire previous three-year period (2016, 2017 and 2018). Even so, the dominant theme of the training program during the period was on competencies for public service and organizational efficiency.

It should be noted that the CNSNS competency management model is consistent with the methodology developed within the International Atomic Energy Agency (IAEA), set out in IAEA Safety Report Series No. 79 "Managing Regulatory Body Competence" and IAEA TECDOC 1757 "Methodology for the Systematic Assessment of the Regulatory Competence Needs (SARCoN) for Regulatory Bodies of Nuclear Installations". This model has been adapted to all substantive areas of the CNSNS with the advice of experts from a national university and the European Union.

- **Developments with respect to financial resources over the pasts three years**

The total budget assigned to CNSNS comes from the Mexican government. The allocation of financial resources in the last three years is shown below.

Year	Budget Mexican Pesos (national currency)	Budget US Dollars
2019	121,310,312	6,065,515
2020	98,834,225	4,941,711

Year	Budget Mexican Pesos (national currency)	Budget US Dollars
2021	116,879,413	5,843,971

Because CNSNS is a deconcentrated body under the Secretariat of Energy, there is no income from its operation; since the fees paid by users of radioactive material for its licencing, handling and transportation, and the payment made by the Laguna Verde Nuclear Power Station (LVNPS) licence holder are collected directly by the Federal Treasury.

– Statement of adequacy of resources

In the year 2018, CNSNS's budget has increased slightly because part of the fee paid by the LVNPP licence holder has been transferred to CNSNS.

In education, the postponement in recent decades of the global growth of nuclear power programmes has led to stagnation and even closing of some nuclear science and engineering programmes in Mexico. However, the same problem does not exist in other fields of engineering, including those covering the design, construction and operation of nuclear power plants. At CNSNS the combination of policies to reduce public spending and early-retirement programmes led to a substantial decrease in personnel early last decade. Although efforts have been made in the past decade to regain the human resources that CNSNS had in 2000, a period of knowledge lost from experienced personnel has been unavoidable. Still, currently approximately 50% of the personnel in the areas of nuclear safety have an average of over 20 years of experience.

The human resources difficulty for the CNSNS is to consolidate a training and knowledge management program that efficiently promotes the professional training of the new generation of regulators based on the knowledge and experience of senior staff.

– Quality management system of the regulatory body

CNSNS has an institutional-wide Quality Management System (QMS) since 2004, which is regularly updated. The QMS includes all the processes carried out to meet CNSNS's regulatory responsibilities regarding nuclear and radioactive installations. The QMS adopts the requirements of ISO 9001-2015 and its implementation is through a Quality Manual and the procedures associated with the processes.

- **Openness and transparency of regulatory activities including actions taken to improve transparency and communication with the public**

The ”Federal Law of Transparency and Access to Public Information” and the “General Law of Transparency and Access to Public Information“, both last amended on May 20, 2021, establish guidelines for classifying government information, whether public, reserved or confidential. Since previous entry into force of these laws, the Federal Government created the web-based application INFOMEX, which is used by CNSNS to provide information to the public when it is requested.

- **External technical support, if appropriate**

Although CNSNS has qualified personnel in various technical areas, in some instances, external consultants from the National Institute of Nuclear Research and national or foreign universities are contracted to support some safety assessments.

These external consultants must provide a detailed written report. The report includes the bases and methods used for engineering evaluation or analysis, as well as additional conclusions and recommendations that may facilitate CNSNS's decision making process.

To avoid any possible obstruction or interference in the regulatory decision-making process, the contracts include a confidentiality clause by the external consultant. Additionally, in other cases when it comes to external consultants performing services for both the Regulatory Body and the LVNPS operator, in order to avoid a potential conflict of interest, the CNSNS includes a clause with mechanisms that guarantee the independence between the LVNPS licence Holder and the external consultant. For instance, it avoids that the same task assigned to the external contractor, is not developed for the Regulatory Body and for the LVNPS operator.

- **Advisory committees, if appropriate**

Article 51 of the Nuclear Law states: *"The National Commission of Nuclear Safety and Safeguards will be headed by a Director General, and will have an Advisory Council and the staff necessary to perform its attributions."*

Likewise, Article 52 of the same Nuclear Law states: *"The Advisory Council's purpose is to advise the National Commission of Nuclear Safety and Safeguards. In order to achieve this goal the council will provide the technical support requested and perform the studies required to attend the consultations made by its President."* However, this Advisory Council has not been created yet.

Article 8 (2) <u>Status of the regulatory body</u>

– Position of the regulatory body in the governmental structure

The Secretariat of Energy has decentralized bodies, coordinated regulatory bodies in energy matters, state productive enterprises and research centres. One of the deconcentrated bodies is the CNSNS, which is part of this Secretariat.

It is the responsibility of the Secretariat of Energy to issue and update, through CNSNS, the appendixes, technical standards, manuals and instructions, needed to develop, make explicit and identify options to comply with the provisions of the General Regulation for Radiation Safety. CNSNS has the authority to interpret and apply this Regulation.

Figure 8.2 shows the position of CNSNS in the Federal Government organisation.

– Reporting obligations (to the parliament, government, specific ministries)

CNSNS is required to file a monthly progress report to the Secretariat of Finance and Public Credit (SHCP) about the compliance with the goals set up at the beginning of the fiscal year. It also has the obligation to provide the administration accountability annual report to the Secretariat of Energy. The report informs about the programmes executed and the results achieved by CNSNS's management.

In addition, a quarterly report on risk management and activities related to institutional internal control is submitted to the Secretariat of Public Function.

– Means by which effective separation is ensured between the functions of the regulatory body and those of any other body or organisation concerned with the promotion or utilization of nuclear energy, and means by which independence of the regulatory body in making its safety-related decisions is assured

According to the provisions of the Nuclear Law, on January 26, 1979, the National Commission of Nuclear Safety and Safeguards was created as a deconcentrated body of the Secretariat of Energy. This Law empowers CNSNS as the responsible agency for all matters related to nuclear resources, control and surveillance of nuclear power production with maximum safety at nuclear installations. CNSNS is also responsible for assuring the adherence to the standards on nuclear and radiation safety, security, and safeguards. It should be noted that the Nuclear Law dated February 4, 1985, states that the Federal Executive Branch can also exercise these powers, through the Secretariat of Energy.

Moreover, Article 6, Fraction VII of the Secretariat of Energy Internal Regulations (October 31, 2014) states that *"The Undersecretaries and the Chief Clerk have, within* *the scope of their competence, the authority to coordinate the administrative units that are assigned to them and have, as well, besides the following powers: Submit for the Secretary consideration, with the opinion of the Legal Affairs Unit, draft laws, regulations, decrees, accords, treaties, international agreements and general legal provisions that contain provisions in the Secretary's area of competence;"* In addition to this, Article 40 of the cited regulation establishes that *"CNSNS and the National Commission for the Efficient Use of Energy shall have the organisation and powers that establish the legal and regulatory laws for which they were created or that govern their organisation and operation"*.

In the same line, Article 10, Sections I, XV, XXII and XXXII, states that: *"The Unit of the National Electric System and Nuclear Policy has the following powers: I. To agree with the Undersecretary of Energy on matters relative to the National Electric System, Nuclear Policy, as well as those that are specifically assigned to them; XV. Initiate, process and resolve administrative proceedings and impose sanctions when applicable, in terms of the Electric Industry Law, its regulations or provisions emanated from it, and others related to the National Electric System and Nuclear Policy; XXII. Apply laws and other legal standards derived from these systems, whose provisions are the responsibility of the Secretariat, in matters of nuclear energy; and XXXII. Prepare and submit for consideration of the Undersecretary of Electricity, the draft of guidelines and programmes related to the nuclear industry and the use and development of nuclear energy and technology;"*

It should be noted that in the cited regulation, Article 42, among other powers of the Director General of CNSNS, are the contents of Fractions VIII, X, XXV, and XXXI through XLIV, which state: *"Issue official Mexican standards, as well as preside and, if necessary, appoint the President of the National Standardization Advisory Committees; Participate, when appropriate, with the administrative units of the Secretariat in drafting applicable Mexican standards; Execute and monitor treaties and conventions related to nuclear and radiation safety, physical security, and safeguards, as well as international agreements, accords and commitments as referenced in the previous fraction; Issue and publish, in the Official Journal of the Federation, declarations related to the determination of what is considered nuclear fuel, source material, special fissionable material and radioactive mineral; Issue the standards that regulate the use of nuclear reactors and monitor compliance with them; Issue the regulations related to the storage, transport and disposal of nuclear fuel and radioactive waste; Issue the regulations in matters of nuclear and radiation safety, physical security, and safeguards, and monitor compliance; Issue, as appropriate and in accordance with applicable legal provisions, authorisation for the production, use and application of radioisotopes other than those produced from nuclear fuel; Collect and remove, if they exist, the instruments, equipment, material on-hand, and generally any movable contaminated items in nuclear installations; Enact the provisions related to energy- and non-energy-use of radioactive materials; Issue, as appropriate and in accordance with applicable legal provisions, authorisation for the handling and custody of radioactive materials; Authorise the appropriate public agencies to temporarily store nuclear fuel and radioactive waste*

derived from its use; Issue authorisation for the production of radioisotopes from nuclear fuel; Issue authorisation for the fabrication of components for nuclear steam supply systems; Issue authorisation for the handling, use , transport, storage, custody and reprocessing of nuclear fuel and materials; Grant, modify, suspend and revoke permits for conducting activities in nuclear installations, as well as grant licences to the personnel that work in them; and Issue authorisation for the acquisition, import, export, possession, use, transfer, transport, storage, and final destination or disposal of radioactive material and ionizing radiation-generating devices, as well as for the import and export of nuclear fuel and materials."
Finally, it is important to note that the last paragraph of Article 50 of the Regulatory Law of Article 27 of the Constitution for Nuclear Material literally states that *"The Federal Executive, through the head of the Secretariat of Energy, may also exercise the powers contained in the previous sections."*

Based on the above, it can be concluded that CNSNS is not administratively independent of the bodies responsible for promoting nuclear technology. Nevertheless, since its creation, CNSNS has had complete technical independence.

- **IRRS Mission information**

CNSNS received two missions: IAEA International Regulatory Review Team (IRRT) in 2001, and IAEA Integrated Regulatory Review Service (IRRS) in 2007.

From both Missions the following recommendations have been made to CNSNS:

- Make more effort to obtain effective independence.
- Enhance the legal basis (completeness and consistency) and improve alignment with international standards and practices.
- Expand the nuclear regulatory framework and develop an enforcement policy.
- Establish mechanisms for an independent communication with the public on the regulatory requirements, decisions, opinions and its bases.
- Enhance the internal working procedures related to the establishment of priorities, the coordination of activities and the allocation of resources
- Enhance the effectiveness of the inspection and evaluation processes
- Integrate a training programme for CNSNS's staff with special attention to inspector training
- Develop the legal mechanisms to ensure sufficient financial resources.

In this regard, the CNSNS has taken the following actions, which have already been described in the Summary of this National Report:

1. Effective independence: The CNSNS, although it is subordinated to the SENER, the latter has already delegated powers to CNSNS, and has technical and administrative autonomy. It is recognized as a National Safety Agency.

2. Improve and expand the nuclear regulatory framework: As indicated in Article 7 of this National Report, the Preliminary Draft Regulations for Nuclear Facilities are still under review by the CNSNS. The licensing process has been reviewed in accordance with the International Atomic Energy Agency (IAEA) Safety Guides.

3. Independent communication with the public: As indicated in Article 7 of this National Report, information related to the licensing system and its processes is available to the public and interested agencies in accordance with the provisions of the Mexicans laws on transparency and access to public information.

4. Improve work procedures and process effectiveness: As indicated in this article, CNSNS has a Quality Management System that addresses this issue. Generally, two internal audits are carried out each year.

Regarding the sufficiency of financial resources, as described in this Article and the Summary, the Federal Government's savings policies have limited the CNSNS budget; however, to compensate for this, the workload is being classified according to the priorities.

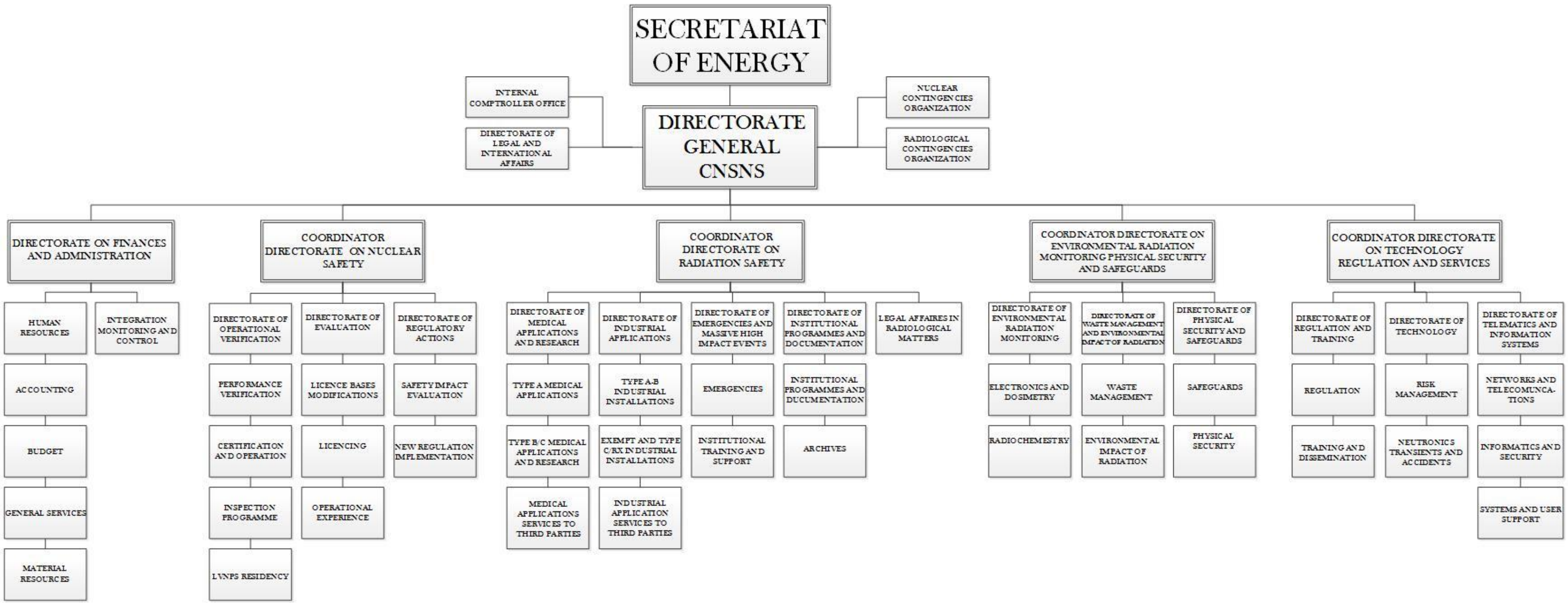

Figure 8.1 National Commission for Nuclear Safety and Safeguards (CNSNS) organization chart

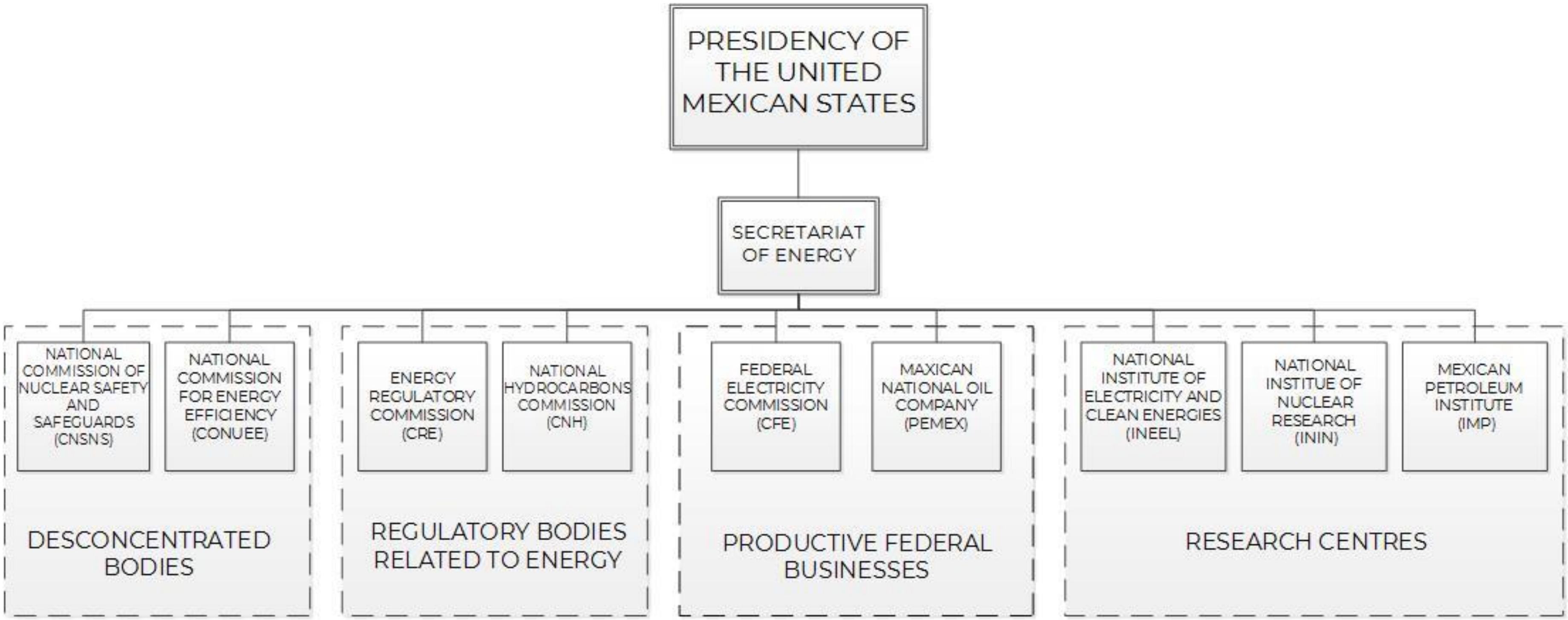

Figure 8.2 Position of CNSNS in the federal government organization

ARTICLE 9. RESPONSIBILITY OF THE LICENCE HOLDER

Obligations

"Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility."

– **Formulation in the legislation (quotation) assigning the prime responsibility for safety to the licence holder**

The Regulatory Law on Nuclear Matters of Article 27 of the Constitution (hereinafter called "Nuclear Law") states in its Article 27 that *"The nuclear installations shall be staffed with the nuclear and radiation safety personnel required, and the head of the corresponding government organization shall be responsible for the strict compliance with applicable standards."*

Likewise, Article 28 establishes that "*Authorisations for the construction and operation of a nuclear facility will only be granted when it is demonstrated, through the provision of relevant information, how the safety objectives will be achieved and what procedures and methods will be used during the phases of siting, design, construction, operation, modification, definitive shutdown and dismantling of the facility* ".

Furthermore, the Law of Civil Liability for Nuclear Damages that entered into effect on December 29, 1974, provides in its Article 4 that *"The operator's public liability for nuclear damages is objective"*; that is, the licence holder of the nuclear power plant is responsible for potential damages that might be caused by this installation.

– **Description of the main means by which the licence holder discharges the prime responsibility for safety**

Federal Electricity Commission responsibility, through its Power Plant Division, on Laguna Verde Nuclear Power Station is recognized and committed in its Quality Assurance Plan. According to this plan, CFE's General Director keeps the obligation before CNSNS for conducting a safe operation of the LVNPS Units 1 and 2, according to the requirements established in the regulatory framework and in compliance with the commitments established in the Authorisations for Operation and the Technical Specifications (TS).

– Description of the mechanism by which the regulatory body ensures that the licence holder discharges its prime responsibility for safety

The prime responsibilities for safety defined by CNSNS to be met by the Federal Electricity Commission, operator of LVNPS, are stipulated in the Authorisation of Operation Terms and Conditions.

Likewise, CNSNS has also established several mechanisms to guarantee that the licence holder satisfies each one of the items related to the obligations acquired through the Authorisation of Operation. These mechanisms include the following:

1. A Baseline Inspection Programme
2. Design changes classified as safety significant that requires CNSNS authorisation
3. Independent analysis of operational events and their safety significance and follow up of safety improvements arisen from the application of the operational experience
4. Assessment of plant nuclear safety performance
5. Nuclear laws and regulation enforcement

As indicated in Article 14, the Baseline Inspection Programme is aimed to collect enough information about the performance of nuclear installations and the licence holder's activities. This allows determining along with the Performance Indicators, when appropriate, if the licence holder is meeting the safety objectives, and identify performance issues to enable the regulatory body to follow-up and take actions before safety is compromised. The inspection frequency depends on the type of activity and its significance for the installation's safety. The Baseline Inspection Programme indicates the minimum number of scheduled inspections to be performed during the period in which the installation performance has a "response from the installation" status. Additionally, the CNSNS Baseline Inspection Programme includes some inspections to verify the following:

1. Quality-related areas
2. Supervising teams; and
3. Cross-cutting areas (programmed with a biennial frequency)

Additional information about the functions and responsibilities of CNSNS, as well as specific activities to verify that the LVNPS meets its responsibilities for safety are presented in Article 14.

– **Description of the mechanisms whereby the licence holder maintains open and transparent communication with the public**

Through the annual broadcast programme for Emergency External Radiation Plan, to the communities surrounding LVNPS, the CFE's Nuclear Corporate Coordination maintain open and transparent communication with the public, providing them with the necessary information required to implement this plan. Moreover, this Division has established a link for informing the public about nuclear technology by providing guided visits of to the nuclear plant.

– **Description of the mechanism by which the Contracting Party ensures that the licence holder of the nuclear installation has appropriate resources (technical, human, financial) and powers for the effective on-site management of an accident and mitigation of its consequences**

The Chamber of Deputies approves the budget allotted to CFE, specifically for LVNPS. This budget is developed under a set of rules and procedures contained in the regulations in budgetary matters.

The budget process covers the entire range of planning and formulation, review and approval, execution and control of spending and audit. Due to LVNPS's technology, it is obligated to comply with various safety standards, including among them the Technical Operating Specifications that ensure the safe and reliable operation of LVNPS. For this reason, the budget planning process for LVNPS focuses on the maintenance of safety-related equipment, as well as the acquisition of goods and services that guarantee the same.

As the executor of spending, LVNPS has the autonomy to implement budgetary processes and assign them to issues that affect or ensure safety, always in compliance with applicable regulations. In this regard the transitory article nineteen of the Law of the Federal Commission of Electricity establishes that "The human, financial and material resources required to comply with the provisions of this Law shall be covered by the budget of the Federal Commission of Electricity"; empowering this Commission to use the resources for the purpose that was created

Additionally, CFE has a Comprehensive Insurance Programme, which is updated annually. This programme consists of eight policies:

1. Comprehensive Policy
2. Policy for Assets and Miscellaneous Risks
3. Policy for Physical Damage to LVNPS
4. Policy for LVNPS's Civil Responsibility
5. Maritime and Cargo Transportation Policy

6. Aircraft Policy
7. Vehicle Fleet Policy
8. Mobile Heavy Equipment Policy

ARTICLE 10. PRIORITY TO SAFETY

Obligations

"Each Contracting Party shall take the appropriate steps to ensure that all organisations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety."

- **Overview of the Contracting Party's arrangements and regulatory requirements regarding policies and programmes to be used by the licence holder to prioritize safety in activities for design, construction and operation of nuclear installations, including:**

▪ Description of the agreements and regulatory requirements

Regarding the agreements and regulatory requirements to give priority to safety, Articles 19, 20, 21, 28, 32, 34, and 50 of the Regulatory Law on Nuclear Matters of Article 27 of the Constitution establishes that of all installation activities performed by the installation owner, including planning, design, construction and operation as well as definitive shutdown and decommissioning, safety always has the highest level of importance to achieve the safety objectives. Likewise, the Regulatory Body has established the conditions under which it will monitor the compliance of nuclear, radiological and physical safety standards and safeguards to ensure that the operation of the facilities is carried out with maximum safety.

For the renewal of LVNPS Authorisation of Operation, extended to 30 years, the Regulatory Body updated the conditions and requirements linked to this authorisation, in order to monitor and maintain the commitment to apply the highest safety standards. These conditions and requirements establish circumstances and deadlines for the delivery of reports and record keeping, as well as conditions that would lead to a suspension, cancellation or revocation of the authorisation of operation, emphasizing the principles of Safety Culture.

▪ Safety policies

Laguna Verde Nuclear Power Station's (LVNPS) safety policy is shown in Figure 10.1a and it is based on the Traits for a Healthy Nuclear Safety culture from Institute of Nuclear Power Operations' (INPO) document INPO 12-12 Rev. 1 of April 1, 2013. These traits and associated attributes described are soundly based on significant events of the nuclear industry. These principles and attributes are connected with, and influence, the values, ownership, experiences, behaviours, beliefs and models of LVNPS's staff.

Likewise, the CFE's General Director, together with the General Secretary of the CFE's Union established the Nuclear Safety Culture Policy, shown in Figure 10.1b below.

LVNPS Top Management is committed to the traits and policies for its daily duties. Any difference or deviation is used as a basis for improvement.

- **Safety culture programmes and development**

The Safety Culture (SC) programme includes the following activities:

- Establishment of the Safety Culture Policy.
- Designation of a group of Safety Culture Ambassadors for the continuous monitoring of Safety Culture, through the collection of cultural events.
- Perform quarterly reports of continuous monitoring of Safety Culture from the 4th Quarter of 2016.
- Semi-annual meetings with the LTS (Leadership Team in Site [Staff of the CFE's Nuclear Corporate Coordination]) issuing and a report, and follow-up actions.
- Development of promotional material.
- Weekly reinforcement of the Traits of a Healthy Culture of Nuclear Safety (THCNS) conducted by the organisation's leaders:
  - Presentation in the supervisors meetings.
  - Presentation by supervisors in workshops.
- SC self-assessment program following the guidelines provided by IAEA during Safety Culture seminars, under the "Enhancing Nuclear Power Plant Life Management and Safety Culture Practices in Latin America" project (RLA9080/RLA9083/RLA9089), which are established in the internal procedure "Guide to conduct a Nuclear Safety Culture Self-Assessment" This methodology is based on the combination of the following techniques:
  - Surveys.
  - Interviews.
  - Focus groups.
  - Documental review.
  - Field observations.
- Feedback to staff about the results of the SC self-assessment.
- Annual survey of Safety Culture.
- Evaluation of the THCNS involved in CFE's nuclear corporate coordination (NCC) events that require a root cause analysis.

In addition to the Safety Culture programme, LVNPS has implemented a set of essential processes, which were developed to create a sustainable framework for Safety Culture. The SC framework is shown in Figure 10.2. The Safety Culture pyramid described in this Figure 10.2 is composed of the regulatory framework and the processes for continuous performance improvement.

The development of the processes for continuous performance improvement consists of the following:

1. The Safety Culture is an integral part of the Policies, Vision and Mission of the CFE's NCC.
2. Extensive on-site communication.
3. Observation programmes.
4. Continuous learning organisation.
5. Continuous monitoring the Safety Culture process.
6. Management process (Planning).
7. Process of effective and conservative decision-making.
8. Process for determining the operability of systems and components.
9. Systematic Approach to Training (SAT).
10. Housekeeping and materials conditions.
11. International agreements.

- **Arrangements for safety management**

LVNPS voluntarily established policies and the Safety Culture Manual, which are monitored through the implementation of continuous improvement processes, and the plant's Safety Culture programme development and support.

- **Arrangements for safety monitoring and self-assessment**

LVNPS is developing Performance Indicators according to the requirements established in the Nuclear Reactor Monitoring System (NEI 99-02 Rev. 6), in order to compare LVNPS performance with similar plants and emulate the best international practices. As an example, in Figure 10.3 the results for the fourth quarter of 2021 are displayed. Performance Indicators for radiation protection, industrial safety and environmental protection have also been developed.

The self-assessment process is being used by LVNPS's groups to identify opportunities for improvement. The process has improved significantly, both in quantity and quality of self-assessments. For instance, in the year 2018, 64 self-assessments were conducted in LVNPS; eight were "Fast" self-assessment, 37 focused in specific topics and 19 were "Follow-up" on topics evaluated in the period 2016 and 2017. Moreover, resulting from each self-assessments, 64 Condition Reports have been documented. Each Condition Report has its analysis and improvement actions.

Additionally, in order to follow-up the LVNPS staff perception on Safety Culture, an annual assessment is performed using the ten principles of INPO/World Association of Nuclear Operators (WANO). The results from these evaluations are presented in Figure 10.4.

- **Independent safety assessments**

Currently, LVNPS is subject to two types of external assessments.

a) The first one, in compliance with the Operation Licence and in accordance with the Technical Specifications (TS) requirement, is an independent inspection to the fire protection and loss prevention system, which is performed at least every 12 months.

These inspections can be performed by Federal Electricity Commission's (CFE) qualified personnel, external inspectors or by staff of a company specialized in fire protection or quality assurance. If CFE's qualified personnel are chosen, then at least every three years the inspection and the audit must be performed by staff of a company specialized in the topics mentioned above.

b) The second type corresponds to external assessments that go beyond regulatory requirements, such as International Atomic Energy Agency (IAEA) Assessment of Safety Significant Events Team (ASSET), Operational Safety Assessment Review Team (OSART) and Safety Culture Assessment Review Team (SCART) missions, as well as peer or counterpart reviews, carried out by WANO, because LVNPS is a member of this association since 1997.

Table 10.1 presents the external assessments conducted from 1997 to December 2020.

Assessment	Date
WANO (Peer review)	November 1999
TUV ANLAGENTECHNIK (Independent audit)	November 2000 to January 2001
WANO (Peer review)	December 2002
WANO (Peer review)	December 2004
WANO (Peer review)	September 2006
WANO (Peer review)	February 2009
SCART	November 2009

Assessment	Date
WANO (Peer review)	May 2011
OSART	October 2012
WANO (Peer review)	October 2013
Independent evaluation of the Safety Culture (by HPA)	February – March 2015
WANO (Peer review)	October 2015
WANO (Peer review)	February 2016
WANO (Peer review)	April 2018
WANO (Peer Review)	Octubre 2020

Table 10.1 LVNPS external assessments

In 2015, Human Performance Analysis (HPA) was contracted to carry out an independent evaluation of the Safety Culture and to obtain a descriptive evaluation of the culture of the NCC, indicating the basic assumptions that govern the culture.

Also in 2015, a group of 20 Safety Culture Ambassadors was formed with the support of the IAEA under project RLA9080. This multidisciplinary team of Safety Culture Ambassadors are responsible for safety culture self-assessments, and to provide all the required information to the organisation to implement the improvement activities needed to positively influence the culture of the NCC.

In 2016 and 2018 the last peer reviews Peer Review were carried out at the Laguna Verde Nuclear Power Plant by WANO Atlanta Center, through which the performance of the plant was evaluated according to the latest revision of the "Objectives and Performance Criteria for WANO peer reviews" (2013). Through this evaluation, recommendations, areas for improvement and strengths were defined for the Organization and areas of the plant. The last WANO Peer Review was conducted in October 2020.

- **Discussion on measures to improve safety culture**

LVNPS is the first Latin American centre to implement the IAEA's Safety Culture Continuous Improvement Process (SCCIP), under the project RLA9080 "Enhancing Nuclear Power Plant Life Management and Safety Culture Practices in Latin America".

With safety performance a priority, the evaluation and understanding of the safety culture at the nuclear power plants are key elements to identify and prevent vulnerabilities that can lead to a decrease in safety performance, as well as production performance.

The process of IAEA´s continuous improving of safety culture, contributes to strengthening and improving the safety culture of the entire organisation. The process consists of five steps:

1. Workshop on safety culture for managers, the purpose of which is to show how the safety culture influences the safety performance, and to understand that a culture change requires a big effort, more so in the managers than in the rest of the organisation.
2. Theoretical and practical training of a team called the Safety Culture Ambassadors, whose purpose is to perform self-assessments of the safety culture and to promote change in the safety culture.
3. Complete a self-assessment of the safety culture with the purpose of obtaining a diagnostic of the organisation that helps define improvement actions.
4. Dissemination of results and feedback from the organisation in order to finalize the report.
5. Implement the improvement actions.

After working through the entire process, steps 3, 4 and 5 will periodically be repeated in the CFE´s NCC (every three years) in order to achieve continuous improvement of the safety culture and to contribute to the safety performance of the plant.

Additionally, LVNPS has incorporated the practices described in NEI 09-07 Rev. 1, “Fostering a Healthy Nuclear Safety Culture,” providing the continuous monitoring and with a higher frequency than the described in the IAEA model, permitting closer monitoring of behaviour and prompt course correction if the desired results are not being obtained.

This model is implemented through the procedure named "Guide to establish a process of continuous monitoring and supervision of Nuclear Safety Culture", for which the Panel for Monitoring Safety Culture (PMSC) formed by the Safety Culture Ambassadors (monthly meetings) and the Leadership Team in Site (LTS) formed by the CFE´s NCC Staff (semi-annual meetings) and based on these meetings, decisions are taken that reinforce the actions taken or redirect them.

- **A process-oriented (quality) management system**

LVNPS developed a Quality Management System (QMS), which consists of a set of documents such as: the quality policy, the organisation manual, processes manual, comprehensive management system plan, work procedures, quality records, and training programmes.

The QMS has been certified by a company accredited in International Quality Certifications by the Mexican Accreditation Authority (EMA) and audited internally according to the following standards: (1) ISO 9001:2015 / NMX-CC-9001-IMNC-2015 "Quality Management Systems", (2) ISO 14001:2015 / NMX-SAA-14001-IMNC-2015 "Environmental Protection Management System", and (3) ISO 45001:2018 / NMX-SAST-001-IMNC-2018 "Occupational Health and Safety."

- **Measures taken by the licence holder to implement arrangements for the priority of safety, such as those above and any other voluntary activities, examples of Good Practices and safety culture achievements;**

The actions and good practices that CFE's NCC has implemented to improve the Safety Culture in its organisation are listed below.

1. Workshops on Safety Culture

   The object of these workshops is to reinforce the values to maintain an organisational Safety Culture through the following:

   a) Stressing a high respect for nuclear technology.
   b) Increasing awareness, understanding and applying the Defence in Depth (DID) concept.
   c) Encouraging the development and implementation of Good Practices for Work and Operation.

2. Safety Culture Monitoring Process

   The guideline to establish the monitoring process and continuous supervision of Nuclear Safety Culture, contains the basis for the monitoring process and continuous supervision of the LVNPS's SC health. The monitoring process is shown in Figure 10.5 and works as follows:

   The Nuclear Safety Culture Monitoring Panel (NSCMP) composed of Safety Culture Ambassadors, monitors the process inputs through the recollection of cultural events which are indicative of the organisation's SC health to identify strengths and potential problems that deserve further attention by the organisation.

   The NSCMP is composed of CFE´s NCC professionals from administrative and technical areas (unionized and non-unionized personnel) with backgrounds in Safety Culture. This group prepare quarterly reports and, in conjunction with its Coordinator assigned by the CFE´s NCC, inform the Leadership Team in Site the results of its continuous Monitoring. A report is generated from this meeting and improvement actions are also established:

The Nuclear Safety Culture Monitoring Panel has the following major functions:

- Continuous monitoring of the Nuclear Safety Culture of the CFE´s NCC (writing cultural events), maintaining a database.
- Form the Monitoring Panel of the Nuclear Safety Culture of the CFE´s NCC (review of cultural events and making quarterly reports).
- Present results of the Monitoring Panel of the Nuclear Safety Culture to the Leadership Team in Site of the CFE´s NCC, preparing a report every six-month.
- Carry out the annual survey of Nuclear Safety Culture of the CFE´s NCC, issuing a final report.
- Carry out the Nuclear Safety Culture CFE´s NCC self-assessment every 3 years.

3. Safety Culture Self-Assessment Process

In the procedure named "Guide to conduct a Nuclear Safety Culture Self-Assessment", the methodology provided by the IAEA is established, based on the combination of the following techniques: Surveys, Interviews, Focus groups, Documentary review and Field observations. Through the collection of cultural events, cultural issues are established to obtain the drivers of Culture and, finally, determine the basic assumptions. The result is to show an image of the culture of the organization in which a report is made, which is disseminated to the organization and actions are established to strengthen the organization's Safety Culture.

4. Assessment of LVNPS staff perceptions on Safety Culture

The surveys that CFE has conducted since 1998, changed in 2000 and 2006. In these instances, a brief questionnaire to measure the level of staff awareness regarding LVNPS Safety Culture was used. The most recent change was made in 2012 to update the survey according to the Utilities Service Alliance’s “Nuclear Safety Culture Assessment Process Manual” (also cited in point 3 above), which provides guidelines for the Safety Culture self-assessment process in the USA. The new survey enables an objective comparison of the results, which allows reorienting the allocation of resources to the areas that need improvement, and provides the means to verify the effectiveness of the actions taken.

5. Implementation and continuous improvement of Safety Culture

Several relevant actions have been implemented to provide continuous improvement on Safety Culture issues, as described previously in the “Safety culture programmes and development” section of this article.

- **Regulatory processes for monitoring and oversight of arrangements used by the licence holder to prioritize safety**

The Reactor Oversight Process measures the safety significance of Safety Performance Indicators, Findings issued during nuclear facility inspections and Self-Evident Findings (Reportable Events); and determines their impact on the seven (7) Safety Fundamentals of the Oversight model. Additionally, for those cases in which some of the entries do not directly affect any of these seven (7) Fundamentals, there is a second evaluation that considers the impact on safety in the so-called "Transversal Areas". The Transversal Areas consider additional aspects to the technical considerations and definitions of the seven (7) Safety Fundamentals considering the items of: Human Performance, Problem Identification and Resolution and Safety Culture. With the results of this evaluation, the CNSNS Basic Inspection Program is fed back to address during the inspections, not only technical aspects but also issues related to Human Factors within which the measurement of aspects related to the Safety Culture of the facility is implicit.

Another opportunity for measurement at the facility is during the conduct of the Corrective Action program inspection, as inspectors can review self-assessments of the licensee's safety culture. If the licensee's performance declines, the inspectors through a special inspection shall verify that the licensee's assessment, the scope of the condition and the scope of the responses of the findings, which are important to the risk, adequately considered the attributes of the safety culture. The above, in order to determine the weaknesses of the safety culture and encourage the licensee to take appropriate action before significant degradation of performance occurs and independently conduct an assessment of the licensee's safety culture.

It is important to clarify that, using the existing Reactor Oversight Process framework, safety culture oversight activities will be based on a step-by-step, open, understandable, objective, risk-informed and performance-based approach. These activities may range from requesting a safety culture self-assessment to a meeting between licensee management levels to discuss licensee performance issues and actions to resolve persistent and ongoing cross-cutting safety culture issues.

- **Means used by the regulatory body to prioritize safety in its own activities**

CNSNS ultimate mission is to protect the health and safety of the population and the environment. This objective extends throughout the organization as a top priority, at all levels of responsibility, from the General Management to the operational levels.

Through its quality policy, CNSNS is committed to continuous improvement in order to maintain international standards of nuclear, radiological and security and safeguards in the peaceful use of nuclear energy. In accordance with the above, and with safety as one of its strategic objectives, CNSNS senior management has adopted as a supreme guiding principle to prioritize nuclear, radiological and security and safeguards of nuclear and radioactive facilities in its decision-making process.

During the period covered by this National Report, the CNSNS updated its "Code of Conduct for Public Servants of the Commission on Nuclear Safety and Safeguards" to integrate the safety culture into the standards of behaviour and performance of its personnel. This document states that CNSNS personnel put into practice the principles and attributes of a safety-oriented organizational culture, promoting, as a supreme priority, safety over any operational aspect of nuclear and radioactive facilities to protect the health of the population and the environment.

The following safety culture principles were incorporated into the Code of Conduct, among its Rules of Integrity and Values:

1. Leadership for safety must be demonstrated at all levels of the organization.

2. All personnel of the organization have the individual and public responsibility to exhibit behaviours that set an example to follow in terms of safety matter.

3. The culture of the organization promotes safety and encourages cooperation and open communication.

4. The implementation of an integral safety perspective in the organization is consolidated by working in a systematized way.

5. Continuous improvement, learning and self-assessment are promoted at all levels of the organization.

Also, with the participation of IAEA experts, in July 2019, the "Safety Culture Self-Assessment Workshop for the Regulatory Body" was held in order to begin the formation of a group of leaders in safety culture. To continue with the formation of this group, arrangements were made with the IAEA to coordinate the "Nuclear Safety Workshop for Assessors" at our facilities, to be held during the year 2022.

CFE
Comisión Federal de Electricidad

GERENCIA DE CENTRALES NUCLEOELÉCTRICAS
CENTRAL LAGUNA VERDE

POLÍTICA DE CULTURA DE SEGURIDAD

En la Central Laguna Verde consideramos a la SEGURIDAD como nuestra mayor prioridad, por lo que todo el personal debe mantenerse responsable por su propia seguridad, apegarse a estándares, mostrar una actitud cuestionadora en todo momento comunicándose de manera eficaz, tomar decisiones conservadoras y conducirse en apego a procedimientos además de aplicar las herramientas de desempeño humano para prevenir errores, valorar el aprendizaje continuo y fomentar un ambiente de trabajo respetuoso. Todo esto con la confianza de poder manifestarse sin temor a represalias.

Con nuestro compromiso personal, directivo y en apego a nuestros procesos fomentamos esta cultura.

HÉCTOR SERGIO LÓPEZ VILLARREAL
Gerente de Centrales Nucleoeléctricas

Agosto del 2020

Figure 10.1.A CFE's Nuclear Corporate Coordination's Safety Culture Policy

FIGURE 10.1.A (Translation to English)

CFE´s Nuclear Corporate Coordination Safety Culture Policy

At Central Laguna Verde we consider SAFETY as our highest priority, so all personnel must remain responsible for their own safety, adhere to standards, show a questioning attitude at all times, communicate effectively, make conservative decisions and conduct themselves in accordance with procedures, as well as apply human performance tools to prevent errors, value continuous learning and foster a respectful work environment. All this with the confidence to speak up without fear of retaliation.

With our personal and managerial commitment and in accordance with our processes, we promote this culture.

HECTOR SERGIO LÓPEZ VILLAREAL
MANAGER OF CFE´s NUCLEAR CORPORATE COORDINATION
August 2020

CFE
Comisión Federal de Electricidad

Suterm

Política de Cultura de Seguridad Nuclear.

La Cultura de Seguridad Nuclear es el conjunto de caracteristicas y actitudes en organizaciones e individuos que aseguran que, como prioridad escencial, las cuestiones de seguridad de centrales nucleoeléctricas reciban la atención que merecen en razón de su importancia. Para la Comisión Federal de Electricidad y el Sindicato Único de Trabajadores Electricistas de la República Mexicana la Seguridad Nuclear es un valor fundamental y es parte integral de la función operativa en todos los niveles de la organización. Es por ello que la Política de Cultura de Seguridad Nuclear constituye las directrices en materia de prevención de riesgos de la Central Nucleoeléctrica Laguna Verde respecto a:

1. Contar con personal altamente calificado y capacitado para la operación y mantenimiento nuclear de manera Segura y Confiable.
2. Mantener los sistemas de seguridad funcionando correctamente para proteger el núcleo, y por extensión, la población, sus empleados y al medio ambiente.
3. Promover incansablemente una sólida Cultura de Seguridad Nuclear para asegurarse que todo el personal esté alentando a externar sus inquietudes a cualquier miembro de nuestra organización.
4. Mantener, evaluar y validar los planes de emergencia para proteger a nuestros empleados, la población, infraestructura y al medio ambiente.
5. Promover al proceso nucleoeléctrico como un proceso que aprende, utiliza la experiencia y mejores prácticas de la industria, así como sus propias lecciones aprendidas para mejorar continuamente los procesos que garantizan la Seguridad Nuclear.

Dr. Jaime F. Hernández Martínez
Director General
Comisión Federal de Electricidad

Sr. Víctor Fuentes del Villar
Secretario General
CEN del SUTERM

Figure 10.1.B CFE's Union, Safety Culture Policy

FIGURE 10.1.B (Translation to English)

CFE Union
Safety Culture Policy

The Safety Culture is the set of characteristics and attitudes in organizations and individuals that ensure that, as an essential priority, the safety issues of nuclear power plants receive the attention they deserve because of their importance. For the Federal Commission of Electricity and the Unique Union of Electrical Workers of the Mexican Republic, Nuclear Safety is a fundamental value and is an integral part of the operational function at all levels of the organization. That is why the Nuclear Safety Culture Policy constitutes the guidelines for the prevention of risks of the Laguna Verde Nuclear Power Station regarding:

1. Have highly qualified and trained personnel for safe operation and maintenance in a safe and reliable manner.
2. Keep safety systems working properly to protect the core, and by extension, its employees and the environment.
3. To promote tirelessly a strong Nuclear Safety Culture to ensure that all personnel are encouraged to extend their concerns to any member of our organization.
4. Maintain, evaluate and validate emergency plans to protect our employees, the population, infrastructure and the environment.
5. Promote the nuclear power process as a learning process, use the experience and best practices of the industry, as well as its own lessons learned to continuously improve the processes that guarantee Nuclear Safety

JAIME F. MARTÍNEZ HERNÁNDEZ, PhD.
General Director of the Federal Commission of Electricity

VÍCTOR FUENTES DEL VILLAR, MR.
General Secretary of the National Executive Committee of the Unique Union of Electrical Workers of the Mexican Republic

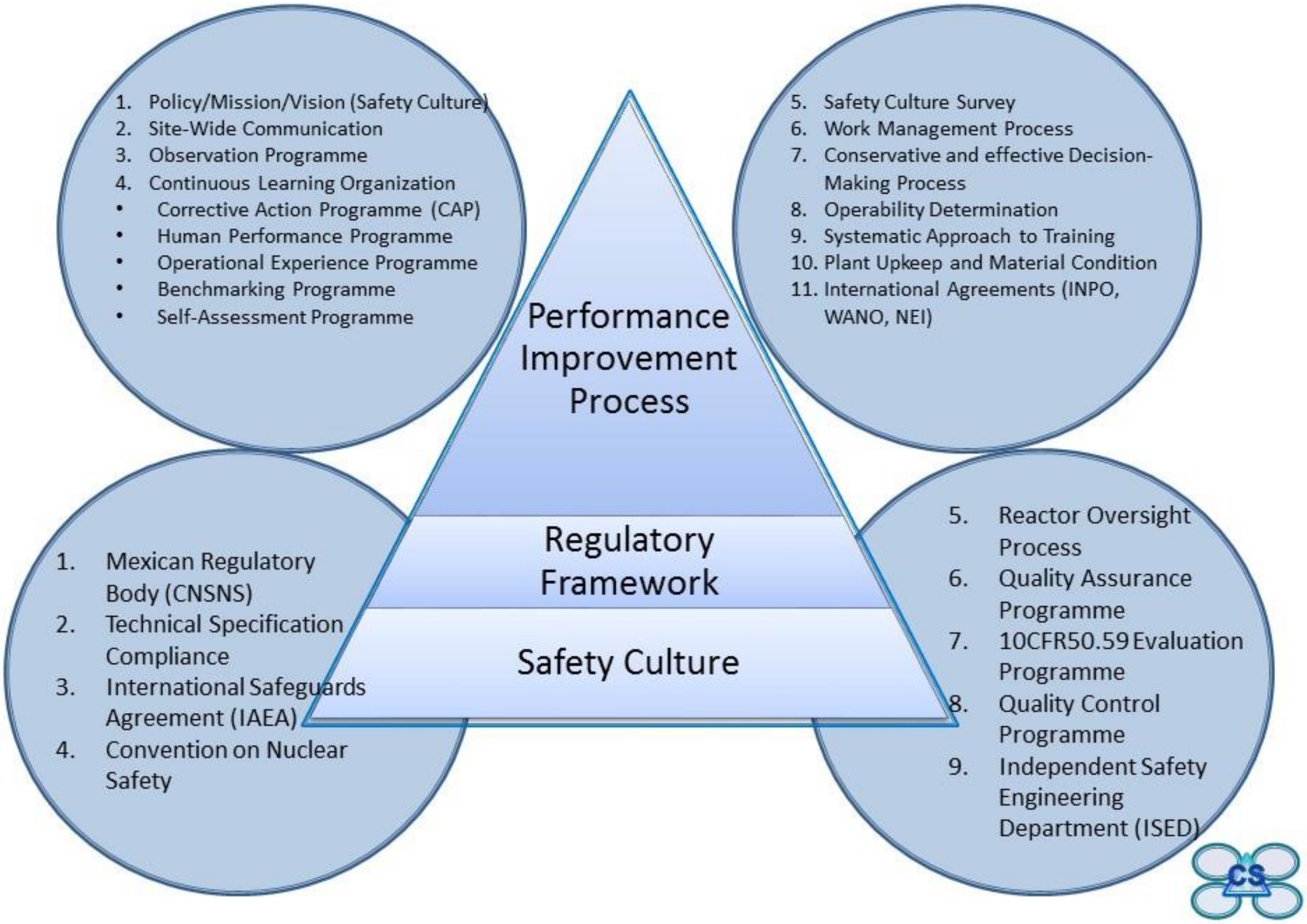

Figure 10.2 Framework of LVNPS's Safety Culture

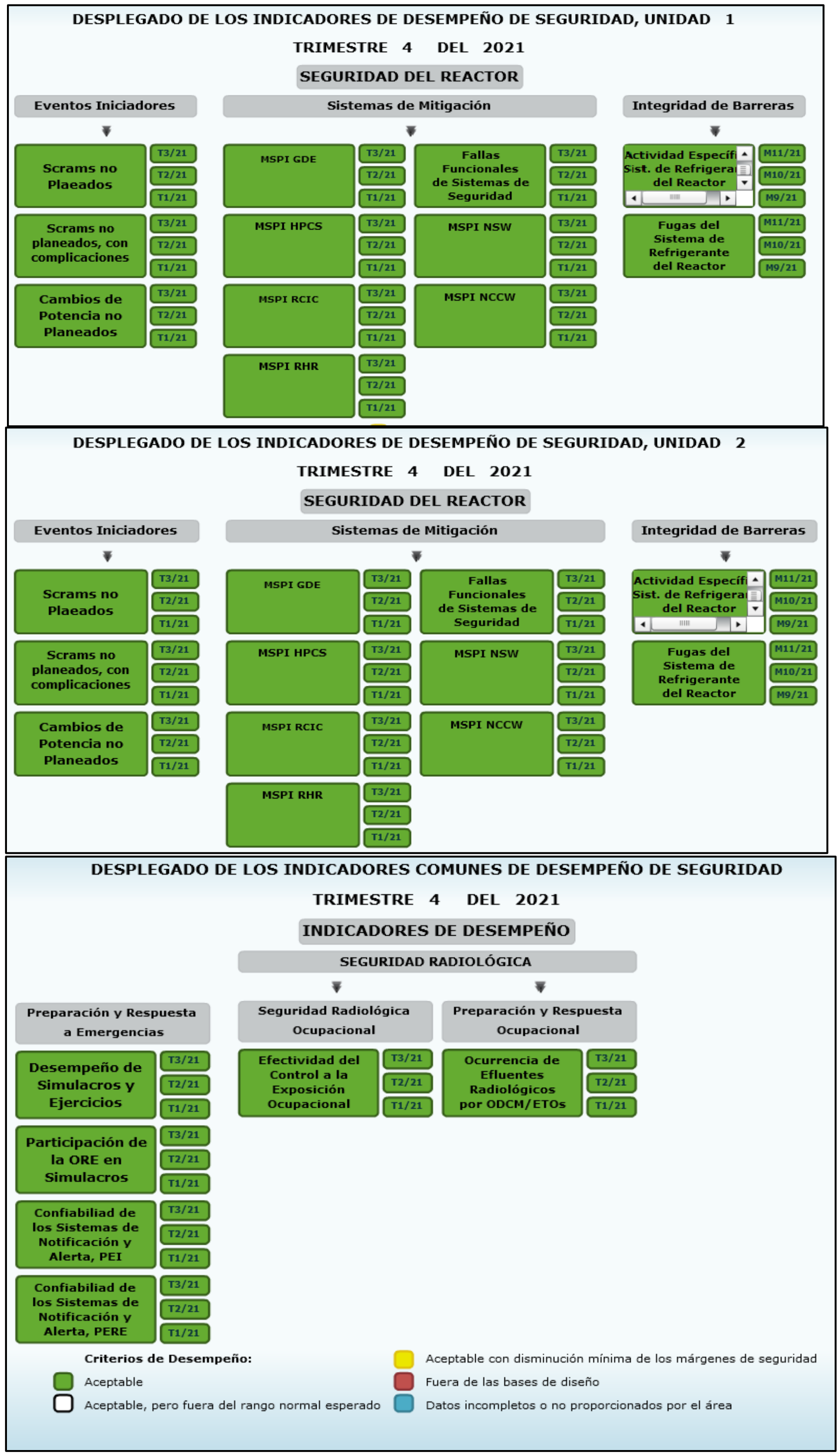

Figure 10.3 Rating Display of Safety Performance Indicators

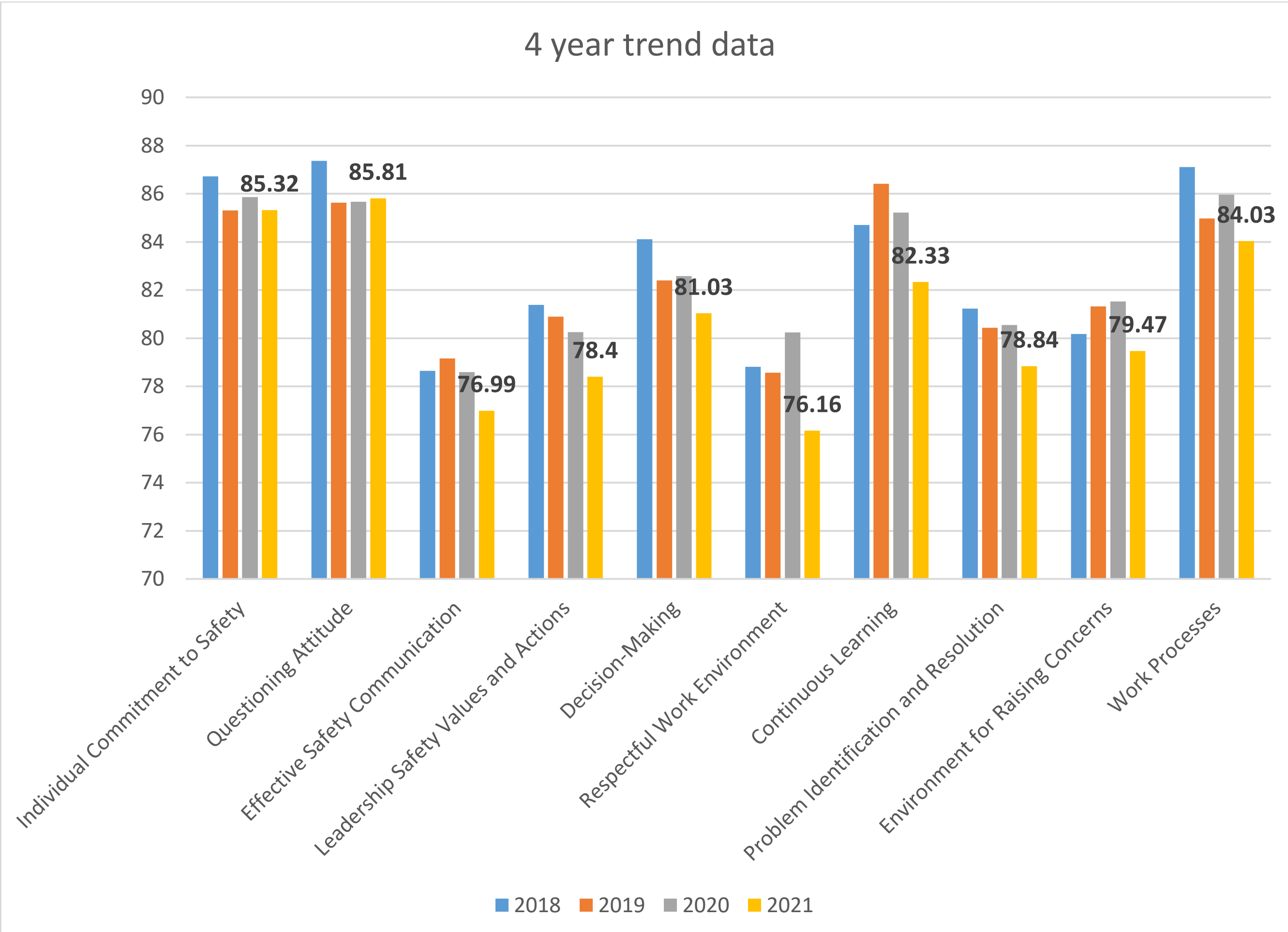

Figure 10.4 Annual survey on safety culture

- The previous figure shows the results obtained when processing the responses of all the Laguna Verde Nuclear Power Station personnel.
- The evaluation of the questionnaire as an average of all the areas of the CFE´s Nuclear Power Plants Division in 2021, indicates that: Safety Culture is in "Good" with an average rating of 81. In a range of "very good" 2 Traits of a Healthy Safety Culture (range between 85% and 100%) and 8 Traits of a Healthy Safety Culture meet with "Good" assessment (between 75% and 85%) (the lowest being Effective safety communication and Respectful work environment with 76).

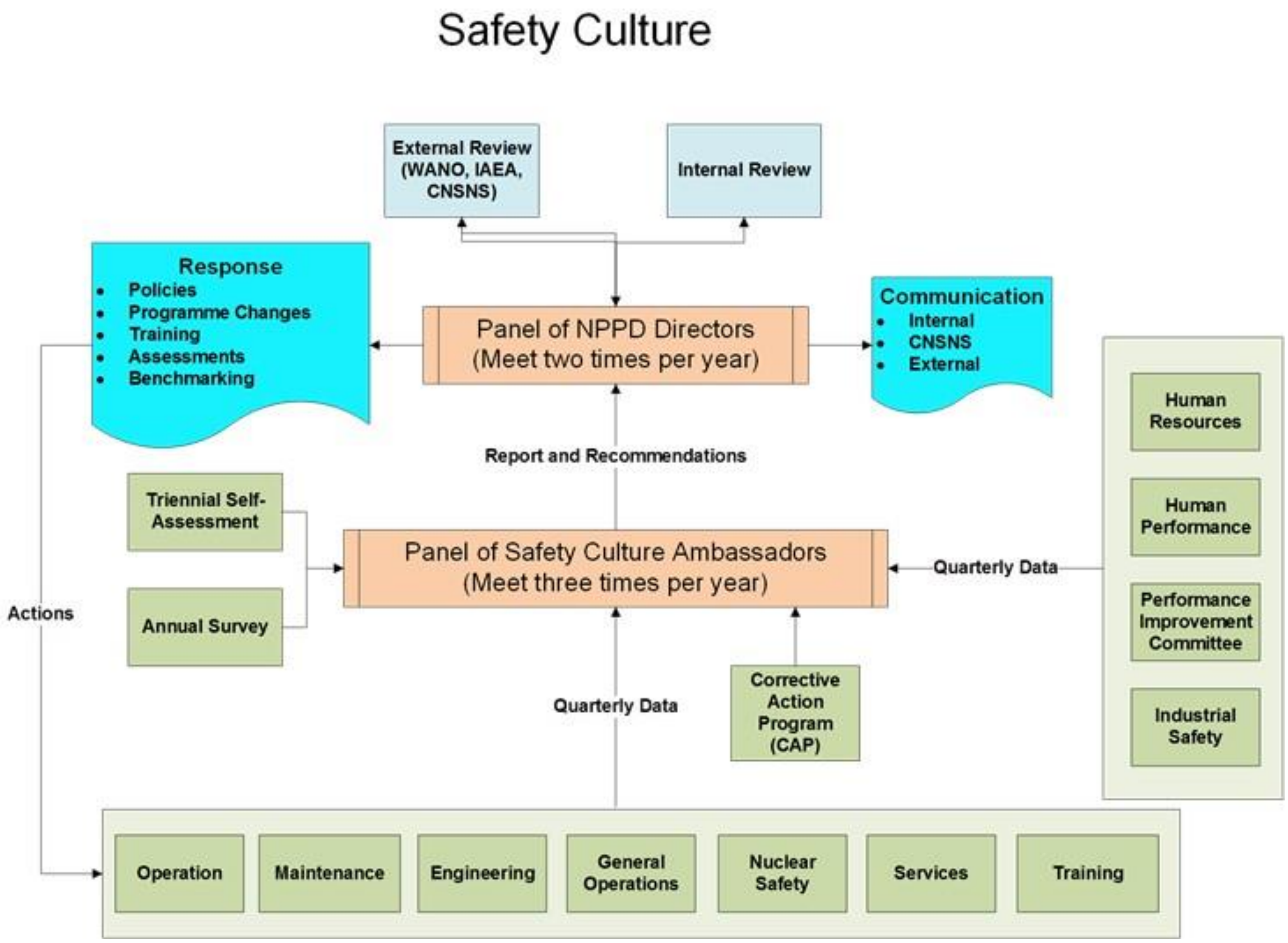

Figure 10.5 LVNPS nuclear safety culture monitoring process

Translation:

01: Personal Responsibility
02: Questioning Attitude
03: Effective Safety Communication
04: Leadership with safety-focused actions and values
05: Decision making
06: Respectful work environment
07: Continuous learning
08: Identifying and solving problems
09: Environment supporting the raising of concerns
10: Work processes

Figure 10.6
Display of Nuclear Safety Culture in LVNPS (2021)

ARTICLE 11. FINANCIAL AND HUMAN RESOURCES

Obligations

1. *"Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its lifetime."*

2. *"Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining, are available for all safety-related activities in or for each nuclear installation throughout its lifetime."*

Article 11 (1) Financial Resources

- **Mechanisms for the provision of financial resources to the licence holder or applicant in order to ensure safety of the nuclear installation throughout its lifetime, including**

- **Principles for the financing of safety improvements to the nuclear installation over its operational lifetime**

Financial resources to assure a safe and reliable operation and maintenance of Laguna Verde Nuclear Power Station (LVNPS) come from the Federal Government. They are requested via the application for authorisation of the budget as part of the strategic and operative programmes.

The Operation and Maintenance expenditures are privileged at LVNPS as compared to the rest of CFE facilities; since the requirements of the Mexican Regulatory Body must be met to maintain compliance with the Authorisation for Operation of LVNPS Units.

The management process of the financial resources contributes to meeting the plant safety standards during normal operation, refuelling outages and major maintenance programmes.

- **Principles for financial provisions during the period of commercial operation for decommissioning and management of spent fuel and radioactive waste from nuclear installations**

The costs for decommissioning, and handling and disposal of radioactive waste from LVNPS at the end of its lifetime are booked and appear in the financial statements. This provision is calculated based on the legal requirement jointly issued by LVNPS and CFE's corporate accountant, where it indicates that LVNPS will integrate a fund of 1,206.13 million dollars US (in 2015) for both units, in accordance with the methodology established by the USNRC in 10 CFR Part 50.75, with data from NUREG 1307 Rev. 15. This amount will be periodically updated based on data issued in new revisions of NUREG 1307. This fund will be integrated into the production costs for future storage of radioactive waste and decommissioning.

LVNPS has chosen a method of decommissioning is named DECON, in accordance with the provisions of NUREG/CR-6174. The method has four stages of work:

1. **Pre-Decommissioning Engineering and Planning**

   Before the cease of the activity, it is the stage of planning, engineering and review of the regulation.

2. **Reactor Deactivation for the Safe Storage**

   The cease of activity and preparation of the installation for storage is carried out.

3. **Safe Storage and Spent Fuel Management**

   Period of safe storage in the plant and operations in the spent fuel pool until its inventory of fuel is zero.

4. **Dismantlement**

   Decontamination and dismantling of the radioactive parts of the plant is being carried out in order to complete the nuclear reactor licensing.

As part of the extended period for safe storage of spent fuel, there is the following:

Prior to the end of useful life of LVNPS's Independent Spent Fuel Storage Installation (ISFSI), HOLTEC International, Inc.'s MultiPurpose Canisters (MPC), loaded with spent fuel, will be transferred to its overpack, called HI-STORM FW, to a transport container, called HI-STAR, for transportation off-site, to an approved final disposal site.

Because the MPC canisters are designed for storage, transport and disposal of spent fuel, the fuel cells will remain sealed inside the canisters, so decontamination of the MPC canisters is not required for transportation to the final repository.

After the transfer off-site of the MPC canisters, the ISFSI can be dismantled, identifying and removing the radioactive waste, and creating a final radiological report.

CFE will evaluate and modify the existing analysis of the dismantling of LVNPS Units 1 and 2 to include the financing cost of dismantling the ISFSI.

- **Statement with regard to the adequacy of financial provisions**

Financial resources for the safe and reliable operation of LVNPS are assured by the Federal Government budget. Furthermore, laws take into account additional resources to respond to contingencies and/or urgent expenses.

LVNPS includes within its own budget annual financial resources for recruiting, qualification, training and retraining of the nuclear installation's personnel. Through that, it guarantees the knowledge transfer and compliance with nuclear-related regulations.

- **Contracting Party's processes to assess the financial provisions**

According to Article 27 of the Constitution, the generation of nuclear energy and the regulation of its application belong exclusively to the Mexican State, so this state is responsible for annually assuring the financial resources for the safe operation of the installation.

- **Description of the Contracting Party's arrangements for ensuring that the necessary financial resources are available in the event of a radiological emergency**

CFE's Nuclear Corporate Coordination (NCC) has, by its nature, two special policies:

- LVNPS Liability Policy
- LVNPS Physical Damage Policy

The general conditions of these policies are as follows: Indemnities that legally or by order of competent judicial authority, the Insured must pay to third parties for damages to persons and/or property as a result of an event or succession of events originating from a nuclear or non-nuclear accident occurring at the LVNPS and/or from the use of radioactive facilities.

Article 11 (2) <u>Human Resources</u>

- **Overview of the Contracting Party's arrangements and regulatory requirements concerning staffing, qualification, training and retraining of staff for nuclear installations;**

For staffing, qualification, training and retraining of staff for nuclear installations, CNSNS and the licence holders agreed at the outset to implement the requirements of standard ANSI/ANS 3.1-1981 "Selection, Qualification and Training of Personnel for Nuclear Power Plants." However, in the case of nuclear power plants, in November, 2000, the requirements of the Mexican Official Standard NOM-NUCL-034 "Requirements for Selection, Qualification and Training of Personnel for Nuclear

Power Plants" entered into force. Currently, this standard has the version NOM-034-NUCL-2016 issued in December 2, 2016.

- **Human Resources of CFE's Nuclear Corporate Coordination**

The workforce of CFE's Nuclear Corporate Coordination (CCN) amounts to 1400 permanent employees as of March 2022.

- **Organisation of CFE's Nuclear Corporate Coordination**

The CFE organization currently approved in the Quality Assurance Plan Rev. 13D has a General Manager and 5 Directors of: Financed Investment Projects, Finance, Operation, Administration, Modernization and Structural Change. Figure 11.1 shows the current structure of CFE and the Nuclear Corporate Coordination.

It is worth mentioning that during the 2019-2021 period, according to the CFE's organic statute of May 10, 2021, the Nuclear Corporate Coordination was authorized, which is the Nuclear Generation Business Unit, and is in charge of the nuclear generation assets. Likewise, it is under the immediate control of the CFE's General Director and its head will be appointed by him, the above to strengthen the needs of reliable and safe operation of nuclear generation assets and to meet the recommendations of the IAEA, modifying the authorized structure of the Nuclear Power Plants Management, to provide direction and leadership for the application of independent nuclear corporate supervision, training, as well as the management of operational planning and administration of human, material and financial resources of the CFE's nuclear facilities.

Currently, the CNSNS is evaluating a request for a change to the Quality Assurance Plan, which was submitted in September 2021. This change is related to the organizational restructuring due to the creation of the Nuclear Corporate Coordination and the compensated movements in order not to reduce the established regulatory commitments.

– **Methods used for the analysis of competence requirements and training needs for all safety related activities in nuclear installations**

The Systematic Approach to Training (SAT) has been applied at LVNPS since 2006, defining the training requirements for personnel performing safety-related activities. This methodology is applied to the positions identified in 10 CFR 50.120; other important safety-related positions are covered by training programs defined in the Quality Control Plan.

The set of competencies that need to be developed and maintained by personnel for a given position under SAT, is determined using the result of the Job Task Analysis, which uses a list of the tasks that require training as its starting point. The selection of the method to achieve the required competencies is based on the information available, which may be one or more of the following:

- Task analysis.
- Competency analysis by group of tasks.
- Competency analysis based on learning objectives.
- Competency analysis based on guidelines.

Additionally, to the training programs obtained from Job Task Analysis, the "Training Needs" are collected continuously which are analysed in order to identify if changes to processes and procedures, plant modifications, reworks, use of new technology, actual or potential performance weaknesses, internal or external operational experience, etc., require training or implementation of other actions to prevent or correct performance weaknesses.

Once the issue or weakness is identified, the technical area generates a Request for Training Needs Analysis. This request may also be generated after evaluating the area performance or whenever the Department Head considers appropriate. Derived from this Request, a meeting is called with the Area Training Committee, for their attention. At that meeting, the corrective or preventive actions to be taken are defined. These actions provide feedback to the training programmes in order to make them both more efficient and effective.

– **Arrangements for initial training and retraining of operations staff, including simulator training**

The initial training for Reactor Operators (ROs) which lasts about 4 years consists of basic training in LVNPS's fundamentals and technology, standards, policies and specific procedures. After about a year, the trainees are sent to the plant to become familiar with all plant systems and activities. Subsequently they take a simulator course in the LVNPS full-scope simulator. Once the candidate approves the simulator course, he is assigned to the Main Control Room (MCR). Finally, they are prepared for the licence examination by reviewing some topics, during this time they receive training on the Emergency Operating Procedures (EOP), both in the classroom and the simulator.

Retraining is carried out every two years and combines at least 40 hours of plant simulator and 60 hours of classroom per year. The retraining covers plant systems, abnormal operation and emergencies, internal and external operational experience, administrative procedures, etc. Additionally, before every refuelling outage, training is carried out, the content of which covers the changes and modifications to be implemented, new nuclear fuel, technical specifications, and plant start-up on the simulator, as well as other subjects (in accordance with national regulations).

- **Capabilities of plant simulators used for training with regard to fidelity to the plant and scope of simulation**

  At the LVNPS full-scope simulator, the updates necessary have been carried out to maintain physical and operational fidelity, with respect to LVNPS Unit 2.

  It is important to mention Units 1 and 2 are very similar facilities, so the differences between the simulator and Unit 1 are minimal. From the beginning of the training, these differences are reviewed by the simulator instructors in conjunction with the operating teams (licensed personnel) of Unit 1 and are included in the scenario guides.

- **Arrangements for training of maintenance and technical support staff**

  Training of maintenance and technical support personnel is carried out according to the training plans developed under the Systematic Approach to Training and the Quality Assurance Plan. These plans describe different environments for training (classroom, laboratory, on-the-job training, interim assignments, etc.). Classroom courses focus mainly on theory, while laboratory-based courses include theory fundamentals supplemented with practical exercises in the laboratory, workshops, and on mock-ups.

  During the initial training, the trainees attend classroom courses or laboratory-based courses. Then they are assigned to the technical area in which they are being trained. The assignment duration is oriented to help the technicians "under training" acquire the skills necessary to complete the qualifications as technicians. During this period, the trainees keep attending training such as interim assignments or on-the-job training, as well as classroom and laboratory training, or other complementary training.

  Later, during retraining, personnel are trained in those topics that are identified as necessary for maintaining their qualifications. The topics include the actions resulting from the Requests for Training Needs Analysis, operational experience, refresher training or specific needs resulting from personnel performance.

- **Improvements to training programmes as a result of new insights from safety analyses, operational experience, development of training methods and practices, etc.**

  External operational experience has required improving procedures, post-drill critique techniques, and the use of human performance tools. Improvements have also been implemented to classroom, full-scope simulator, process simulator, workshops and mock-up training.

  Since 2008 a hydraulic loop or Process Simulator has been in operation for practical training on technical subjects, reinforcing the adherence to plant standards, and application of error prevention techniques.

In 2013 LVNPS implemented an Internet-based system that provides workers with operational experience lessons and online evaluation to reinforce the learning.

Simulator training activities and online training continue to be used in staff training and qualification activities. In 2020, a simulator was implemented for the commissioning of the emergency diesel generator.

- **Methods used to assess the sufficiency of staff at nuclear installations**

During the initial training, personnel are evaluated on theoretical aspects through written examinations, while the practical skills are evaluated on-the-job training. For licenced personnel (Reactor Operator [RO] and Senior Reactor Operator [SRO]) the initial training is very rigorous with multiple written examinations, while the practical skills are assessed in the full-scope simulator. The job performance, for all personnel executing safety-related functions, is evaluated by observers, using an evaluation card. The results are used to determine a Performance Indicator to take corrective actions when deviations are identified.

The evaluation of the RO and SRO licensed personnel (to obtain a license) is carried out by the CNSNS. For non-licensed personnel in the different technical areas, the partial evaluation is controlled by the LVNPS´s Central Training Center, but the final release to perform the functions of the position is authorized by the Head of the Technical Department after their field stays.

- **Policy or principles governing the use of contracted personnel to support or supplement the licensee's own staff**

The principles governing the use of contractor personnel to support or supplement LVNPS staff are established considering two types of contractors:

1. Contractors who carry out their activities under the responsibilities of the Quality Assurance Programme of the CFE´s NCC and/or
2. Contractors evaluated and qualified by the Quality Assurance Department of the CFE´s NCC, to perform safety-related activities under their own Quality Assurance Programme.

Also the following procedures are established:

- General administrative process for contracting goods and services, and important to safety works.
- Participation of the Quality Assurance Department in the process of contracting important to safety services.

- Guidelines for the receipt of work performed by contractors to ensure that all work and its associated documentation are properly completed and delivered to CFE.

- **Methods used to assess the qualification and training of contractor's personnel**

  Contractor personnel who perform safety-related functions are required to present evidence of the qualification of their personnel, which is evaluated by the Quality Assurance Department and the contracting area. The qualification and training requirements for such personnel are stipulated in the corresponding contract.

- **Methods used for the analysis of the competence, availability and sufficiency of additional personnel required for severe accident management, including contracted personnel or personnel from other nuclear facilities**

  LVNPS has departments of Emergency Response Planning, an Internal Emergency Response Organization and an Organization of Response to External Radiological Emergencies. Internally, the organization covers the functions and requirements of the regulatory framework, using operational procedures in emergencies and, recently, the implementation of severe accident guidelines is in process (in accordance with the recommendations of the BWR Owners Group).

  The functions necessary for the response of external radiological emergencies are covered by a committee composed of different federal and state government agencies (including the LVNPS itself), which provide the qualified human resources and materials necessary to cover the emergency response functions.

- **Description of the national supply of, and demand for, experts in nuclear science and technology**

  As stated in the "Measures to develop and maintain competence" section of Article 8, only one nuclear power plant is operated in the country. Although there have been declarations regarding the construction of new reactors, there are no formal requests for licensing, so the demand for professionals in nuclear engineering and science areas is low, even considering the requirements of all the entities involved, such as the operator of the LVNPS, the Regulatory Body and research institutes. The supply of educational programs and graduates in the nuclear area is consequently also low. On the other engineering areas (mechanical, electrical, civil, chemical, and so on.), which constitute the largest percentage of professionals to operate or regulate a nuclear facility, the offer of academic programs and graduates is considerable; however, their training is directed only to non-nuclear conventional systems.

  Additionally, the CFE has established linkage mechanisms with universities and technological colleges for the incorporation of personnel from different engineering areas, carrying out specialized introductory courses on nuclear energy. This is done in order to facilitate the entrance of graduates to the nuclear power plant's work force. In the last two years, graduates from national universities and technology centers with degrees in nuclear engineering or specialties related to radiation protection have been invited to participate in the selection process for supervisors in the areas of reactor engineering, radiation protection and chemical engineering.

- **Regulatory review and control activities**

CNSNS evaluates the following: (1) on an annual basis - the revisions of the initial training and retraining programmes of the personnel required in 10 CFR 50.120 (Systematic Approach to Training) and the personnel performing safety-related activities; (2) on semi-annual basis - the performance of the technical staff of the areas of maintenance (electrical, mechanical and, instrumentation and control), chemistry, radiation protection, plant engineering, design engineering, reactor engineering and Field Assistant Operators, and (3) on a quarterly basis - the performance of Reactor and Senior Reactor Operators, as well as the performance of the LVNPS full-scope simulator. This evaluation activity is performed in compliance with Mexican Official Standard NOM-034-NUCL-2016 "Selection, qualification and training requirements of personnel in nuclear power plant", and it is documented through the "Minutes and Report on the Evaluation of Conformity with NOM-034-NUCL-2016".

As part of the control measures established by CNSNS is the preparation of the following: (1) the semi-annual results report on the implementation of the Systematic Approach to Training for the personnel specified in 10 CFR 50.120 and reactor engineering; (2) the quarterly results report on the retraining cycles of Reactor and Senior Reactor Operators; (3) the annual results report on the evaluation of ROs and SROs; (4) the biennial programme of retraining for the ROs and SROs; and (5) the annual programme of retraining for the simulator instructors. These reports are presented by the LVNPS authorisation holder to CNSNS.

The reports mentioned above are reviewed by the specialist staff of CNSNS. The purpose of the review is to verify that the qualification and training requirements of personnel performing a key function for the safe operation of nuclear installations are met at all times. Recently, the CNSNS initiated the "evaluation" of the LVNPS reactor operators and supervisors' requalification program by means of the following indicators: (1) at least 75% of the operators and supervisors must approve all sections of the exam in the participant (written and simulator), and (2) at least two thirds (66%) of the operating shifts must pass the simulator exam.

For the case of contractors’ personnel, CNSNS has established in the Mexican Official Standards the specific requirements. It is required that the staff of those companies or organisations engaged in any activity or function for more than a year must meet all regulatory requirements for such activity or function.

For cases when an interim activity or function is performed for less than one year, CNSNS, as part of its Baseline Inspection Programme, verifies that the personnel of the contractors have been accredited by the nuclear installation, and they are duly qualified to perform the task assigned. The verification is performed using one of the following options:

1. Contractor documents which were used to qualify its personnel to perform the assigned task;
2. Previous verification of the ability of the contractor's personnel to perform the task assigned, by personnel of the nuclear installation;
3. Successful completion by the contractor's personnel of those licence holder´s training programme segments regarded as necessary to perform the task assigned.

– **Actions taken by CNSNS to manage risks related to the Covid-19 pandemic**

In connection with the examination program, the CNSNS implemented the following actions:

1. Rescheduling operational tests on the simulator located at the site.
2. Approved a time relief for training during this period.

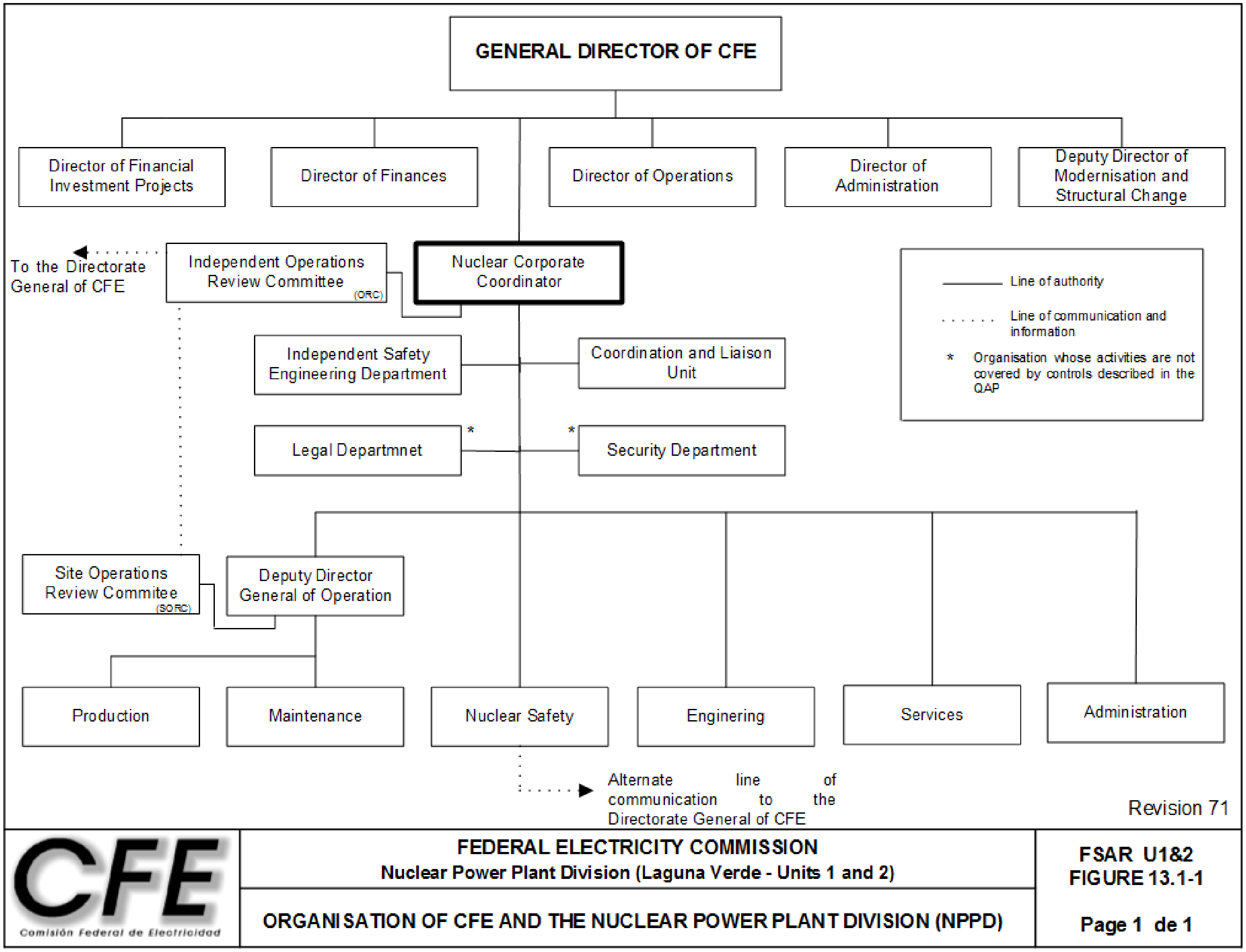

Figure 11.1 Federal Electricity Commission (CFE) Nuclear Corporate Coordination Organisation chart

ARTICLE 12. HUMAN FACTORS

Obligations

"Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the lifetime of a nuclear installation."

- **Overview of the Contracting Party's arrangements and regulatory requirements to take human factors and organizational issues into account for the safety of nuclear installations**

As mentioned in Article 7, since the inception of the Laguna Verde Nuclear Power Station (LVNPS) Project, government authorities decided that, in addition to applying the regulations of the International Atomic Energy Agency (IAEA), the regulations of the Nuclear Steam Supply System (NSSS) supplier's country of origin would be equally applied. This requirement is stated in Conditions No. 3 and 4 in the current Operating Authorisation of Units 1 and 2, respectively. For this reason, 10 CFR 50.34(f)(2)(iii) is applied in the Mexican regulation, which requires a variety of controls and displays to aid to the operator, and a control room that reflects the state of art of the Human Factors Engineering principles.

- **Consideration of human factors in the design of nuclear installations and subsequent modifications (see also Article 18 (3) of the Convention);**

As a result of the accident at the Three Mile Island Nuclear Power Plant in 1979, the United States Nuclear Regulatory Commission (USNRC) published the document NUREG-0660, and later on NUREG-0737 and its Supplement No. 1. These documents required a detailed revision be performed of the design of control rooms (item I.D.1) at nuclear power plants in operation and under construction as well, to be equipped with a Safety Parameter Display System (SPDS) (item I.D.2) in order to improve the human-machine interface, and in this way, reduce the probability of occurrence and the severity of operator error as well as to help them in their decision-making during abnormal and emergency conditions.

To meet the requirements mentioned above, CFE issued the "General Plan for LVNPS Unit 1 Main Control Room Design Review." Once the plan's activities were concluded, CFE forwarded to CNSNS the document "Report on LVNPS Unit 1 Main Control Room Design Review" in compliance with the requirement established in 10 CFR 50.34(f)(2)(iii).

Regarding the compliance of Unit 2 with the requirements of NUREG-0700 and NUREG-0801, CFE agreed with the CNSNS to execute a two-phase project plan, taking into account that LVNPS has twin units that are identical in design, except for a few very specific differences. During the first phase of the project plan, all Unit 1 changes were implemented in Unit 2. In the second phase, all the differences between the control rooms were identified. Then, based on the documents generated, several inspections were performed. In the second phase, a Job Task Analysis (JTA) of the Emergency Operating Procedures (EOP) was also performed and the results were used to develop several accident scenarios, which were used for training the Unit 2 crews on the LVNPS full scope simulator. In order to be able to fulfil the activities in the second phase, CFE issued and put under the consideration of the CNSNS, the “LVNPS Unit-2 General Control Room Design Review Plan”.

As part of the improvements introduced to the design since the start-up of LVNPS Units 1 and 2, there is an SPDS in each unit’s control room that is an integral part of the Process Data Integral System, which is used to monitor and record all process parameters. This system allows the operator to have real time visualization as well as a retrospective view of the behaviour of the most important process parameters, allowing appropriate decision-making and reducing possible errors. Also LVNPS constantly has been making improvements to the control rooms, which are logged in the Corrective Action Programme (CAP).

It has been reported in previous National Reports that CFE satisfactorily concluded the execution of the programme for reduction of alarms presenting problems in order to achieve the “Blackboard” condition. A list was made of the alarms that had operated inadequately since the original design of LVNPS Units 1 and 2. The design modifications to eliminate the alarms with problems were performed in accordance with the established programme. This issue arose during the pre-start-up testing of both LVNPS units, caused by configuration problems manifested by faulty alarms. The "Blackboard" condition is currently maintained in both LVNPS control rooms.

Also, the results of the Levels 1 and 2 Probabilistic Safety Analysis (PSA) and human reliability analysis are continually considered to identify accident sequences where the human factor is a major contributor to the core damage frequency. The specific application of these results is through the simulation of the dominant sequences in the full scope LVNPS simulator to train and test operators on appropriate responses.

Moreover, in what could be regarded as LVNPS human factors, the following operative aids were implemented:

a) Symptom-based procedures with flow charts and operational support devices to handle operational transients and accidents, which will allow the operators to respond adequately to these types of events.

b) SPDS was installed in the simulator and training material was prepared for abnormal or emergency conditions.

c) Use of self-assessment and self-checking verification card. Cards TOMO (Spanish abbreviation of: Observation Card for Operation Manoeuvres) and TEVA (Spanish abbreviation of: Evaluation Card for Performance Operators).

d) Since 1998, the Independent Safety Engineering Department (ISED) carries out an assessment of the CFE's Nuclear Corporate Coordination Top Management performance, to identify improvements needed in human performance.

e) The modifications derived from the power increase of Unit 2 were implemented in the simulator, modifying the model and interfaces of the EHC System and other auxiliary systems of the turbine and the main generator.

f) In 2013, light emitting diodes (LEDs) satisfactorily replaced the alarm lamps in the full-scope simulator. The technical feasibility of making the same change in the Main Control Room (MCR) of both LVNPS units was evaluated and concluded to be possible. The change will be included as part of the engineering improvement projects (2017-2021).

g) In 2021, a project focused on the use and adherence to procedures was developed and implemented, through focused observations, development and dissemination of videos and propaganda materials, as well as mini-workshops to raise awareness among the technical staff of the different areas of the Nuclear Power Plant's Division of CFE.

h) At the beginning of 2022, prior to the fuel refueling scheduled for that year, reinforcement of Human Performance Fundamentals and Tools was carried out with additional personnel from all areas, with greater emphasis on the Maintenance and Quality Control areas.

i) During the 17th Refueling Outage for LVNPS Unit 2, an electronic observation program was implemented through an application that can be used on any electronic device that has access to data. This observation card was designed based on the plant's own cards, which made it possible to identify real-time trends in incidents and alert the organization of observed behaviours.

j) Currently, the plant has behavioural observation programs that allow early identification of aspects related to the human performance of the personnel, in order to reinforce them through corrective and preventive actions.

- **Methods and programmes of the licence holder for analysing, preventing, detecting and correcting human errors in the operation and maintenance of nuclear installations**

The Human Performance Coordination was formed in order to give a better attention in relation to Human Performance and the prevention of errors in the Laguna Verde Nuclear Power Plant. This organization promotes knowledge of the Human Performance Foundations and its application in activities of the plant, based on a proactive attitude to prevent errors, with the main objective of achieving a safe and reliable performance.

The Human Performance Programme is ruled by the following guidelines:

1.- Tools for Error Prevention Guideline
2.- Procedures Use and Adherence Guideline
3.- Change Management Guideline
4.- Programme for the Human Performance Indicator
5.- Managerial Observation programme
6.- Comments and suggestions mailbox Guideline of the CFE's Nuclear Corporate Coordination
7.- Program of Human Performance for the CFE's Nuclear Corporate Coordination

This Human Performance Programme is carried out through the following activities:

- Review and update of the guidelines for the use of human error reduction techniques at LVNPS.
- Establish metrics and indicators, for use by different areas, to identify areas of opportunity for human performance-related events that have occurred at LVNPS.
- Communicate the use of error reduction techniques through training involving electronic devices and multi-media.
- Develop propaganda media that help the continuous reinforcement of Human Performance tools with the staff through the design of leaflets, posters and information boards in the workshops.
- Perform the trend analysis of the human performance-related events indicator and define with the essential areas the actions to help reducing the gap between the current and expected performance level.
- Participate in the root-cause analysis of events reported in the human performance-related events indicator.
- Observe work activities and processes, and prepare a report to provide short-term feedback on the gaps identified to the departments involved, in the short term, by means of an activity observation report:
  - Adopt leadership behaviour to align processes and organisational values to optimise worker performance at the workplace using error reduction techniques.
  - Promote a common language and understanding about human performance terminology.

- Incorporation of the courses on "Human Performance Basics" and "Teamwork" into the initial training programs of personnel with important to safety functions.
- In coordination with the Training Centre, provide training support for the course on "Human Performance Basics", error prevention techniques and other subject related educational and training applications.

One of the important aspects that has enabled continuous improvement at LVNPS, among others, is the implementation and follow-up of the Human Performance Programme for preventing errors. This programme consists of activities to improve staff behaviour by knowledge of human performance basics and through using and applying error reduction techniques to meet the task goals in accordance with LVNPS established standards. These techniques have minimised the events and their safety significance.

The Management Oversight Programme, started in 2013 and in the year 2021 changed to Field Leader Observation Program, that is designed to promote improved performance of NCC personnel by observing their work activities, intervening when appropriate (only if necessary), and providing coaching to reinforce expectations and compliance of Nuclear Professional. By 2022, this process has been consolidated, sending monthly-observed behaviour trends, as well as the feedback from all the observers. These trends are discussed during the monthly Performance Improvement meeting for each area and on a quarterly basis with the Management Staff (NCC Deputy Managers), where strategies are defined to address and mitigate them. In addition to the programmed observations, there is the option of voluntary observation of activities for all CFE Nuclear Power Plant Management personnel; these are carried out on an interdepartmental basis for those areas that may have "workshop blindness".

In 2015, an indicator for human performance at the department level was added to the existing one for the organisation level. Likewise, an accounting of the quasi-events by department is made. through them, specific low-threshold areas of improvement have been identified for the different departments of the NCC and, in general, aspects for improvement have been identified at the organizational level, in both management processes and in the execution of activities. Currently, actions derived from the trend analysis of these indicators with satisfactory results are being implemented.

Weekly, the trend of Human Performance events is sent to the LVNPS´s management staff and to the Human Performance Coordinators of each department, with the purpose of disseminating them in their areas and reinforcing them with the staff. Likewise, each coordinator of Human Performance of the area, in case of having departmental or organizational events, must review it and, in conjunction with the Human Performance Coordination, identify causes and evaluate possible improvement actions, as soon as the event is presented. This evaluation can be found in the Human Performance Intentionality Report.

Monthly meetings are held with the Human Performance Coordinators (Human Performance Committee) to review trends, establish commitments and actions to improve the performance of the departments, review the established commitments and follow up on the proposed actions in order to focus on the areas that require reinforcement to reverse these trends.

At the end of 2018, contact was made with groups of the nuclear industry on the issue of Human Performance through INPO and WANO, in order to establish links and keep the CFE's Nuclear Corporate Coordination updated on the issue, as well as exchange points of view, operational experience and adopt best practices.

Based on the observations, self-evaluations and the experience of the industry, during the period 2013-2015, the revision of the Human Performance Guides was developed to update the information in order to conduct the CFE's Nuclear Power Plants Division to the highest standards of the nuclear industry, which continues to be made and updated based on industry information.

To date, the Human Performance program continues and the continuous monitoring of staff performance based on the observations and follow-up of the condition reports of the Corrective Action Program.

The Corrective Action Program Group, created since 2004 to implement the Corrective Action Program, remains in force to date. This group coordinates evaluations in general, giving greater importance to those of Root Cause (including aspects of Human Performance, Programmatic and Organizational Factors among others). In addition to the above, the Performance Improvement Process Committee (created in 2015) continues to function in order to continuously improve performance, through the implementation and measurement of indicators for the most important LVNPS processes.

– **Self-assessment of managerial and organizational issues by the operator**

The self-assessment performed in 2019 was on the following topics:

- Improved Scheduling Performance by the Planning "Clock Reset" Indicator.
- Human Performance Program
- Use of and Adherence to Operating Procedures
- Compliance Standards
- "Fundamentals" of Operation.
- Principles of Technical Awareness

- Provisions of Nonconformance Reporting at the Sub-Engineering Management
- Management Involvement in Corrective Action Program
- Process for Strengthening Effective Leadership and Teamwork in Middle and Senior Management
- “Fundamental” of Radiological Condition Monitoring
- Follow-up of “Fundamentals” of Operation

In 2020, self-assessments were conducted on the following topics:

- “Fundamentals” of Radiation Protection (Performance)
- Human Performance
- Weaknesses in Use of Human Performance Tools
- Determination of Programmatic and Organizational Factors
- Quality of Self-Assessments
- Effectiveness of Quality of Evaluations Apparent Cause
- Use of Error Prevention Tools
- Tracking Program Performance Improvements by Planning "Clock Reset" Indicator
- Follow-up of Human Performance Program
- Follow-up of “Fundamentals” of Operation
- Follow-up and use and Adherence to Operating Procedures
- Follow-up of Standards Compliance
- Follow-up of Monitoring of Auxiliary Operators' Performance
- Follow-up of “Fundamentals” of Technical Maintenance
- Follow-up of Technical Awareness Principles

The self-assessments performed in 2021 were on the following topics:

- Use of Human Performance Tool Verification in the Electrical Maintenance Group
- Use and Adherence to Procedures
- Compliance with Standards for Operating Assistants
- Radioactive Waste and Purification Personnel Standards Compliance
- Substation Personnel Standards Compliance

- "Fundamentals" of Operation
- "Fundamentals" and Instrumentation and Controls Maintenance and Technical Skills
- "Fundamentals" and Electrical Maintenance and Technical Skills
- "Fundamentals" and Mechanical Maintenance and Technical Skills
- "Fundamentals" and Predictive Maintenance and Technical Skills
- Safety Culture
- Performance Monitoring
- Evaluating the Management Process
- Follow-up of "Fundamentals" of Radiation Protection (Performance)
- Follow-up of Standards Compliance
- Follow-up of Assistant Operator Performance
- Follow-up of Weaknesses in the Use of Human Performance Tools.
- Follow-up of the use of error prevention tools.
- Follow-up of the Determination of Programmatic and Organizational Factors.
- Follow of Quality of Self-Assessments

According to the LVNPS self-assessment programme, the self-assessment reports generates condition reports, which define corrective actions in the respective area. The objective of these corrective actions is to close the gaps identified and contribute to improving LVNPS performance.

– **Arrangements for the feedback of experience in relation to human factors and organizational issues**

The events that occurred during the 2019-2021 period have produced collective efforts aimed to correction and improvement of plant processes, and staff behaviour improvement regarding implementation of high standards. The database, generated by the events reported is the event indicator for human performance, allows a collective analysis. The analysis has identified latent weaknesses of the Management through the evaluation of "Human Performance and Programmatic and Organizational Factors" that are being addressed with several inter-group actions to close the gaps. In addition, this database represents a learning source that will prevent their future recurrence. Among the aspects to evaluate during the analysis of events of the plant are:

- The Precursors of Error associated with the event such as: Task Demands, Work Environment, Individual Characteristics of Workers, Human Nature.

- Defective Defenses (defects in defensive measures that failed to protect people or equipment against risks, or in preventing the occurrence of active errors) that allowed or contributed to the event such as: Error prevention tools, procedures, instructions, plans of quality, physical or administrative barriers and signs, personal protection equipment, monitoring activities, alarms and automatic protection systems.
- The Programmatic and Organizational Factors that contributed to the Precursors of Error, Defective Defenses and / or condition such as: Training, directive supervision, decision making, planning and programming, design or process changes, values, priorities or policies, involvement of supervision, organizational interfaces and finally work practices.

– Regulatory review and control activities

As a result of the Three Mile Island (TMI) accident in the United States of America, the CNSNS established as a requirement for CFE the implementation of 10 CFR 50.34(f)(2)(iii). The objective of this requirement is that the LVNPS staff playing a vital role in the efficient and safe generation of electric power (e.g., operators and maintenance personnel) operate, verify and reset the plant equipment and its components in such a way that the causal factors of human error are eliminated as much as possible.

Consistent with this requirement, a general guideline was also established that in order to comply with 10 CFR 50.34(f)(2)(iii), LVNPS should follow the directions of the Standard Review Plan Chapter 18, NUREG-0800 (USNRC, 2004), which in combination with the Human Factors Engineering Programme Review Model described in NUREG-0711, provide detailed criteria to be considered in a Human Factors Programme.

As a result of the implementation of all tasks required in the Standard Review Plan Chapter 18, the CNSNS reviewed the LVNPS compliance with the human factors engineering principles. Also, to ensure that the conditions to minimise human errors were maintained, The CNSNS imposed two requirements for Unit 2 in its current LVNPS Commercial Operation Authorisation in order to keep this authorisation in force:

a) Requirement No. 2 establishes that the LVNPS simulator should meet the requirements of fidelity, response and reliability. Likewise, the simulator shall be equipped with the Safety Parameters Display System.

b) Requirement No. 6 establishes that LVNPS must continue with the Alarm Reduction Programme in the Main Control Room, implementing the necessary design changes.

In the case of Unit 1, its Operating Permit, renewed until 2050, no longer explicitly describes the above, as this is embedded in compliance with Condition No. 4, which indicates the obligation to comply with the regulations of the reactor's country of origin.

In relation to Human Factors review and control activities, CNSNS has opted for:

1. Continue the practices suggested in the “Human Factors Engineering Program Review Model” described in NUREG-0711 whose recommendations can and must be applied during the design, construction and operation of nuclear installations.

   According to this review model, the inclusion of the Human Factors Engineering principles was verified in several CFE activities by reviewing the following items:

   a. Operational experience - CNSNS inspections systematically consider operational experience, as does review of the condition reports, in which the involvement of operational experience is documented. In addition, an evaluation of operational experience, as established in the basic inspection programme, is performed every two years. During these activities the External and Internal Operational Experience evaluation and feedback process is reviewed.
   b. Man-machine interface design - During examinations for new operator licences and renewals for Reactor Operators (RO) and Senior Reactor Operator (SRO), the man-machine interface was continually evaluated in order to identify human error precursors caused by the new controls and operator aids, and to make changes in the Main Control Room if necessary.
   c. Training Programme - CNSNS continually follows the analysis, development, implementation, evaluation, and feedback processes of the Systematic Approach to Training. This approach considers the knowledge and skills that the staff must have to safely perform a task.
2. The root cause analysis of operational events has improved the identification of causal factors of human error, such as: environmental conditions; interface with equipment design or condition; verbal and written communication; training methods and qualification of personnel; planning and work practices; supervision methods; and administrative methods. The above has allowed to fully identify the factors that originated the human error.

Regarding the inspection program, as mentioned in Article 7, during the period covered by this National Report, no inspections were carried out on activities related to human and organizational factors at the Laguna Verde Nuclear Power Plant Units 1 and 2. However, it is aware that in the event of any change in the organization and updating of equipment, as well as structures, systems and components, the following activities should be verified:

a. Review of the programs related to the evaluation of human and organizational factors within the facility, as well as the areas in charge of carrying them out.

b. Review of processes related to identification, classification, and resolution of problems related to human and organisational performance.

c. Review of processes related with the improvement of the man-machine interface in the design and modification of controls, recorders, indicators, and other devices used in the field and in the facility Main Control Room.

d. Review of the process of considering human factors issues while drafting changes and modifications to facility procedures.

e. Review of the process of determining the workforce needed to complete each facility department's programs and functions.

f. Review of the process of considering human factors when developing qualification and training programs.

g. Review of the use of management tools for decision making at the management level.

Finally, it can be considered that the CNSNS tasks developed during the period 2019-2021, are related to the topics of Safety Culture that measures the impact of the organization in this culture; as well as the tasks related to the improvement of the design of the facilities derived from the Fukushima Daiichi event; same as described throughout this document.

ARTICLE 13. QUALITY ASSURANCE

Obligations

"Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the lifetime of a nuclear installation."

– Overview of the Contracting Party's arrangements and regulatory requirements for quality assurance programmes, quality management systems, or management systems of the licence holders

▪ Provisions and regulatory requirements for the quality assurance programmes

During the commercial operation phase of Laguna Verde Nuclear Power Station (LVNPS) Units 1 and 2, the execution of activities important to safety is regulated through the Quality Assurance Plan (QAP), which was designed to meet the requirements set in 10 CFR 50 Appendix B, the Subpart G of 10 CFR 72 and NUREG-0800, Rev. 2, according to the regulatory framework established for the LVNPS licencing. This plan has a set of procedures to achieve its implementation, which includes all activities covered by the QAP. The procedures are reviewed every two or five years, depending upon their safety significance, as indicated in Article 19 (3).

Also the QAP considers the compliance with the USNRC's Regulatory Guides (RGs), established in the Safety Reports, and the controls and requirements of ANSI/ANS-3.2-1982, with exceptions to be agreed upon with CNSNS.

The QAP also describes the quality assurance requirements and controls that apply to the LVNPS Units 1 and 2 during its useful lifetime, including decommissioning. Besides the QAP scope regarding the four quality assurance categories (plus fire protection and radioactive waste), the QAP has a broader scope; because it includes the Technical Specifications (TS), the software classified as important for safety, the Radiation Protection Programme, the training activities, the Internal Emergency Plan (IEP) and the External Radiological Emergency Plan (EREP), among others, and three categories established for equipment, systems, materials, process and services related with the Independent Spent Fuel Storage Installation (ISFSI).

▪ Quality management systems

In the event that LVNPS adopts an internationally accepted quality system, such as the International Organisation for Standardization (ISO) standards, CNSNS would review how these international standards compare with 10 CFR 50 Appendix B. Based on this review, CNSNS must conclude if some requirements are needed, in addition to those already established in the existing regulations.

- **Status with regard to the implementation of integrated management systems at nuclear installations**

As part of the Federal Electricity Commission's (CFE) Institutional Programme of Total Quality and in compliance with the guidelines of the General Directorate, the Nuclear Corporate Coordination (NCC) permanently maintains a policy of continuous improvement of its Division-wide Quality System. This has allowed certifying the NCC´s Quality Management, Environmental, and Occupational Health and Safety Systems since September 1997, January 1999 and November 2002, respectively. So far these certifications remain valid.

In 2005, as a result of the evolution of the management systems of the NCC, and integral certification of the Quality Management, Environmental and Industrial Safety, and Occupational Health Systems was achieved. Later, in 2007 the NCC, as part of the generation branch of CFE's Direction of Operation (DO), participated in establishing, implementing and maintaining a multiple-site Integral Management System (IMS) applicable to all workplaces of the DO. The IMS included aspects relating to Quality, Environmental, Safety and Occupational Health based on the requirements of ISO-9001, ISO-14001, and ISO-45001, valid standards. This helps the continuous improvement of the efficiency and effectiveness of the NCC Management System, and its competitiveness to meet the customer and stakeholder requirements. In October 2008 the IMS certification was achieved, while recertification was received in November 2011, June 2015, November 2018 and November 2021. All the above in adherence to the international standards listed below.

Año	Certification
1995	Accreditation of the Environmental Engineering Laboratory, awarded by the Mexican Accreditation Entity
1997	Institutional Total Quality Award, granted by CFE General Directorate
1997	Certification on NMX-CC-003-1995, equivalent to the ISO-9001:1994 (Quality Management System)
1999	Certification on NMX-SAA-001-IMNC-1998, equivalent to ISO-14001:1996 (Environmental Management System)
2002	Certification on NMX-SAST-001-IMNC-2000, equivalent to BSI OHSAS-18001:1999 (Occupational Health and Safety Management System)
2003	Certification on NMX-CC-9001-2000, equivalent to ISO-9001:2000 (Quality Management System)
2005	Integral Certification of the Quality Management, Environmental Protection and Industrial Safety System
2006	Accreditation of the Metrology Laboratory, granted by the Mexican Accreditation Entity

Año	Certification
2006	Migration to the NMX-SAA-14001-IMNC-2004 Standard, equivalent to ISO-14001:2004 (Environmental Management System)
2006	Certification as a Clean Industry, granted by the Mexican Federal Attorney for Environmental Protection
2007	Environmental Excellence Award, granted by the Mexican Federal Attorney for Environmental Protection
2008	2007 National Quality Award
2008	Multi-site Management Integral Certification, granted by the International Entity “Quality Certifications”, as part of CFE’s DO
2009	Golden Ibero-American Award, granted by the Ibero-American Foundation of Quality (FUNDIBEQ)
2010	Best in Class Award, based on the Malcolm Baldrige Model methodology, granted by the Asia Pacific Quality Organisation (APQO)
2014	Golden Ibero-American Award, granted by the Ibero-American Foundation of Quality (FUNDIBEQ)
2015	Global Performance Excellence Award (GPEA), granted by the Asia Pacific Quality Organisation (APQO)

- **Main elements of a typical quality assurance, quality management or management system programme covering all aspects of safety throughout the lifetime of the nuclear installation, including delivery of safety related work by contractors**

- **Quality assurance essential elements**

The essential elements of the QAP to cover safety aspects during the construction, testing, licencing, operation and decommissioning phases are defined based on the following:

1. All activity related with design, construction, testing and operation of Structures, Systems and Components (SSC) important to safety must be conducted under strict management and administrative controls to ensure that the operation of LVNPS Units 1 and 2 does not cause an undue hazard to the public health and safety.

   These controls consist of planned and systematic actions that guarantee the adequate accomplishment of activities related to design, purchasing, fabrication, handling, shipping, storage, cleaning, assembling, installation, inspection, testing, operation, maintenance, reparation, refuelling and changes, are carried out in such a manner that the SSCs important to safety perform satisfactorily in service.

2. Properly qualified and trained personnel shall perform the activities above-mentioned using approved procedures, likewise, control actions must be carried out by personnel independent of those performing the activities under control.

CFE, represented by its General Director, holds the total responsibility for the implementation of the Quality Assurance Plan through the NCC director, who in turn delegates the responsibility for the development, control and verification of its effective execution to the Chief of the Quality Assurance Department. In order for the Quality Assurance Chief to be able to carry out his/her responsibilities in an efficient and timely manner, he/she has sufficient organisational authority, freedom and support from the NCC management as well as from the General Direction observed through an alternate line of authority through the Nuclear Safety Division Office.

Four categories were determined to be part of the Quality Assurance Plan. These four categories define the Quality Assurance effort required for Structures, Systems and Components, as well as towards suppliers, service contractors, in terms of the safety significance of such components or services, and three categories established for equipment, systems, materials, processes and services for the Independent Spent Fuel Storage Installation (ISFSI).

Quality Assurance (QA) categories:

QA-1 Category: Assigned to components, subsystems, systems, structures, processes and services requiring the highest level of reliability in their functioning. It applies to components of the reactor coolant pressure boundary and core support structures wherein a failure may cause loss of the reactor coolant at a greater rate than the normal capacity of the makeup water system.

QA-2 Category: Classification assigned to structures, systems, subsystems, components, processes and services required to:

1. Insert negative reactivity for shutting down the reactor.
2. Prevent rapid insertion of positive reactivity.
3. Maintain appropriate core geometry under any plant process condition.
4. Provide emergency core cooling.
5. Provide and maintain containment.
6. Remove reactor and core residual heat.

QA-3 Category: Classification assigned to components, subsystems, systems, Class 1E equipment, structures, processes and services that:

1. Provide or support any safety system function.

2. Process or contain radioactive waste whose release in the event of a component failure may cause a person within the limits of the site, a whole body dose or its equivalent in any part of the body, greater than 5 mSv.

QA-4 Category: Classification assigned to components, subsystems, systems, structures, processes and services which do not have a safety function assigned, but are Seismic I Category. It also applies to supports that do not have a Seismic I Category, but are designed in such a manner to not harm seismic or safety-related components upon failure.

In order to maintain a very high level of quality two additional categories were defined, and partial fulfilment of 18 Quality Criteria in 10 CFR 50 Appendix B were set in other systems necessary to comply with the objectives of minimising fire risks and radioactive waste control. These categories are:

QA-SPCI Category: Classification assigned to fire protection components that do not belong to the Safe Shutdown Earthquake Fire Protection System (SSEFPS), but are used to protect areas containing QA category equipment.

QA-RW Category: Classification assigned to process equipment, pipes and valves that are not Class 1, 2 or 3, but form the radioactive waste pressure barrier.

The six quality categories, aforementioned, include the application of quality principles to equipment and components in which the function is: to maintain the structural integrity of the coolant pressure boundary, control essential functions (reactivity, core cooling, containment integrity) and handling of radioactive waste (in which a failure would produce doses greater than 5 mSv).

Quality Assurance (QA) categories for the Independent Spent Fuel Storage Installation (ISFSI).

Category ITS-A: Classification assigned to structures, components, and systems whose failure could directly result in a condition adversely affecting public health and safety. The failure of a single item could cause loss of primary containment leading to release.

Category ITS-B: Classification assigned to structures, components, and systems whose failure or malfunction could indirectly result in a condition adversely affecting public health and safety. The failure of a Category B item, in conjunction with the failure of an additional item, could result in an unsafe condition.

Category ITS-B: Classification assigned to structures, components, and systems whose failure or malfunction would not significantly reduce the packaging effectiveness and would not be likely to create a situation adversely affecting public health and safety.

The requirements and controls described in the QAP apply to:

1. Activities affecting the SSC with quality assurance Category 1, 2 and 3.
2. Activities affecting the original design conditions and installation of SSC with quality assurance Category 4.
3. The development, control, use and modification of the software used in safety-related applications such as calculations, operation and equipment and systems response, calibration of measuring equipment, etc. It also applies to the software used to comply or support compliance with regulatory requirements such as record management, compliance with the LVNPS Technical Specifications, ISFSI Technical Specifications, dose control of personnel, etc.
4. Radiation protection activities and ALARA policies of the plant, as well as environmental radiation surveillance activities required by the LVNPS Technical Specifications and ISFSI Technical Specifications.
5. Activities affecting systems and components with quality assurance category SPCI. The criteria described in the QAP Chapters 3, 4, 5, 7, 10, 11, 14, 15, 16, 17 and 18 will apply, in compliance with Branch Technical Position APCSB-9.5-1 Appendix A. A detailed description of how the Fire Protection Programme complies with the rest of the BTP-APCSB-9.5-1 requirements is provided in Table 9.5-4 of the Safety Analysis Reports.
6. Activities of designing, purchasing, assembling, installation, testing, and systems and components operation that form the radioactive waste pressure barrier (QA-RW Category). The criteria described in QAP Chapters 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17 and 18 will apply.
7. Activities related to the Process Control Programme and the Off-Site Dose Calculation Manual (ODCM).
8. Calibration and maintenance activities of the instrumentation necessary to collect the data required by the LVNPS Technical Specifications and ISFSI Technical Specifications.
9. Activities related to the Internal Emergency Plan and External Radiological Emergency Plan that are the responsibility of the CFE´s NCC.
10. The compliance with the requirements of the Safety Analysis Reports, authorisation for Operation and Permits granted by CNSNS and the regulations, codes and standards applicable to LVNPS.
11. Training, indoctrination and personnel qualification activities established in QAP Section 2.5.
12. Reporting activities (according to the position established by CNSNS), for manufacturing defects found in safety-related components.

13. Activities that affect Structures, Systems and Components (SSC) with category ISFSI´s Important to Safety. For SCC ITS-A, all the QAP Chapters will apply; for SCC ITS-B, the criteria described in QAP Chapters 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18 will apply; and for SCC ITS-C, only QAP Chapters 1, 2, 5, 6 and 16 will apply.

- **Authorisation to contractors**

There are approved procedures to authorise contractors, which ensure that the work at the LVNPS will be performed based on a Quality Assurance Programme according to 10 CFR 50 Appendix B, either by the contractor's own QAP or by the NCC's QAP.

The authorisation process for safety-related work to be carried out by contractors is performed considering two types of contractors:

1. Contractors who carry out their activities under the responsibilities of the Quality Assurance Programme of the CFE´s NCC and/or
2. Contractors are evaluated and qualified by the Quality Assurance Department of the NCC, to perform safety-related activities under their Quality Assurance Programme.

- **Corrective actions**

The QAP establishes measures to ensure that the identified Conditions Adverse to Quality (CAQs) be immediately controlled, analysed, corrected and, according to their significance, informed to appropriate management levels.

Currently, LVNPS is implementing an integrated corrective action system, called Corrective Action Programme (CAP), which is similar to the one used at all United States of America nuclear power plants. This programme is part of the continuous improvement efforts and has the objective to promote reporting the CAQs related to nuclear, radiation, and industrial safety; physical security; and internal and external operational experience. One of the CAP's main mechanisms is that the different organisations of CFE´s Nuclear Corporate Coordination respond to the Findings documented during CNSNS's inspections and the Deficiencies generated during quality, environmental, industrial safety and occupational health audits with the purpose of determining, communicating and planning the appropriate corrective actions.

The CAQs are classified according to their safety significance as: Level 1 (L1), 2 (L2) and 3 (L3). These levels are based on the criteria established and evaluated through the root cause analysis, apparent cause, or direct cause to determine the corrective actions and their implementation period, according to their safety significance. During the period 2015-2018, an average of 6,500 Condition Reports (CRs) per year have been issued.

It is important to note that all LVNPS staff has access to the Corrective Action Programme through 1,300 computer stations.

- **Reporting**

There is a licence holder - regulatory body interface through a reporting system based on the regulations listed below:

Reporting	**Applicable regulation**
Component defects	10 CFR 21
Important deficiencies (IDR)	10 CFR 50.55 (e)

Reports for component defects correspond to non-conformities in the components design and manufacture, and equipment that affect their performance. Usually these reports are extrinsic to the licence holder and are generated by manufacturers and suppliers of equipment and services important to safety, with the exception of equipment and components that have been procured by the licence holder as commercial-grade and dedicated for use in the nuclear installation.

The Important Deficiency Report (IDR) is a significant breach of the Quality Assurance Programme and even though the original regulation only applies to the construction phase, the licence holder and CNSNS have agreed to keep it valid during the LVNPS operation phase.

It is important to note that the reporting system is managed by CFE´s Quality Assurance Department.

- **Periodic assessment of the quality assurance programme**

The Nuclear Corporate Coordination (NCC) of the of the CFE, with independent and qualified staff, evaluates at least every two years:

1. Effectiveness of the Quality Assurance Programme, and
2. The performance of the personnel and the organisation of the NCC.

These assessments are conducted by the Independent Safety Engineering Department (ISED). The ISED reports directly to the Manager and is totally independent of all functional areas of the NCC. The basic objective is to verify that the QAP implementation is effective in ensuring safe and reliable operation of LVNPS, and in determining what improvements are needed to promote successful operation.

The effectiveness of the QAP implementation is determined based on the following aspects.

a) Review and assessment of:

1. The performance indicators of the Corrective Action Programme Management and Control System, which are based on the data gathered about the staff and organisation performance, as well as the SSC related to each one of the 18 QAP criteria.
2. Changes made to the organisation of the NCC.
3. Quality assurance reviews and audits results.

b) Performance assessment of the Top Management identifying recommendations regarding:

1. Failure to effectively assign responsibility and authority.
2. Inability to anticipate, identify and correct problems by oneself.
3. Failure to achieve and maintain a quality culture.
4. Failure to optimise the use of key resources.
5. Inadequate interaction between organisations.
6. Inability to focus on long-term performance.

– Audit programmes of the licence holders

The Quality Assurance Programme incorporates measures to establish and execute a system of planned audits and surveillances to verify the correct implementation of the QAP requirements in all the organisations responsible for providing a required service. The audits include an objective assessment of the practices, procedures, instructions, activities, performance of the areas, etc., as well as review of documents and records to ensure that the QAP is properly and effectively implemented. The surveillances are carried out by the CFE´s NCC Quality Assurance Department.

The NCC has established the policy that the maximum interval between audits to the same functional area is two years. However, for areas that need more attention due to recurring problems or their situation, audits could be performed more frequently than two years. Also the Technical Specifications prescribe performing semi-annual and annual audits for some specific areas.

As an example, for operation and engineering quality assurance audit programmes for the 2019-2021 period are presented in Annexes 13.1 and 13.2, respectively.

- **Audits of vendors and suppliers by the licence holders**

CFE's Quality Assurance Department assesses and qualifies all suppliers of equipment, components and services important to LVNPS safety. The assessment is performed by a CFE direct audit of the supplier's or vendor's quality assurance programme or by audits carried out under the Nuclear Utilities Procurement Issues Committee (NUPIC) cooperation programme since CFE is a NUPIC member. The qualifications are generally based on ANSI/ASME N 45.2.12 "Quality Assurance Programme Requirements for Nuclear Facilities" and ANSI/ASME N 45.2.13 "Quality Assurance Requirements for the Procurement Control of Items and Services for Nuclear Facilities."

As an example, the audit programme of the Suppliers Control Group for 2019 through 2021 is presented in Annexe 13.3.

- **Regulatory review and control activities**

During the construction and operation phases, CNSNS assesses the LVNPS Quality Assurance Plan and its changes, to verify the fulfilment with the requirements set in 10 CFR 50 Appendix B and NUREG-0800, Rev. 2, as it is described in the mandatory regulatory framework for LVNPS licencing. During this reporting period, changes to QAP were evaluated and approved, related with:

- Modifications to the organisation of LVNPS;
- Changes in responsibilities between groups;
- Include safety significant and non-safety significant activities for Operating Authorisation Renewal and Extended Period of Operation activities,
- Eliminate the Justification for Continued Operation for exceptions to compliance with the TS and Operating Authorisation, and
- Modifications to adapt requirements established in the Quality Assurance Plan.

Also, as stated in Article 14, CNSNS, through its Baseline Inspection Programme, reviews the programmes and activities of quality-related areas, such as quality assurance and quality control; the supervision groups such as the Independent Operations Review Committee (IORC) and the ISED, suppliers and contractors, and programmes for dedication of commercial-grade items and for corrective actions.

For the Corrective Action Programme, both the resident inspectors (monthly, semi-annually and annually) and the headquarters inspectors (every two years) verify: (1) the CAP effectiveness to identify and resolve problems according to their safety significance; (2) specific problems with generic implications; (3) the impact that the combination of otherwise riskless individual problems have on safety; and (4) if the LVNPS authorisation holder is properly logging the information.

Additionally, in order to reduce the response and implementation time a continuous communication channel has been established between CFE's Quality Assurance Department and CNSNS. This communication allows following up on the corrective, preventative, and improvement actions resulting from the findings documented during the inspections carried out by CNSNS at LVNPS.

Finally, by monitoring indicators and evaluating the results of Maintenance Rule (10 CFR 50.65) inspections, CNSNS verifies that the licence holder is following up on issues that may affect the operability and availability of equipment covered by this regulation.

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YEAR 2019 AREA OR ACTIVITY	Audit No.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
INDEPENDENT SAFETY ENGINEERING DEPARTMENT	01/19-DIIS (YRH)	√											
IN-SERVICE INSPECTION	02/19-ISI (ART)				√								
TECHNICAL SPECIFICATIONS	03/19-ETO (LFHG)			√									
PROCESS CONTROL PROGRAMME	04/19-PCP (JMT)						√						
TRAINING	05/19-ENTTO-C (ART)						√						
ORGANIZATION	06/19-ORG-C (YRH)		19 RFO U1			16 RFO U2	√						
CORRECTIVE ACTIONS	07/19-AC-C (JMT)							√					
REACTOR ENGINEERING	08/19-IRX (YRH)								√				
EMERGENCY PLANS	09/19-PEI/PERE (ART)								√				
INSTRUMENTATION AND CONTROL	10/19-I&C (JMT)									√			
PLANNING	11/19-PLAN (LFHG)											√	
MAINTENANCE	12/19-MANTTO (ART)											√	
SYSTEMS ENGINEERING	13/19-ING SIST (JMT)												√
ENVIRONMENTAL RADIATION MONITORING	14/19-MRA (YRH)												√
CORRECTIVE ACTIONS	15/19-AC-C (LFHG)												√
INDEPENDENT AUDIT FP AND LOSS PREVENTION	SPECIAL											⏩	

Key:
- ▲ Audit Scheduled
- ⏩ Audit Rescheduled
- √ Audit Performed
- ■ Audit Cancelled

Rev. 5
Issuance date: 01/jan/2021

Prepared by:
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NATIONAL REPORT

Annexe13.1 Page 2 of 3, Biennal Audit Quality Assurance Program, Operation

YEAR 2020 AREA OR ACTIVITY	Audit No.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
INDEPENDENT AUDIT FP AND LOSS PREVENTION	SPECIAL	√								20 RFO U1			17 RFO U2
LICENSING	01/20-LIC (YRH)	√											
FIRE PROTECTION	02/20-PCI (YRH)		√										
TECHNICAL SPECIFICATIONS	03/20-ETO (JMT)	√											
MODIFICATIONS	04/20-MOD (ART)		√										
TRAINING	05/20-ENTTO-C (ART)								√				
CROS Y CIRO	06/20-CROS / CIRO (JMT)			√									
CORRECTIVE ACTIONS	07/20-AC-C (YRH)							√					
OPERATION	08/20-OPER (ART)						√						
EMERGENCY PLANS	09/20-PEI / PERE (FRR)							√					
CHEMISTRY	10/20-QUIM (JMT)							√					
QUALITY CONTROL	11/20-CC (CASR)										√		
RADIATION PROTECTION	12/20-PR (FRR)										√		
ENVIRONMENTAL RADIATION MONITORING	13/20-MRA (CASR)										⏩	√	
CORRECTIVE ACTIONS	14/20-AC-C (LFHG)										⏩		√
INDEPENDENT AUDIT FP AND LOSS PREVENTION	SPECIAL										√		

Key:
- ▲ Audit Scheduled
- ⏩ Audit Rescheduled
- √ Audit Performed
- ■ Audit Cancelled

Rev. 5
Issuance date: 01/jan/2021

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Annexe 13.1 Page 3 of 3, Biennal Audit Quality Assurance Program, Operation

Comisión Federal de Electricidad

BIENNAL AUDIT PROGRAM Sub-Department of Quality Asurance

YEARS 2021 - 2022

YEAR 2021 AREA OR ACTIVITY	Audit No.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
INDEPENDENT SAFETY ENGINEERING DEPARTMENT	01/21-DIIS (YRH)	√											
IN-SERVICE INSPECTION	02/21-ISI (CASR)		√										
TECHNICAL SPECIFICATIONS	03/21-ETO (LFHG)		√										
PROCESS CONTROL PROGRAMME	04/21-PCP (JMT)			√									
TRAINING	05/21-ENTTO (YRH)						√						
ORGANIZATION	06/21-ORG (ART)					√							
CORRECTIVE ACTIONS	07/21-AC-C (JMT)								√				
REACTOR ENGINEERING	08/21-IRX (LFHG)					√							
EMERGENCY PLANS	09/21-PEI/PERE (CASR)					√							
INSTRUMENTATION AND CONTROL	10/21-I&C (LFHG)						√						
PLANNING	11/21-PLAN (FRR)									√			
MAINTENANCE	12/21-MANTTO (CASR)									√			
SYSTEMS ENGINEERING	13/21-ING SIST (YRH)											√	
ENVIRONMENTAL RADIATION MONITORING	14/21-MRA (ART)											√	
CORRECTIVE ACTIONS	15/21-AC-C (FRR)												√
GEHI NUCLEAR ENERGY AMERICAS CONTRACT 800935360	16/21-GEHI-MOA (RAB)									■			
RADIATION PROTECTION (CALIBRATION)	17/21-PR (FRR)								√				
AUD. INDEP. AL PPCI Y PP 2021	SPECIAL REGULATORY										√		

Simbología:

- ▲ Audit Scheduled
- ⏩ Audit Rescheduled
- √ Audit Performed
- ■ Audit Cancelled

Rev. 2
Issuance date: 04/jan/2022

Prepared by: Fís Ramón Alvarado Bustos, Responsible for Area

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Annexe 13.2 Page 1 of 3, Biennal Audit Quality Assurance Program, Engineering

YEAR 2019	AREA OR ACTIVITY	Audit LVI No.	JAN					FEB				MAR				APR				MAY					JUN				JUL				AUG					SEP				OCT					NOV				DEC				
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3
	ASME XI Certification, Isometrics and Supports	341/19/ISOM (JMSV)													⏩	✓																																							
	Enginnering Analysis Activities	342/19/AI (AGM)															✓																																				
	Purchases	343/19/COM (BACG)																							⏩									✓																				
	Modification Packages U-1 / U-2	344/19/PM (JMSV)																									⏩	✓																									
	As-Modified U-1 / U-2	345/19/AM (AGM)						19RFOU1													16RFOU2									⏩												✓													
	Maintenance of Environmental Qualification and Dedication	346/19/CAL (BACG)																																⏩												✓								
	INEEL Activities	347/19/INEEL (JMSV)																																		■																		
	ININ Activities	348/19/ININ (BACG)																																					⏩															✓
	Engineering Services	359/19/SER (AGM)																																				■			⏩													
	GE Activities	350/19/GE (ENP)																																												■								

Key:
- ▲ Audit Scheduled
- ⏩ Audit Rescheduled
- √ Audit Performed
- ■ Audit Cancelled

Rev. 5
Issuance date:
08-oct-20

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Annexe 13.2 Page 2 of 3, Biennal Audit Quality Assurance Program, Engineering

Comisión Federal de Electricidad

Biennal Audit Quality Assurance Program, Engineering

YEARS 2019-2020

YEAR 2020	AREA OR ACTIVITY	Audit LVI No.	JAN					FEB				MAR				APR					MAY				JUN				JUL					AUG				SEP				OCT					NOV				DEC				
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3
	Software Quality Assurance Program	351/20/SW-C (ARP)																																																			
	Contracts and SOT's under PGC-CFE	352/20/SOT-C (AGM)						√																																													
	Program and Component Engineering Activities / DRC's	353/20/IPC (JMSV)									⏩												√																														
	Document Control	354/20/CD (BACG)											√																						20RFOU1														17RFOU2						
	Procedures and Instructions	355/20/PI-C (AGM)																			⏩																							▲											
	ININ Activities	356/20/ININ (JMSV)																								⏩ →																													
	INEEL Activities	357/20/INEEL (ARP)																							■																														
	GE Activities	358/20/GE (ENP)																									■																												
	Engineering Services	359/20/SER (AGM)																											■																										

Key:

- ▲ Audit Scheduled
- ⏩ Audit Rescheduled
- √ Audit Performed
- ■ Audit Cancelled

Rev. 5

Issuance date: **08-oct-20**

Prepared by:
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Annexe 13.2 Page 3 of 3, Biennal Audit Quality Assurance Program, Engineering

Comisión Federal de Electricidad

Biennal Audit Quality Assurance Program, Engineering

YEARS 2019-2020

YEAR 2021	AREA OR ACTIVITY	Audit LVI No.	JAN					FEB				MAR				APR				MAY					JUN				JUL				AUG					SEP				OCT					NOV				DEC				
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3
	ASME XI Certification, Isometrics and Supports	361/21/ISOM (JMSV)						✓																																															
	Enginnering Analysis Activities	362/21/AI (ARP)							⏩			✓		U1															U2																										
	Purchases	363/21/PM (AGM)									✓																																												
	Modification Packages U-1 / U-2	364/21/COM (BACG)												O				⏩	✓										O																										
	As-Modified U-1 / U-2	365/21/AM (JMSV)						19RU1						U						⏩									U											✓															
	Maintenance of Environmental Qualification and Dedication	366/21/CAL (ARP)												T								✓							T																										
	INEEL Activities	367/21/INEEL (AGM)												A										■					A																										
	ININ Activities	368/21/ININ (JMSV)												G								✓				⏩			G																										
	Engineering Services	369/21/SER (AGM)												E															E									■																	
	GE Activities	370/21/GE (ENP)																																							■														
	IDOM Engineering Services	360/21/IDOM (ENP)																																												■								

Key:

- ▲ Audit Scheduled
- ⏩ Audit Rescheduled
- √ Audit Performed
- ■ Audit Cancelled

Rev. 3
Issuance date:
08-oct-20

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COMISIÓN FEDERAL DE ELECTRICIDAD

ANNUAL AUDIT PROGRAM Suppliers Control Group

YEAR 2019

SUPPLIER / CONTRACTOR	NUPIC AUDIT	Audit No.	JAN					FEB				MAR				APR					MAY				JUN				JUL					AUG				SEP				OCT					NOV				DEC			
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2
WESTINGHOUSE D&D SERVICES		NLVE-352													✓																																							
TELEDYNE BROWN ENG. ENVIRONMENTAL SERVICE	24791	NLVE-341																✓																																				
INGENIERÍA Y PROYECTOS DE INNOVACIÓN (IPI)		NLVE-354																								✓																												
FLOWSERVE, FLOW CONTROL DIVISION (LIMITORQUE)	24743	NLVE-345																								✓	⏩																											
HILTI MEXICANA		NLVE-353																										✓																										
GLOBAL NUCLEAR FUEL - AMERICAS	24750	NLVE-346																													■	■																						
GE-HITACHI NUCLEAR ENERGY AMERICAS LLC	24746	NLVE-347																													■	■																						
MAGNETROL INTERNATIONAL INC	24765	NLVE-344																																■																				
WESTINGHOUSE ELECTRIC SWEDEN AB	24795	NLVE-343																																		✓																		
Tecnatom		NLVE-348																																			■																	
Ringo Valves		NLVE-349																																				■																
CARBOLINE COMPANY	24723	NLVE-350																																								⏩							✓					
TE CONNECTIVITY	24789	NLVE-351																																													⏩				✓			
PARAGON ENERGY SOLUTIONS	24771	NLVE-342																																																⏩	✓	✓		

Key:
- ▲ Audit Scheduled
- ⏩ Audit Rescheduled
- √ Audit Performed
- ■ Audit Cancelled

Rev: 4
Issuance date:
20-dec-19

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COMISIÓN FEDERAL DE ELECTRICIDAD

ANNUAL AUDIT PROGRAM Suppliers Control Group

YEAR 2020

SUPPLIER / CONTRACTOR	NUPIC AUDIT	Audit No.	JAN					FEB				MAR				APR					MAY				JUN				JUL				AUG					SEP				OCT					NOV				DEC			
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2
TIOGA PIPE COMPANY	24944	NLVE-355			✓																																															
KSB PUMPS		NLVE-367									✓																																									
TECHNETICS GROUP COÑUMBIA (GARLOCK HELICOFLEX)	24942	NLVE-356										✓																																								
TECNATOM		NLVE-363				✓ ←							▲																																							
RINGO VALVES		NLVE-358												■																																						
MIRION TECNOLOGIS (CONAX NUCLEAR), INC	24919	NLVE-359															▲ →					■																														
HILTI CORPORATION	24908	NLVE-360																	▲ →																																		2021	
DAHER VALVES		NLVE-361																					■																															
TARGET ROCK, INDUSTRIAL DIVISION CURTISS-WRIGHT	24940	NLVE-362																							▲ →																												2021	
WESTINHOUSE ENGINEERING	24955	NLVE-368																									■																											
SOR INCORPORATED	24935	NLVE-364																																													▲ →						2021	
HENRY PRATT COMPANY	24906	NLVE-365																																																	⏩ →		2021	
PCI-PROMATEC	24924	NLVE-366																																																		⏩ →	2021	

Key:
- ▲ Audit Scheduled
- ⏩ Audit Rescheduled
- √ Audit Performed
- ■ Audit Cancelled

Rev: 2
Issuance date: 04-dec-20

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Annexe 13.3 Page 3 of 3, Biennal Audit Quality Assurance Program, Suppliers

COMISIÓN FEDERAL DE ELECTRICIDAD

ANNUAL AUDIT PROGRAM Suppliers Control Group

YEAR 2021

SUPPLIER / CONTRACTOR	NUPIC AUDIT	Audit No.	JAN					FEB				MAR				APR				MAY				JUN					JUL				AUG					SEP				OCT				NOV				DEC				
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2
PCI-PROMATEC	24924	NLVE-366			✓																																																	
SOR INCORPORATED	24935	NLVE-364										✓																																										
TARGET ROCK, INDUSTRIAL DIVISION CURTISS-WRIGHT	24940	NLVE-362																				✓																																
WELDSTAR COMPANY	25122	NLVE-372																				✓																																
CONTINENTAL FIELD SYSTEMS , INC.	25050	NLVE-371																				▲			✓																													
GENERAL CABLE CORPORATION	25077	NLVE-369																														✓																						
SENIOR FLEXONICS PATHWAY	25112	NLVE-374																																							✓													
PAWLING ENGINEERED PRODUCTS, INC	25102	NLVE-370																																									✓											
HENRY PRATT COMPANY	24906	NLVE-365																			▲																					⏩			✓									
OKONITE	25099	NLVE-376																																									▲	▲	✓			✓						
STUDSVIK SCANDPOWER, INC.	25124	NLVE-375																																								▲					✓							
HILTI CORPORATION	24908	NLVE-360																																	▲																✓			
FRAMATOME INC.	25074	NLVE-373																															▲	▲																	✓	✓		
HYDROAIRE SERVICE INC.	25079	NLVE-377																																																	▲		2022 →	

Key:
- ▲ Audit Scheduled
- ⏩ Audit Rescheduled
- √ Audit Performed
- █ Audit Cancelled

Rev: 3
Issuance date:
15-dec-21

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ARTICLE 14. ASSESSMENT AND VERIFICATION OF SAFETY

Obligations

"Each Contracting Party shall take the appropriate steps to ensure that:

i) Comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its lifetime. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;

ii) Verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions."

Article 14 (1) Assessment of safety

- **Overview of the Contracting Party's arrangements and regulatory requirements to perform comprehensive and systematic safety assessments**

According to the provisions of the Regulatory Law on Nuclear Matters of Article 27 of the Constitution, Chapter IV Articles 25 and 28, and Chapter VI Article 50 Fractions III, IV, V, VII and XIII, CNSNS has the authority for reviewing, evaluating and authorising the bases for the siting, design, construction, operation, modification, cease of operations, definitive shutdown, and decommissioning of nuclear and radioactive installations; as well as everything related to the manufacture, use, handling, storage, reprocessing and transportation of nuclear fuels and materials, radioactive materials and equipment containing them; and the processing, conditioning, dumping, and storage of radioactive wastes; and any disposal of them.

- **Safety assessments within the licencing process and the safety analysis reports for different stages in the lifetime of nuclear installations (e.g., siting, design, construction, operation)**

Safety assessments - construction phase

In 1973 prior to Laguna Verde Nuclear Power Station construction, the CFE presented to the Department of Reactors of the National Institute for Nuclear Energy (identified at that time as the "Regulatory Authority"), the safety analyses corresponding to the: Preliminary Safety Analysis Report (PSAR), Preliminary Environmental Impact Assessment Report (PEIAR) and Construction Quality Assurance Programme (CQAP).

Subsequently, during this construction phase, the LVNPS installations were subjected to different evaluations, inspections and audits, which were performed by CNSNS and plant organisations as well as external auditors.

1. LVNPS internal audits/inspections

   The audits and surveillances were carried out by the Quality Control and Quality Assurance Departments. The activities of both organisations were continuously performed under a specific programme.

2. Regulatory activities performed by CNSNS

   For the Construction Permit to be awarded, CNSNS evaluated the PSAR. Eight hundred questions were generated from this, resulting in the issuance of 44 amendments to the PSAR.

   The assessment process allowed granting several Provisional Construction Permits. The Definite Construction Permit for LVNPS was awarded in 1979. Later, in September 1992, an extension to the Definite Permit was issued, specifically for completing the construction of LVNPS Unit 2.

   During the construction of LVNPS Units 1 and 2, CNSNS performed inspections and surveillances of activities of design, engineering, installation, special processes and non-destructive testing. Similarly, following a continuous and systematic programme, CNSNS performed audits and inspections to the main suppliers of services and equipment important to nuclear safety. In addition to the aforementioned activities, resident inspectors were assigned to the construction site.

   In order to carry out some of these assessment activities the International Atomic Energy Agency (IAEA) provided technical assistance to CNSNS through experienced personnel.

3. External assessments

   The external assessments had the support of three IAEA missions through the Operational Safety Evaluation Groups and were conducted in January 1986, January 1987 and September 1987. In addition, there was a mission carried out by the Radiation Protection Advising Team in December 1986. There were no substantial defects reported in the LVNPS safety systems, including the administrative and quality assurance systems.

4. Pre-operational testing programme

   The pre-operational testing programme started with the transfer of systems and components from the construction organisation to LVNPS operation personnel.

Since the outset of the assessment of this programme, CNSNS developed a work plan which, among other activities, included: evaluation of safety-related test procedures, witness tests and evaluation of test results.

Safety assessments during start-up testing

Just like for the pre-operational stage, prior to initial nuclear fuel loading, CFE presented a start-up generic testing programme in order to demonstrate that LVNPS Units 1 and 2 can handle foreseen transients with sufficient safety margins during its operation lifetime. In this respect, CNSNS developed a work plan including among other activities: evaluation of test procedures for safety-related systems, witness of tests and evaluation of test results. The specific details of these activities are presented in Article 19 (1) of this National Report.

Safety assessments - operation phase

1. <u>Licence for Commercial Operation (100% RTP)</u>

   On June 29, 1979, CFE submitted to CNSNS a Final Safety Analysis Report (FSAR) to support the application for the Licence for Commercial Operation of LVNPS Unit 1. The FSAR was assessed by CNSNS, obtaining acceptable results; therefore, on July 24, 1990 a Licence for Commercial Operation for LVNPS Unit 1 with a thermal power of 1,931 MWt was granted. Given the differences between Units 1 and 2 of LVNPS, in 1994 a second FSAR specifically for Unit 2 was presented for evaluation by CNSNS who determined that this report was acceptable. On April 10, 1995 a Licence for Commercial Operation for Unit 2 at the same power as Unit 1 was issued.

2. <u>First amendment to the Licence for Commercial Operation (105% RTP)</u>

   In the second semester of 1995, CFE began approaching CNSNS regarding its intention to perform a 5% thermal power uprate for both LVNPS units. Then in early 1999, CFE presented a formal application to CNSNS. After reviewing the amended sections of the Safety Analysis Report and the support documentation, CNSNS approved the testing programme in order to verify a stable performance of LVNPS under this new condition.

   During the evaluation process, CNSNS asked 55 questions and held 39 technical meetings with CFE. CNSNS also evaluated the Technical Specifications (TS) that were modified for this new condition. Generally speaking, as a result of these assessments, CNSNS confirmed that it was not necessary to implement any physical changes to the Structures, Systems and Components (SSC) of LVNPS Units 1 and 2. CNSNS also witnessed all phases of testing during the rise of power in steps of 1%, concluding that the test results were within the specified acceptance criteria.

CNSNS's evaluation and inspections results were documented in a Safety Evaluation Report, which was the basis for recommending to the Secretariat of Energy that a modification of the power in the original Licence for Commercial Operation, from 1,931 MWt to 2,027 MWt, could be granted. Based on the successful results and the favourable opinion of CNSNS, on December 8, 1999, the CFE received from the Secretariat of Energy two new Licences for Commercial Operation for both units of LVNPS, authorising a 5% power uprate up to 2,027 MWt.

3. Second amendment to the Licence for Commercial Operation (120% RTP)

In November 2005, CFE announced its intention to make a 20% power uprate with respect to the power originally licenced. On July 10, 2008, the CFE presented the formal application to CNSNS for authorisation to the Extended Power Uprate (EPU).

The regulatory evaluation process carried out by CNSNS finished in June 2018, and 784 Request for Additional Information were issued. The most important assessment issue was the structural integrity of the reactor steam dryer subjected to acoustic loads, which pointed to the installation of reinforcements for this component in both LVNPS units. This evaluation was divided into two main stages:

- Acoustic loads on the dryer: CFE used Westinghouse's proprietary Acoustic Circuit Model (ACM) Version 4.2, with stationary wavelet transform (SWT) technology, to determine the pressure loads on the dryer.
- Calculation of fatigue alternating stresses: With acceptance criteria established by CNSNS for the Alternating Stress Ratio for fatigue to be greater than or equal to 2.0.

Other CNSNS´s concern was regarding to the high temperature of the ultimate heat sink.

The results of the regulatory evaluations and inspections were documented by CNSNS in a Safety Evaluation Report that contains a favourable opinion, and finally in June 19, 2018 CFE received from CNSNS two new authorisations to operate LVNPS both units to a maximum power of 2,317 MWt , maintaining the original expiration dates:

Unit 1: July 24, 2020
Unit 2: April 10, 2025

4. Assessments during commercial operation

During the commercial operation, the major activities carried out by CNSNS are described below.

a) Assessment of the following:

1. Proposals of changes to Technical Specifications or amendments to the Authorisation for Commercial Operation.
2. Changes to the Pumps and Valve Operability Programmes (In-Service Testing) under ASME Code, Section XI, and proposals of exemption to comply with the code.
3. Results of In-Service Inspection (ISI) Programmes under ASME, Section XI for active and passive components, and proposals of exemption to comply with the code (Repairs, Code Cases, etc.)
4. New reactor cores for each Fuel Cycle.
5. Event Reports that CFE has delivered to CNSNS.
6. Activities of ageing control and mitigation (maintenance of environmental qualification, corrosion, radiation embrittlement at the reactor pressure vessel wall, water chemistry, etc.), and structural integrity.

b) Review of the following:

1. Applicability of the internal and external operational experience to LVNPS.
2. Design changes (modifications) to Structures, Systems and Components important to safety.
3. Tests and experiments to be performed at LVNPS.
4. Development and implementation of new regulations.

The assessments of the Change Requests of the LVNPS Units 1 and 2 Licence for Commercial Operation were among the relevant activities. The change requests were to modify the licenced range of the core total flow from 87-107% to 81-107%. This change was known as “Operational Flexibilities”. CNSNS’s assessment covered, among others, areas such as: transient analysis, protection against over pressure of the Reactor Pressure Vessel (RPV), thermal-hydraulic stability, performance of emergency systems, technical specifications, etc.

- **Re-evaluation of hazard assumptions (e.g., according to international best practice, using deterministic and probabilistic methods of analysis)**

CNSNS, in accordance with international practice, uses traditional engineering methods combined with a “risk-informed” approach to make regulatory decisions at LVNPS.

In April 2015, CFE presented LVNPS's updated probabilistic risk assessment (PRA). Among the main results were:

In March 2020, CFE presented LVNPS updated Probabilistic Safety Assessment (PSA). The purpose of this revision was to incorporate changes due to improvements to meet the requirements of ASME RA/Sb-2005 "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications" in its Capability II category, as well as updating mitigation system success criteria due to new information published in recent years, major changes in the risk profile due to plant modifications in response to regulatory requirements for strategies called Flex and B.5.b, as well as rigid wet well venting, as part of the Post-Fukushima actions. Other modifications also include a:

- Human factors after an initiating event for the Anticipated Transient Without Scram (ATWS), taking into account changes made to two emergency operating procedures, as well as observations made during simulator training of licensed personnel.
- Installation of the rigid wet well vent.
- Settings for connection of portable pump hoses.
- Settings for connection of the CAS diesel generator and portable diesel generators to power battery chargers.
- 125 VDC control power supply for switches and motor control center (MCC).
- Limits on the operation of the Reactor Core Isolation Cooling (RCIC) at low pressure according to recent information from the BWR Plant Owners Group (BWROG) and specific analyses by the LVNPS.
- Impact of small and medium steam LOCA on short-term BOP.
- Impact of medium steam LOCA on long-term depressurization and injection.
- Nuclear Service Water System (NSW) success criteria for long-term ATWS.
- Likewise, the differences between units are highlighted, and the significant variances existing in the current version of the study and their impact on Core Damage Frequency are presented.

By this date. CFE continues with the update of the PRA in Stage 1 (determination of the Core Damage Frequency) and Stage 2 (determination of the Source Term).

– **Overview of periodic safety assessments of nuclear installations during operation, including references to appropriate standards and practices and illustrations on how new evidence is taken into account (e.g., in the light of operating experience, and of other significant new safety information)**

Requirement No. 7 and Condition No. 5 of the Licence for Commercial Operation of LVNPS Units 1 and 2 were established as Periodic Safety Review (PSR). This review is not intended to renew the licence every ten years or object to the operation of the plant for the period licenced. It is useful rather to complement the analyses and studies that are continuously carried out to support applications for authorisation of design changes or changes to the Technical Specifications. The PSRs are performed every ten years following IAEA recommendations.

The objective of the Periodic Safety Review is to make an overall assessment about the installation safety conditions including the status of radioactive waste, taking into account the operational experience acquired.

The scope of the Periodic Safety Review, using deterministic and probabilistic methods, includes the different aspects of the installation nuclear safety described below:

a) Plant

   i) Plant design.
   ii) Current status of SSC.
   iii) Equipment qualification.
   iv) Ageing management.

b) Safety analysis

   i) Deterministic Safety Analysis.
   ii) Probabilistic Safety Analysis (PSA).
   iii) Risk analysis.

c) Performance and operational experience feedback

   i) Safety performance.
   ii) Use of internal and external experience and research findings.

d) Leadership

i) Organisation and management.
ii) Procedures.
iii) Human factors.
iv) Emergency plan.

e) Environment

i) Radiological impact on the environment.

The PSRs shall analyse the following safety factors:

Safety Factor No. 1 "Plant design"

The objective of the nuclear plant design review is to determine the design and documentation adequacy with respect to established standards and current international practices.

Safety Factor No. 2 "SSC current condition"

The review objective is to determine the current condition of safety significant SSC, and if they meet the design requirements and the applicable regulations. In addition, the review shall confirm that the SSC condition is properly documented and considered.

Safety Factor No. 3 "Equipment qualification"

The objective of reviewing the factor "Equipment qualification" is to verify that the safety significant equipment installed in harsh environment is environmentally and seismically qualified to perform their safety function during the Licence for Commercial Operation period. It is also verified that the required documentation exists, and that this is a continuous process from the plant design phase until the end of the equipment service life.

Safety Factor No. 4 "Ageing management"

The objective of reviewing the factor "Ageing management" is to verify the SSC performance during the design life of the plant.

Safety Factor No. 5 "Deterministic safety analysis"

The review objective of the deterministic safety analysis is to verify to what extent the analyses of the safety report are still valid, when the following aspects are considered: present facility design; present SSC condition and expected condition by the end of the PSR period, current deterministic methods, standards and current knowledge. In addition, the review shall also identify any weaknesses negatively affecting the Defence in Depth concept.

Safety Factor No. 6 "Probabilistic Safety Analysis"

The review objective of the Probabilistic Safety Analysis is to verify that the scope of the existing PSA remains valid as a representative model of the plant when the following aspects are taken into account: changes in the plant design and operation, new technical information, and operational information.

Safety Factor No. 7 "Risk analysis"

The review objective of the risk analysis is to determine the adequate protection of the nuclear power station against internal and external hazards considering the current plant design, site characteristics, actual SSC condition and expected condition by the end of the PSR period, and current analytical methods and safety standards.

Safety Factor No. 8 "Safety performance"

The review objective is to evaluate the safety performance based on the safety indicators defined by the plant.

Safety Factor No. 9 "Use of internal and external experience and research findings"

The lessons learned from internal operational experience and the nuclear industry experience help to prevent recurrent operational incidents and potential failures of important equipment that might affect the plant safety. Using this experience helps to improve the equipment and processes performance, and human performance, benefitting the nuclear plant operation. It also ensures that the nuclear industry experience is integrated through preventive actions to improve the plant safety and reliability, and prevent similar events.

Safety Factor No. 10 "Organisation and management"

The objective of reviewing the factor "Organisation and management" is to verify that the organisation has set high performance standards for activities related to safe operation of the installation. The leadership shall ensure that the organisation is well structured with clear lines of authority and communication, and that safety policies are well implemented and observed by all personnel.

Safety Factor No. 11 "Procedures"

The review objective is to verify that the procedures have established policies and administrative controls for a safe operation. It shall be established that all activities affecting a safe operation must be indicated in procedures or special instructions ensuring compliance with the Technical Specifications and regulatory requirements.

Safety Factor No. 12 "Human factors"

The review objective is to determine the condition of human factors that may affect the plant's safe operation. It is important to include the selection, training and development of personnel who are entrusted with the plant's safe performance.

Safety Factor No. 13 "Emergency plan"

The review objective is to verify that the organisation has adequate plans, personnel, facilities and equipment to cope with potential emergencies; the organisation has properly coordinated arrangements with national and local systems; and the integrated response is periodically tested by exercises and drills.

Safety Factor No. 14 "Radiological impact on the environment"

The review objective is to determine that the installation has adequate programs to monitor and evaluate the radiological impact on the environment, verifying compliance with the established regulatory framework.

- **Overview of safety assessments performed and the main results of those assessments for existing nuclear installations including the summary of significant results for individual nuclear installations and not only according to their type and generation**

Analysis of operational experience

The analysis of the operational experience includes the experience about: a) the operation, b) the operational radiation protection, c) the control of liquid and gaseous effluents, d) environmental radiation surveillance, and e) the solid radioactive waste management for the period considered.

It is important to mention that the Periodic Safety Review for operational experience is performed by methodologies of deterministic analysis.

Analysis of equipment performance

The analysis of equipment performance shall include compliance verification with: seismic and environmental qualification requirements, the Maintenance Rule, the In-Service Inspection Manual, the Surveillance Requirements set in the Technical

Specifications and the Management Plan for the plant useful lifetime.

It is important to mention that the Periodic Safety Review for operational experience in this particular topic is performed by methodologies of deterministic and probabilistic analysis.

Design changes

All design changes made to LVNPS's structures, systems, or components (SSC) that modify the design basis are reviewed and assessed, in order to verify that they continue to provide for the safe operation of the plant. The assessment identifies the changes made, including the design requirements as input, in order to perform design checks to ensure that the design bases are maintained.

Configuration control

The review is intended to verify: (1) whether the corrective actions resulting from the programme performed for LVNPS's design bases revision have been adequate and fully implemented and (2) the existence of a process to ensure maintenance of the plant design bases, and if a design bases change may be needed, the change should be properly controlled, analysed, documented and, handled in accordance with the applicable requirements.

Situation analysis of the new international regulation and the new regulation of the nuclear steam supply system supplier's country of origin

Based on the plant licencing basis requirements, the analysis by the new regulation shall include standards issued by international organisations, specifically, the IAEA safety codes and guidelines, and regulations issued by the Nuclear Steam Supply System (NSSS) supplier's country of origin. The review is intended to verify whether the corrective actions resulting from the new regulation analysis have been adequate and fully implemented.

Management system

The licence holder shall evaluate the implementation progress, effectiveness and improvement actions of the management system. In addition, the licence holder shall conduct a review of the organisation, policies, and strategic and operation planning.

- **Regulatory review and control activities**

Regarding the safety assessments performed by the licence holder, in 1997 CNSNS requested to CFE that the LVNPS Unit 1 PSR report had to include all the FSAR table of contents. Later in 2006, CNSNS established that to meet the LVNPS Unit 2 PSR requirement, CFE should follow the IAEA Safety Guide NSG-2-10, including the radioactive waste situation. Since the guidance was superseded by SSG-25, this is now the current document that governs the issuance of PSR reports.

These reports have been delivered by CFE to the regulatory body, allowing to identify areas for improvement, changes, plant ageing issues, operational experience, and technical processes, in order to ensure the highest level of safety and an analysis with respect to the latest standards and practices. The regulatory assessment of the documentation provided by the licence holder did not find any safety-significant issues.

The next reports to be issued, according to the Operating Authorisations in force for the LVNPS are: For Unit 1, in the year 2024; and for Unit 2, in the year 2030.

Article 14 (2) Verification of safety

- **Overview of the Contracting Party's arrangements and regulatory requirements for the verification of safety**

  In accordance with the provisions of the Nuclear Law, Chapter IV Article 32 and Chapter VI Article 50 Section XII, CNSNS has the authority to conduct inspections, audits, verifications and surveys to confirm compliance and adherence to the legal provisions regarding nuclear and radiation safety, physical security, and safeguards; and to execute enforcement actions and decree administrative sanctions as foreseen by this Law and its regulations.

- **Main elements of programmes for continued verification of safety (in-service inspection, surveillance, functional testing of systems, etc.)**

  During the 2019-2021 period, CNSNS has been following the USNRC's Reactor Oversight Process (ROP) guidelines, to comply with the IAEA Safety Guide GS-R-1 "Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety".

  The Baseline Inspection Programme is used for the continuous verification of safety, as part of the ROP. Annexe 14.1 shows the "Control Matrix of Scheduled Inspections" which identifies the Baseline Inspection Programme to be executed every two years. The Baseline Inspection Programme is aimed to collect enough information about the performance of nuclear installations and the licence holder's activities. This allows determining along with the Performance Indicators, when appropriate, if the licence holder is meeting the safety objectives. Another purpose is to identify performance problems so CNSNS can follow-up and take the necessary actions before LVNPS safety is compromised.

  The inspection frequency depends on the type of activity and its significance for the installation's safety, as well as on the results of previous inspections. CNSNS Baseline Inspection Programme indicates the minimum number of scheduled inspections to be performed during the period in which the installation performance has a "response from the installation" status. Additionally, the Baseline Inspection Programme includes some inspections to verify: (1) the quality-related areas, (2) the supervising groups, and (3) the cross-cutting elements.

It should also be noted that sometimes, there might be the need to conduct special inspections focused on: (1) verifying safety related arising generic issues; (2) following-up when the licence holder performs major manoeuvres, such as functional testing after a power uprate or replacement of major components; (3) responding to issues resulting from the performance assessment using the Performance Indicators and the Findings of scheduled inspections; (4) verifying the licence holder's response to operational events, which should be evaluated on a case by case basis and (5) the activities related with the Licence Renewal Application.
Both the inspectors from CNSNS's headquarters and the resident inspectors at LVNPS (one resident inspector for each unit) take part in the programme implementation. The resident inspectors also verify daily LVNPS operation, as well as compliance with the Technical Specifications and other regulatory requirements established by CNSNS. The resident inspectors also follow-up the events that occur in the installation and the corrective and preventive actions that are taken to prevent their recurrence.

Additionally, as part of CNSNS continuous verification, the findings documented during inspections and operational events are categorized according to their safety significance. This exercise has the purpose of determining performance indicators similar to the United States Nuclear Regulatory Commission's (USNRC) Reactor Oversight Process performance indicators, in order to compare LVNPS performance with similar plants and emulate the best international practices.

For the Corrective Action Programme (CAP), both the resident inspectors (monthly, semi-annually and annually) and CNSNS headquarter inspectors (every two years) verify: (1) the Corrective Action Programme effectiveness to identify and resolve problems according to their safety significance; (2) the specific problems with generic implications, (3) the impact that the combination of otherwise riskless individual problems have on safety; and (4) if the licence holder is properly logging the information.

- **Elements of ageing management programme(s)**

LVNPS has had, almost from the beginning of its commercial operation, some programmes for ageing management. These programmes have been based on one or more of several sources. LVNPS established a commitment to CNSNS to comply with ASME Code and the USNRC's Generic Letters, as is the case with In-Vessel Visual Inspections (IVVI), In-Service Inspection (ISI), and monitoring of the reactor vessel materials embrittlement. LVNPS also bases its ageing management programmes on operational experience from within and outside the nuclear industry, as is the case with their use of EPRI and INPO Guidelines, and WANO recommendations in the Erosion-Corrosion programmes, Tanks, and others.

In 2012 LVNPS formally began its application for renewal of its Licence for Commercial Operation for Units 1 and 2, in conformance with the regulatory framework established by CNSNS through application of USNRC's 10 CFR 54 (its guidelines and endorsed standards). Specifically, in accordance with 10 CFR 54.21(a)(1)(i) and (ii), which require applicants to prepare an integrated plant assessment (IPA), CFE performed an assessment to determine which systems comply with the selection criteria established by the scoping and screening process. Subsequently the mechanisms and effects of ageing were identified for each combination of material and environmental medium (ageing management review, AMR) and with this information established which ageing management programs (AMP) must be implemented to conform with NUREG 1801 Rev. 2. In March 2015, CFE submitted their application for renewal of the Licence for Commercial Operation to CNSNS for an additional period of 30 years. This application establishes the commitment to implement a total of 47 AMP programs, including: A) prevention programmes associated with the application of protective coatings on tanks, specifically, and equipment in general, to prevent external corrosion; B) mitigation programmes, including for example, water chemistry to minimize internal corrosion effects in tubes and other equipment; C) condition-monitoring programmes, such as IVVI and ISI; D) function-monitoring programs, where through testing it is possible to determine the capacity of structures and components to perform the functions for which they were designed, for example, monitoring heat exchangers, among others.

These programmes comply with the ten elements established in NUREG 1801 Rev. 2 in order to be valid for licence renewal: 1) programme scope, 2) preventative actions, 3) monitored or inspected parameters, 4) detection of ageing effects, 5) tendency monitoring, 6) acceptance criteria, 7) corrective actions, 8) process confirmation, 9) administrative controls, and 10) operational experience. These programs were scheduled to be implemented prior to the expiration of the current operating authorisations (2020 for Unit 1 and 2025 for Unit 2).

The applicable aging management programs for the LVNPS are listed below:

Number according NUREG-1081	Programme for LVNPS
XI.M1	ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD
XI.M2	Water Chemistry
XI.M3	Reactor Head Closure Stud Bolting
XI.M4	BWR Vessel ID Attachment Welds
XI.M5	BWR Feedwater Nozzle
XI.M6	BWR Control Rod Drive Return Line Nozzle
XI.M7	BWR Stress Corrosion Cracking
XI.M8	BWR Penetrations

Number according NUREG-1081	Programme for LVNPS
XI.M1	ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD
XI.M9	BWR Vessel Internals
XI.M17	Flow-Accelerated Corrosion
XI.M18	Bolting Integrity
XI.M20	Open-Cycle Cooling Water System
XI.M21A	Closed Treated Water Systems
XI.M23	Inspection of Overhead Heavy Load and Light Load
XI.M24	Compressed Air Monitoring
XI.M26	Fire Protection
XI.M27	Fire Water System
XI.M29	Aboveground Metallic Tanks
XI.M30	Fuel Oil Chemistry
XI.M31	Reactor Vessel Surveillance
XI.M32	One-Time Inspection
XI.M33	Selective Leaching
XI.M35	One-Time Inspection of ASME Code Class 1 Small-Bore Piping
XI.M36	External Surfaces Monitoring of Mechanical Components
XI.M38	Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components
XI.M39	Lubricating Oil Analysis
XI.M40	Monitoring of Neutron-Absorbing Materials Other than Boraflex
XI.M41	Buried and Underground Piping and Tanks
XI.M42	Internal Coatings/Linings for In-Scope Piping, Piping Components, Heat Exchangers, and Tanks
XI.S1	ASME Section XI, Subsection IWE
XI.S2	ASME Section XI, Subsection IWL
XI.S3	ASME Section XI, Subsection IWF
XI.S4	10 CFR Part 50, Appendix J
XI.S5	Masonry Walls
XI.S6	Structures Monitoring
XI.S7	Inspection of Water-Control Structures Associated with Nuclear Power Plants

Number according NUREG-1081	Programme for LVNPS
XI.M1	ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD
XI.S8	Protective Coating Monitoring and Maintenance Program
XI.E1	Insulation Material for Electrical Cables and Connections not Subject to 10 CFR 50.49 Environmental Qualification Requirements
XI.E2	Insulation Material For Electrical Cables and Connections not subject to 10 CFR 50.49 Environmental B.2.1.38 Qualification Requirements used in Instrumentation Circuits
XI.E3	Inaccessible Power Cables not Subject to 10 CFR 50.49 Environmental Qualification Requirements
XI.E4	Metal Enclosed Bus
XI.E5	Fuse Holders
XI.E6	Electrical Cable Connections not Subject to 10 CFR 50.49 Environmental Qualification Requirements
X.M1	Fatigue Monitoring
X.E1	Environmental Qualification (EQ) of Electric Components

In addition, the following specific AMP are available for the LVNPS:

- SF6 GIS: Gas Insulated Substation with SF6 gas (sulfur hexafluoride).
- High Voltage Insulators, Switchyard Bus and Connections, Transmission Conductors and Connections.

With respect to the Application for Renewal of Operating Authorisation submitted to CNSNS in March 2015, the CFE issued 5 annual Amendments, the last one being delivered in April 2020.

The evaluation process by CNSNS was carried out through Audits, Inspections and the issuance of questions (Requests for Additional Information - RAI). In this sense, the evaluation of the LRA was focused on the following three stages:

1. Scope and Screening (S & S).
2. Ageing Management Review (AMR).
3. Ageing Management Programs (AMP) / Time Limited Ageing Analysis (TLAA).

The CNSNS conducted 13 audits and 2 inspections. It also issued a total of 386 Requests for Additional Information, which were met by the CFE to the satisfaction of CNSNS.

Finally, onJuly 24, 2020, the Secretariat of Energy (SENER) based on the favourable technical opinion of the National Nuclear Safety and Safeguards Commission (CNSNS), granted the renewal of Unit 1, so it is currently operating with an Extended Period that expires until July 2050. Regarding Unit 2, its Operation Authorisation is still in force, so before its expiration date, SENER will issue its resolution on the renewal application.

- **Arrangements for internal review by the licence holder of safety cases to be submitted to the regulatory body**

As mentioned in the "Overview of the secondary legislation for nuclear safety" section of Article 7 (2) (i), the government authorities decided that, in addition to applying the regulations of the IAEA, the regulation of the Nuclear Steam Supply System supplier's country of origin would be equally applied. For this reason, 10 CFR 50.59 is used to preserve the original licencing bases contained in the information provided to CNSNS, as part of the application for the Licence for Commercial Operation and subsequent application for Amendments.

Any change, test or experiment must be submitted to this regulation. Modifications to the plant are in the category "changes" and its assessment is continuously made under 10 CFR 50.59 approach and, should an amendment to the Authorisation result, it must be approved by CNSNS before its implementation. If an amendment to the Authorisation is not required, based on the 10 CFR 50.59 d (2), these modifications must be included in a document that describes them in a summarized manner together with their justification.

Also, in accordance with 10 CFR 50.71, the Safety Reports are updated every 24 months, incorporating all FSAR / ISSE change requests that come from modifications in the plant or in the organization (organizational restructuring).

In the case of requests to change to the Technical Specifications of Operation, these are accompanied by a format to evaluate the modifications to the bases of the LVNPS Authorisation.

- **Regulatory review and control activities**

Introduction

CNSNS follows up on the LVNPS Authorisation holder programmes to manage the ageing effects on the SSC, through the Baseline Inspection Programme which includes the following:

- ASME Code Section XI: In-Service Inspection (ISI) and In-Vessel Visual Inspection (IVVI)
- Erosion corrosion (flow-accelerated corrosion)
- Snubbers
- Reactor Pressure Vessel integrity
- Leak testing of primary containment
- Water chemistry
- Quality Assurance
- Corrective Action Programme
- Maintenance Rule
- Environmental qualification
- Fire protection

Some of these surveillances are described with more detail in the following sections.

ASME Code Section XI: In-Service Inspection (ISI)

CNSNS continues verifying the In-Service Inspection activities, through periodic volumetric, surface and visual examinations of components and their supports to look for indications of degradation. The LVNPS examinations have been mainly used to verify the structural integrity of Class 1, 2 and 3 mechanical components, such as piping, welding, elbows, etc., according to ASME Code Section XI, Subsections IWB, IWC and IWD guidelines, respectively. The examinations also have been used to maintain the components' ASME classification and certification when they are repaired according to ASME Section XI. For all Class 1, 2, and 3 SSC, the volumetric studies are reviewed, and non-destructive inspections, such as ultrasonic, radiographic, liquid penetrant and magnetic particle, are verified.

In connection with the application of Risk-Informed ISI to LVNPS, CNSNS authorized the following three alternate cases to the traditional ASME Code Section XI methods:

- Class 1 and 2 piping welds, Units 1 and 2: Based on Probabilistic Safety Analysis and ASME Code Case N-578-1.
- Unit 1 reactor vessel body circumferential welds: Based on BWRVIP-05.
- Unit 1 reactor ve vessel nozzle welds: Based on ASME Code Case N-702.

The examinations required by the IWE Subsections (for the metal parts of the LVNPS concrete primary containment) and IWL (for the concrete of the LVNPS primary containment) of the ASME Code Section XI, are in progress in LVNPS both units. As of the cut-off date of this National Report, no relevant condition has been detected in the components examined.

ASME Code Section XI: In-Vessel Visual Inspection (IVVI)

CNSNS inspected the In-Vessel Visual Inspection (IVVI) work performed by CFE to verify the structural integrity of the RPV internal components through surface examinations, such as visual inspection.

The following internal components of the reactor vessel were given special follow-up:

LVNPS Unit 1:

- Riser Pipe Jet Pumps (pairs 09-10 and 05-06 of Loop "A" of the Reactor Recirculation System) to monitor existing flaw indications and the state of hardware repair parts installed to maintain the integrity of the aforementioned pumps.
- Core shroud – monitor flaw growth.
- Steam dryer - monitor flaw growth and state of the additional hardware installed (in the Steam dryer and Main Steam Piping) to operate in Extended Power Uprate condition up to 2.317 MWt.
- Moisture separator - flaw growth.

LVNPS Unit 2:

- Riser Pipe Jet Pumps (pairs 01-02 and 13-14 of Loops "A" and "B", respectively, of the Reactor Recirculation System) – monitor existing flaw indications and the state of hardware repair parts installed to maintain the integrity of the 13-14 pumps.
- Core shroud – monitor flaw growth.
- Steam dryer - monitor flaw growth, and state of the additional hardware installed (in the Steam dryer and Main Steam Piping) to operate in Extended Power Uprate condition up to 2.317 MWt.
- Moisture separator - monitor flaw growth.

At the cutoff date of this National Report, it has not observed any condition that adversely affects the integrity of the aforementioned components, and the fulfilment with ASME acceptance criteria is maintained.

For the 2019-2021 period, CFE submitted periodic reports (after each refuelling outage) which describe the components' condition and the progress of corrective and preventive activities. These reports are reviewed by CNSNS's evaluation staff.

– Post-Fukushima Daiichi Actions at LVNPS

Results from external events re-assessment
Earthquakes

Based on the Stress Test requirements set by CNSNS, CFE asked the Engineering Institute of the National Autonomous University of Mexico (IIUNAM, Spanish abbreviation) to update the seismic information and the calculation methodologies for the Design Basis Earthquake (DBE) maximum acceleration assessment in order to confirm that the seismic design basis remains valid.

The seismic deterministic risk assessment consisted of the following:

1. Reassessment of LVNPS seismic risk.
2. Measurements, analytical and empirical studies on the possible effects in the LVNPS-site vicinity.
3. For rock conditions, the response spectra, which might occur at LVNPS, were estimated.

It was found that in all cases, the original design spectrum bounds the spectral accelerations estimated as part of the seismic design basis review and update performed.

Therefore, it was concluded that the LVNPS seismic design basis was validated by obtaining a Peak Ground Acceleration (PGA) of 0.24g, a value that is lower than the Design Basis Earthquake acceleration or the Safe Shutdown Earthquake (SSE) acceleration of 0.26g. This implies that LVNPS has a design margin of 8% for this initiator event.

Additionally, LVNPS has a Seismic Monitoring System that meets the USNRC Regulatory Guides 1.12 Rev. 2 and 1.166 Rev. 0. LVNPS also features tri-axial accelerometers, alarm annunciations in the control room of both units, and a procedure to obtain data from external sources if the monitoring system is inoperable. This system does not have mechanisms for an automatic shutdown of the plant.

A comparative evaluation of the seismic design basis of Fukushima Daiichi and LVNPS plants was performed as part of the activities and the specific verification testing already started by CFE after the Fukushima Daiichi nuclear accident. It was concluded that during the Fukushima Daiichi event the actual acceleration measured at the site reached a PGA of 105% (0.63g) DBE (0.60g), while for LVNPS the maximum accelerations recorded by the seismic monitoring network have not exceeded 10% (0.01 to 0.02g) DBE (0.26g).

The LVNPS seismic design basis review and update were completed in the second half of 2012.

CNSNS completed its review of the new seismic study, and is in agreement with CFE's general conclusions that there is an 8% margin for the Design Basis Earthquake and that the earthquakes perceived at LVNPS have had only minor impact on its structures.

Flooding:

CFE conducted a review and update of LVNPS design basis flood. The scope included using the original methodology and validation of the data used. The original work related to the design for flooding was reviewed, concluding that the original design was made using valid methodologies and data appropriate for the specific conditions at the LVNPS site. The assessment utilized the recorded meteorological information for the region of the LVNPS site during its commercial operation period, using the current available technology for flooding risk analysis.

Sea-Land

The analysis of the hydro-meteorological conditions from the marine environment that affect the coastal strip in front of the LVNPS site used recorded historical wind data. Different numerical models using that wind data were prepared in order to have summarised statistical information of wind, high tides and storm-induced surge flood in similar conditions to the values used in the original design. The assessment results are the following:

i) High tides analysis

The results of the mean tide level and offshore storm modelling show that approximately 50% of the tides arriving to the area does not exceed a height of one metre. It is important to point out that in case of storms, the tide level reaches heights of 10 to 12 m. The outliers are: a tide level of 11 m with a return period of 100 years, and 13.6 m with a return period of 1,000 years.

On the other hand, for a maximum sea-to-earth flood caused by waves during a maximum probable hurricane (MPH), the maximum expected flood level is 3.32 m with respect to the construction level (PDR) or 4.372 m with respect to the low average sea level (1.MSI). Therefore, taking into account that the critical elevation for Sea-Land high tides flood is the Nuclear Service Water System pumps elevation in the intake structures is 6.5 m with respect the 1.MS1, so the flooding margin is 2.128 m.

ii) Wind analysis

The maximum sustained wind speed that was obtained is the following: 138 km/h for a return period of 100 years, and 175 km/h for a return period of 1,000 years. These speeds are lower than those considered in the LVNPS design, which were: 250 km/h for a return period of 100 years, and 277 km/h for a return period of 1,000 years. The wind gusts speed used for the design of structures in the LVNPS original design was equal to 1.1 times the maximum sustained wind speed. The wind gusts speeds that were obtained are the following: 275 km/h and 304 km/h for a return period of 100 and 1,000 years, respectively. During the assessment a factor of 1.3 was used. The wind gusts speeds that were obtained are the following: 180 km/h and 226 km/h for a return period of 100 and 1,000 years, respectively. It is observed that the latter values are lower than the wind gusts speed that were used for the original design.

iii) Tidal Surge analysis

The storm-induced surge analysis considered two causes: high tides and wind. The surge caused by high tides has a height of 1.31 m for a return period of 100 years, exceeding the breakwaters, inside the basin. The surge caused by wind has a height of 0.69 m for a return period of 100 years. The combination of both gives a total flood level of 1.35 m for a return period of 100 years, and 1.81 m for a return period of 1,000 years. Therefore, it is concluded that LVNPS design value of 2 m for the flood level is appropriate for the available information and the updated analyses conducted.

Based on the above, the review of design basis flood considering the Sea-Land effects of high tides, wind, and storm-induced surge determined that the updated values are lower than those used in the original design, thus validating the corresponding design bases.
Land-Sea

The analysis of the Land-Sea effects included the Probable Maximum Precipitation (PMP), runoff volumes and the modelling of the hydraulic system. Based on recorded data, the updated PMP and the maximum flowrates in the basins of the LVNPS region are larger than the values used in the original design. The maximum water level in the north area ("Laguna Verde") would be 4 m, and in the south area ("Laguna Salada") 5 m. However, although the updated values are larger than those used in the original design, these levels do not reach the access elevation of the buildings, which is 10.15 m. It is considered the LVNPS site has sufficient design margin to prevent the loss of safety functions or fuel damage caused by this natural phenomenon.

Additionally, it was found that the rainwater drainage system has the capacity to dispose of a water volume of 379 mm/h caused by the PMP. This disposal is performed using 4 discharges which were analysed. The analysis, without taking into consideration the last discharge segments, indicates that drainage facilities are sufficient for rainwater disposal. The original design for flood remains unchanged and there are margins that prevent weaknesses or limiting conditions. In addition, there is no building that would be affected by a flood event.

The LVNPS design basis flood review and update was completed in the first half of 2012.

CNSNS completed its review of the new flood assessment, and is in agreement with CFE's general conclusions that the flood levels are below the LVNPS access elevation.

Also as a result of the Special Inspection performed by CNSNS's inspecting staff and carried out in accordance with USNRC Temporary Instruction 2515/183, "Follow-up to the Fukushima Daiichi Nuclear Station Fuel Damage Event", it was determined that LVNPS has to establish a maintenance programme for the following: (1) the seals of the entrance gates to the emergency systems, which are located at elevation -0.65 m of the Reactor Building, and (2) the roofs of the facility process buildings and the strainers located in the outside areas of these buildings; it was also required to change the seals of the Reactor Building entrance doors. The monitoring of this maintenance program has been carried out as part of the basic inspection programme.

<u>Other extreme natural events</u>

Hurricanes

The assessment of the hurricane effects was included in the LVNPS design basis flood review and update.

All LVNPS Seismic Category I structures are designed to withstand Probable Maximum Hurricane (PMH) effects with a wind speed of 275 km/h and wind gusts of 304 km/h; a design basis tornado with a wind speed of 241 km/h or a design wind speed of 180 km/h. It is assumed that these wind speeds act horizontally at an elevation of 10 m above the ground level. Also, all LVNPS Seismic Category I structures are designed to withstand the effects caused by hurricane winds and missiles generated by a design basis tornado (hurricane).

The Structures, Systems and Components located outside the site (substation equipment, structures and transmission lines) were designed based on a design wind speed of 180 km/h. It is assumed that this wind speed acts horizontally at an elevation of 10 m above ground level. In general, all non-seismic and non-safety-related structures were designed based on the same design wind speed.

CNSNS completed its review of the hurricane impact assessment, and given LVNPS's location in the Gulf of Mexico, this phenomenon, if it were to occur, may induce a loss of offsite power, due to potential damage to transmission lines and structures, as well as means of communication.

Annexe 14.1

Control Matrix of Scheduled Inspections

Inspection Area	Initiating Events	Mitigation Systems	Barrier Integrity	Emergency Preparedness	Occupational Radiation Safety	Public Radiation Safety	Baseline Programme	Frequency	Responsible Area
Operation Units 1 and 2	X	X	X	X	-	-	YES	A	SCO
Mechanical Maintenance Units 1 and 2	X	X	X	-	-	-	YES	A	SPV
Electrical Maintenance Units 1 and 2	X	X	X	-	-	-	YES	A	SPV
I&C Maintenance Units 1 and 2	X	X	X	-	-	-	YES	A	SPV
Radiation Protection Units 1 and 2	-	-	-	X	X	X	YES	D	SIP
Systems Engineering Unit 1	X	X	X	-	-	-	YES	B	SCO
Systems Engineering Unit 2	X	X	X	-	-	-	YES	B	SCO
Reactor Engineering Unit 1	X	X	-	-	-	-	YES	B	SCO
Reactor Engineering Unit 2	X	X	-	-	-	-	YES	B	SCO

Inspection Area	Initiating Events	Mitigation Systems	Barrier Integrity	Emergency Preparedness	Occupational Radiation Safety	Public Radiation Safety	Baseline Programme	Frequency	Responsible Area
Effluents Monitoring Units 1 and 2	-	-	-	-	-	X	YES	A	SIP
Fire Protection Units 1 and 2	X	X	-	-	-	-	YES	A	SPV
Internal Emergency Plan	-	-	-	X	-	-	YES	A	SCO
Training	-	X	X	X	-	-	YES	A	SCO
Maintenance Rule	X	X	X	-	-	-	YES	A	SPV
Refuelling Activities Unit 1	X	X	X	-	-	-	YES	R	SR
Refuelling Activities Unit 2	X	X	X	-	-	-	YES	R	SR
ISI, IVVI and Snubbers Unit 1	-	-	X	-	-	-	YES	R	SPV
ISI, IVVI and Snubbers Unit 2	-	-	X	-	-	-	YES	R	SPV
Radiation Protection Refuelling U1	-	-	-	-	X	-	YES	R	SIP
Radiation Protection Refuelling U2	-	-	-	-	X	-	YES	R	SIP

Inspection Area	Initiating Events	Mitigation Systems	Barrier Integrity	Emergency Preparedness	Occupational Radiation Safety	Public Radiation Safety	Baseline Programme	Frequency	Responsible Area
Suppliers Units 1 and 2	-	-	-	-	-	-	NO	R	SIP
Performance Indicators	X	X	X	X	X	X	YES	A	SPV
External Operational Experience	-	-	-	-	-	-	NO	B	SCO
Quality Assurance Operation	-	-	-	-	-	-	NO	B	SIP
Quality Assurance Engineering	-	-	-	-	-	-	NO	B	SIP
Site Operations Review Committee (SORC)	-	-	-	-	-	-	NO	B	SCO
Independent Operations Review Committee (IORC)	-	-	-	-	-	-	NO	B	SIP
Independent Safety Engineering Department (ISED)	-	-	-	-	-	-	NO	B	SIP

Inspection Area	Initiating Events	Mitigation Systems	Barrier Integrity	Emergency Preparedness	Occupational Radiation Safety	Public Radiation Safety	Baseline Programme	Frequency	Responsible Area
Dedication Process	-	-	-	-	-	-	NO	B	SIP
Quality Control	-	-	-	-	-	-	NO	B	SIP
Waste Management	-	-	-	-	-	X	YES	A	SIP
ASME XI Certification Units 1 and 2	-	-	-	-	-	-	NO	B	SPV
Organisation and Human Factors	X	X	X	X	X	X	YES	B	SPV
Corrective Action Programme	X	X	X	X	X	X	YES	B	SIP
Safety Culture	X	X	X	X	X	X	YES	B	SCO
Residence Inspections Units 1 and 2	X	X	X	X	X	X	YES	C	SR
Operation RTMIII	-	-	-	-	-	-	YES	A	SCO
Maintenance and Fire Protection RTMIII	-	-	-	-	-	-	YES	A	SPV
Radiological Protection RTMIII	-	-	-	-	-	-	YES	B	SIP

Inspection Area	Initiating Events	Mitigation Systems	Barrier Integrity	Emergency Preparedness	Occupational Radiation Safety	Public Radiation Safety	Baseline Programme	Frequency	Responsible Area
Quality Assurance RTMIII	-	-	-	-	-	-	YES	B	SIP
Nuclear Materials Department at the Nuclear Research National Institute	-	-	-	-	-	-	YES	A	SCO

KEYS:

A = Annually
B = Two years
R = Refuelling Outage
D = No Refuelling (this year)
SCO = Subdirection of Certification and Operation
SIP = Subdirection of Inspection Programme
SR = Subdirection of Residence in LVNPS
SPV = Subdirection of Performance Verification
RTMIII = Reactor TRIGA Mark III of the Nuclear Research National Institute

ARTICLE 15. RADIATION PROTECTION

Obligations

"Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits."

- **Overview of the Contracting Party's arrangements and regulatory requirements concerning radiation protection at nuclear installations, including applicable laws not mentioned under Article 7**

Initially, there were no national regulations for nuclear power plants at the time the Laguna Verde Nuclear Power Station (LVNPS) was built, so government authorities decided that the regulations of the country of origin of the reactor would be applied. Therefore, compliance with USNRC 10 CFR 20, in force at that time in United States of America, was explicitly set as a requirement. Subsequently, in 1988 the General Regulation for Radiation Safety entered into force, which still is valid and is consistent with the International Commission on Radiological Protection's ICRP-26, additionally as a complement CNSNS considered the implementation of only the adequate sections of the 10 CFR 20.

- **Regulatory expectations for the licence holder's processes to optimise radiation doses and to implement the "as low as reasonably achievable" (ALARA) principle**

Article 7 of the General Regulation for Radiation Safety indicates that the dose received as a consequence of an exposition of ionising radiation sources and from practices that involve irradiation with ionising radiation or incorporation of radioactive material, will be subject to a dose limiting system whose fundamental principles are the following:

a) Practices that may produce doses to workers shall not be approved unless a positive net benefit is obtained.

b) The design, planning, use and subsequent application of the sources and practices should be carried out in a manner that ensures that the expositions are maintained as low as possible, considering social and economic factors.

c) The establishment of limits for dose equivalents.

Also, this regulation in Title I, Chapter III, establishes the annual dose equivalent limits for stochastic and non-stochastic effects, and the considerations for operationally exposed personnel and for the public. It also establishes the monthly and annual monitoring of the Dose Equivalents received by operationally exposed personnel, with the purpose of permanently monitoring the trend of the personnel's Dose Equivalent.

In addition, Title VII establishes the obligations of the license holder, those in charge of radiation safety and the operationally exposed personnel, which emphasizes the obligation to comply with radiation safety commitments, training and education on radiation safety issues, maintenance of safety standards in the facility, and the preparation and maintenance of information.

With the monitoring of the requirements and obligations established in the General Radiation Safety Regulations, and in a complementary manner with the sections of 10 CFR 20 and with the principles of Safety Culture, it is expected that the operation of equipment, materials and facilities do not constitute risks to the health of the public or the detriment of the quality of the environment.

- **Implementation of radiation protection programmes by the licence holder, including:**

- **Observation of dose limits, main results for doses to exposed workers**

In order to limit operation personnel doses, LVNPS buildings were divided into zones (reactor, turbine, radioactive waste, liquid purification, Main Control Rooms (MCRs) of both units, hot workshops, and open areas of low potential contamination). These zones include five categories that consider radiation levels according to the following extreme cases:

a) Zone 1 - unlimited permanence is allowed with an exposure rate of less than 25 E-7 Sv/h, when integrated per year does not exceed the 0.005 Sv/year dose limit.

b) Zone 5 - the highest radiation level zone. Access is restricted and controlled.

Also, LVNPS has a specific group called "Radiation Analysis and Exposure Control Group", to orient and drive the implementation of the ALARA criterion in all activities developed by its personnel. The group belongs to the organisational structure of the Radiation Protection Department, which is part of the Nuclear Corporate Coordination (NCC) of CFE. The "Radiation Analysis and Exposure Control Group" is responsible for the analysis, evaluation, control, and optimisation of personnel radiation exposure.

Table 15.1 presents a summary of the historic workers' collective and individual average radiation doses for LVNPS Units 1 and 2. Figures 15.1a and 15.1b present the historic data for the workers' annual collective radiation dose for LVNPS Units 1 and 2, and for LVNPS, respectively. Figure 15.2 presents the data for LVNPS in both units.

Regarding the individual radiation dose, while CNSNS set a Limit for the Total Effective

Dose Equivalent (TEDE) of 50 mSv/year, LVNPS adopted in 2003 an administrative average level of 20 mSv/year over a period of five years. This administrative level has been achieved since 2003 and Table 15.1 shows the compliance with it.

TABLE 15.1

Summary of Workers' Collective and Individual Radiation Doses

Year	Annual Collective Dose (Sv-person)		Individual Dose (mSv)	
	Unit 1	Unit 2	Average	High (max)*
1990	1.34435	N/A	1.1610	10.07
1991	5.14748	N/A	2.0520	N/A
1992	5.44015	N/A	2.4510	20.30
1993	1.96603	N/A	1.7460	20.59
1994	6.02126	N/A	2.4020	19.92
1995	4.93073	0.9974	2.7510	24.75
1996	12.51806	3.6390	5.4270	37.97
1997	1.94839	2.5529	2.1140	18.76
1998	5.95528	3.5833	3.3650	31.72
1999	6.20219	1.1332	2.1700	21.54
2000	1.33760	4.3173	2.5800	23.02
2001	3.97322	2.6083	2.9251	26.75
2002	2.89238	0.5401	2.1062	17.95
2003	0.66160	3.1542	1.9926	18.52
2004	3.59474	3.4792	1.8064	21.72
2005	2.78328	0.5748	1.0420	14.59
2006	0.65405	2.3086	0.8612	12.43
2007	3.05512	2.4202	1.2998	18.72
2008	8.72841	0.6497	1.9377	22.84
2009	1.30837	3.3115	0.8803	14.10
2010	6.2316	3.7883	0.1430	24.74
2011	0.7822	0.8819	0.0540	17.34

Year	Annual Collective Dose (Sv-person)		Individual Dose (mSv)	
	Unit 1	Unit 2	Average	High (max)*
2012	5.2403	3.3184	2.3300	27.90
2013	0.59175	0.55850	0.4971	10.87
2014	5.75491	6.04770	2.8266	30.76
2015	9.18300	0.48300	2.4107	29.58
2016	1.13163	7.25068	2.1146	27.05
2017	6.90065	4.88931	3.3718	43.00
2018	0.83679	0.61778	0.6379	14.96
2019	7.5067	6.09193	3.367716691	38.23
2020	5.41741	0.98627	2.7609213	42.16
2021	1.08632	0.42785	0.827235412	16.76
TOTAL	**131.12595**	**70.61132**		

* NOTE: The values presented in this column correspond to the maximum values for that year and they are not necessarily for the same individuals. However, for any individual, the average value of 20 mSv has not been exceeded over the last five years.

- **Conditions for the release of radioactive material to the environment, operational control measures and main results**

There is environmental radiation surveillance information available from the pre-operational phase (9-12 years before the start of LVNPS commercial operation) up to this date. The information has been collected through the surveillance and sampling systems of LVNPS's Environmental Engineering Laboratory. Figures 15.4 and 15.5 present the historical results of the direct environmental surveillance. Such figures make it evident that the radiation levels remain in the same order as the levels existing during the pre-operational phase. It is worth noting that during all these years; events non-related to LVNPS have been detected, which contributed to raising the environmental background level.

The radiological impact on the general public is calculated from LVNPS emissions, using the models established in the Technical Specifications. In all cases, the impact represents a small fraction of the corresponding limits, as is shown in the following figures:

- Figure 15.6.- Annual historical data of liquid releases (Units 1 and 2)
- Figure 15.7.- Annual historical data of gaseous releases (Unit 1) - noble gases.

- Figure 15.8.- Annual historical data of gaseous releases (Unit 2) - noble gases.
- Figure 15.9.- Annual historical data of gaseous releases (Unit 1) – iodides, particulates, and tritium.
- Figure 15.10.- Annual historical data of gaseous releases (Unit 2) – iodides, particulates, and tritium.

As is shown in Figure 15.6, the annual dose due to liquid releases has shown a drastic reduction since 1996, due to improved water re-utilisation management; which substantially reduced liquid releases.

Since 1996, there is a reduction tendency in the public dose due to gaseous releases, which can be observed in Figures 15.7 to 15.10.

- **Processes implemented and steps taken to ensure that radiation exposures are kept as low as reasonably achievable for all operational and maintenance activities**

Introduction

Figure 15.2 shows that LVNPS's collective dose had a steady reduction tendency up to 2006. However, when the actions and recommendations to protect the Reactor Pressure Vessel (RPV) internals were implemented, this trend was reversed. The application of Hydrogen and Noble Metals produced a substantial change in the reactor water chemistry. The chemical recombination processes produced an increase of the Cobalt 60 (Co-60) concentration, with respect to the values observed in previous years. This change was reflected, in both, the collective dose and the Boiling Water Reactor Radiation Assessment and Control (BRAC) index of both units.

The radiation control started when the technology to reduce the effects of the intergranular corrosion to the RPV internals was proposed, taking advantage of the best global experience. As part of this project, the zinc injection was adopted to control the iron and, consequently, the Co-60, concentrations.

The Dose Reduction Committee is taking dose control measures aimed at the following three fundamental aspects.

- Source term control (Figures 15.3 a/b)
- Work practice improvement.
- Equipment reliability.

Regarding the source term control, the actions include: a reduction of the Co-60 sources (Stellite-free turbines as part of the Extended Power Uprate [EPU] project changes); and the use of cobalt-selective resins which are being applied in the Reactor Water Cleanup System, iron control, hydrogen injection control, on-line application of noble metals, and the application of EPRI's water chemistry guide during shutdowns and refuelling outages.

The work practices have been improved using mockups to reduce activity execution time and, consequently, the dose. The use of the human performance tools for error reduction is another action that impacts the dose reduction by reducing the rework required.

As for the equipment reliability, preventive maintenance and the actions before the component failures are considered strategies that have a greater impact during normal operation. For equipment and/or systems recurring failures, the Equipment Reliability Committee recommends which failures are part of the "Top Ten" failures list. Then, the Equipment Reliability Committee proposes specific actions and strategies to solve the problems.

Implemented strategies

The strategies implemented to reduce LVNPS's collective dose can be summarised as follows:

1. The Dose Reduction Committee was formally founded.
2. Use of the lessons learned from internal operational experiences. For example, the problems identified during the 13th Refuelling Outage of LVNPS Unit 1 were corrected and the improvement actions were implemented in the 10th Refuelling Outage of LVNPS Unit 2.
3. Follow-up to the Dose Reduction Plan commitments.
4. EPRI´s staff advisory on the source term control.
5. Benchmarking with other nuclear plants to adopt the best industry practices.
6. Appointment of a full-time leader to take care of the source term and collective dose reduction. The integration of a working group has been formalized which is formed of Radiation Protection, Chemical Engineering and Engineering Design personnel.
7. It started a replacement program for components with Stellite in accordance with the engineering analysis reflected in the program for replacing valves that contribute to the source term.
8. The cleaning, after intrusive works, was implemented in valves that have Stellite in their seats, to prevent the Co-59 (elemental) from being activated and generating Co-60.
9. Ultrasonic cleaning of spent fuel that returns to the nuclear core during the 19th Refuelling Outage of Unit 1 and the 16th Refuelling Outage of Unit 2.

10. Aspirate of insoluble cobalt by means of temporary filtration systems during Refuelling Outages such as submersible pumps and Solid Collector Filter (SCF).
11. Elimination of insoluble cobalt by ion exchange of fixed systems and submersible demineralizing filters during Refuelling Outages.

Future strategies

The foreseen collective dose reduction strategies for the 2020-2030 period will be established based on the recommendations of the Group for the reduction of the Source Term and Collective Dose, established in the Source Term Reduction Plan 2020-2030. The Plan will be approved by the Nuclear Corporate Coordination´s Head and all LVNPS Departments will commit to its adherence and enforcement.

- ### Environmental monitoring and main results

For LVNPS, CFE has an Environmental Radiation Surveillance Programme which ensures continuous monitoring of the environmental impact during normal operation. The highlights of LVNPS's environmental surveillance are presented below.

Atmospheric releases

a)	External radiation, air	30 sampling stations
b)	Inhale, air	16 sampling stations
c)	Radiation deposited on soil	7 sampling stations
	Rainwater	2 sampling stations
	Agricultural products	7 sampling stations
	Grass	4 sampling stations
	Milk	4 sampling stations
	Beef	1 sampling station

Liquid effluents

a)	Release to ocean	1 sampling station
b)	Fish	2 sampling stations
c)	Aquatic biotic (Shrimp)	1 sampling station
d)	Bio-tracers	4 sampling stations
e)	Sea sediment	4 sampling stations

f)	Beach sand	4 sampling stations
g)	Underground fresh water	3 sampling stations

Conclusions

a) The concentration limits set in LVNPS's Technical Specifications have never been exceeded, neither by any single sample nor considering the average.

b) Since the concentration limits were not exceeded and the exposures measured with Thermo Luminescent Dosimeters (TLD) remained below the pre-operational values; it can be established that no member of the general public exceeded the limits due to LVNPS emissions.

c) The total beta activity detected during the reporting period remains well below the Technical Specifications limit, which is similar to the behaviour of the previous years. The variations observed from 1978 to date are of the same order.

d) The results from the Radiological Environmental Surveillance Programme have shown that the radiation dose for LVNPS's vicinity population has not increased, due to LVNPS operation; or at least, if there is an increase, it cannot be discriminated from the very low values measured during the reporting period.

e) Cs-137 is the only artificial radionuclide that has been detected in the samples with relatively high regularity; Sr-90 appears, but rarely. However, they were detected during the pre-operational surveillances, even before LVNPS construction. It is presumed that nuclear weapons testing produced them and reached the LVNPS site through radioactive fallout.

f) During the 2013-2020 period, some radionuclides due to LVNPS operation were detected, including Mn-54, Co-60, Co-58, Cr-51, Zn-65, and I-131, all with very low activity.

– Regulatory review and control activities

Annexe 14.1 of This National Report presents the "Control Matrix of Scheduled Inspections," which includes the inspections of radiation protection areas, effluents, and radioactive waste management. In addition to the inspections, the performance of the strategic area of radiation protection is monitored through the Reactor Oversight Process (ROP). As part of the assessment, both the general public radiation safety and LVNPS workers' occupational safety fundamentals are considered.

Regarding the surveillance of exposure to the public caused by LVNPS normal operation, CNSNS has several mutually independent ways to verify compliance with the current regulation on environmental impact:

a) Assessment of LVNPS semi-annual accounting reports for effluents. The report consolidates data from sampling procedures and isotopic analyses of liquid and gaseous emissions during the reporting period. The second half-year reports are an annual summary, which also contains dose calculations and relevant weather information. Part of CNSNS´s assessment is an independent reproduction of those dose calculations to verify their consistency. The assessment is performed in accordance with the USNRC Regulatory Guide 1.109, the verification of compliance with the Operating Technical Specifications, the General Radiological Safety Regulations and the standard NOM-041-NUCL-2013 "Annual incorporation limits and release concentrations".

b) Assessment of the Environmental Radiation Surveillance Annual Programme Report prepared by an external laboratory, which contains sampling and isotopic analysis information from different environmental strata. This includes the analysis of the radiological environmental impact due to the operation of the LVNPS, trend analysis and verification of compliance with the Operating Technical Specifications and the requirements established in the General Radiological Safety Regulations.

c) An independent assessment of LVNPS Units 1 and 2 radiation environmental impact, through measurement of environmental dose rate through airborne particle sampling stations, TLD environmental dosimetry, probes in the plant and its surroundings, and an isotopic analysis of environmental samples periodically collected in the plant's vicinity and processed in CNSNS's laboratory. These programmes have functioned as additional verifications, whereby CNSNS has confirmed the consistency of the information submitted by LVNPS's licence holder.

LVNPS and CNSNS laboratories participate in international programmes for inter-comparison to ensure their measurement reliability.

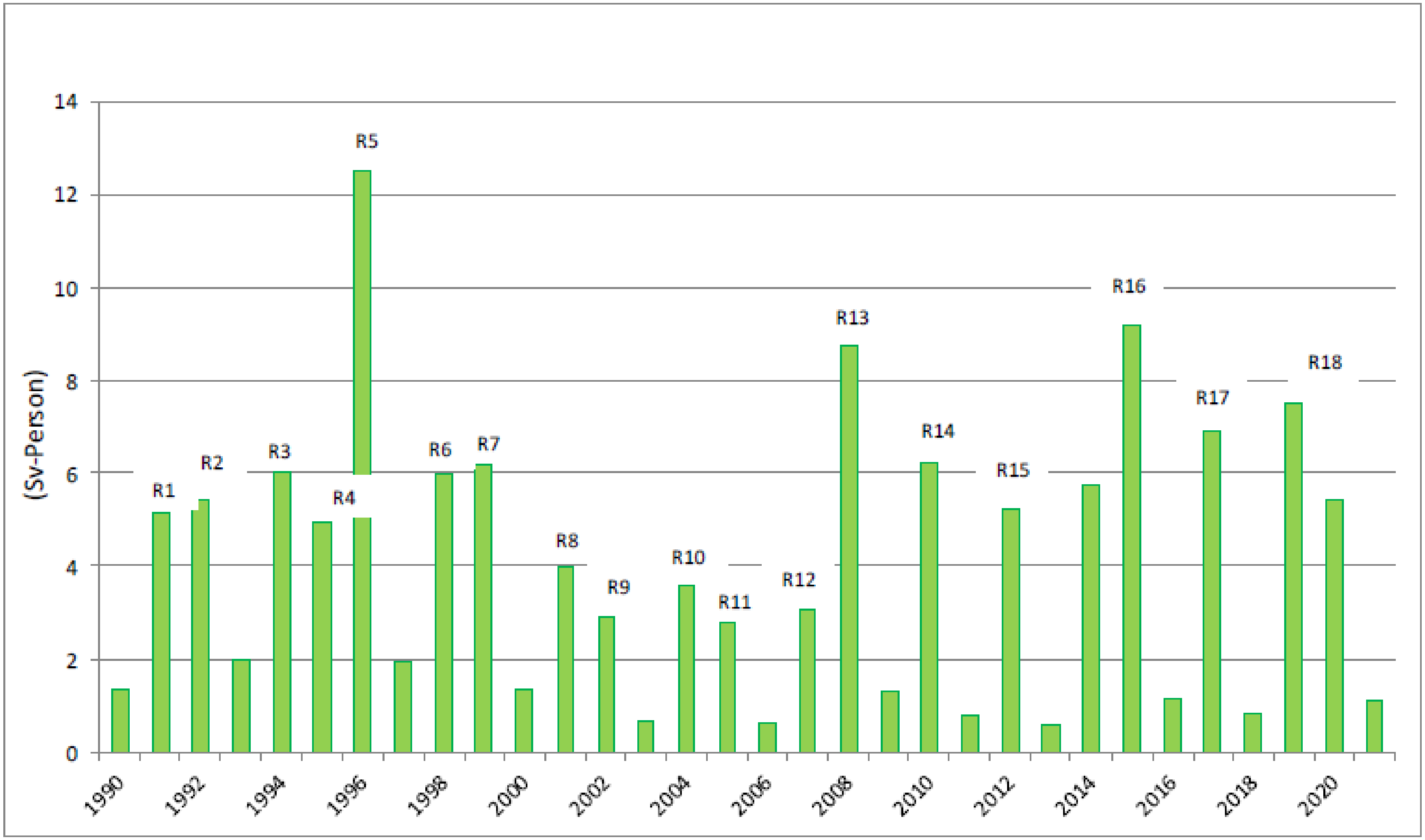


Figure 15.1a Historical data for workers' collective annual radiation dose, for Unit 1

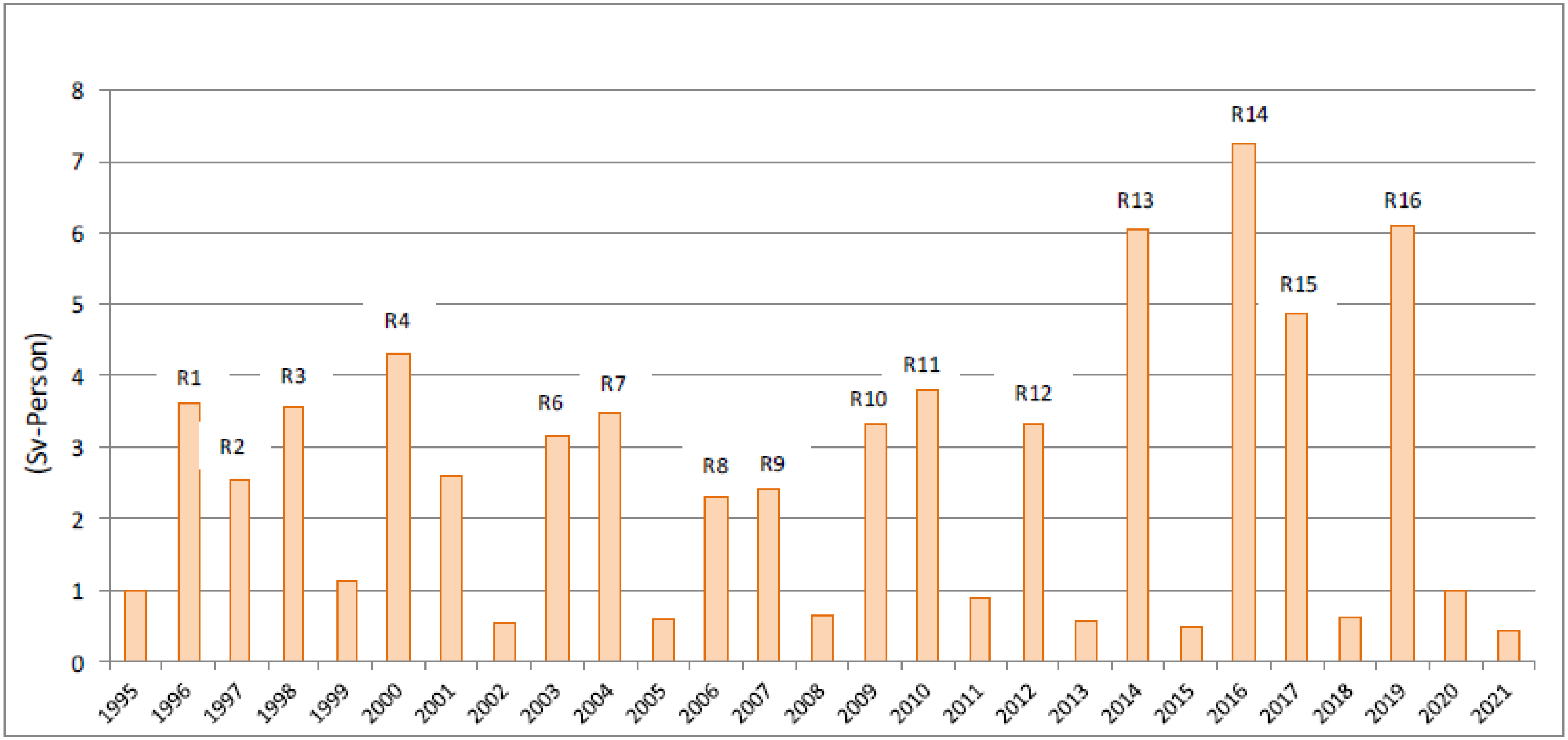


Figure 15.1b Historical data for workers' collective annual radiation dose, for Unit 2

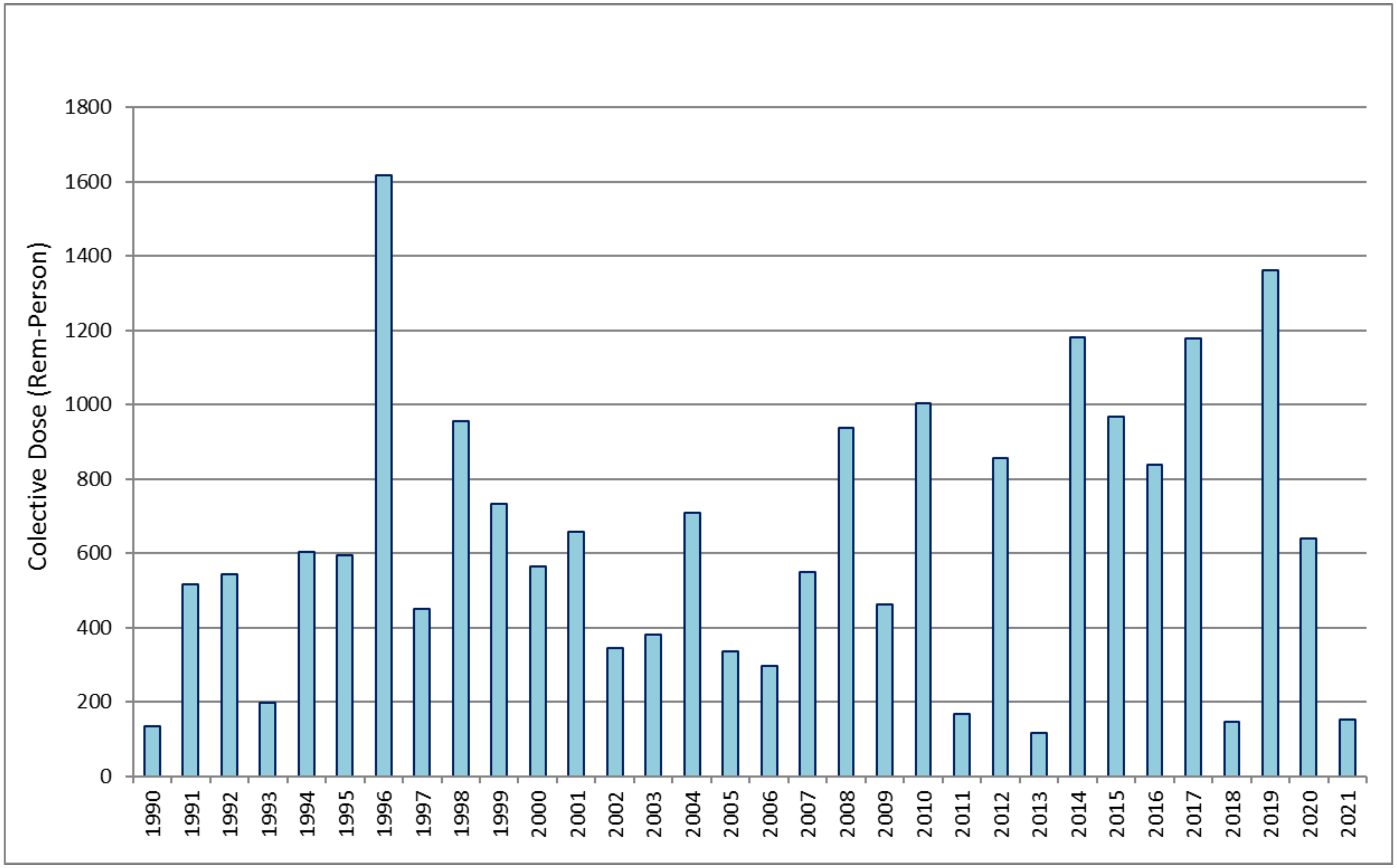


Figure 15.2 Evolution of LVNPS collective dose

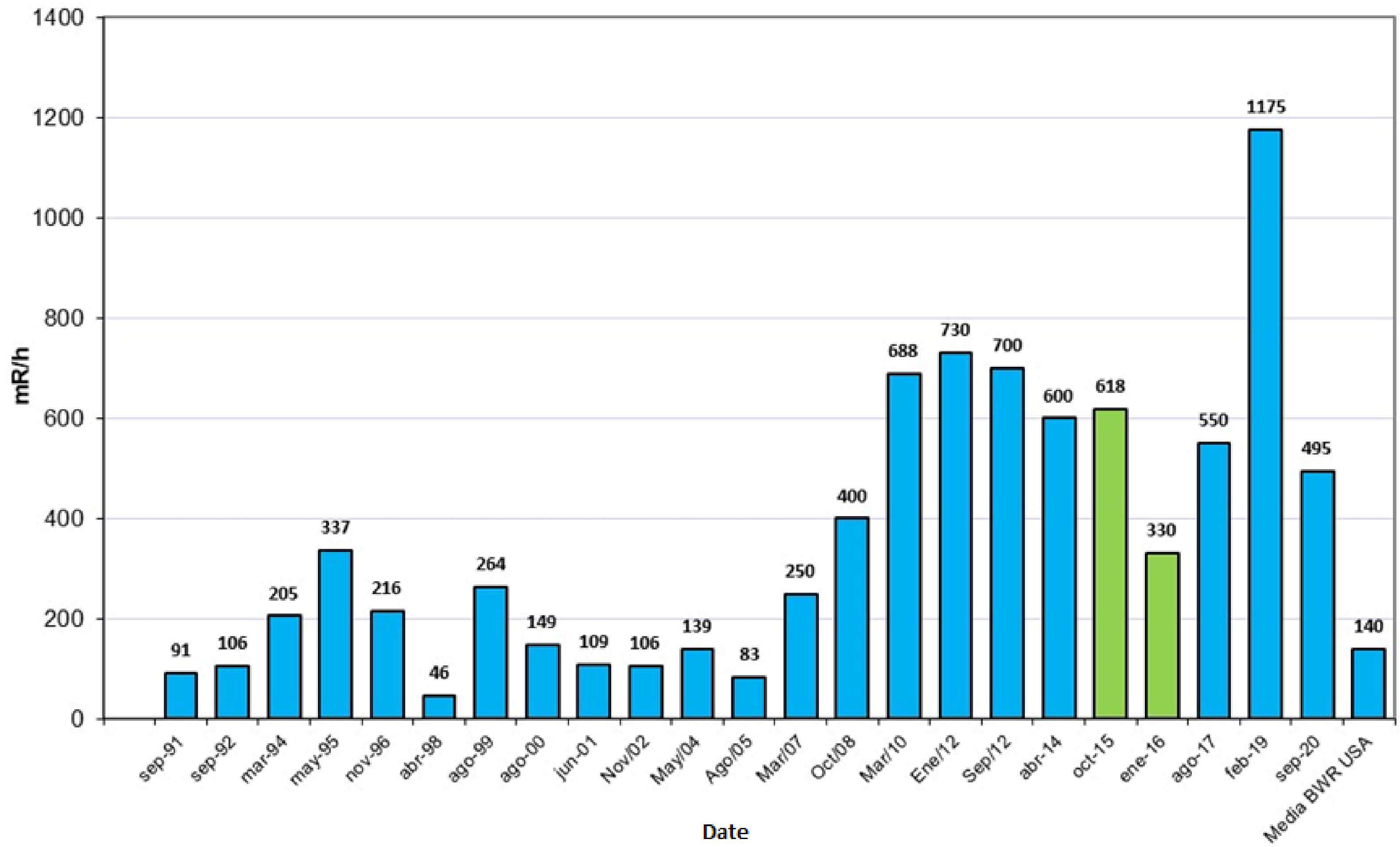


Figure 15.3a Primary radiation systems level monitoring (BRAC) for Unit 1

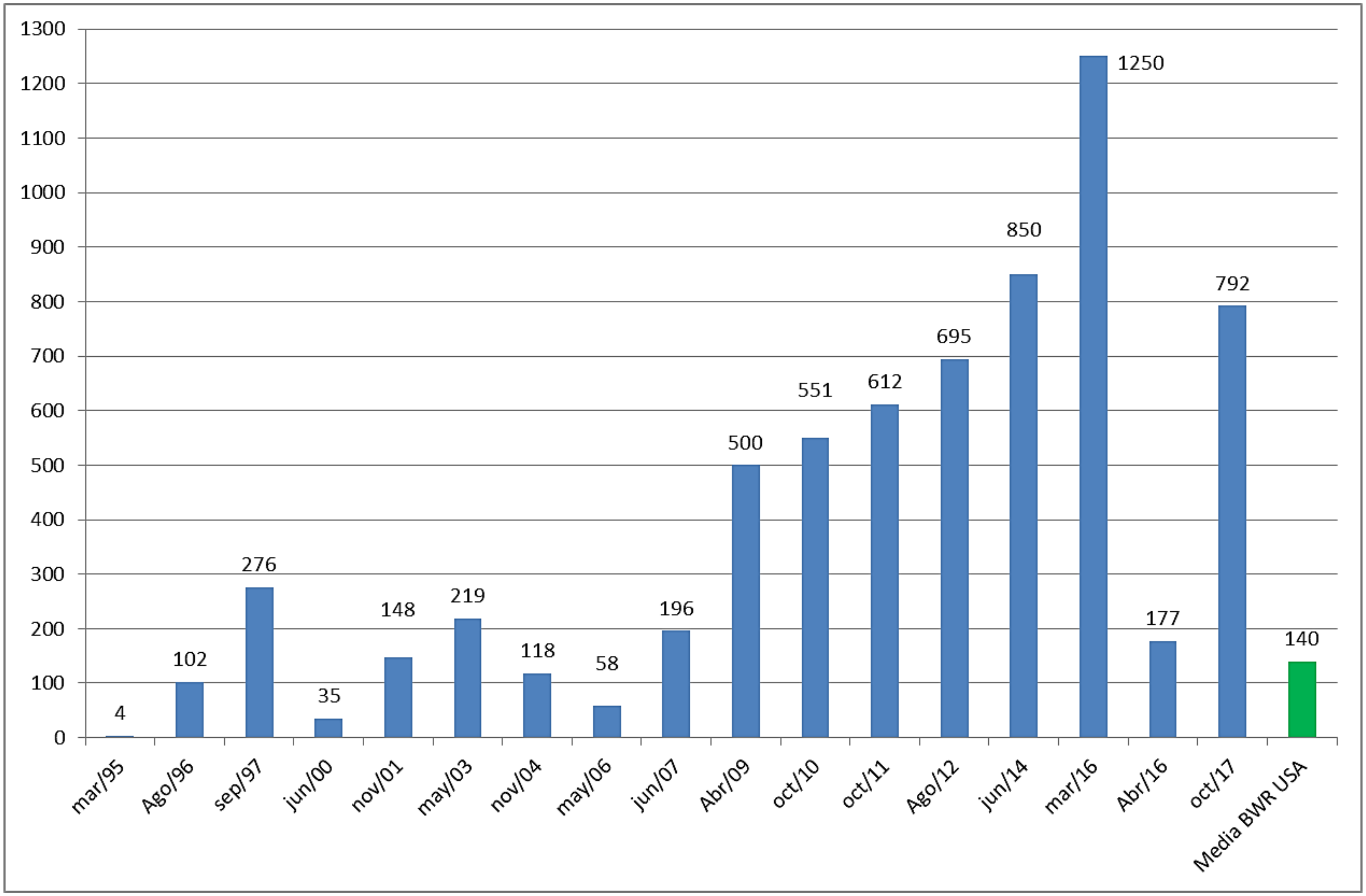


Figure 15.3b Primary radiation systems level monitoring (BRAC) for Unit 2

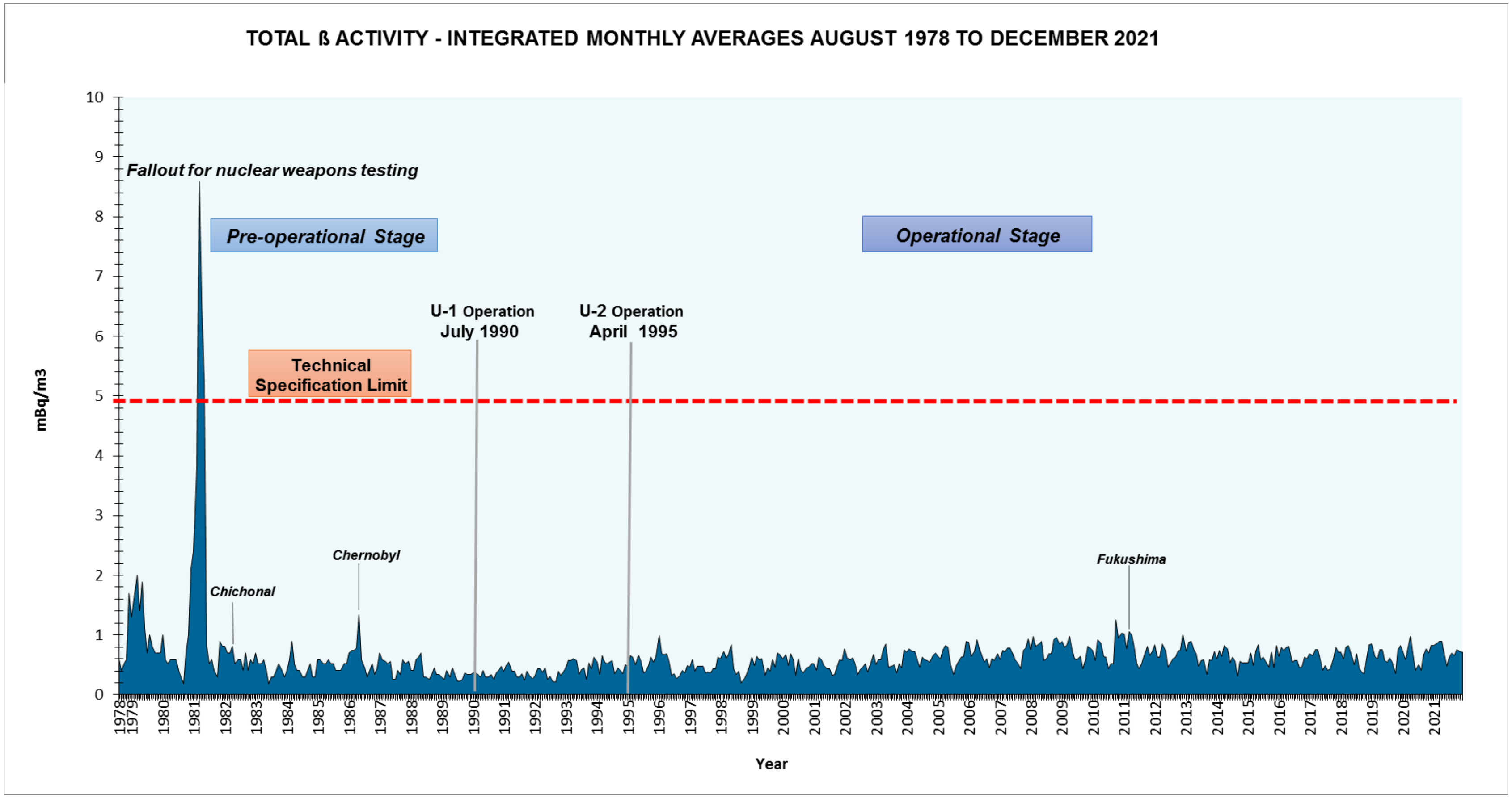


Figure 15.4 Integrated monthly averages of total β activity

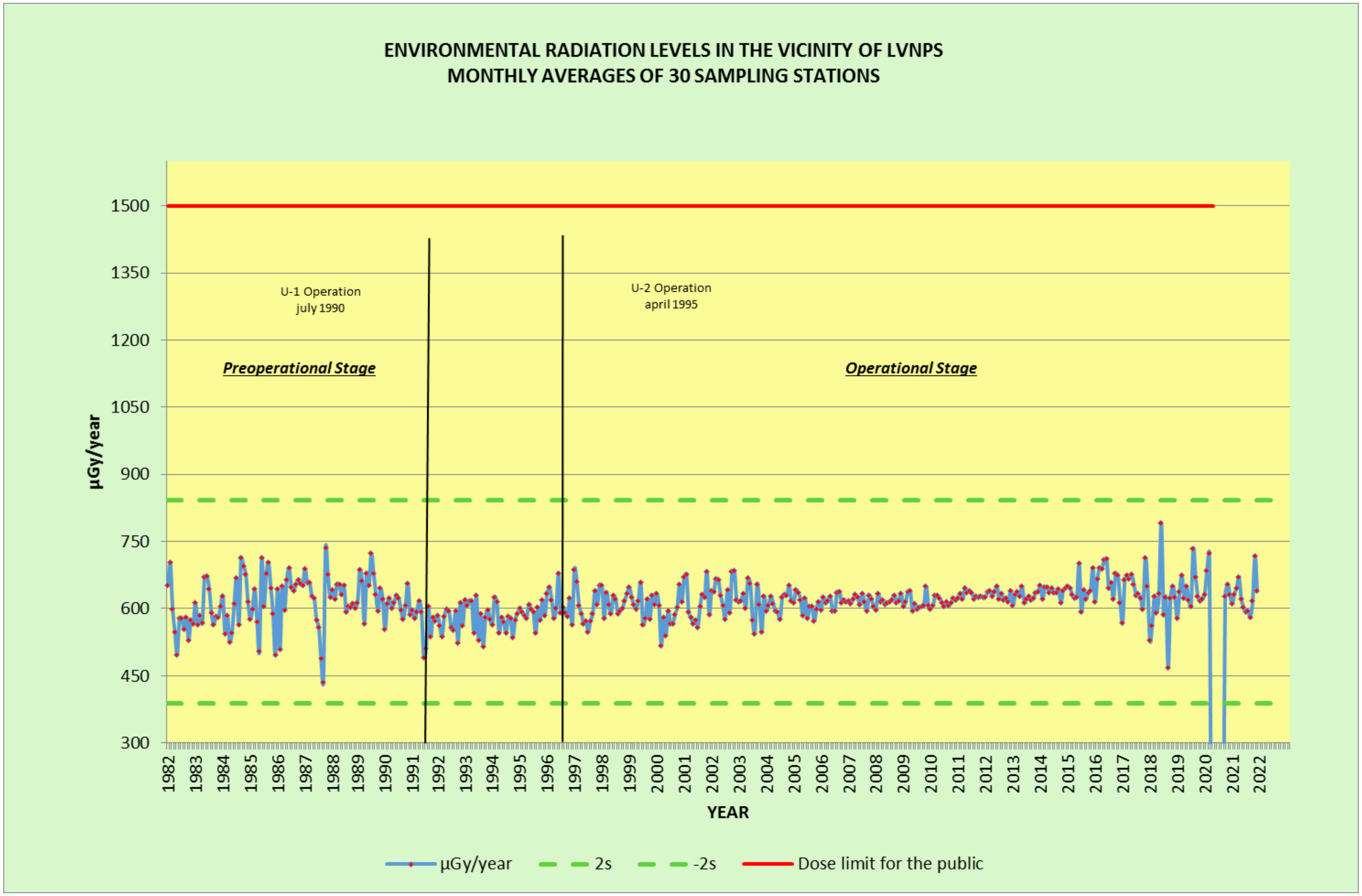
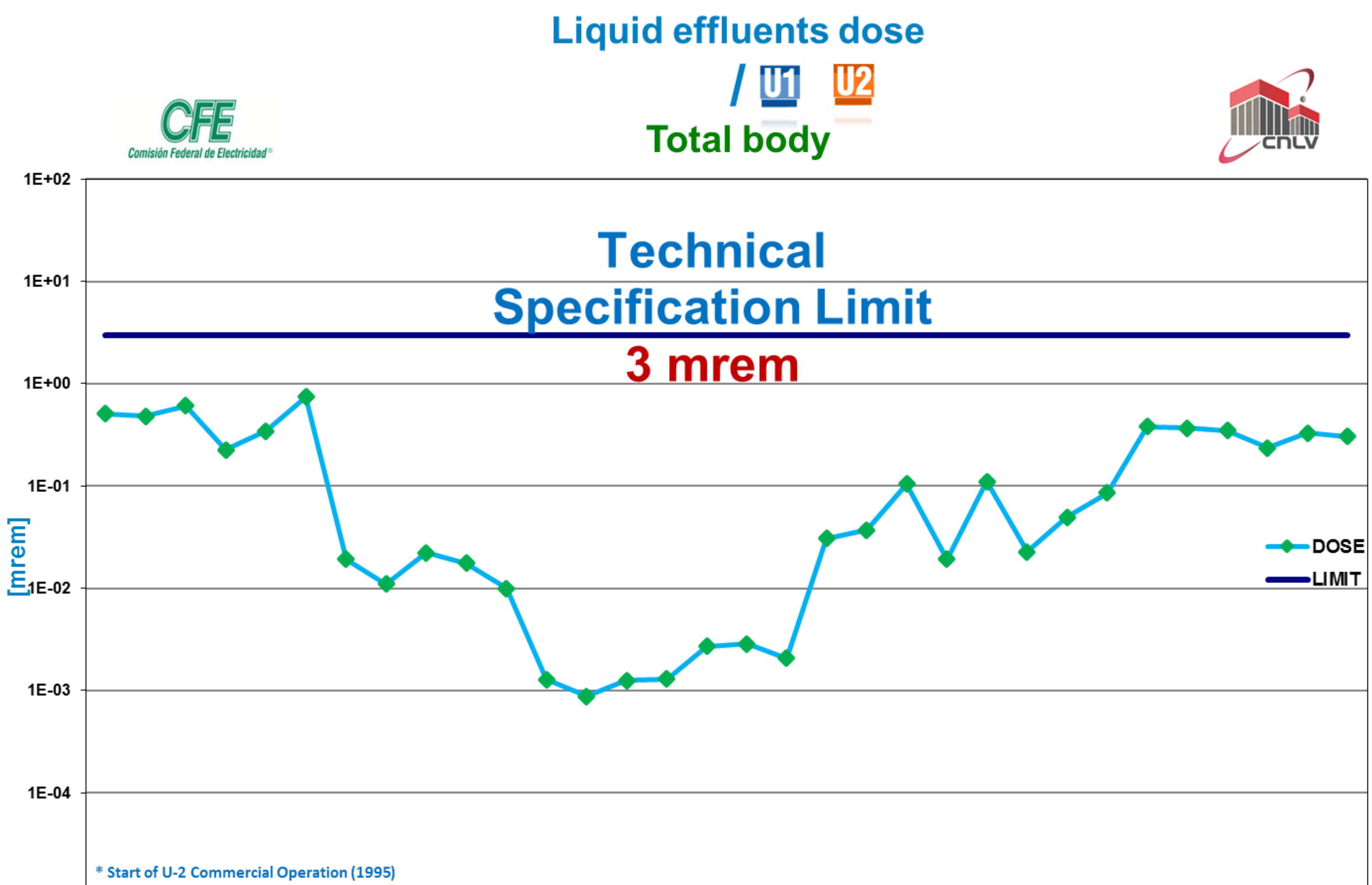


Figure 15.5 Environmental radiation levels in the vicinity of LVNPS

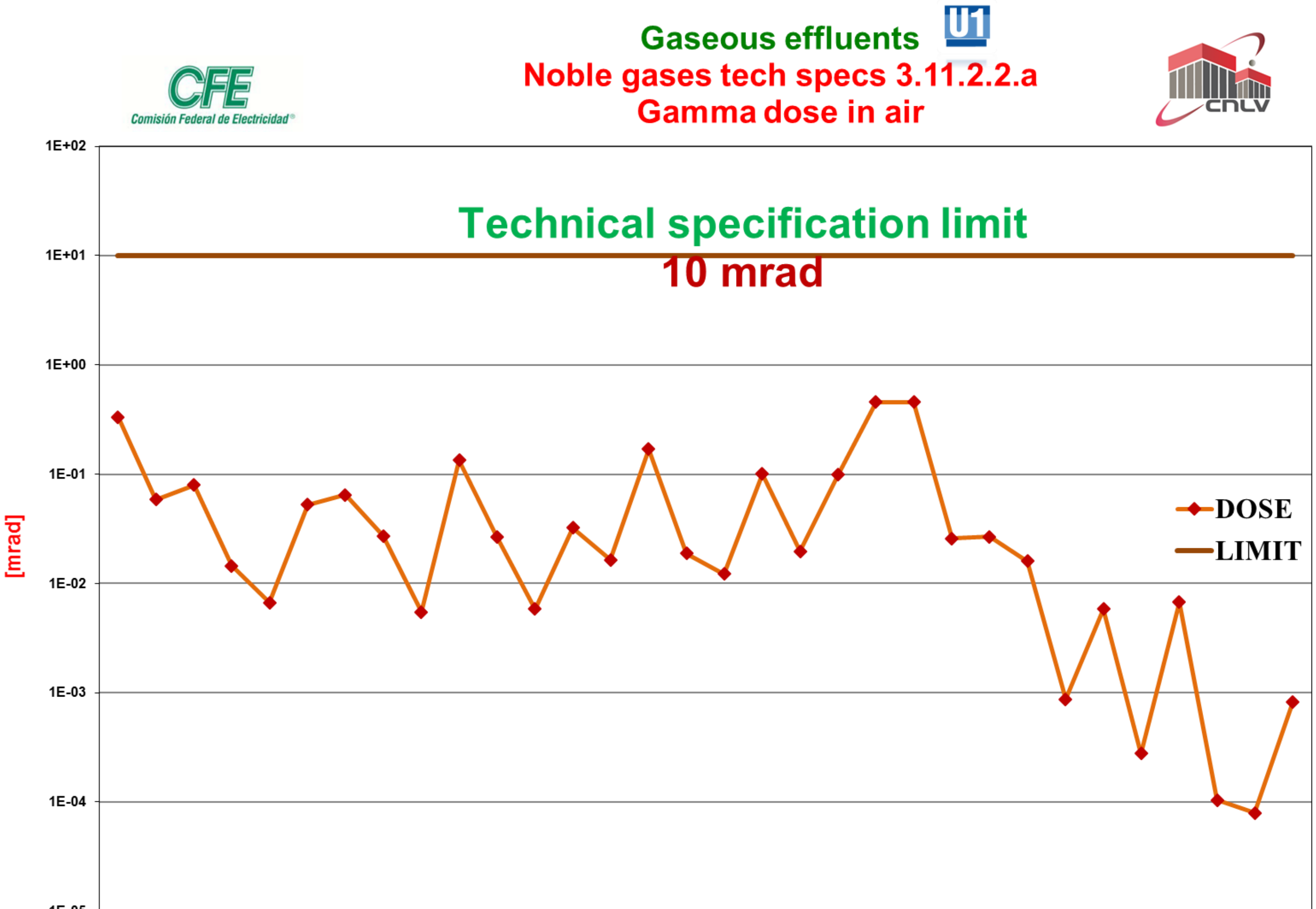


	1990	1991	1992	1993	1994	1995*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
DOSE	5.09E-1	4.82E-1	6.11E-1	2.25E-1	3.43E-1	7.42E-1	1.92E-2	1.11E-2	2.21E-2	1.75E-2	1.00E-2	1.29E-3	8.74E-4	1.26E-3	1.30E-3	2.70E-3
LIMIT	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
DOSE	2.87E-3	2.07E-3	3.06E-2	3.70E-2	1.05E-1	1.93E-2	1.10E-1	2.28E-2	4.97E-2	8.56E-2	3.81E-1	3.68E-1	3.48E-1	2.37E-1	3.28E-1	3.06E-1
LIMIT	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

NOTE: All years below the limit

Figure 15.6 Annual historical data of liquid releases (Units 1 and 2)

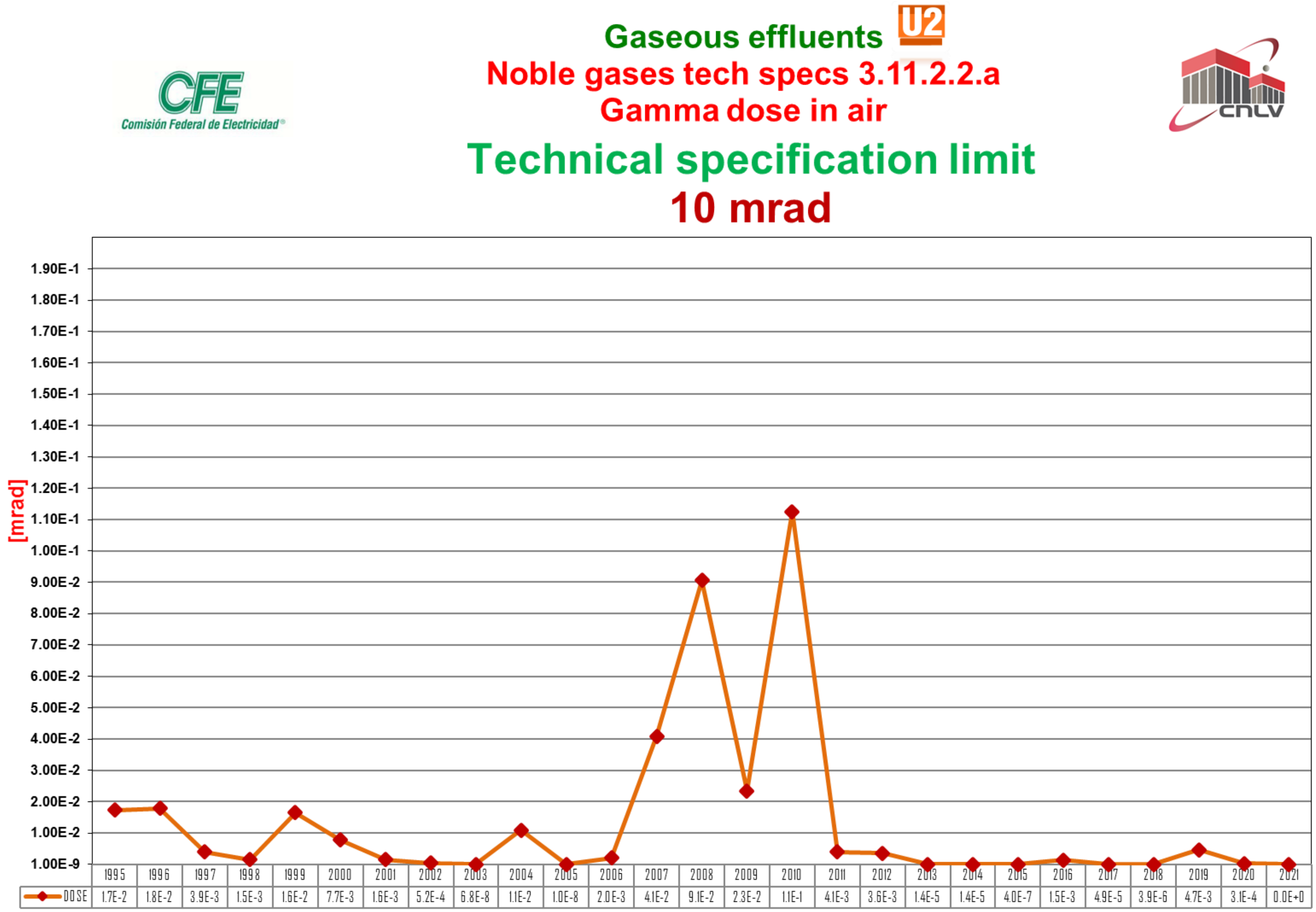


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
DOSE	3.3E-1	5.9E-2	7.9E-2	1.5E-2	6.7E-3	5.3E-2	6.5E-2	2.7E-2	5.5E-3	1.3E-1	2.7E-2	5.8E-3	3.2E-2	1.6E-2	1.7E-1	1.9E-2
LIMIT	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
DOSE	1.2E-2	1.0E-1	2.0E-2	9.9E-2	4.6E-1	4.6E-1	2.6E-2	2.7E-2	1.6E-2	8.7E-4	5.8E-3	2.8E-4	6.7E-3	1.0E-4	7.9E-5	8.3E-4
LIMIT	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

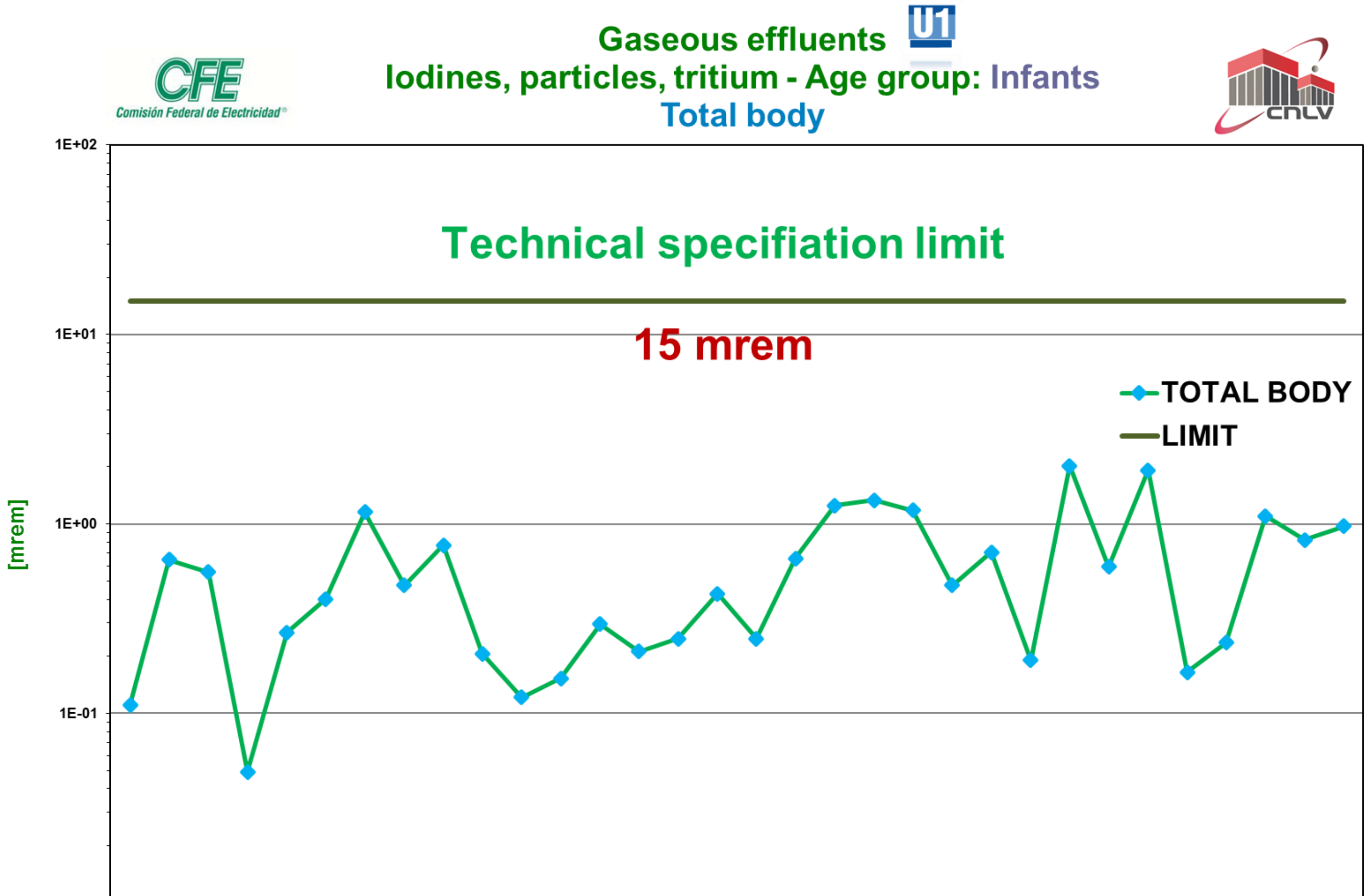
NOTE: All years below the limit

Figure 15.7 Annual historical data of gaseous releases (U-1) - noble gases



NOTE: All years below the limit

Figure 15.8 Annual historical data of gaseous releases (U-2) - noble gases

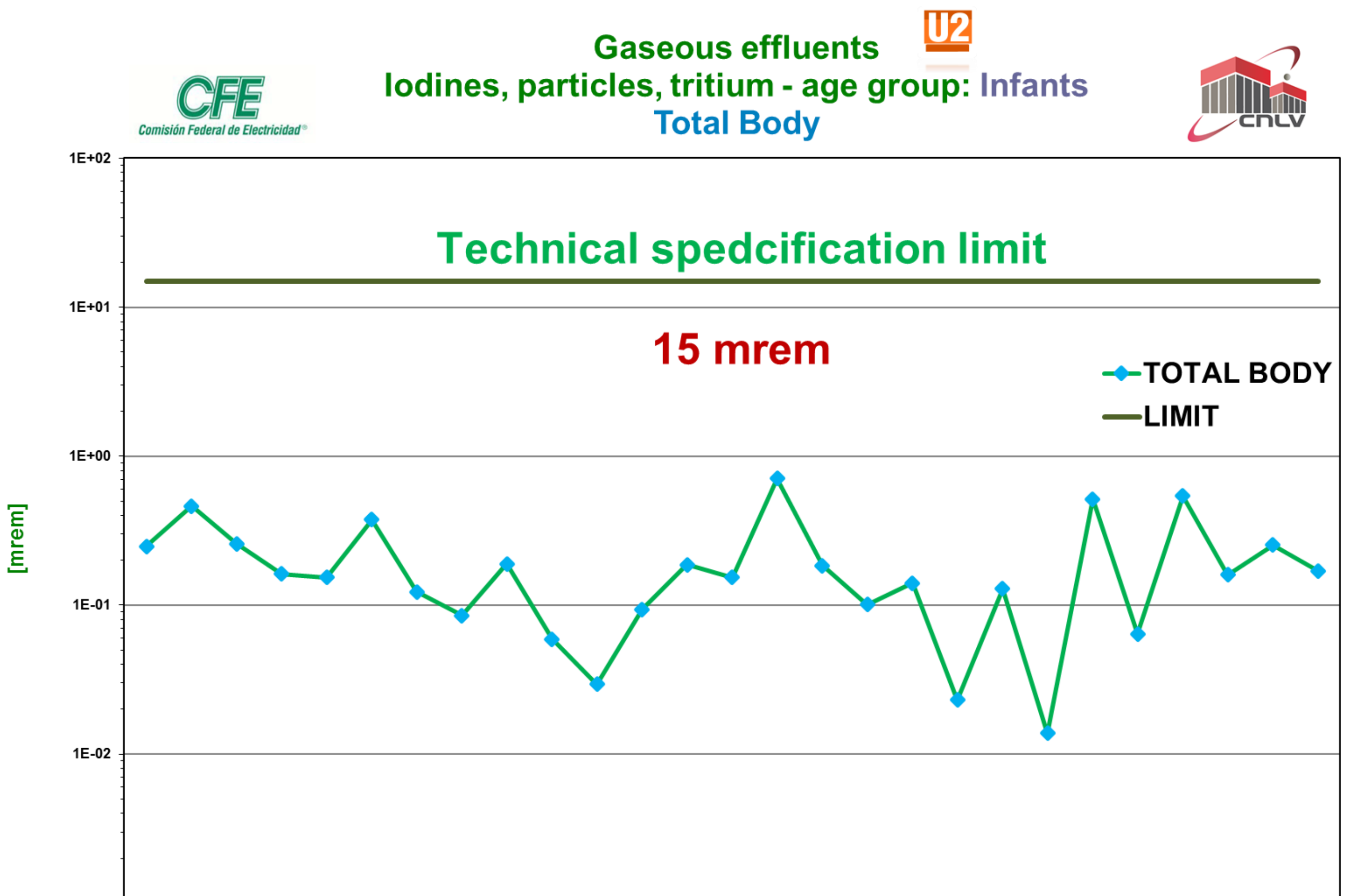


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
TOTAL BODY	1.1E-1	6.5E-1	5.6E-1	4.9E-2	2.7E-1	4.0E-1	1.2E+0	4.7E-1	7.7E-1	2.1E-1	1.2E-1	1.5E-1	3.0E-1	2.1E-1	2.5E-1	4.3E-1
LIMIT	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
TOTAL BODY	2.5E-1	6.6E-1	1.2E+0	1.3E+0	1.2E+0	4.7E-1	7.1E-1	1.9E-1	2.0E+0	5.9E-1	1.9E+0	1.7E-1	2.4E-1	1.1E+0	8.2E-1	9.7E-1
LIMIT	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

NOTE: All the year below the limit

Figure 15.9 Annual historical data of gaseous releases (U-1) – iodines, particles and tritium



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
TOTAL BODY	2.5E-1	4.6E-1	2.6E-1	1.6E-1	1.5E-1	3.8E-1	1.2E-1	8.5E-2	1.9E-1	5.9E-2	3.0E-2	9.4E-2	1.9E-1
LIMIT	15	15	15	15	15	15	15	15	15	15	15	15	15

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
TOTAL BODY	1.5E-1	7.1E-1	1.8E-1	1.0E-1	1.4E-1	2.3E-2	1.3E-1	1.4E-2	5.2E-1	6.4E-2	5.4E-1	1.6E-1	2.5E-1	1.7E-1
LIMIT	15	15	15	15	15	15	15	15	15	15	15	15	15	15

NOTE: All year below the limit

Figure 15.10 Annual historical data of gaseous releases (U-2) – iodines, particles and tritium

ARTICLE 16. EMERGENCY PREPAREDNESS

Obligations

1. *“Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency.*

   For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.

2. *Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear facility are provided with appropriate information for emergency planning and response.*

3. *Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.”*

Article 16 (1) Emergency plans and programmes

- **Overview of the Contracting Party’s arrangements and regulatory requirements for on-site (including multi-unit nuclear installations and/or multi-facility sites) and off-site emergency preparedness, including applicable laws not mentioned under Article 7**

Article 28 of the Nuclear Law states: *"Authorisations for construction and operation of a nuclear installation shall be issued only when it can be demonstrated, by presenting the pertinent information, how safety objectives are to be attained and which procedures and methods will be used during the siting, design, construction, operation, modification, cease of operations, definitive shutdown, and decommissioning. In addition, the corresponding radiological emergency plan shall be presented. Such information should follow the terms and forms stipulated in the regulatory provisions of this Law”*.

In the same way, Article 50, Section VII, defines CNSNS attributions and responsibilities: *"Prior to the start-up of operations, review, assess and authorise the plans that should be in place for dealing with anomalous or emergency conditions in nuclear and radioactive installations"*.

The General Regulation on Radiation Safety establishes in a particular manner, in Article 124, that: *“Prior to initiating operations, any radioactive installation must have* *an Emergency Plan congruent with the National System for Civil Protection guidelines and based on a survey of the radiological consequences of accidents that could occur at the installation”*.

In the case of Laguna Verde Nuclear Power Station (LVNPS), Units 1 and 2:

- Unit 1: The Renewal of Operating Authorisation states:
  - Condition No. 10: "CFE shall ensure that its emergency plans have the characteristics to take appropriate protective actions for workers, the public and the environment in the event of an emergency, and that any deficiencies identified in the plans will be corrected within the timeframe established by the CNSNS. Otherwise, the reactor must be shut down and placed in safe conditions until the CFE corrects such deficiencies and the CNSNS authorizes its restart."
  - Requirement No. 9: "CFE shall maintain in force all plans and programs approved during the different stages of authorisation, mainly the Environmental Radiological Monitoring Programme, the Internal and External Emergency Plans, the Quality Assurance Plan, the Security and Safeguards Plans, and the LVNPS-U1 Fire Protection Program."
  - Requirement No. 16: "Modifications to the internal and external emergency plans, quality assurance program and security and safeguards plan must be requested to the CNSNS for evaluation and approval prior to implementation."

- Unit 2: Condition No. 13 of the current Operating Authorisation emphasizes the need to keep the Internal and External Emergency Plans up to date. It should be clarified that when the Operating Authorisation for this unit is renewed, this condition will be standardized with the condition and requirements of Unit 1 in terms of text. In any case, CNSNS surveillance is uniformly applied as in Unit 1.

– **Overview and implementation of main elements of national plan (and regional plan, if applicable) for emergency preparedness, including the chain of command and roles and responsibilities of the licence holder, the regulatory body, and other main actors, including State organizations**

Introduction

Emergency response at the LVNPS consists of two emergency planning programmes known as the Internal Emergency Plan (IEP) and the External Radiological Emergency Plan (EREP).

Internal Emergency Plan

The Internal Emergency Plan forms part of LVNPS's Integrated Emergency Preparedness, developed by CFE.

The Internal Emergency Plan describes the organisation, resources and directives that will be applied under emergency situations at LVNPS, fulfilling the requirement established in the USNRC NUREG- 0654.

The Emergency Response Organization (ERO) is divided into two groups that are activated according to the declared emergency: Interim and Nominal. The interim ERO is made up of the Emergency Coordinator on Site (ECS), who is the Shift Operator of the LVNPS, and the personnel in duty in the areas of Maintenance, Operation, Chemistry, Physical Security, Medical Service, Notifier of Emergencies and Rapid Engineering Response.

The Nominal ERO is conformed by an essential group called "Technical Support Group" composed of the Coordinator of Emergencies at the Site and four directors (Radiation Control, Evaluation of Accidents, Repairs of Emergency, and Operation Support) supported by two Notifiers of Emergency and an Advisory Group, (Liaison Engineer and Advisor of the Emergency Coordinator on the Site) with task groups for each of the response areas such as: Operational Support, Evaluation of Accidents, Chemistry, Dose Projection, Monitoring and Decontamination, Environmental Monitoring, Damage Control, Logistics Support and Security, Medical Service and the Fire Protection Brigade which are made up of specialized personnel from the plant's functional areas.

Additionally, LVNPS has a Technical Support Centre located in an area adjacent to the Main Control Room (MCR) of each LVNPS unit, where there are work stations with signals from the Safety Parameters Display System (SPDS), which provides safety parameters display and key variables of the operating plant status, and the radiation and environmental status.

External Radiological Emergency Plan

This plan includes the development of procedures for performing specific tasks that allow the gathering of the information needed to make accurate and timely decisions to eliminate or reduce risks to the population. The plan also represents the inter-sectoral coordination and joint action used to rapidly activate the presence of all organizational levels of the government on-site and in the area surrounding the emergency.

The radiological emergency response organisation is composed of the federal and state agencies listed below. These entities form the External Radiological Emergency Plan Committee (EREPC):

- Secretariat of Security and Civil Protection:
  - National Coordination of Civil Protection
  - General Direction of Civil Protection
  - National Centre for Prevention of Disasters (CENAPRED)
  - National Guard (NG)

- Secretariat of National Defence (SEDENA)
- Secretariat of the Mexican Navy – Army (SM - AR)
- Secretariat of the Environment and Natural Resources (SEMARNAT)
  - National Water Commission (CONAGUA)
  - Federal Attorney for Environmental Protection (PROFEPA)

- Secretariat of Energy (SENER)
  - National Commission for Nuclear Safety and Safeguards (CNSNS)
  - Federal Electricity Commission (CFE) Nuclear Corporate Coordination

- Secretariat of Infrastructure Communications and Transportation (SCT)
  - Veracruz Centre of the SCT
  - Mexican Airspace Navigation Services (SENEAM)

- Secretariat of Health (SS)

- Secretariat of Agriculture and Rural Development:
  - Mexican Food Security
  - DICONSA
- Federal Institute of Telecommunications (IFT)
  - Compliance Unit
  - Radio electric Spectrum Surveillance Unit
  - General Verification Office

- State Government of Veracruz (GEV):
    - Secretariat of Civil Protection (SPC-GEV)
    - Secretariat of Health, Services of Health (SESVER)
    - Department of Social Communications

All the entities in the emergency response organisation have a controlled copy of the EREP, which will be updated with modifications or amendments determined by the subcommittees or the task forces, validated by the EREPC's Technical Secretary (SETECO Abbreviation in Spanish). In addition, the response personnel are trained in accordance with valid procedures and manuals. Verification of the human and material resources is performed following the valid procedures. Information is released to the public based on the corresponding task forces' schedules. The drills are conducted according to the training plan of the corresponding entity, and the integrated exercises included to evaluate the effectiveness of the plan are performed according to regulations and/or the CNSNS instructions.

The responsibilities that each organisation must take to keep the plan valid and operational are defined in the EREP. Table 16.1 shows the responsibilities for the preparation stage, taken from the EREP Manual. The table's column headings are defined above, as part of the EREPC.

Table 16.1 Matrix of responsibilities of the EREP Committee during the preparation stage

No.	Activity	SETECO	CFE	SCT	SEDENA	SEMAR	SPC-GEV	SESVER	CONAGUA	PROFEPA	DICONSA	GN	CENAPRED	IFT
1	Update plan	X	X	X	X	X	X	X	X	X	X	X	X	X
2	Specialized training	X	X	X	X	X	X	X	X	X	X	X	X	X
3	Public information	O	O				X							
4	Population census	O	X				O							
5	Verification of human resources and materials	X	O	O	O	O	O	O	O	O	O	O	O	
6	Supervised practices, drills, and exercises	X	X	X	X	X	X	X	O	O	O	X	O	O
7	Maintenance of the primary and alternate emergency control centre		X											
8	Maintenance of evacuation routes		O	X			X							
9	Maintenance of vehicle decontamination centres		X											
10	Maintenance of aircraft and armament decontamination					X								
11	Maintenance of evacuee monitoring centres		X					X						
12	Maintenance of exposure control checkpoints		X					X						
13	Maintenance of temporary shelters						X							
14	Maintenance of vehicles, equipment, and materials required during an emergency		X	X	X	X	X	X	X	X	X	X		X
15	Maintenance of laboratories		X											
16	Maintenance of the communication network		X	O	O	O	O	O	O	O		O		
17	Radioelectric Spectrum Surveillance													X
18	Clearing harmful interference													X

X: Primary O: Co-responsible

– **Implementation of related measures**

In order to maintain effectiveness, the EREP includes, as part of its material and human resources and its agreements with state and local authorities, the following:

a) Equipment for radiation monitoring to control the spread of contamination and to determine the type and extent of radioactive deposits in food and water. This equipment allows, with anticipation, determination of radioactive releases to determine which protective actions should be taken for the population.

b) Equipment to immediately notify on-site and off-site IEP and EREP emergency personnel, as well as the state and federal agencies that are part of the EREP.

c) Vehicles and equipment to evacuate on-site personnel and the public from the closer affected areas.

d) On-site facilities and supplies at LVNPS to decontaminate people on-site.

e) Off-site facilities and supplies (to the North and South of LVNPS) to decontaminate response personnel and evacuees.

f) On-site medical facilities and supplies to provide first aid during an emergency.

g) Off-site medical facilities and supplies (to the North and South of LVNPS) to provide first aid and specialised medical attention to response personnel and evacuees.

h) Arrangements to provide qualified medical staff to handle on-site radiological emergencies.

i) Arrangements to provide qualified medical staff to attend to response personnel during a radiological emergency.

j) Arrangements for transporting injured and contaminated people from the site and from the evacuated areas.

k) Technical support and operations facilities near the site, from where effective management and control can be performed during an emergency.

l) At least one on-site and another off-site communication system, each having its backup power system.

m) Arrangements to provide temporary shelters to evacuees.

n) Arrangements for surveillance of the emergency zone, as well as for search and rescue for people possibly affected.

o) Arrangements to control the distribution of water and food.

- **Implementation of emergency preparedness measures by the licence holders**

- **Classification of emergencies**

The EREP describes measures for determining the magnitude of a radioactive material release, as well as its continuous assessment. Also includes the emergency action levels that are used to define the necessities of notification. The need for notification and participation of local and state authorities are determined using those emergency action levels. When and what kind of personnel and public protective measures are to be used on-site and off-site boundaries are determined based also on the emergency action levels. There are four classes of emergencies defined as follows.

Unusual Event – This class refers to uncommon events in progress or which have occurred, indicating a potential degradation of the plant safety level. In an event of radioactive releases, the value of these exceeds 2 times the Technical Specifications limit for a period greater than 60 minutes, not requiring a response or off-site monitoring, unless degradation of safety systems persists. In this condition, only the Internal Emergency Plan is performed.

Alert – This class includes those events in progress or which have occurred involving a real or potential substantial degradation in plant safety level. This class of events requires the EREP activation and defines the beginning of the response actions for public protection.

On-Site Emergency – This class refers to events in progress or which have occurred involving real or potential major failures of operations necessary for public protection.

General Emergency – This class includes those events in progress or which have occurred involving real or imminent substantial degradation of the core, or melting of the core with a potential loss of containment integrity.

LVNPS regulations establish areas around the plant that require protective measures for the population. The resulting Emergency Planning Zone (EPZ) is divided into two:

- Plume Zone – An area with a radius of 16 km surrounding LVNPS's reactors. The area may change based on actual events and NUREG-0654 "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants."

  In the Plume Zone, the primary risk of radiation exposure is via the plume or cloud as it spreads.

  Inside this zone is the Caution Zone, 0 – 5 km radius around the plant.

- Ingestion Zone – The area where the main means of exposure is through the consumption of surface water, contaminated food, and radioactive material deposited on the ground and in the soil.

Both zones have been divided into geographical sectors of 22.5 degrees, starting with the North sector, which is centred on the geographic north. Counterclockwise, each sector is assigned with identification letters according to the geographic orientation.

To support emergency preparedness activities, the following tools are available:

a) Integral Process Information System, which includes the Safety Parameter Display System (SPDS).

b) The RASCAL computer code "Radiological Assessment System for Consequences Analysis" developed by Oak Ridge National Laboratory.

c) Methods of core damage estimation based on computer code known as MELCOR (Methods for Estimation of Leakages and Consequences of Releases) developed by Sandia National Laboratory.

d) Events control system for the Control Head.

In addition to these computational tools, the following analytical tools are available, for confirmatory purposes only:

a) Isotopic analysis using Gamma spectrometers.

b) Ionic chromatography.

c) Atomic adsorption.

All systems and equipment mentioned above are available at LVNPS, and trained personnel to operate them are available.

- **Main elements of the on-site and, where applicable, off-site emergency plans for nuclear installations, including availability of adequate resources and authority to effectively manage and mitigate the consequences of an accident**

Internal Emergency Plan

The implementation of the preparedness, response and recovery phases of the Internal Emergency Plan is CFE's responsibility.

The Internal Emergency Plan is made up of the following facilities:

a) Technical Support Centre.

b) Main Control Room.

c) Emergency Notification Cubicle.
d) Operational Support Centre.
e) Dose Projection Cubicle.
f) Accident Evaluation Cubicle.
g) Damage Control Centre.
h) Radiological Monitoring Point
i) Alarms Central Station
j) Decontamination and First Aid Station.
k) Post-Accident Sampling Station.
l) LVNPS Laboratory, Chemical Group.

The IEP also provides for the existence of the following materials and equipment:

a) Personal Protective Equipment.
b) Breathing protective equipment.
c) Radiation monitors.
d) Contamination monitors.
e) High-volume air monitoring.
f) Electronic dosimeters and Thermo Luminescent Dosimeters (TLDs).
g) Primary and alternative communication systems.
h) Plant alarm systems (fire, emergency and evacuation).
i) Fire Truck.
j) Buses for personnel transportation.
k) Potassium iodine for radiation prophylaxis.

External Radiological Emergency Plan

The External Radiological Emergency Plan (EREP) is a responsibility shared by several federal agencies and the State Government of Veracruz, constituted in a EREP Committee. The participating institutions are the Secretariat of Security and Civil Protection, the Federal Electricity Commission, the Secretariat of National Defense, the Secretariat of the Navy, the Mexican Navy, the Secretariat of Infrastructure Communications and Transportation, the National Guard, the Secretariat of Civil Protection of the State of Veracruz, the Secretariat of Health of the State of Veracruz, the Federal Institute of Telecommunications, the Federal Attorney for Environmental Protection, the CONAGUA and CONASUPO, S.A. de C.V. (DICONSA).

- **Facilities provided by the licence holder for emergency preparedness**

The responsibilities of each agency are defined in the EREP Manual and in its procedures for each phase of the plan: preparedness, response and recovery.

Facilities that make up the External Radiological Emergency Plan are the following:

Operated and maintained by CFE:

a) Main Emergency Control Centre.
b) Alternate Emergency Control Centre.
c) Equipment and Vehicles Decontamination Centre – North.
d) Equipment and vehicles decontamination centre – South.
e) Monitoring Centre for Evacuees – North.
f) Monitoring Centre for Evacuees – South.
g) Exposure Control Post – North.
h) Exposure Control Post – South.
i) Exposure Control of Main Emergency Control Centre.
j) Evacuation Routes within Plume Zone (over 130 km of paved roads)
k) Environmental Engineering Laboratory (TLD reading and sampling analysis)
l) EREP Communications Network including Central and Repeater Stations.

Operated and maintained by other institutions:

a) Evacuation Routes Within the Plume Zone (more than 140 kilometres of paved roads)
b) Temporal shelters.
c) Hospital of Specialised Medical Assistance.
d) State (of Veracruz) Health Laboratory.
e) Aircraft Decontamination Centre.
f) Hospitals for general medical assistance.

The EREP also provides for the existence of the following materials and equipment:

a) Personal protective clothes (Anti-Contamination).
b) Breathing protective equipment (masks and filters).
c) Radiation detection monitors.
d) Contamination detection monitors.
e) High-volume air monitors.
f) Electronic dosimeters and TLDs.
g) Primary and alternative communication systems.
h) Ambulances.
i) Vehicles to notify the population.
j) Tow trucks to clear evacuation routes.
k) Buses for personnel transportation
l) Potassium iodine for radiation prophylaxis

- **Training and exercises, evaluation activities and main results of performed exercises, including lessons learned**

The training related to emergency plans and programmes given to LVNPS personnel is valid for a year and is divided into the Internal Emergency Plan and the External Radiological Emergency Plan.

Training for personnel involved in the Internal Emergency Plan

The nearly 750 LVNPS employees who have assigned duties in the Internal Emergency Plan receive continuing training every year. The following table shows the number of courses attended, depending upon the tasks the staff is involved.

Table 16.2 Retraining of the personnel in the Internal Emergency Plan

Training (courses)	Year		
	2019	2020	2021
Technical Support Group	2	2	1
Operation Support Group – Licensing	8	9	9

Training (courses)	Year		
	2019	2020	2021
Operation Support Group – Non-Licensing	7	3	8
Notifiers in Emergency	11	12	10
On-site Environmental Monitoring Group	2	SENL-CENAC	3
Monitoring and Decontamination Group At the Unit	9	2 SENL-CENAC	7
Chemical Group	6	6	8
Medical Service Group	2	4	4
Damage Control Group	13	SENL-CENAC	13
Storehouse Coordinator	3	SENL-CENAC	1
Accident Assessment Group	3	4	4
Dose Projection Group	1	3	3
Physical Security Group	5	SENL-CENAC	8

Note: Adjustments are made based on the COVID situation and the implementation of sanitary protocols in the LVNPS from the year 2020, for which training is applied in the following platforms:

SENL (Abrv. in Spanish) - Online Training System

CENAC (Abrv. in Spanish)- Northeast National Training Center

Training for personnel involved in the External Radiological Emergency Plan

The nearly 390 LVNPS employees who have assigned duties in the External Radiological Emergency Plan receive continuing training every year. The following table shows the number of courses attended, depending upon the tasks the staff is involved.

Table 16.3 Training in the External Radiological Emergency Plan

Training (courses)	Year		
	2019	2020	2021
Evacuee Monitoring Centre	4	4	5
Vehicle Decontamination Centre	4	4	6
Exposure Control	2	2	2
Notification	3	3	3
Services	1	1	1
Dose Calculation	1	2	2
Technical Analysis	1	2	2
Monitoring and Decontamination Techniques	3	3	3
CFE's Task Force Coordination	1	1	1
Logistics Support	1	1	1
Environmental Surveillance	1	3	3
EREP Coordinator's Emergency Planning Course (NEI)	1	1	1
On-site Count	7	7	8
Transportation	2	2	2
Laboratory	1	1	1
Notification and Decontamination	1	1	1

Training (courses)	Year		
	2019	2020	2021
Accident and Protection Actions Evaluation	1	1	1
Communication and Information Technology	2	2	2
Emergency Infrastructure and Facilities and Evacuation Routes	3	3	3
Information Technology Task Units	2	2	2
Financial Management	1	1	1
Supply	1	1	2
Advisory Group	1	1	1

In addition, the CFE provides training support to the various state and federal agencies participating in the EREP through their participation in the following courses given by LVNPS: for instance personnel from the Federal Attorney for Environmental Protection participate in the Supervised Practice of the Vehicle Monitoring and Decontamination Centre, support was provided to the National Centre for Prevention of Disasters (CENAPRED) in the delivery of the courses: Monitoring and Decontamination Techniques, EREP Instructor Training Course, Handling of Communications Equipment, Emergency Plan, Introduction to the Laguna Verde Nuclear Power Plant, and Radiation Monitors and Records Management.

Internal Emergency Plan exercises and drills

During the 2019-2021 period, several Internal Emergency Plan drills were conducted to verify the facilities and equipment readiness, and staff training. The number of drills for each area per year is summarised in the following table.

Table 16.4 Drills of the Internal Emergency Plan

Emergency Response Organization (ERO)	2019
Technical Support Group	4
Interim ECS	27
Notifiers	21
Accident evaluation	17
Dose Projection	2
Operation Support Group – Non-Licensing	25
Monitoring and Decontamination	1
Medical Service	2
Chemical group	11
Damage Control	1
Logistics Support (Warehouse)	1
Task Force No. 82(FT-82)	3
Physical Security	5

ERO group drill scheme	2020	2021
Damage Control Operation Support– Non-Licensing Group Physical Security	2	N/A
Operation Support– Licensing Group	7	
Damage Control Monitoring and Decontamination Operation Support Non-Licensing Group	6	N/A

ERO group drill scheme	2020	2021
Chemical group Industrial Safety Medical Service Physical Security Record Manager		
Operation Support Non-Licensing Group Monitoring and Decontamination	22	17
Accident evaluation	2	3
All the ERO groups and EREP or FT-82	1	1
Operation Support– Licensing Group Monitoring and Decontamination Chemical Group	8	15
Notifiers	8	14
Dose Projection	1	3
Monitoring and Decontamination	N/A	2
Note: Adjustments are made based on the COVID situation and the implementation of sanitary protocols in the LVNPS.		

External Radiological Emergency Plan exercises and drills

During the 2019-2021 period, several External Radiological Emergency Plan drills were conducted to verify the facilities and equipment readiness, and the staff training. The number of drills for each area per year is summarised in the following table.

Table 16.5 Training in Drills of the External Radiological Emergency Plan

Training (courses)	Year		
	2019	2020	2021
EREP instructors training			
Evacuee Monitoring Centre	5	2	2
Vehicle Decontamination Centre	5	2	4
Exposure Control	3	2	2
Notification	6	6	6
Services	1	1	1
Dose Calculation	1	1	1
Technical Analysis	1	1	1
Monitoring and Decontamination Techniques	1	1	1
CFE's Task Force Coordination	1	1	1
Logistics Support	1	1	1
Environmental Surveillance	3	2	2
On-site Count	1	1	1
Transportation	1	1	1
Laboratory	3	2	2
Notification and Decontamination	1	1	1

Training (courses)	Year		
	2019	2020	2021
Accident and Protection Actions Evaluation	1	1	1
Communication and Information Technology	1	1	1
Emergency Infrastructure and Facilities and Evacuation Routes	1	1	1
Information Technology Task Units	1	1	1
Financial Management	1	1	1
Supply	1	1	1
Advisory Group	1	1	1

The Integrated Exercise was carried out on November 28, 2019, which was evaluated by the CNSNS, with the participation of all COPERE agencies. The main purpose of this integrated exercise was to evaluate the performance of personnel in Command and Control activities, Decision Making, shift changes, activation of emergency facilities committed in the EREP (Response Facilities, Hospitals, Temporary Shelters, Naval Air Base, among others) and transfer of responsibility from the Primary Emergency Control Centre to the Alternate Emergency Control Centre.

Evaluation activities

Training on emergency planning is provided via two methods as mentioned above. Theoretical training (classroom training) and practical training (field drills). The training evaluation is done as follows.

a) Theoretical training

At the end of the training session, the trainees are evaluated by a written examination to demonstrate that the necessary knowledge to carry out the activity that they have been assigned in the Organization for Emergencies Response was acquired and/or reinforced.

b) Practical training

This training is done in two stages. The first is a "supervised practice," during which trainees (staff) perform activities based on a planned scenario, making use of the resources available to them. The training supervisor can stop the activity to make observations and to show how the function should be performed.

In the second stage, carried out without the interaction with the supervisor, the trainees are required to perform an activity, one that is part of the emergency plan, for an accident scenario that is unknown to them until the session begins. They need to use all available material resources to perform the activity, and each trainee is evaluated according to his or her performance, which must be in adherence to procedures and the operations manual, specifically taking into account the critical steps to satisfactorily perform the activity.

Both the theoretical and practical training are evaluated following the LVNPS internal procedures.

Main results

During the 2019-2021 period, the following emergency plans improvements were made.

External Radiological Emergency Plan

a) Reinforcement on Record Filling to the elements of Task Force 82 of the EREP.
b) Improvements in the training given to the Dose Calculation Group, regarding the calculation of doses by manual method.
c) Design of scenarios with multidisciplinary participation of the units involved in COPERE's emergency response.
d) Participation of COPERE Task Forces in activities to disseminate information to the population, visits to schools within 16 km.
e) Development of drills where medical care hospitals and temporary shelters are activated.
f) Measurement of notification and evacuation times of the population within 16 km.

Internal Emergency Plan

a) Formation of 4 independent groups of ERO personnel who perform key activities to mitigate emergencies. This has allowed more personnel to be trained, ensuring the transfer of knowledge and sufficient personnel to attend to emergencies in both units of the LVNPS, in a standardized and simultaneous manner.

b) Optimization of the post-drill and post-training critique process. Procedures were updated to ensure the participation of multidisciplinary controllers in the drills, so that they, in turn, objectively evaluate the performance of the ERO and ensure the documentation of lessons learned, resulting in an emergency plan that is constantly updated, incorporating internal operating experience.

c) Continued development and dissemination of a defined and harmonized strategy for the prioritization of work and optimization of human resources in emergencies, according to the needs and condition of the plant. This has allowed for integrated participation among the response groups, with the appropriate sense of urgency, from the initial stages of the emergency.

d) Development of dynamic learning activities on Post-Fukushima strategies for personnel training. This has resulted in ERO technical personnel being able to recognize procedures, accessories, machines and tools that are necessary to respond to an event that exceeds the plant's design basis.

- **Regulatory review and control activities**

Internal Emergency Plan

According to the Baseline Inspection Programme, CNSNS annually inspects the Internal Emergency Plan to verify the following:

a) The changes made to the Organization for Emergencies Response.

b) The independent reviews and audits, and the internal reviews and audits conducted to the Internal Emergency Plan.

c) The alert and notification system.

d) The method for increasing the Organization for Emergencies Response personnel.

e) The changes to the emergency action levels and the Internal Emergency Plan.

f) The effectiveness in identifying and correcting weaknesses and deficiencies.

g) The drills programme and the assessment of the drills performed.

h) The facilities and equipment.

i) Organization for Emergencies Response member training.

Moreover, CNSNS inspectors ask LVNPS staff to perform exercises, to witness compliance with the Internal Emergency Plan applicable regulation.

As a result of these inspections, CNSNS found that the activities associated with the Internal Emergency Plan fulfil the requirements of the Operating Authorisation, Technical Specifications, Quality Assurance Plan and with specific procedures for this area.

External Radiological Emergency Plan

The CNSNS control and assessment of the External Radiological Emergency Plan (EREP) have been implemented by CNSNS through a documental review, a field inspection of the EREP's task forces and the execution of exercises for the EREP activities.

In 2019, the Laguna Verde Nuclear Power Station conducted an integrated exercise with the purpose of verifying the adequacy of the EREP and its response. Said exercise was evaluated by the CNSNS, identifying 78 findings to the various Task Forces that compose it, without these representing a risk to the population during the response to a General Emergency at the plant. Currently, the Task Forces are working on the implementation of the modifications, and carrying out the relevant training, prior to the integrated exercise that was planned for 2021; however, the exercise was rescheduled for 2022 at the request of the CFE and the National Civil Protection Coordination.

– **International arrangements, including those with neighbouring States, as necessary.**

See Annexes 7.1 and 7.2 of this National Report.

Article 16 (2) <u>Information to the public and neighbouring states</u>

– **Overview of the Contracting Party's arrangements for informing the public in the vicinity of the nuclear installations about emergency planning and emergency situations**

One of the key factors for a successful implementation of the measures to protect the population living in a radius of up to 16 km from LVNPS is the information regarding their participation in the event of a radiological emergency.

The main information media are the following:

a) The EREP calendar, which is distributed in all homes and businesses located in a radius of up to 16 km from LVNPS. The calendar has information on actions to be completed by the population in case of an emergency. This information is delivered to about 4,000 households.

b) Visits of communities to the LVNPS Information Centre. The Information Centre makes the invitation and provides transportation for the community groups. The communities have the opportunity to go to the centre and receive information about the External Radiological Emergency Plan. This programme receives an average of 300 people per year.

c) Visits to schools around LVNPS. Over the past three years, information about LVNPS and the EREP has been shared with more than 1,700 students.

- **Arrangements to inform competent authorities in neighbouring States, as necessary**

Since 1988, Mexico has been a part of the “Convention on Early Notification of a Nuclear Accident” and the “Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency”. Based on these conventions, there is an established procedure to declare a radiological emergency at a Mexican nuclear installation if an event has the likelihood of affecting neighbouring states. The procedure’s objective, to provide early notification, and its application are the responsibility of CNSNS. Notwithstanding the preceding, Mexico has bilateral agreements for exchanging technical information (including the occurrence of significant events) with their closest neighbours.

Mexico is also part of the IAEA Early Communications International System, which would be used to immediately provide information to the IAEA in the event of a radiological emergency at LVNPS. The same information would be available to neighbouring states. Mexico is also a signatory of the “Vienna Convention on Civil Liability for Nuclear Damage”. It is important to mention that the LVNPS site is over 500 km away from the border of the nearest country.

Mexico has a National System for Civil Protection. In the event of a radiological emergency at a nuclear installation in Unites States of America, near the border with Mexico, with the likelihood to affect the national territory, the DN-III Plan would be activated. The Ministry of Defence is responsible to apply the DN-III Plan under the direction of the Secretariat of the Interior, assisted by the Secretariat of Health and DICONSA. The DN-III Plan includes the infrastructure required to establish adequate communications, evacuation capacity and establishment of control points for taking the appropriate actions during the emergency. However, it should be noted that the United States nuclear power plants are sited more than 100 km from Mexico’s border and other Central American countries such, as Guatemala, do not have this kind of power stations.

Technical issues to be considered

- **Related to the Event at Japan’s Fukushima Daiichi Plant**

In connection with the event that occurred at the Fukushima Daiichi plant in Japan on March 11, 2011, and in compliance with the instructions included in the "Technical Points to be Considered" section of CNS/ExM/2012/12 Rev. 1 ("Chairman's Report of the Special Meeting, Second Special Meeting of the Contracting Parties to the Convention on Nuclear Safety", August 2012, Annexe III, Paragraph 23), also described in the minutes (point 2.b) of the "6th Board Officers Review Meeting" of the Convention on Nuclear Safety, held on October 29, 2012, the following is reported:

Emergency preparedness and response improvements

1) Multiple-unit sites

The strategies implemented at the LVNPS to increase the response capacity to situations arising from the occurrence of extreme natural events are based on the assumption that the event will simultaneously affect both units of the plant. Based on this assumption, the LVNPS developed strategies in which the response capacity is not compromised by the failure of any common system and/or equipment.

2) Additional responsibilities of government agencies

As mentioned before in this Article 16, with regard to the External Radiological Emergency Plan, the Organization for Emergencies Response is formed by the federal and state agencies listed previously, which form the External Radiological Emergency Plan Committee.

3) New procedures

LVNPS has developed the Severe Accident Management Guidelines (SAMG) based on the guidelines for the Emergency Procedures and for Severe Accidents EPG / SAG (Emergency Procedure Guidelines / Severe Accident Guidelines) Rev. 3 of the BWR Reactor Owners Group. The SAMGs coordinate the control of the key parameters of the plant under severe accident conditions, and provide the guidelines to flood the core and its slag.

Additionally, support procedures (PDS) have been developed for the SAMGs, which contain the information to perform the necessary actions to carry out the alignments, connections and disconnections required for the monitoring of the SAMGs.

4) Joint actions with various agencies and improvements in international cooperation

Mexico, through CNSNS, participates in the Organisation for Economic Co-operation and Development's (OECD) Nuclear Energy Agency (NEA) Senior Task Force on the "Impact of the Fukushima Daiichi Nuclear Plant Accident".

CNSNS is also a member of the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies (FORO in Spanish), which has developed as one of its tasks, stress tests for nuclear power plants. The tests are similar to the ones defined by the European Nuclear Safety Regulators Group (ESREG) and the Western European Nuclear Regulators Association (WENRA).

Regarding cooperation with international groups on this issue, the CFE is an active committee member within the BWR Reactor Owners Group (BWROG). This membership allows CFE to be prepared for events beyond the design basis in accordance with the fleet of reactors of the same type. The CFE´s interaction with committees such as the Fukushima Response Committee (FRC) and the Emergency Procedures Committee (EPC) facilitates the integrated response within the industry to the orders issued by the USNRC and endorsed by the CNSNS. Additionally, the interaction with plants of the same type allows the exchange of experiences with nuclear power plants that have already implemented the orders of the USNRC EA-12-049, EA-12-051 and EA-13-109, which have been required to theCNSNS.

Actions of the Regulatory Body

As a consequence of the accident at the Fukushima Daiichi nuclear power plant in Japan, the CNSNS required the LVNPS to implement the necessary mitigation strategies to comply with NRC Order EA-12-049 (Flex) during the initial, transition and final response phases, to address beyond design basis accidents; as well as, the development and implementation of procedures and guidelines for CFE's response to these accidents.

In response to the above, CFE acquired additional equipment and material to comply with the Order and reevaluated the areas established as Response Centers, in order to guarantee the protection of the members of the emergency response team, due to the leakage of radioactive material.

As a result, the following actions were taken at the LVNPS:

1. The location for the storage of materials and equipment necessary for CFE's emergency response was determined, which corresponds to the Flex Building, which complies with the characteristics required by Order EA-12-049.
2. A new Technical Support Center (CAT, Abbreviation in Spanish), called "Alternate CAT" was assigned for the Internal Emergency Plan (IEP), located in the Integral Process Information System building, which will be used in the event that the support centres of both units of the LVNPS are disabled.
3. The amount of potassium iodide tablets needed was reevaluated in order to have a sufficient reserve for the emergency response personnel and the population living within the 16 km zone, in case radiological prophylaxis is required.

How the IAEA safety standards are taken into account

As mentioned in Article 7 (1), section "Ratification of International Agreements and Legal Instruments Related to Nuclear Safety", Mexico has committed to implement the safety and health protection measures, as stated in the Informative Circular No. 18/Rev.1, by subscribing an agreement with the International Atomic Energy Agency whereby the Agency would assist in the implementation of a project for a nuclear power plant. Thus, Mexico is obliged to comply with and applies the IAEA´s Basic Safety Standards.

Actions committed to for improving openness and transparency with stakeholders

As mentioned in the Introduction, this report and the previous ones are public documents in compliance with the following national laws in force: "Federal Law of Transparency and Access to Public Information" and the “General Law of Transparency and Access Information” both last amended on May 20, 2021, as well as the recommendations from the Convention contained in the document INFCIRC/572/Rev. 6, dated January 19, 2018.

ARTICLE 17. SITING

Obligations

"Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;

ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;

iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;

iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation."

Article 17 (1) Evaluation of site related factors

- **Overview of the Contracting Party's arrangements and regulatory requirements relating to the siting and evaluation of sites of nuclear installations, including applicable national laws not mentioned under Article 7 of the Convention**

Prior to granting the construction permit, the licence or authorisation holder of Laguna Verde Nuclear Power Station (LVNPS) provided information to the competent authority for authorisation of the location of the site where the construction was to initiate; even though the Nuclear Law is posterior to the initiation of the construction work, the regulatory standards to approve this stage of the installation were 10 CFR 100 and 10 CFR 50 Appendix A. The following United States Nuclear Regulatory Commission (USNRC) Regulatory Guides (RG) were added as soon as edited:

a) RG 1.29, defining seismic design classification.

b) RG 1.59, related to design basis for flooding.

c) RG 1.60 defining seismic design response spectrum.

d) RG 1.61 establishing seismic design damping values.

e) RG 1.70 on safety report standard forms and contents.

f) RG 1.76 on design basis tornado.

g) RG 1.91 considering human activities nearby nuclear installations, defining explosion characteristics occurring within the vicinity of the plant.

h) RG 1.102 on protection against floods.

i) RG 1.111 on radioactive effluent dispersion.

j) RG 1.132 on foundation investigations.

k) RG 4.2 on environmental impact reports.

Also, the USNRC Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion" was used in 1999 to assess the changes to the Technical Specifications (TS).

- **Overview of assessments made and criteria applied for evaluating all site related factors affecting the safety of the nuclear installation, including multi-unit failure, loss of infrastructure, and site access following an event**

The main objective of assessing the location of nuclear installations from the nuclear safety standpoint is to protect the public and the environment from the radiological consequences of radioactive releases due to accidents. The assessment must also take into account the emissions caused by the normal operation of the installation. The suitability assessment of a site to build a nuclear installation must take into consideration the following aspects:

1. The effects of external events that take place in the region where the site is located (these events can be natural or man-made);
2. The site and the characteristics of its surrounding that could influence the exposure of humans and the environment to emissions of radioactive materials;
3. The population density and distribution, and other off-premise characteristics insofar as they are likely to prevent applying emergency measures and assessing the risks to individuals and the population.

Additionally, as a result of the Fukushima Daiichi accident, CNSNS required CFE to comply with 10 CFR 50.54(hh)(2), following the guidelines of NEI 06-12 Rev. 2, to address beyond-design-basis accidents. Currently, CFE is implementing diverse and flexible coping strategies (FLEX), as described in NEI 12-06 Rev. 1, as well as NEI 12-02 Rev. 1 and NEI 13-02 Rev. 1 (see Articles 6 and 18).

- **Overview of design provisions used against human made external events and natural occurring external events such as fire, explosion, aircraft crash, external flooding, severe weather conditions and earthquakes and the impact of related sequential natural external events (e.g., tsunami caused by an earthquake, mud slide caused by heavy rain)**

LVNPS Units 1 and 2 siting design basis

After performing an analysis, with the technical assistance of experts from the International Atomic Energy Agency (IAEA) in 1968, on the different sites proposed, it was decided that the site with suitable seismic, accessibility, cooling water supply, demographic and location characteristics was the place located on geographic co-ordinates UTM Latitude 19° 43’ 30” North and Longitude 96° 23’ 15” West, in the State of Veracruz.

Once the preliminary selection was made, detailed studies were initiated, considering Geography, Demography, Meteorology, Hydrology, Geology, Geotectonic, and Seismicity as well as the impact these would have on the installations, occurrence of diverse weathering and man-made activities.

This information was provided as part of the Preliminary Safety Analysis Report (PSAR), later updated in the Final Safety Analysis Report (FSAR) and submitted to CNSNS as support of the original application for a Licence for Commercial Operation for LVNPS Units 1 and 2. CNSNS also requested the delivery of a Final Environmental Impact Report (FEIR) in addition to the information presented in the Final Safety Analysis Report.

Main site characteristics (Geography and Demography, Impact of Industrial Installations and Geology, Seismology and Geotectonic Engineering) used in defining design basis related to LVNPS Units 1 and 2 siting are briefly identified below.

Geography and Demography

The demography analysis performed took into account population growth perspectives, zones of its influence and changes in land use up to the year 2020. Areas of property over which CFE has authority were defined exactly as required by the applicable standards, for instance, the Restricted Area, Controlled Area and Exclusion Area.

There are no high-density population areas within a vicinity of 10 km from LVNPS and there is only one settlement of 5 inhabitants within a radio of 2 km from the plant. The low population area, as defined in 10 CFR 100, consists of an area of a radius of 16 km from the site. Population projected within this zone for the year 2020 is approximately 34,530 inhabitants, which is considered a low-density population. The population centres of over more than 20,000 inhabitants within an area of 70 km radius from

LVNPS (according to the census of the National Institute of Statistics and Geography -INEGI- 2015) are:

City	Population	Distance from site (km)	Direction
Coatepec	93,911	65.6	WSW
Xalapa	488,531	57.5	WSW
Veracruz and surrounding suburbs	607,209	70.0	SSE

Impact of industrial transportation and military facilities nearby the site

There are no military, chemical or manufacturing industries, airport or chemical storage facilities within a radius of 8 km from the site which could potentially affect the operation of LVNPS Units 1 and 2.

The most important route of transportation within a radius of 10 km is Federal Road No. 180 running North to South and located 2 km East from the site. This road serves as the means of access to LVNPS and has a vehicle flow of fewer than 3,000 vehicles per day.

The nearest commercial railway is located at 40 km from the site and there is a private industrial railway extension 15 km from the site, which is rarely used.

The nearest airport is located 70 km south of Laguna Verde, in the city of Veracruz. Its main runway is 2,500 m long and 45 m wide.

A maritime route between Veracruz and Tampico passes in front of the site at an approximate distance of 83 km. In addition, small fishing boats operate over 5 km away from Laguna Verde's coast. The design of the intake structure of LVNPS Units 1 and 2 considers breakwaters to protect it from any impact produced by this kind of boats.

A 7.5 cm diameter oil piping and another 121 cm diameter piping for natural gas, property of the Mexican Oil Company (hereinafter called "PEMEX") pass by LVNPS' installations (Reactor Building) at approximately 1,200 m.

As part of the assessment of the impact of facilities within the vicinity of LVNPS Units 1 and 2, the following events were analysed:

- Explosions
    - Due to the distance between the road and maritime routes, and LVNPS, no event postulated on such routes represents a credible risk for structures important to safety, since their effects are covered by considerations for a

design-basis earthquake, design-basis tornado and design-basis hurricane.

- Postulation of gas pipeline incidents were analysed in regards to explosion and thermal load through ignition of leaked gas. The results of the analysis show both that the pressure peak caused as well as the thermal load produced by the explosion are less than the design-basis hurricane and thermal design of the structures.
- An event of particular interest for CNSNS was the mining project "Caballo Blanco". The exploration phase of the project was performed in 2011. The mine is located 3.5 km away from LVNPS, outside its property. Two controlled blasts were carried out, which induced particle accelerations and velocities below the LVNPS Operating Basis Earthquake (OBE) and the allowable limits in the United States of America (US) Bureau of Mines Bulletins 442 and 656, as well as other international standards. The maximum acceleration produced by both explosions was 0.0025 g, which is less than the 0.14 g OBE. This project was cancelled at the end of 2012 by the Secretariat of the Environment and Natural Resources (SEMARNAT).

- Toxic chemicals

  - No important amounts of toxic chemicals are used or stored within the vicinity (8 km) of LVNPS.

- Fires

  - There are not any external installations within the vicinity of LVNPS, which could lead to producing fire conditions.

Therefore, considering the above-cited information, it is observed that there are not any installations within the vicinity which may be considered as a basis for the design of LVNPS.

The design of Structures, Systems and Components (SSC) for LVNPS Units 1 and 2 was based upon normal and extreme meteorological and hydrological conditions, which could hypothetically appear at the site. This includes the consideration of maximum sustained winds, tornado winds, effects from a Probable Maximum Hurricane (PMH), probable maximum flood and seiche, surge and tsunami wave effects. Furthermore, and conservatively, structures important to safety have been analysed against stresses resulting from an elevated 3 m high flood above the installation's foundation elevation.

Geology, Seismology and Geotechnic Engineering

LVNPS siting is located at the intersection of parallel 20 and the Trans-Mexican Volcanic Belt (TMVB). This belt is an East-West trending belt of volcanic vents and volcanic units that extends from the Pacific coast north of "Puerto Vallarta" to the area of the LVNPS site on the Gulf of Mexico. The TMVB is the indirect result of the subduction of the oceanic Cocos Plate sliding beneath continental plate Mexico from the Central America Trench along the Pacific Coast of southern Mexico. The subducted slab of the Cocos Plate melts at depths of about 100 km, producing magma that rises to form the volcanoes and related magma bodies of the TMVB.

Heat flow measurements suggest that the TMVB typically have a thin brittle crust with the remaining crust below being typically plastic. This thin brittle crust cannot store great strain energy, which explains why the TMVB is located in an area of relatively low seismicity, and that the damaging earthquakes that have occurred within the TMVB have not approached in magnitude to the great earthquakes typical of the Benioff Zone.

LVNPS's siting is located in the Trans-Mexican Volcanic Belt, close to the eastern border of the province. The installation is founded on a mass of Pliocene-Pleistocene basaltic rocks running along the Gulf of Mexico over an approximate 1.4 km extension of a variable 30 to 50 m thickness. Stratigraphic studies show the existence of a subjacent layer of alluvium consolidated deposits of a 40 to 65 m thickness deposited over andesitic material, extending itself 150 m in depth. The basaltic layer presents a columnar fracture of thermal nature of lengths going from 6 to 8 m.

In order to satisfy the regulatory requirements, CFE performed the following studies: Physiography, Geological History, Differential Settlements and Upheavals, Stratigraphy, Faulting, Chemical Weathering, Cavernous and Carstic Terrain, Subsoil Faults Under Dynamic Load, Pre-consolidation Evidence by Volcanic Erosional Processes, Liquefaction, Slope Stability, Permeability and Water Table, Seismic Stability of Alluvium Materials subjacent to Superficial Basalt and Flow of Ashes and Lava from a Potential Volcano Eruption.

Because of the proximity of the site to different volcanoes of the eastern TMVB, the near field effects (ash fall and lava) at “El Abra” and the far field effects eruption at “Pico de Orizaba” were analysed. Due to the geologic characteristics, and morphology of the cone and crater, other kinds of possible effects were not considered possible. There is not any evidence to associate the cinder cones at “El Abra” with historic macro-seismicity.

In this speciality, the atmospheric shock waves induced by explosions were also considered.

The following regional studies were performed covering a radius of 320 km: Volcanic activity, Superficial faulting, Tsunami and Tectonic of sea bed, Attenuation of vibratory movements of Trans-Mexican Volcanic Belt ground, Tectonic provinces and maximum historically-related earthquakes, Acelerograms, Determination of Design Basis and Operation Basis Earthquakes, Geological-Seismic conditions on the continental platform and Sea bed boundary, Correlation of regional seismicity with site seismicity, Structural relations between "Graben", "Palma Sola", "Cofre de Perote" and "El Farallon", Related tectonics; Analysis of two faults parallel to volcanic cones of "El Abra", Related tectonics; Distribution of mine fracture systems and the zone of "La Viga-Tuxtla" as well as distinction fracture system of "El Abra”, Tectonics related.

The seismic design basis for LVNPS was defined using the Peak Ground Accelerations (PGAs) that were computed for the maximum earthquakes identified for each seismotectonic province and similarly for each of the potential seismogenic structures that were identified within the Trans Mexican Volcanic Belt.

Peak Ground Accelerations were computed using six different formulas that appear in common literature (Campbell, Joyner and Boore, Idriss, Bufaliza, Esteva and Villaverde, and Esteva conservative).

The response spectrum for the Safe Shutdown Earthquake (SSE) was obtained using the criteria of the USNRC Regulatory Guide 1.60 and, the value of 0.26 g for the safe shutdown peak acceleration was determined. The return period for the SSE is 2,000 years. From this value, it was obtained 0.14 g for the Operating Basis Earthquake (OBE) which corresponds to nearly half of the SSE.

These seismic design parameters for LVNPS were originally developed from a conservative assessment of the potential for earthquakes in eastern continental Mexico and the adjacent area of the Gulf of Mexico and were based on 1979 site-specific studies regarding site ground motion characteristics. Subsequently, CFE undertook a series of geological, geophysical, and seismological investigations to better evaluate the potential for earthquake-induced ground motion at the site. The results of these studies confirmed the conservatism of the original design parameters and did not suggest the necessity for changes in the original design criteria.

These last studies were issued in 1987 and performed taking into account a large amount of data coming from different sources: PEMEX, the US Geological Survey, the Texas University, and the Texas A & M University. These studies not only confirmed the original design ground acceleration and potential for an earthquake, but they strongly indicate that a lower ground acceleration motion could be proposed to CNSNS. The original and current ground motion is 0.26 g and the after mentioned studies suggest an acceleration of 0.18 g. As part of the Periodic Safety Review (PSR) process, performed back in 1999, the above was confirmed.

Particularly, in relation to the volcanic risk and as an example of the detail and deepness of the studies performed, both active and non-active volcanoes within a radius of 150 km from the site, including those corresponding to the sea bed, were analysed. In order to provide conservative results of the effect of a volcano eruption, the following was considered as an analysis basis event:

1. The birth of a new volcano 13.5 km away from the site in direction of the ash volcanoes "El Abra", producing quantities of ash and lava equivalent to the known data for volcano “El Paricutin”, and

2. The eruption of "Pico de Orizaba", considering the amount of ash expulsed equivalent to that of Mount St. Helens in the United States of America on May 18, 1980.

Results determined that the effect of a nearby ("El Abra”) or so far ("Pico de Orizaba”) volcano eruption would not affect the safe condition of LVNPS Units 1 and 2. The last eruption of the “Pico de Orizaba” volcano, located 120 km from the site, occurred in 1846 and has been inactive since then. The nearest active volcano is “Popocatepetl”, located 245 km from the site. The “El Abra” ash volcanoes, located 12 km from the site, are inactive.

In regards to the impact of sequential external natural events (tsunami caused by an earthquake, mudslide caused by heavy rains), CFE is implementing diverse and flexible coping strategies (FLEX), as described in NEI 12-06 Rev. 1, as well as NEI 12-02 Rev. 1 and NEI 13-02 Rev. 1 (see Articles 6 and 18)

- **Regulatory review and control activities**

CNSNS assessed the FSAR provided by the licence applicant to ensure that the report includes on-site and off-site characteristics and analysis of relevant accidents. Compliance with the site-related regulations presented in Article 17 (1) was also assessed. The physical characteristics and the man-made risks assessed are presented below.

Earthquakes

The seismic and geological conditions of the region, and the geological and geotechnical engineering aspects of the site area were assessed. Additionally, information on historical earthquakes and the earthquakes recorded by the instrumentation of the region was collected and documented, in order to determine the earthquake’s associated risks through regional seismotectonic assessments.

Superficial faults

An assessment was made to determine if there were superficial faults in the site´s vicinity and the probability that earthquakes could have been caused by them.

Volcanoes

The existence of volcanoes in the site’s vicinity and the effects they would have on the installation safety were assessed.

Hurricanes and tornadoes

The possibility of having hurricanes and tornadoes in the region of the site was assessed and historical data on these phenomena were collected. For hurricanes, the associated risks were determined with the available data, considering factors such as wind speed, pressure and extreme rainfall. For tornadoes, the risks considered were based on the maximum rotation of wind, pressure differentials and the pressure rate of change. In both cases, the missiles supposedly generated by these phenomena were taken into account.

Floods

The possibility of occurrence of floods due to rains, tsunamis and seiches was assessed. For floods caused by rain, the meteorological and hydrological model was reviewed, taking into account the uncertainty and the amount of available data for the region. For floods caused by tsunamis, the likelihood of occurrence based on the seismic records and the known seismotectonic characteristics was addressed.

Geotectonics

The site and its surroundings were assessed to determine the potential for slope instability and ground liquefaction. The geologic maps to determine the existence of natural formations, such as caves, were also reviewed and the geotectonic characteristics of subsurface materials and the site soil profile were investigated.

Explosions

The region activities involving the handling, processing, transportation and storage of chemicals, or flammable materials that could cause explosions or clouds capable of producing gas deflagration or detonation were assessed. The risks associated with the explosions in terms of overpressure and toxicity were also assessed, taking into account the distance to the installation.

Regarding the mining project “Caballo Blanco" that was developed in 2011, CNSNS concluded that the controlled explosions carried out during the exploration phase did not impact adversely LVNPS structures. At the end of 2012, this project was cancelled by SEMARNAT. However, CNSNS will follow up, and if the project is resumed or a similar one is started, the corresponding evaluation would be performed to ensure that the design basis of LVNPS structures is maintained.

Airplane crashes

The potential airplane crashes in the vicinity of the site were assessed, based on the characteristics of air traffic.

Article 17 (2) Impact of the installation on individuals, society and environment

- **Criteria for evaluating the likely safety related impact of the nuclear installation on the surrounding population and the environment**

Article 28 of the Regulatory Law on Nuclear Matters of Article 27 of the Constitution establishes that "the request will contain the necessary information on the impact of the facility on the environment, for its evaluation by the CNSNS and by the other authorities in accordance with their attributions".

In compliance with the General Law of Ecological Equilibrium and Environmental Protection, as well as the requirements for granting LVNPS's original Licence for Commercial Operation, CFE submitted to CNSNS a Final Environmental Impact Report following the guidelines of the USNRC Regulatory Guide 4.2. The main purpose of this report was to demonstrate that the impact of LVNPS operation will not cause relevant disturbances in the site's immediate environment.

As part of the ongoing plans for the licence renewal application that LVNPS worked on, CNSNS incorporated 10 CFR 51 as part of the regulatory framework and guidelines of Regulatory Guide 4.2 Supplement 1, in order to establish standards for evaluating the facility's radiological impact on the environment over its lifetime. The corresponding information was submitted to CNSNS in March 2015, and attached to the aforementioned Renewal Application.

- **Implementation of these criteria in the licencing process**

LVNPS's licence or authorisation holder has established an environmental surveillance program to determine the impact of normal LVNPS operation. The surveillance program is governed by Section 12 of the LVNPS Units 1 and 2 Technical Specifications. This program was run since 1978, depending on the type of sample, in the pre-operational phase up to 1988 to determine the baseline. This baseline enables comparing the data generated during normal LVNPS operation, allowing detection quickly and safely of any alteration to the environment. It is important to mention that LVNPS carries out an environmental surveillance program 300% larger than that established in the TS, ensuring more effective and efficient surveillance of the environment and the population.

Prior to the granting of the original Licences for Commercial Operation for LVNPS Units 1 and 2, CNSNS assessed the Environmental Report, for normal operation conditions, in terms of the radioactive liquid and gaseous, chemicals, biocides and sanitary effluents; as well as for abnormal conditions or accident scenarios, which resulted from postulated events with a very low occurrence probability whose objective was to verify the facility's capacity to control and mitigate them, CNSNS concluded that the real impact of LVNPS operation produces effects on the environment that fully meet the design bases of the installation. Despite the appropriateness and reliability of the environmental surveillance program developed and implemented by CFE, and that its results are subjected to an international inter-comparison analysis; since 1979 CNSNS started a program for measuring environmental samples to determine the baseline and monitor LVNPS operation completely independent of CFE's program.

Up to now, the results obtained by CFE have been consistent with those obtained by CNSNS. The pre-operational environmental radioactivity values and the current data show no statistically significant variations among them.

Article 17 (3) Re-evaluation of site related factors

- **Activities for re-evaluation of the site related factors as mentioned in Article 17 (1) of the Convention to ensure the continued acceptability of the safety of the nuclear installation conducted according to appropriate standards and practices**

The site-related factors that have required re-assessment to ensure a continuous safety level at LVNPS are:

1. Seismic events.

   LVNPS staff has recorded several seismic events. However, in no case has exceeded the design basis, even with CFE incorporating the concept of cumulative absolute velocity (CAV).

2. Identification of the design basis for the maximum wave height, the magnitude and direction of winds, and tide applicable to the design of LVNPS's intake structure.

   LVNPS staff, driven by the external operational experience, reviewed the available historical data of the wave height, and the magnitude and direction of winds and tide to determine if they are covered by the original design or implement if they were necessary changes based on the results.

3. Intake structure fouling due to the entry of sargassum (a type of seaweed).

   LVNPS staff, driven by the external operational experience, reviewed if there were intake structure fouling events caused by organic and inorganic material.

– Results of recent re-evaluation activities

The results from site-related activities that have required re-assessments were:

1. Seismic events.

   It was concluded that the seismic events re-assessed have not had adverse effects on LVNPS safety. However, conservatively the following measures were taken: (a) the guidelines of the USNRC Regulatory Guide 1.166 "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions", which consider the effects of high-frequency ground motions, were adopted. Therefore, the OBE Exceedance Criterion was incorporated into LVNPS; (b) the nuclear damage scale proposed in Electrical Power Research Institute (EPRI) NP-6695 "Guidelines for Nuclear Plant Response to an Earthquake" was incorporated, which is similar to the Mercalli Intensity Scale; (c) LVNPS seismic monitoring system was updated; and (d) after the Fukushima nuclear plant accident, the analysis "Re-assessment of the seismic risk for the Laguna Verde Nuclear Power Station site" was prepared in 2012. The analysis using current techniques and methods, confirms that LVNPS meets the design requirements set by the regulatory guidelines.

2. Identification of the design basis for the maximum wave height, the magnitude and direction of winds and tide applicable to the design of LVNPS's intake structure.

   It was determined that:

   a) For the period 1980 to 2018, a maximum wind speed of 163 km/h at the site occurred in 1986, which is below the Probable Maximum Hurricane of 304 km/h and the Standard Design Hurricane (SDH) of 234 km/h parameters for LVNPS. For the period 1871-2015, the maximum wind speed recorded in the vicinity of the site is 280 km/h due to the tropical cyclone "Janet" which occurred in 1955. Therefore, the wind magnitude and direction used as a design basis remain valid.

   b) The average wave heights that have been recorded at LVNPS site are in the range of 0.1 to 0.5 m. Therefore, the actual maximum wave height has not exceeded the design parameter of 5.5 m.

   c) The sea levels recorded at LVNPS's intake structure associated with the natural low and high tides are within the design range of -1.6 m and 4.136 m. As a preventative measure, dredging the water intake channel is an ongoing maintenance task.

3. Intake structure fouling due to the entry of sargassum.

As a result of the assessment, it was found that the fixed and travelling mesh capacity, based on the design parameters, is greater than the water intake requirements. However, considering the maximum expected rate of arrival and the physical characteristics of the sargassum, and the rake configuration, both the fixed and travelling mesh would be blocked by the sargassum trapped into them. To address this issue, a nylon mesh at the basin entrance preventing the massive transfer of sargassum into the intake was installed. The amount of sargassum that can go through the nylon mesh is within the removal capacity of the fixed and travelling mesh cleaning systems.

It has been experimented and registered in some previous years the excess of sargassum overflowed in the basin in the years 2003, 2007 and 2011 the amount of 60, 60 and 67.7 tons, respectively, and in extreme values in the years 2006 and 2014 an amount of 125 and 116 tons, respectively. For these average and extreme values, a second nylon net is placed at the entrance of the dock, which prevents or minimizes the entry of this seaweed into the intake work without damaging or blocking the fixed and/or travelling meshes. The maximum amount of sargassum that could surpass the two nylon meshes in extreme cases is well below the amount of removal of the cleaning systems of the fixed and/or travelling meshes inside the intake site.

– **Regulatory review and control activities**

The activities performed include the following:

1. Seismic events.

   CNSNS has assessed the analysis performed by the licence holder to evaluate the effects of seismic events. CNSNS has determined that no damage has occurred to the LVNPS Structures, Systems and Components. The actions taken by CFE for LVNPS were also considered conservative and acceptable.

   As a result of the 2011 Fukushima Daiichi event, CNSNS agrees with CFE that the seismic design bases are validated by obtaining a peak ground acceleration (PGA) which is less than the design value for a safe-shutdown earthquake (SSE) of 0.26g.

2. Identification of the design bases for the maximum wave height, the magnitude and direction of winds and tide applicable to structures in LVNPS's intake structure.

   As a result of the assessment performed by CNSNS, it was found that the tide (sea water levels), the magnitude and direction of winds, and swell at the LVNPS's intake structure are within the original design parameters. In addition, the ongoing dredging of the water intake channel has kept the water level in the basin always above the established minimum.

As a result of the 2011 Fukushima Daiichi event, CNSNS agrees with CFE that the controlling design event is a tsunami, while in the case of LVNPS the controlling event is a hurricane. From the point of view of design margins under flooding, in the Fukushima Daiichi event, the maximum water level reached, according to experts, exceeded 10 m, while the critical design level is 5.7 m. At LVNPS, the critical design level is 6.5 m, while the probable maximum level during a design-basis hurricane is only 3.66 m.

3. Intake structure fouling due to the entry of sargassum.

As a result of the assessment performed by CNSNS, which included the possible loosening of the nylon mesh, it was found that it is not possible to have an accident different from those previously analysed in the FSAR nor it is an amendment to the current operation authorisation. Although the fixed and travelling mesh system is not safety related, the arrival of sargassum does not compromise LVNPS safety because of the adequate monitoring and filtering and cleaning devices installed, as well as their current status contributes to not compromising the safe operation of LVNPS.

Article 17 (4) Consultation with other Contracting Parties likely to be affected by the installation

– International arrangements

An international agreement subscribed by Mexico is understood as any *"written international agreement agreed between States and governed by international law, whether embodied in a single instrument or in two or more related instruments, and whatever its particular designation"* as stated in Article 2, Paragraph a) of the Vienna Convention on the Law of Treaties of 1969 and those celebrated between Mexico and international organisations.

The international treaties signed by Mexico on nuclear safety are presented in Annexe 7.1 of this National Report.

– Bilateral agreements with neighbouring States, as applicable and necessary

A bilateral agreement signed by Mexico is understood as any agreement reached by two States that legally obliges only the two of them and it has benefits that generally are not shared with a third State.

The bilateral agreements signed by Mexico on nuclear safety are presented in Annexe 7.2 of this National Report.

ARTICLE 18. DESIGN AND CONSTRUCTION

Obligations

"Each Contracting Party shall take the appropriate steps to ensure that:

i) The design and construction of a nuclear installation provides for several reliable levels and methods of protection (defence in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

ii) The technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

iii) The design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface."

Article 18 (1) <u>Implementation of defence in depth</u>

– Overview of the Contracting Party's arrangements and regulatory requirements concerning the design and construction of nuclear installations

The Regulatory Law of the Constitutional Article 27 on Nuclear Matters in Articles 15, 19, 20, 21, 25, 26, 28, 32, 34 and 50, in general terms, establishes the requirements to be satisfied by nuclear installations from the design phase, during construction and the operation phase.

Since the first edition of the Nuclear Law that dates from 1979, when the design of Laguna Verde Nuclear Power Station (LVNPS) was found to be quite advanced and the construction already had initiated four years back, the criteria that ruled the general conception of the original design was based on the philosophy that *"any nuclear installation built in Mexico shall satisfy the applicable requirements as it should be licenced in the country of origin of the Nuclear Steam Supply System"*. Due to this, the first agreement of the referenced standard for licencing LVNPS was based on Title 10 "Energy" of the Code of Federal Regulations (CFR) of the United States of America or 10 CFR.

In particular, 10 CFR 50 and his Appendix A establish fundamental criteria for design, fabrication, construction, testing and performance requirements for Structures, Systems and Components (SSC) important to safety. This ensures in a reasonable manner that the installation may be operated without undue risk to health and safety of operational personnel and that of the public and their property.

Based on this regulatory framework, basic design criteria satisfied the following six groups: General Requirements, Protection by Means of Multiple Barriers Against Fission Products, Protection and Reactivity Control Systems, Fluid Systems, Reactor Containment, and Fuel and Radioactivity Control.

On the other hand, the construction process was performed in compliance with industrial standards, codes, industrial and quality standards corresponding to the quality required by the nuclear industry in the USA. For example, concrete structures were raised under the standards of the American Concrete Institute (ACI), mechanic systems and components under the standards of the American Society of Mechanical Engineers (ASME) Code Section III, Division I and the United States Nuclear Regulatory Commission (USNRC) Regulatory Guides (RGs) 1.20, 1.46, 1.60, 1.61, 1.92 y 1.122, among others.

Electrical and electronic components were constructed, fabricated and qualified to take into account the standards requirements of the Institute of Electrical and Electronic Engineers (IEEE); the selection of special materials, welds, paintings, etc. were performed in accordance with the standards of the American Society of Testing Material (ASTM).

Other aspects such as the Pre-service and In-service Inspections of the coolant pressure boundary components were carried out and currently are performed based on the ASME Code Section XI, and the assessment of the Quality Assurance Programmes (QAP) based on standards from the American National Standards Institute (ANSI), Series ANSI N45.2.

- **Status with regard to the application for all nuclear installations of the defence in depth concept, providing for multiple levels of protection of the fuel, the primary pressure boundary and the containment, taking into account internal and external events and the impact of related sequential natural external events (e.g., tsunami caused by an earthquake, mud slide caused by heavy rain)**

The barrier integrity maintenance to prevent the leak of radioactive material was adopted from the siting selection, conceptual and specific design stage including the construction stage of LVNPS.

The focus covered the five following levels:

Level One

Prevention of abnormal operation and failures. LVNPS has been demanding a high degree of reliability to prevent the occurrence of abnormal situations by incorporating in the design the redundancy and diversity necessary to guarantee that critical functions (reactivity control, core cooling and control of radioactive material) are permanently guaranteed, relying for this purpose on methodologies such as quality assurance and the capability of important systems to be tested and inspected.

Level Two

Control of abnormal operation and failures. LVNPS postulated that despite the care adopted in Level one, occasional abnormal situations could arise; therefore, all necessary devices should be incorporated in the design to avoid such situations from becoming an accident. This consist in the control and protection and limitation systems that provide methods of surveillance of abnormal operation.

Level One and Two were evaluated in Chapter XV of the Final Safety Analysis Report (FSAR) and in the Probabilistic Safety Analysis (PSA) Levels 1 and 2 (Individual Plant Examination).

Level Three

Control of accidents, within design bases. Despite preventions taken, accidents can occur. Engineered safety features and protection systems provide protection against the development of severe accidents and help confine radioactive material within the Containment. These measures are aimed at preventing particularly damage to the nuclear core.

Level Four

Control of severe conditions, including prevention of accident progression and mitigation of consequences of severe accidents. The general objective of the fourth level of defence is to ensure that the probability of an accident causing serious damage to the nuclear core and the magnitude of radioactive releases, in the unlikely event of a serious condition of the plant, remain as low as reasonably possible, taking into account economic and social factors. Accident management can not be used to justify design deficiencies at previous levels.

Level Five

Mitigation of radiological consequences and significant release of radioactive material to the environment. Although the levels described above are designed to be effective, the defense in depth considers Emergency Plans, known in the LVNPS as External Radiological Emergency Plan (PERE, abbreviation in Spanish) and Internal Emergency Plan (PEI, abbreviation in Spanish). Emergency responses on the site and offsite are integrated with each other and with accident management, taking into account the size and nature of the potential source terms. At this level the authorities collect information about the levels of radiological exposure and take deterministic actions complemented with probabilistic information.

As a result of the accident happened at the Fukushima Daiichi nuclear power plant in

Japan, LVNPS, like the rest of the industry, and in compliance with the CNSNS request, is in the process of adding capabilities to maintain the key safety functions of the plant after a large-scale natural disaster; update of assessments on the potential impact of seismic events and floods; new equipment to better manage potential events of damage to the reactor core; and the strengthening of emergency preparedness capabilities. Combined, these actions ensure that the nuclear industry and the LVNPS are prepared for the unexpected (see Articles 6 and 18 of this National Report).

- **Extent of use of design principles, such as passive safety or the fail safe function, automation, physical and functional separation, redundancy and diversity, for different types and generations of nuclear installations**

The list presented below provides a better understanding to what extent the design principles are used at LVNPS.

1. The essential safety actions are carried out by equipment with sufficient redundancy and independence, in such a way that no single failure, of active or passive components, prevents the function required, even in some cases in the long term.
2. The passive components of safety systems and engineered safety features are operated from the control room.
3. The design of nuclear safety systems and engineered safety features assure their functionality demonstration.
4. The design of nuclear safety systems and engineered safety features includes factors that take into consideration natural phenomena such as: earthquakes, floods and storms that might occur at LVNPS site.
5. The electrical power supplies on reserve have sufficient capacity to energize all the required nuclear safety systems and engineered safety features.
6. The design incorporates electrical power supplies on reserve to enable a fast shutdown and reactor decay heat removal, when the normal auxiliary power is not available.
7. LVNPS has redundant capacity and operational independence for shutting down the reactor, independently of the normal reactivity control. This support system has the capacity to shut down the reactor from any normal condition and to keep it in that condition.
8. The systems that have a redundant or backup safety function are physically separated and arranged so that any credible event that could cause damage to a region of the nuclear island does not compromise the functional capacity of the counterpart system.
9. None of the equipment or systems required for a safe shutdown of the reactor is shared between LVNPS Units 1 and 2.

- **Implementation of design measures or changes (plant modifications, backfitting) with the objective of preventing beyond design basis accidents and mitigating their radiological consequences if they were to occur (this applies to the entire nuclear installation including spent fuel pools)**

  Despite being in an advanced phase of the design of the LVNPS Units, CFE included in its design and operating procedures, the lessons learned from the accident of the Three Mile Island plant in the United States of America. Actions taken in compliance with NUREG 0737 are described in Appendix A of the Final Safety Analysis Report (FSAR).

  The CFE has committed the implementation of improvements and lessons learned from the Fukushima Daiichi event in LVNPS Units 1 and 2. Among these measures are the mitigation strategies derived from events with extensive damage of 10CFR50.54 (hh) (2), as well as the Orders EA-12-049 "Mitigation Strategies for Beyond Design Basis External Events", EA-12-050 (EA-13-109) "Reliable Hardened Containment Vents Capable of Operation Under Sever Accident Condition" and EA-12-051 "Reliable Spent Fuel Pool Instrumentation".

  As a consequence of this commitment, the CFE has installed in LVNPS both units, instrumentation capable of reliably monitoring the parameters of the Spent Fuel Pool (level and temperature) during the Extended Loss of AC Power (ELAP) and during accident conditions, complying with the EA-12-051. Additionally, modifications have been made to provide alternate methods of replenishment of water inventory in the Reactor and the Spent Fuel Pool, and spray of Containment to maintain the integrity of the same in compliance with orders EA-12-049 and EA-13-109 and 10CFR50.54 (hh) (2). In addition to the modifications already mentioned for the EA-13-109, as of the date of issuance of this National Report, the LVNPS is making the final modifications to install a hard and reliable venting of the Primary Containment in LVNPS both units.

- **Implementation of particular measures to maintain, where appropriate, the integrity of the physical containment to avoid long term off-site contamination, in particular actions taken or planned to cope with natural hazards more severe than those considered in the design basis**

  As mentioned in several sections of this National Report, LVNPS is in the process of implementing the lessons learned from the accident at the Fukushima Daiichi plant. Within these lessons is the installation of a Reliable Hardened Containment Vent in accordance with the provisions of Order EA-13-109 and following the NEI 13-02 Rev. 1 guidelines; the operation of this vent will allow releasing in a controlled manner overpressure in the Primary Containment that could occur during events beyond the design bases that can progress in severe accidents. This vent, located in the suppression chamber (Wetwell), the lower part of the Primary Containment, allows the opportunity to "wash" the gases to be released to the outside when passing previously by the suppression pool.

Actions taken or planned to withstand natural risks, more severe than those considered in the design basis, are taken in accordance with the filtering carried out following the guidelines of the NEI 12-06 Rev. 2. This subject is described in detail in "Post-Fukushima Daiichi (1F) Actions at Laguna Verde Nuclear Power Station".

– **Improvements implemented for design of nuclear power plants as a result of deterministic and probabilistic safety assessments made since the previous National Report; and an overview of main improvements implemented since the commissioning of the nuclear installations**

The main LVNPS improvements have been implemented since start-up of its units. During the 13th Refuelling Outage of Unit 1 (August 31 to December 9, 2008) and the 10th Refuelling Outage of Unit 2 (April 5 to May 31, 2009), modification packages were implemented in preparation for the Extended Power Uprate (EPU) project up to 120% of the Rated Thermal Power (RTP). This was known as the 1st Phase of the EPU project.

The 1st Phase of the EPU project included restoring and modernization of the Balance of Plant (BOP) systems of LVNPS Units 1 and 2, to ensure the operation in a correct and efficient manner. LVNPS major improvements during the years 2008 and 2009 is presented below.

Replacement of the Moisture Separator Reheaters with new equipment designed for the EPU conditions

The assessment for the Extended Power Uprate operation conditions of up to 120% RTP concluded that it was necessary to replace, at least, the moisture separator and the piping of the two-stage reheating. However, considering the damage that they already had due to the erosion-corrosion effect experimented during the first years of operation, all the Moisture Separator Reheaters (MSRs) were replaced with others of a new design.

Installation of the new instrumentation of the MSR

The change of the Moisture Separator Reheaters (MSR A/B) with others of new advanced design with greater resistance to erosion–corrosion required replacing the following related instrumentation:

a) 10 level transmitters with advanced analogue technology.

b) Additional monitoring instrumentation for temperature and flow.

c) Impulse lines and digital flow transmitters in the MSR A/B area for normal system operation.

d) 2 instrument racks were installed in an area that meets the ALARA criterion, which will have local panel displays of the temperatures measured in the body of each MSR and Flow Indicators (FIs) for measuring the flow of the high and low-pressure sides, and the drains of each MSR.

Replacement of the low and high-pressure feedwater heaters

In preparation for the new EPU conditions, the existing low and high-pressure feedwater heaters were replaced by heaters of greater capacity, which also have various thermal and mechanical improvements to enhance their performance.

Replacement of the main condenser piping

As a result of the LVNPS Extended Power Uprate project up to 120% of the RTP and the system operability, the main condenser was redesigned to:

1. Improve the BOP thermal cycle performance for the new EPU conditions.
2. Accommodate the air removal system due to the non-condensable flow increase, for the new EPU conditions.
3. Eliminate the copper carryover to the Feedwater System and the Reactor Pressure Vessel by replacing the Cu-Ni piping with Titanium piping.
4. Provide 40 years of service while minimising the potential for flow-induced vibration, maintenance and inspection intervals, and also excluding operational problems.

Installation of an on-line cleaning system for the main condenser

A cleaning system for the condenser piping was installed in each one of 108" lines of the Water Circulation System, to have an efficient operation of the condenser for the 120% EPU conditions.

Replacement of the LVNPS Unit 1 primary containment H_2/O_2 analysers with similar ones to Unit 2

Before replacement, hydrogen concentration monitoring in LVNPS Unit 1's primary reactor containment was done using the Post-Accident Sampling System's (PASS) hydrogen analyser. This equipment was not redundant, so in case of failure, there was no other way to monitor this parameter. Previously, oxygen concentration monitoring was done with the System T61's oxygen analyser, which was redundant.

According to LVNPS Unit 1 operational experience and maintenance records, the time required to calibrate the oxygen analysers had been excessive. Moreover, in some cases, it was necessary to ask the equipment supplier to check and calibrate the system. Additionally, there was increasing difficulty to obtain spare parts due to its obsolescence.

Acoustic Side Branch installation in the safety relief valves standpipe of LVNPS Units 1 and 2 main steam lines

One of the main LVNPS improvements during this National Report period was implemented during the 14th Refuelling Outage of Unit 1 and the 11th Refuelling Outage of Unit 2. The improvement consisted of the Acoustic Side Branch (ASB) installation in the safety relief valves standpipe of LVNPS Units 1 and 2 main steam lines to comply with the required structural margins and qualification of the existing steam dryer for the Extended Power Uprate conditions.

Installation of a 4th condensate booster pump in LVNPS Units 1 and 2

A 4th condensate booster pump was installed as a result of the Extended Power Uprate project to have operation flexibility. The 4th pump prevents transients and loss of power generation and is designed with the same operation logic and setpoints of the existing pumps. The installation included the necessary instrumentation and control for the system operation and control.

Replacement of main generator and its associated instrumentation in LVNPS Units 1 and 2

The main generator and its associated instrumentation were replaced in LVNPS Units 1 and 2 as a result of the Extended Power Uprate project. The new generator has a larger electrical capacity and its design meets the EPU conditions. In this activity, 18 current transformers of the protection system were replaced with transformers that have a higher transformation ratio. The generator grounding cubicle and all the associated wiring to this equipment were also replaced.

Modernization of HP, LP1 and LP2 turbines in LVNPS Units 1 and 2

The high pressure (HP) steam turbine and the two low pressure (LP1 and LP2) turbines were modified and refurbished as a result of the LVNPS Extended Power Uprate project to meet the conditions of this project. The new turbine was designed based on the Thermal Balance design for the existing turbines (HP, LP1 and LP2), but using the new generator capacity (817,106 kW) and the new components thermodynamic characteristics of the HP, LP1 and LP2 turbines to operate in optimum conditions.

Article 18 (2) Incorporation of proven technologies

- **Contracting Party's arrangements and regulatory requirements for the use of technologies proven by experience or qualified by testing or analysis**

As CFE policy, major changes and equipment upgrades taking place in LVNPS, follows the criterion of not using technologies that are not tested or have not been used firstly in other nuclear power plants.

- **Measures taken by the licence holder to implement proven technologies**

All the modifications that use new proven technologies are evaluated according to the 10 CFR 50.59 and released to the regulatory body, CNSNS, for advanced approval. The objective of the evaluation is to assure that facility changes don't result in the plant operating in a condition that hasn't been analysed or authorised, determining if the activity, change, test, or experiment requires previous authorisation from CNSNS. This is done with the intention to maintain the original basis for licencing contained in CNSNS's summary information component of the Licence or Authorisation for Operation application and its subsequent amendments.

- **Analysis, testing and experimental methods to qualify new technologies, such as digital instrumentation and control of equipment**

All the digital instrumentation that uses software and control panels of equipment are tested and validated before and after their installation. This software is governed by a Quality Assurance Plan based on the requirements of 10 CFR 50, Appendix B. The software's QA programme is monitored by CNSNS and controlled by CFE using its own procedures.

- **Regulatory review and control activities**

CNSNS verifies that the new technologies are tested in accordance with the provisions of 10 CFR 52.47(b) either through the analysis of information provided by the supplier, a suitable testing programme, operational experience, or a combination of all of the above.

In relation to reactor fuel and control rods, CNSNS establishes the following requirements:

- Model for thermo-mechanical performance of the fuel rod (PRIME): 10 CFR 50 Appendix A, General Design Criteria, 10 CFR 50.46, 10 CFR 50.62, as well as the ASTM and ASME Codes.
- Marathon Ultra control rods: 10 CFR 50 Appendix A, General Design Criteria.
- NSF Fuel Channels: 10 CFR 50 Appendix A, General Design Criteria.

In the case of the spent fuel of the reactor that will be stored in an Independent Spent Fuel Storage Installation (ISFSI) to operate within the LVNPS property, the Regulatory Body has required the suppliers considered by the plant owner to have their container designs certified under 10 CFR 72.238.

Article 18 (3) Design for reliable, stable and manageable operation

- **Overview of the Contracting Party's arrangements and regulatory requirements for reliable, stable and easily manageable operation, with specific consideration of human factors and human-machine interface (see also Article 12 of the Convention)**

LVNPS has considered the human factors and human-machine interface in his design. Specifically, the FSAR documents the review of the human factors engineering in the design of the Main Control Room and control centres that are located outside the MCR. Article 12 of this National Report also discusses the human factors issue in more detail.

LVNPS has given attention to the activities related to human factors engineering and human-machine interface according to Chapter 18 of NUREG-0800 "Standard Review Plan" Rev. 1, and NUREG-0700 "Human-System Interface Design Review Guideline" Rev. 2 issued in May 2002. In addition, LVNPS also uses NUREG-0711 "Human Factors Engineering Program Review Model" Rev. 2 to evaluate the design of the control rooms.

- **Implementation measures taken by the licence holder**

The measures taken by the LVNPS licence holder to consider human factors resulting from the Three Mile Island accident are described in Article 12 of this National Report.

- **Regulatory review and control activities**

Recently, LVNPS has continued replacing analogue instrumentation with digital instrumentation. The digital technology is able to improve the operational performance and the adoption of these technologies in the nuclear industry represents a challenge for regulatory bodies. In particular, these challenges include (1) digital technology is more complex than analogue technology; (2) digital technology is rapidly changing and requires the CNSNS's staff to update their knowledge about the design, testing and applications; (3) new failure modes associated with digital instrumentation; and (4) the need to update the acceptance criteria and review the procedures used to evaluate the digital system's safety.

As part of the control activities for safe, stable and easily manageable operation with special consideration for human factors and human-machine interface; the CNSNS has been following-up these issues through its Baseline Inspection Programme in the

Operation, Training, Maintenance, Instrumentation and Control, and Engineering areas, as well as during the LVNPS Reactor Operators (ROs) and Senior Reactor Operators (SROs) licencing process.

During the period covered by the present National Report, CNSNS continued reviewing human and organisational factors through an inspection based on NUREG-0711, "Human Factors Engineering Program Review Model," which is described in detail in Article 12.

Currently, an early phase continues for defining the procedures to be followed by the CNSNS to carry out the inspections of its baseline programme to verify the safety assessment and improvement programmes regarding Organisation and Human Factors, as part of the Reactor Oversight Process.

Post-Fukushima Daiichi (1F) Actions at Laguna Verde Nuclear Power Station

In compliance with the CNSNS requirements for Post Fukushima actions, CFE has implemented Mitigation strategies derived from events with extensive damage of 10CFR50.54 (hh) (2), such as Orders EA-12-049 "Order Modifying Licenses with regard to Requirements for Mitigation Strategies for Beyond Design-Basis External Events", EA-12-050 (EA-13-109) "Order to Modify Licenses with regard to Reliable Hardened Containment Vents" and EA-12-051 "Order to Modify Licenses with regard to Reliable Spent Fuel Pool Instrumentation".

In addition to the requirement of compliance with the NRC's orders, the CNSNS requested the LVNPS to re-evaluate the safety margins by means of the Stress Tests in accordance with the provisions of the European Nuclear Safety Regulators Group (ENSREG) with the technical support of the Western European Nuclear Regulators Association (WENRA). The final review of the Stress Test Report was submitted to the CNSNS in 2018.

As of the date of issuance of this National Report, the CFE has successfully completed the installation of reliable instrumentation in the Spent Fuel Pool in accordance with the NEI 12-02 Rev. 1 guidelines, and has developed mitigation strategies for events with extensive damage according to 10CFR50.54 (hh) (2). Additionally, LVNPS has concluded the necessary modifications to comply with Order EA-12-049 according to the NEI 12-06 Rev. 2 guidelines and the Order EA-13-109 in accordance with the NEI 13-02 Rev. 1 provisions.

Attention to the "Technical Points to be Considered" instruction:

In compliance with the "Technical Points to be Considered' in CNS/ExM/2012/12 Rev. 1 ("Chairman's Report of the Special Meeting, Second Special Meeting of the Contracting Parties to the Convention on Nuclear Safety", August 2012, Annexe III, Paragraph 23), also described in the minutes (point 2.b) of the "6th Board Officers

Review Meeting" of the Convention on Nuclear Safety, held on October 29, 2012, the following is reported:

A. <u>Earthquakes and Floods; Follow-up actions taken or planned, including improvement measures</u>

Based on CNSNS's stress test requirements, CFE requested the Engineering Institute of the Mexican National University (IIUNAM) to update the seismological and flood-related information and the associated calculations in order to confirm the seismic and flood (sea-land and land-sea) design bases are still valid.

This study concluded that, from the point of view of actual accelerations at the site, in the case of the Fukushima Daiichi event the actual acceleration measured reached a Peak Ground Acceleration of 105% (0.63g) of Design Basis Accident DBE (0.60g), while for LVNPS the maximum accelerations recorded by the seismic monitoring network have not exceeded 10% (0.01 to 0.02g) of DBE (0.26g). Therefore, it is considered that the LVNPS design margins are still valid for the prevention of earthquakes and flooding.

The Regulatory Body (CNSNS) carried out the evaluation of these studies and agrees with the conclusions of the CFE. The detailed results are described in Article 14 of this National Report.

B. <u>Follow-up actions taken or planned to withstand beyond-design-basis natural hazards</u>

The combination of land-sea events (probable maximum precipitation/runoff) with sea-land events (waves/swell/wind/tidal surge) present a beyond-design-basis condition for LVNPS, however, they are not a weak point or a limiting situation for its buildings or components. This is because of the raised elevation of the buildings, the flood levels determined for the postulated events, and finally, the fact that there is no direct connection between the basin and the two lagoons, Laguna Salada and Laguna Verde. Their only connection is via the sea.

In relation to the combination of events such as an earthquake that could induce failure of a water-retention structure (e.g., dam, retaining wall) or a body of water (reservoir or lagoon) and consequently a beyond-design-basis flood; at LVNPS there doesn't exist in the main basin or the neighbouring lagoons a structure or body of water with said characteristics, thus the postulated sequence of events is not applicable.

C. <u>Improving the management of accidents from extreme natural phenomena</u>

1) Core cooling

In relation to the currently available measures of management of accidents involving protecting the core in the distinct stages of a scenario of loss of cooling, LVNPS has established, in the Emergency Procedures and Support Procedures in the Internal Emergency Plan and its procedures, the actions that the Emergency Response Organization personnel must perform during an event in order to avoid damage to the nuclear core. Said procedures include actions that allow depressurization of the primary system, as well as planned measures to prevent core damage.

Based on the improvements suggested by NEI 06-12 Rev. 2 and 10CFR50.54 (hh) (2), LVNPS has developed a set of procedures/guidelines to depressurize the Reactor Vessel and provide the make-up inventory water with low-pressure systems. These emergency measures must mitigate the consequences of an accident by preventing damage to the core, in the event of an event beyond the design basis, and by delaying or reducing the release of radioactive material. Due to the nature of this strategy, it consists of two phases:

- The Depressurization phase contains the actions necessary to depressurize the reactor by locally energizing the solenoid valves of the ADS subsystem, while,
- The Injection phase to the vessel uses a portable submersible pump which is driven by a diesel engine, named as a portable pump, to supply a make-up flow by alternate methods.

In the case of an ELAP (Extended Loss of Alternating Current Power) and LUHS (Loss of Normal Access to the Ultimate Heat Sink), as indicated in NEI 12-06, the main strategy for supplying cooling to the core is through injection by means of equipment. of portable pumping with suction from the Gulf of Mexico.

In relation to the adequacy and viability of the instrumentation, LVNPS is in the process of developing a Support Procedure to have a method for reading its critical parameters in case of a total loss of electrical power.

2) Primary containment

Currently, as a consequence of the implementation of the requirements of 10CFR50.54 (hh) (2) and the order EA 12-049, LVNPS has the capacity to provide cooling to the primary containment by portable equipment. Using the portable pump, the atmosphere of the Dry Well (DW) and Wet Well (WW) can be cooled, as well as cooling the debris core out of the vessel and washing the fission products, in case there is core damage and the subsequent failure of the reactor vessel.

Additionally, as part of the implementation of the two phases of order EA-13-109, the CFE installed the Reliable Hardened Containment Vent system in its two phases, in accordance with the Guide NEI-13-02 "Industry Guidance for Compliance with Order EA-13-109" and developed the Severe Accident Water Addition and Management (SAWA/SAWM) methodology, following the guidelines of NEI 13-02.

The operation of this vent will allow releasing in a controlled manner the overpressure in the containment that could occur during events beyond the design basis that could progress in severe accidents allowing the “cleaning” of the gases to be released to the outside by the previous passage through the suppression pool, while the SAWA/SAWM strategy allows controlling the addition of water during the different stages of the accident to maintain the venting capacity.

3) Spent fuel pool

Currently, the CFE has fully complied with the EA-12-051 "Issuance of Order to Modify Licenses with Reliable Spent Fuel Pool Instrumentation" in both LVNPS units, for having installed the reliable instrumentation of wide range in the Spent Fuel Pool (SFP). To allow the operation of wide range instrumentation before an event beyond-design-base when the internal and external AC (alternating current) energy is lost as well as the DC (direct current), there is an emergency panel in the main control room that can be powered by a portable gasoline generator and its corresponding inverter rectifier.

On the other hand, the monitoring of the documentation for compliance with 10CFR50.54 (hh) (2), has meant that LVNPS developed water replenishment strategies for the SFP in scenarios beyond-design-bases, either with internal equipment (installed) or with external equipment (portable equipment). In the case of the replacement of water to the SFP with installed equipment, LVNPS has the capacity to use the diesel fire pump, while the replacement to the SFP with external means will be done by means of a portable pump. These strategies ensure the replacement, in supply mode and in spray mode, in case the normal supply of water to the SFP is inoperable or unavailable.

Regarding what is indicated in NEI 12-06 or FLEX Strategies, for compliance with order EA-12-049, in the case of an ELAP (Extended Loss of Alternating Current Power) and LUHS (Loss of Normal Access to the Ultimate Heat Sink), LVNPS has the capacity of reposition to the SFP, through the portable pumping, through piping located in the Reactor Building.

4) Alternate water supply

   LVNPS is in the process of implementing improvements to the facility to provide an alternate supply of water in addition to the sources considered in the original design (ultimate heat sink, condensate storage tanks, suppression pool, etc.).

   To this end, and based on scenarios that don't rely on external and internal sources of alternating current for more than the beyond-design-basis time (ELAP, Extended Loss of AC Power) and for more than 72 hours, the strategy to be implemented considers the following:

   - An arrangement with on-site portable equipment that will be deployed when required to ensure adequate core cooling, containment integrity, and cooling of the spent fuel pool. The portable equipment will rely on primary and alternate connection points to perform the cooling and supply replenishment functions.

     Portable equipment to be used for an alternate supply of water will be protected against unexpected effects in a facility relatively near LVNPS's process buildings.

   - There are two options for the water supply for replenishing the inventory:

     a) Gulf of Mexico

     b) Tanks: Fire Protection tanks, Demineralized Water tanks and an alternate connection to the Condensate Water tanks. All these tanks have quick connections for the connection of portable pumping equipment.

5) Availability of a source of power

   LVNPS is connected to the eastern system of the national power grid by means of 7 transmission lines: 400 kV lines and 230 kV lines. LVNPS has the advantage of having an unusual number of transmission lines connected to the substation (in comparison with other plants of similar design), as well as having these lines coming from different directions, although finally, they converge in the LVNPS. This means that there are at least three alternate, external sources of power for plant services in the case that one of them is lost.

   As part of the response to the NRC orders, strategies have been implemented in the LVNPS to prolong the life of the batteries. It was also implemented the interconnection of diesel generators from the Central Alarm Station (CAS) and the Integrated Process Information System (SIIP, abbreviation in Spanish) to the battery bank chargers of Unit 1 and 2, respectively, and kept the possibility of connecting a portable generator to the battery banks of both units.

Also, as part of the support strategies to keep the reactor adequately cooled, fast connections have been installed in three different locations; a) Main Control Room, b) Remote Shutdown and c) Local Panel in Level 25.10 of the Reactor Building, to manipulate the solenoids of the SRV valves with ADS function. The manipulation is done by energizing the solenoids with the help of a portable gasoline generator and inverter rectifier that allows selecting the ADS valve (to open) in case of not having internal, external or sufficient voltage in the battery bank.

Additionally, the wide-range reliable instrumentation of the Spent Fuel Pool has an emergency panel in the main control room. This panel has quick connectors to be energized by the gasoline generator set and the inverter rectifier in case of not having internal, external or sufficient voltage in the battery bank.

D. Loss of off-site power (LOOP)

In the case of loss of off-site power, LVNPS has two emergency diesel generators, Divisions I and II, that will begin to restore alternating current power to the battery chargers. During start-up and charging of the emergency generators, the battery banks provide direct current.

The emergency diesel generators have the capacity to supply power for the essential divisions for the residual heat removal. The storage tanks contain sufficient fuel for the generators to run continuously for 176 hours. Additionally, the Division III generator begins to provide power to the high-pressure core spray system, and its fuel tank will allow it also to operate continuously for 176 hours.

The design characteristics allow LVNPS to sustain a loss of external power for more than 72 hours.

E. Loss of on-site and off-site power or station blackout (SBO)

As part of the licencing process, LVNPS analysed the scenario of a total loss of internal and external alternating-current power, also known as a station blackout (SBO), in conformity with USNRC Regulatory Guide 1.155 Rev. 0 and NUMARC 8700. This methodology takes into account the characteristic climate of the site, the design of the power grid, the characteristics of the substation, the redundancy of the emergency alternating-current electrical system, and the reliability of the emergency diesel generators. The analysis determined that the facility must have the capacity to face a 4-hour SBO.

F. Actions to improve LVNPS's response to an ELAP

As part of its commitments with CNSNS, CFE has implemented the following mitigation strategies to strengthen the response to an ELAP:

- LVNPS has evaluated its Coping Time with an ELAP, and has concluded that using procedures to cut non-essential loads, the duration of the batteries is 8 hours.
- The mitigation strategies in compliance with NEI 12-06 Rev. 2, as well as NEI 12-02 Rev. 1 and NEI 13-02 Rev 1. These strategies are summarized as follows:
  - i. Diversification of Spent Fuel Pool level instrumentation and inventory replenishment alternatives.
  - ii. Portable power supply for reactor vessel depressurisation and water injection with a portable pump.
  - iii. Manual operation of the containment hardened vent system.
  - iv. The diesel generators currently installed at LVNPS will be electrically interconnected, in order to supply power to the direct-current battery chargers:
    1. For Unit 1 the Central Alarm Station DG was connected to a new Motor Control Center (MCC) installed on level 10.15 at the Control Building to power the 125 and 250 DCV battery chargers.

    2. In the case of Unit 2, the DG of the Integrated Process Information System (SIIP Abbreviation in Spanish) was connected to the new MCC installed on level 10.15 at the Control Building. As in the case of Unit 1, this interconnection will contribute to powering the 125 and 250 VDC battery chargers.

    3. Additionally, a quick connection box was installed in both units to connect the MCC to a Portable Diesel Generator to power the 125 and 250 VDC battery chargers.

G. Emergency preparedness and response improvements

This information is presented in Article 16.

H. Implementation of diverse and flexible coping strategies (FLEX)

As mentioned, CFE is committed to complying with the order of the NRC EA-12-049 through the guidelines established in the NEI 12-06 Rev. 2. Such compliance commits LVNPS to have alternatives diverse and flexible to maintain the cooling capacities of the core, cooling of the Spent Fuel Pool and the integrity of the Primary Containment before an event beyond the design bases that lead both LVNPS Units to Extended Loss of AC Power (ELAP) and Loss of Normal Access to the Ultimate Heat Sink (UHS) condition.

There are three phases of the mitigation strategy:

1. In the first phase, the event must be faced, making use of the equipment installed at LVNPS.
2. The second phase involves transitioning from using installed equipment to on-site portable equipment.
3. In the third phase, additional response capacity must be obtained and redundant portable equipment from off-site must be utilized until electric power, the inventory of water, and the coolant injection systems have been restored.

On the three phases required for the FLEX strategies, LVNPS has developed the procedures for compliance with Phase 1 and Phase 2, and is making the last modifications to satisfy the requirements of Phase 2. Phase 3 of these strategies are still in development.

I. Severe Accident Management Guidelines

The CFE has developed the Severe Accidents Management Guidelines (SAMG) based on the guidelines for the Emergency Procedure Guidelines / Severe Accident Guidelines EPG / SAG Rev. 3 of the BWR Owners Group. These guidelines were developed in response to NUREG-0737. Item IC1 "Guidance for the evaluation and Development of Procedures for Transients and Accidents" and NEI 91-04 "Severe Accident Issue Closure Guidelines", Rev. 1, respectively. So CFE has developed its Emergency Procedures and Severe Accident Guides adapting them to the LVNPS particular characteristics.

The SAMGs coordinate the control of the key parameters of the plant under severe accident conditions, and provide guidelines for flooding the core and its slag. These guidelines are sustained in the Support Procedures which contain the information to perform the necessary actions to carry out the alignments, connections and disconnections required for the SAMG monitoring.

J. Regulatory Body (CNSNS) Actions

With respect to the actions programmed for the LVNPS in order to meet the regulatory requirements established by the CNSNS, to respond to an event of the magnitude of the impact to the Fukushima Daiichi power plant, during the period covered by this Report National, the Regulatory Body held quarterly meetings with the CFE in order to verify compliance with its program of activities.

As a result of the review of the actions carried out by the CFE, the following is described:

With respect to the update of the Probabilistic Safety Analysis (PSA) Level 2, in its second phase, the CFE issued the 2014 version. As a result of the evaluation made by the CNSNS to the responses issued by the CFE to the Requirements for Additional Information (RAI), CNSNS determined that these analyzes were performed in accordance with the accepted methodologies under best practices and the results identify early stage releases. Therefore, CFE will be requested an update program based on the modifications that are consistent with the orders required by the NRC, to counteract the vulnerability of early release.

Regarding the actions required by regulation 10 CFR 50.54 (hh) 2), CNSNS verified its implementation in the construction stages in accordance with the modification packages generated by the CFE to comply with this regulation. It is currently pending the conclusion report delivery to the Regulatory Body.

For the mitigation strategies of events beyond the design bases, CNSNS authorized CFE to implement the modification packages required for the implementation of the Hard Venting order in its 2nd Stage of Phase 1 in the LVNPS Units 1 and 2. With respect to the reliable instrumentation order for the spent fuel pool, the CNSNS witnessed the implementation of the corresponding modification packages, determining that the construction phase was completed. Finally, with regard to the FLEX Order, the CFE established the strategies to be carried out during the 1st and 2nd phase of response of the LVNPS, before events beyond the design bases, pending the definition of the response of the 3rd phase by the CFE. In addition to the above, the CNSNS required the CFE to provide comprehensive evaluation reports on each of the previous orders, to verify compliance with the provisions of the regulatory framework.

As for the Severe Accident Management Guidelines (SAMG), CFE has informed CNSNS on time, of the progress that BWROG is making regarding the release of the Extensive Damage Mitigation Guidelines (EDMG). On the other hand, regarding the Emergency Procedures based on the EPG / SAG Rev. 3 of the BWROG and its Support Procedures, CNSNS has verified that these procedures are included in the Retraining Program of Licensed Personnel.

Finally, CNSNS prepared, in May 2017, the National Report on Assessment Report on Stress Tests at the Laguna Verde Nuclear Power Plant. This report recapitulates the activities carried out in Mexico, regarding to the whole process related to the tests stress. In this report, the updates implemented in the LVNPS are also integrated, since the last meeting of experts-members of the Ibero-American Forum of Radiological and Nuclear Regulatory Agencies (FORO in Spanish). Additionally, good practices and experiences identified during the process are included, in order to exchange them with the other regulatory bodies of the region.

ARTICLE 19. OPERATION

Obligations

"Each Contracting Party shall take the appropriate steps to ensure that:

i) the initial authorisation to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

ii) operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

iv) procedures are established for responding to anticipated operational occurrences and to accidents;

v) necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

vi) incidents significant to safety are reported in a timely manner by the corresponding license holder to the Regulatory Body;

vii) programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;

viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal."

Article 19 (1) Initial authorisation

- **Overview of the Contracting Party's arrangements and regulatory requirements for the commissioning of a nuclear installation, demonstrating that the installation, as constructed, is consistent with design requirements and safety requirements**

As mentioned in other articles of this National Report, CNSNS is a semi-autonomous organism body under the Secretariat of Energy responsible for verifying the compliance of the national and international regulations for the siting, design, construction, commissioning and operation of nuclear installations.

CNSNS, to fulfil its functions, has established a two-stage "Licencing Process": the first one starts with the formal delivery by the licence holder of the Construction Permit Application accompanied by an installation characteristics description with particular emphasis on the safety systems that the installation will have to ensure that it will not present an undue risk to public and environment. Among the documents sent by CFE to CNSNS to support the Laguna Verde Nuclear Power Station (LVNPS) application are the following:

In order to perform this function, CNSNS established a "Licensing Process" comprised of two stages; the first stage began with the formal submission of a Construction Permit Application which was accompanied by a description of the characteristics of the facility with special emphasis on the safety systems it would have to guarantee that it would not represent an undue risk to the population and the environment. Among the documents that the CFE sent to the CNSNS to support the aforementioned request for the LVNPS were:

a) Preliminary Safety Analysis Report (PSAR)

b) Preliminary Environmental Impact Assessment (PEIA) Report.

During this stage, CNSNS reviewed the design criteria (Structures, Systems and Components [SSC] characteristics, nuclear analysis, etc.) and particularly all the issues related to the impact of the site characteristics on the SSC design of the installation, and the impact of the installation on the environment. After reviewing these reports, a technical report was sent to the Secretariat of Energy to support and issue the Construction Permit.

During the LVNPS construction, CNSNS through audits and inspections, supervised this phase to assure that the installation was built in accordance with the safety analysis report and the conditions set by the Construction Permit.

Once the detailed design of the installation was finalized, a Licence for Commercial Operation was requested for the licensee, as part of CNSNS's licencing process second stage. The following information supported the application:

a) The Final Safety Analysis Report (FSAR)
b) Final Environmental Impact Report (FEIR)

CNSNS assessed these reports, including the acceptance criteria for pre-operational testing, and start-up testing; also the proposed Technical Specifications were assessed. These assessments and the results from CNSNS's inspections and audits allowed preparing a technical report for the Secretariat of Energy to issue the LVNPS original Licence for Commercial Operation.

- **Conduct of appropriate safety analyses**

In the LVNPS licencing, the Preliminary and the Final Safety Analysis Reports were defined within the regulatory framework and in accordance with the format set in the USNRC Regulatory Guide 1.70.

For granting the LVNPS Licence for Commercial Operation, CNSNS reviewed the Final Safety Analysis Report, taking advantage of the experience gained in reviewing the Preliminary Safety Analysis Report, supported by experts from the International Atomic Energy Agency in some particular topics, through the Technical Cooperation Programmes.

Later, in the LVNPS commercial operation phase, CNSNS reviewed and assessed the safety analysis report for the power uprate up to 5% of the Rated Thermal Power (RTP) which covered almost every topic of the original Final Safety Analysis Report. CNSNS's assessments were documented in a Safety Evaluation Report. CNSNS witnessed each of the five output levels, from 101% to 105%, so it was found to steady behaviour of the plant. The safety analysis, for total steam and the new thermal power conditions, was performed as part of the primary containment systems safety analysis in the event of a Loss of Coolant Accident (LOCA), both inside and outside the containment.

In 2008, during LVNPS's operational stage, CNSNS started the review of the safety analysis for an extended power uprate of 20% of RTP. For this uprate, CFE made modifications to the plant (see Article 18), the most relevant being made to the nuclear steam supply system and the steam dryer, housed in the reactor of both units. The Regulatory review of this document observed that several important questions were answered by CFE. At that time, the CFE was granted the Operating Authorisations for both LVNPS units for a maximum power of 2317 MWt, maintaining the original expiration dates.

CFE submitted to the CNSNS in March 2015 the LVNPS Application to Request for License Renewal for additional 30 years.

This application consisted of 47 Aging Management Programs (AMP) and 28 Time Limited Aging Analyses (TLAA). The CFE provided five annual updates to this application. For its part, the CNSNS conducted 13 audits and 2 inspections and issued a total of 386 Additional Information Requests, which were met by the CFE to the satisfaction of the CNSNS. Finally, on July 24, 2020, the Ministry of Energy (SENER), based on the favourable technical opinion of the National Nuclear Safety and Safeguards Commission (CNSNS), granted the Unit 1 license renewal, so it currently operates with an Extended Period that expires until July 2050. Regarding Unit 2, its Operation Authorisation is still in force, so before its expiration date, SENER will issue its resolution on the license renewal application.

Another issue that has involved performing a safety analysis is the event that occurred at the Fukushima Daiichi plant in Japan in March 2011. For this, the CFE carried out the evaluations called "Stress Tests" and has in the process the Post-Fukushima Actions required by the USNRC, which were required by the CNSNS. These analyses are described in Article 14 of this National Report.

– **Commissioning programmes**

As part of the compliance obligation with USNRC Regulatory Guide 1.68, a start-up programme was implemented in LVNPS. This programme began with the initial fuel loading for which the Technical Specifications were applied. The start-up programme was divided into four main phases:

Phase I. Tests with Reactor Pressure Vessel (RPV) open (initial fuel loading)

Phase II. Initial heating

Phase III. Power tests

Phase IV. Warranty tests

Testing conditions

Within the previously mentioned testing phases, the start-up programme was divided into 8 test conditions, in which specific Structures, Systems and Components tests were performed.

Test condition	Conditions / Region of Flow-Power map
VA	From fuel loading up to the time of installation of the drywell cover.
CA	After installing the drywell cover and up until the reactor was settled at pressure and temperature rated conditions.

Test condition	Conditions / Region of Flow-Power map
C1	Before and after synchronisation of the main generator of 5% to 20% of the Rated Thermal Power, with reactor recirculation pumps at low speed and the control valve between the maximum and minimum position.
C2	After main generator synchronisation, with a control rod pattern of 50% to 75% at or below the recirculation flow master control lower analytical limit, up to a 50% RTP.
C3	From 50% to 75% of the control rod pattern, above 80% of the core flow and within the maximum allowable valve control opening up to a 75% RTP.
C4	At the natural circulating line and its intersection with the lines between 95% and 100% of rod patterns up to a 75% RTP.
C5	From the lines of 95% to 100% of the control rod patterns and between those of a minimum flow at the recirculation pumps (control valve in minimum position) rated speed and 5% above the inferior analytical limit of the recirculation flow automatic control up to a 75% RTP.
C6	Within 95% to 100% of RTP and between 95% and the maximum allowable flow through the core.

General acceptance criteria

Three general acceptance criteria were established to validate the start-up testing:

a) Level 1 Acceptance criteria

Failure to meet the criteria of this level forces the unit to be led to a standby condition considered satisfactory and safe based on test results previously performed.

b) Level 2 Acceptance criteria

Failure to meet the criteria of this level does not require altering the test programme or operation of the unit. It is recommendable to investigate adjustments required as well as analytical and surveillance methods.

c) Level 3 Acceptance criteria

Failure to meet the criteria of this level does not require altering the test programme or unit operation. Limits established under this category are related to individual component expectations or transient behaviour of control loops. This level is not associated with RPV or fuel protection systems.

Start-up testing performed

The number of start-up tests performed for each one of the tests conditions to verify the Balance of Plant systems (VS) and System Test (ST) for the systems of the Nuclear Steam Supply System (NSSS) is shown below.

Test Condition	(ST) Test Performed	(VS) Test Performed
Open RPV (VA)	15	3
Heating (CA)	28	11
Condition 1 (C1)	15	18
Condition 2 (C2)	21	36
Condition 3 (C3)	35	22
Condition 4 (C4)	6	0
Condition 5 (C5)	7	0
Condition 6 (C6)	47	40
Warranty	2	0
T O T A L:	**176**	**130**

Testing for the 5% power uprate

Since under the 5% power uprate condition, neither the pressure at the Reactor Pressure Vessel nor the reactor recirculation flow were affected, many of the start-up tests were validated by analysis of the test results during the initial start-up testing for both LVNPS units. However, the change in the main steam flow required the following tests to prove the stable operation under this new condition:

a) Steady-state behaviour for normal operation.

b) Steady-state operation of the Reactor Core Isolation Cooling (RCIC) System.

c) Thermal limits evaluation and calibration of feedwater flow transmitters for each power step from 100% up to 105%.

d) Pressure Regulator Electro-Hydraulic Control (EHC) (including regulator failure to verify the transference to the backup regulator)

e) Feedwater control and feedwater system, stable RPV level control and operation.

f) Chemistry.

g) Isotopic analysis.

h) Environmental radiological monitoring at the release and discharge points, inside the Restricted Area.

Testing for the 20% Extended Power Uprate

Once the changes resulting from the Extended Power Uprate (EPU) project were concluded, the testing execution for the power uprate started on May 2011. CNSNS authorised a 30-day testing period.

During this testing period, the manoeuvres for the power uprate in LVNPS Unit 1 were witnessed, which were executed in six steps authorised according to applicable procedures and Reactor Engineering instructions. The following power steps values (percentages based on 2,317 MWt of Rated Thermal Power) were used:

a) First power step at 89.6% RTP
b) Second power step at 91.9% RTP
c) Third power step at 94% RTP
d) Fourth power step at 96.2% RTP
e) Fifth power step at 98.4% RTP
f) Sixth power step at 100% RTP

For each one of the power steps, the following tests were performed.

Power Step	Test Performed
a) First power step at 89.6% RTP	a) Power stabilisation test. b) Core performance and steam carryover determination test. c) Plant systems monitoring tests.
b) Second power step at 91.9% RTP	a) Functional test of the Feedwater Control System (FWCS) at EPU conditions (2,317 MWt) b) Functional test of the Digital Electro-Hydraulic Control (DEHC) c) Functional test for area radiation mapping. d) Core performance and steam carryover determination test. e) Plant systems monitoring tests.
c) Third power step at 94% RTP	a) Functional test for area radiation mapping. b) Core performance and steam carryover determination test. c) Plant systems monitoring tests.

Power Step	Test Performed
d) Fourth power step at 96.2% RTP	a) Functional test of the FWCS at EPU conditions (2,317 MWt) b) Functional test of the DEHC. c) Core performance and steam carryover determination test. d) Plant systems monitoring tests. e) Chemical and radiochemical parameters monitoring tests.
e) Fifth power step at 98.4% RTP	a) Core performance and steam carryover determination test.
f) Sixth power step at 100% RTP	a) Core performance and steam carryover determination test. b) Chemical and radiochemical parameters monitoring tests. c) Acquisition data test for the regulation increment. d) Functional test for area radiation mapping.

The same testing activity for the LVNPS Unit 2 additional 15% power uprate was verified and witnessed by CNSNS staff, using the same power steps of LVNPS Unit 1. Finally, it was found that CFE met the acceptance criteria for all the tests established in the respective procedures for both LVNPS units.

- **Programmes of verification that installations, as constructed, are consistent with the design and in compliance with safety requirements**

Introduction

Once the nuclear safety levels are established by the design of the installation, acceptance criteria are established to ensure that, during the construction stage, the erection and testing of Structures, Systems and Components (SSC) are in compliance with the design criteria and applicable norms, codes and standards as well as quality requirements, in accordance with their importance to nuclear safety, and that they meet the corresponding regulatory requirements. Similarly, it is required that the adequacy and quality of SSC important to safety are kept and optimized through the operation phase. This is to ensure that facility operation does not represent an undue risk to public health and safety.

Construction stage

At this stage, the main mean for achieving the safety levels required was strict compliance with LVNPS' Construction Quality Assurance Plan (CQAP).

Compliance with CQAP requirements was applied both to the behaviour of individuals and organisations.

The application of the CQAP is a means for guaranteeing, in a highly reliable manner, that SSC important to safety shall be built, installed, inspected and tested in conformance with applicable design specifications, codes and regulations.

Operation stage

The following means have been implemented for the operation stage to maintain the installation at the highest safety levels required by CNSNS.

Technical Specifications

The document that regulates the operation of nuclear installations within the limits deriving from the safety analysis is denominated Technical Specifications and its existence is ruled by the 10 CFR 50.36.

LVNPS was designed under criteria directed to avoid radioactive material releases to the environment. To demonstrate the adequacy of its implementation, accidents hypothetically postulated were analysed and results were presented as part of the information in the Final Safety Analysis Report. This served to establish safety parameters or limits and conditions that restrict the operation of the installation beyond the same.

The TS were developed based on USNRC NUREG-0123, parameters identified in the FSAR and recommendations in standard ANSI/ANS 5.8.4 in which it is specified that:

a) Each nuclear plant licence application shall include in the request “Technical Specifications” proposed, their bases and the administrative controls.

b) Each licence shall include Technical Specifications deriving from safety analysis and their evaluation by CNSNS.

The TS are incorporated in the Authorisation for Commercial Operation and they contain guidelines and conditions under LVNPS plant must operate. Compliance with the TS ensures that the operation is maintained within the limits determined by the safety analysis. Any deviation requires corrective actions to be taken and immediate notification to CNSNS. Any modification to the TS requires previous authorisation from CNSNS, since they are part of the Licence for Commercial Operation.

The TS are integrated by the following sections: (1) Definitions; (2) Safety limits and limiting setpoints of safety systems; (3) Operating limiting conditions; (4) Surveillance requirements; (5) Design characteristics; and (6) Administrative controls.

Maintaining the Safety Reports

In order to assure that LVNPS Units 1 and 2 shall operate during their lifetime in conformance with the bases that served for awarding the Operating Licences or Authorisations, any change or modification to the installation, the procedures or the execution of tests or experiments ought to be submitted for a Safety Evaluation. The purpose of such evaluation is:

a) To review that all change proposed to be covered by licence bases; that is, by analyses, models, methods and assumptions made in Safety Reports. This way, it is ensured that these bases are not modified and therefore do not require the previous approval of CNSNS.

b) For those cases in which it is identified that the change proposed is not covered by the licence bases, ensure that approval of CNSNS is required before the implementation of the change.

c) To identify whether the change proposed modifies or affects a Technical Specification, in which case previous authorisation shall be requested to CNSNS. If the authorisation is granted, the modification of such TS will be done by CNSNS.

d) To request a periodic summary report briefing every change performed, that due to their nature was not submitted for approval of CNSNS before their implementation, so that the regulatory body is informed of the nature of all changes.

This process maintains the effectiveness of the safety analysis reports, implying that the operation of LVNPS Units 1 and 2 is always covered by the licence bases.

Periodic safety review

The Periodic Safety Review (PSR) provides a global view of plant safety, with the objective of determining the modifications that should be carried out in order to maintain a high level of safety. The specific goals of the PSR are the following:

a) Analyse the installation behaviour for different aspects of nuclear safety in a time period long enough to identify trends.

b) Verify the adequacy of the methodology used in conducting the analysis of various aspects of the nuclear safety of the installation documented in the periodic reports.

A more detailed description of the PSR is presented in Article 14 (1) of this National Report.

– **Regulatory review and control activities**

Revision of the FSAR, Section 14 "Testing Programmes" was performed to determine the capability of the initial test programme for LVNPS Units 1 and 2 as well as the evaluation of the execution of such tests and verification of the acceptance of the final results from a safety point of view. All this, as a prerequisite for the initial authorisation of operation of both LVNPS units.

In order to establish very strict control over the performance of tests and over the power uprate programme and to have no doubt about the reliability of the course and the decisions made on the route to 100% of power, CNSNS established a requirement through which different power steps would be subjected to an evaluation of LVNPS behaviour as regards to the testing performed at the preceding step. From here, it was established that LVNPS had to achieve authorisation from CNSNS to carry on. This process, during the testing to be performed, ensured that LVNPS would maintain itself within the standards established by the acceptance criteria. If for some reason, these tests did not satisfy the acceptance criteria, the corresponding analyses were demanded immediately.

During the start-up testing phase, CNSNS carried out 39 inspections to LVNPS Unit 1 and 17 inspections to LVNPS Unit 2. These inspections were intended to verify groups and activities related to the start-up testing, such as Instrumentation & Control, Reactor Engineering, Maintenance, Start-up Superintendence, Quality Assurance and Quality Control. Based on the above, the original Operation Licences were awarded on July 24, 1990, for LVNPS Unit 1 and April 10, 1995, for LVNPS Unit 2.

For the 5% Power Uprate condition, CNSNS evaluated and authorised the testing programme for both LVNPS units. The safety-related tests were witnessed by CNSNS's staff in order to verify that the expected values for safety and operational parameters were obtained as described in the Safety Analysis. As a consequence of the evaluation and analysis of the results, CNSNS determined LVNPS had a stable behaviour and that it could operate in the 5% Power Uprate condition. Finally, the Secretariat of Energy granted the new Licence for Commercial Operation on December 8, 1999, for both LVNPS units with the same expiration date as the original ones, that is, July 24, 2020 (Unit 1) and April 10, 2025 (Unit 2).

For the 20% Extended Power Uprate condition, CNSNS evaluated and authorised the testing programme for both LVNPS units. The safety-related tests were witnessed by CNSNS's staff in order to verify that the expected values for safety and operational parameters were obtained as described in the Safety Analysis. On June 19, 2018, the CFE received from the National Commission of Nuclear Safety and Safeguards (whom Secretariat of Energy delegated to grant the authorisations for nuclear facilities, see Article 7 (2) (ii) of this National Report) two new Operating Authorisations for LVNPS both units for a maximum power of 2317 MWt, maintaining the original expiration dates.

Regarding CFE's Application for License Renewal of both LVNPS units, submitted to CNSNS in March 2015, and its 5 annual Amendments; the regulatory evaluation was focused on the following stages: Scoping and Screening, Aging Management Review and Aging Management Programs / Time-Limited Aging Analysis. As a result, on July 24, 2020, the Ministry of Energy (SENER), based on the favourable technical opinion of the National Nuclear Safety and Safeguards Commission (CNSNS), granted the license renewal of Unit 1, so it currently operates with an Extended Period that expires until July 2050. In the case of Unit 2, at the closing date of this National Report, its Operating Authorisation is still in force, so before its expiration date (April 2025) SENER will release its resolution on the license renewal request.

Article 19 (2) Operational limits and conditions

- **Overview of the Contracting Party's arrangements and regulatory requirements for the definition of safe boundaries of operation and the setting of operational limits and conditions**

The LVNPS Units 1 and 2 Authorisations for Commercial Operation contains the Technical Specifications (TS) that establish the set of limits and conditions for the safe operation of the LVNPS units. These limits and conditions are derived from the safety analysis, testing and operational experience. The 10 CFR 50.36 defines the requirements for the TS of a plant. The Technical Specifications should describe, at least, the specific characteristics of the installation and the operating condition required to protect the public health and safety. The applicant should identify the items that apply directly to maintain the integrity of physical barriers that are designed to contain radioactive material. Specifically, 10 CFR 50.36 requires that the TS should be derived from the analysis and assessments that are in the Final Safety Analysis Report. The LVNPS authorisation holder cannot, for any reason, change the TS without prior permission of CNSNS.

- **Implementation of operational limits and conditions, their documentation, training in them, and their availability to plant personnel engaged in safety related work**

The control of the limits and operating conditions are defined in the Technical Specifications, which determine and establish the actions to be performed for the proper control of the situations that reduce the safety margin, whether planned or unexpected. The staff in charge of this control is generally the Licenced Reactor Operator (RO) or Senior Reactor Operators (SROs), who have been trained on the installation operation, with emphasis on compliance with the Technical Specifications.

The staff in charge of monitoring safety-related equipment is trained following the Systematic Approach to Training (SAT) methodology. This training is provided to the personnel in the operation, maintenance (mechanical, electrical or Instrumentation & Control), chemistry, engineering, and radiation protection areas.

The controlled copy of the Technical Specifications is under the custody of the CFE´s staff designated by CNSNS as responsible for a controlled copy; in particular, at least two copies are located in the Main Control Room (MCR) of each LVNPS unit.

Additionally, an updated electronic version of the TS is available in the LVNPS intranet, which can be accessed from any computer station located within the installation premises. There are also updated copies at CFE's Engineering offices located in the location named "Dos Bocas" (in the State of Veracruz). In CNSNS headquarters located in Mexico City, there is a TS digital copy that can be consulted by its personnel.

CNSNS surveils the compliance and implementation regarding training programmes for personnel performing safety-related activities, in compliance with the Mexican Official Standard NOM-034-NUCL-2016 "Requirements for selection, qualification and training of nuclear power plant personnel" for operating, maintenance (mechanical, electrical or instrumentation and control), chemistry, engineering and radiation protection personnel. This surveillance is documented in the inspection reports and through the NOM-034-NUCL-2016 Conformity Assessment Reports and Opinions.

- **Review and revision of operational limits and conditions as necessary**

The review of and changes to the Technical Specifications are usually performed when the facility's equipment, operating conditions, or administrative controls are changed.

Changes to the Technical Specifications are supported by 10 CFR 50.92 risk evaluation, which should include the potential impact on the accidents previously evaluated in the Final Safety Analysis Report, as well as, the impact on the LVNPS safety margins. The Technical Specification changes request must be sent to CNSNS for evaluation, and if applicable, approval is granted.

- **Regulatory review and control activities**

Assessment activities

Any request for a change to the Technical Specifications enters into the assessment process of CNSNS. This process is composed of a Preliminary Review of the documentation to verify its completeness and a Detailed Assessment of the specific aspects applicable to the authorisation holder. Throughout the process, the compliance with the licensing bases of the plant is verified. The final result of the assessment process is an Evaluation Report and the corresponding conclusion.

Control activities

Any non-compliance to the Technical Specification shall be notified by the authorisation holder to CNSNS. In addition, the CNSNS´s resident inspector verifies the operation log daily to assure the non-compliances were reported in accordance with the provisions of the existing regulation.

Article 19 (3) Procedures for operation, maintenance, inspection and testing

- **Overview of the Contracting Party's arrangements and regulatory requirements on procedures for operation, maintenance, inspection and testing of a nuclear installation**

As described in Article 13 of this National Report, all activities important to safety relating to the LVNPS Units 1 and 2 operation are performed with strict adherence to the Quality Assurance Plan. This obliges the use of approved procedures by qualified personnel.

- **Establishment of operating procedures, their implementation, periodic review, modification, approval and documentation**

Establishment of operating procedures

In order to control all activities ruled by the Quality Assurance Plan, LVNPS has divided its procedures into the following groups.

1. Administrative Procedures. These are the procedures used in the Management of Nuclear Power Plants to describe policies, instructions, practices, authority, organizational interfaces and to designate responsibilities of two or more Sub-Managers or Autonomous Departments that report directly to the Manager or Deputy Managers of the LVNPS.
2. Operating procedures. These are the procedures used by the departments and different areas of the Nuclear Power Plants Management, to carry out in a standardized way the activities of their responsibility. These are subdivided into:
    a) General Operation, Systems Operation, Abnormal Operation, Alarm Response, Operation in Emergency, and Operational Verification, Support Procedures and Operation Procedure.
    b) Maintenance procedures are classified into Preventive, Corrective, Refuelling Outages, Special Processes, Generic Maintenance, Instrumentation and Control Maintenance and Predictive Maintenance.
    c) Reactor Engineering: Reactor Verification, Reactor Analysis, Fuel

Handling, Nuclear Analysis and Uranium Supply.

d) Radiation Protection: Radiation Protection (Generic) and Reduction in Personnel Exposure, Waste Storage and Waste Alarm, Offsite Dose Calculation Manual.

e) Internal Emergency Plan (IEP).

f) Instrumentation: Instrumentation Maintenance and Instrumentation Verification.

g) Chemistry and Radiochemistry.

h) Materials Control.

i) Security.

j) Training.

k) Quality Control: Generic Quality Control Activities, Non-destructive Examination, and Functional Testing.

l) Control of Documents/ Requirements.

m) Fire Protection

n) Programming and Results

Application

LVNPS has a policy for applying the procedures, which establishes that all the installation personnel shall use and adhere to the procedures relating to their work activity.

Periodic assessment

A specific LVNPS procedure establishes the requirements for the preparation, issuance, revision, approval, cancellation and reactivation of LVNPS administrative procedures. This procedure also establishes the requirements for the preparation, issuance, review, approval, cancellation, and reactivation of the LVNPS operation procedures. The periodic assessments may be annual, every two years, every five years, or depending on the needs (for example, operational changes).

The procedure modifications can be due to reassignments, operational changes or periodic review results.

The operational changes are those modifications to the procedures that do not change their purpose but are necessary to continue their application on the field; otherwise, the plant safety or reliability would be affected. The scope of operational changes includes the modifications generated by the Corrective Action Programme (CAP) or modification packages.

- **Availability of the procedures to the relevant nuclear installation staff**

There are stands for the control and availability of procedures in all areas, such as maintenance, operation, etc. The location of the procedures that all staff can use is clearly indicated in these stands.

Additionally, an updated version of all the procedures is available in the LVNPS intranet, which can be accessed from any computer located within the installation premises. There are also updated copies at CFE's offices located in "Dos Bocas" (in the State of Veracruz) and CNSNS's headquarters located in Mexico City.

- **Involvement of relevant nuclear installation staff in the development of procedures**

LVNPS has a policy for developing the procedures, which establishes that all the qualified personnel must be involved in the preparation, revision and approval of the procedures.

- **Incorporation of operational procedures into the management system of the nuclear installation**

The management system of procedures is indicated in two specific procedures:

- For the management of technical-operational procedures, and
- For the management of administrative procedures.

- **Regulatory review and control activities**

During the preparation and conduction of the inspections contained in CNSNS's Baseline Inspection Programme, the inspection staff follows the guidelines established in USNRC Procedure IP-42453 "Operating Procedures Inspection". The regulatory review and control activities include the following:

a) Verify that the plant procedures are reviewed and approved in accordance with the Technical Specifications and Operation Authorisation conditions.

b) Verify that the technical adaptation of the procedures is consistent with the desired actions and operation modes.

c) Verify that interim changes to procedures are performed in accordance with the requirements of the Technical Specifications and administrative procedures.

Article 19 (4) Procedures for responding to operational occurrences and accidents

- **Overview of the Contracting Party's arrangements and regulatory requirements on procedures for responding to anticipated operational occurrences and accidents**

As a result of the accident at the Three Mile Island Nuclear Power Plant in the United States of America, CNSNS requested CFE to review existing procedures for addressing transients and accidents. This motivated the application of the PSTG to LVNPS Units 1 and 2, which were developed in a generic manner for Boiling Water Reactors by the BWR Owner's Group (BWROG) of which CFE forms part.

The incorporation of the revised Emergency Operating Procedures (EOP) does not require amending the design basis of the LVNPS and they are not part of the design basis considerations, but rather guidelines to respond to conditions beyond the authorisation basis.

CFE developed EOP for LVNPS using the Plant Specific Technical Guidelines (PSTG), which is based on the Emergency Procedures Guidelines (EPG) in NEDO 31331 "BWR Owner's Group Emergency Procedures Guidelines" to comply with the intention of Item I.C.1 of NUREG-0737 "Guidelines for the assessment and development of transient and accident procedures"; therefore, the PSTG are based on the following:

a) The entry conditions and operator actions are linked to certain parameters and symptoms of the plant. The actions are appropriately specified to restore and maintain these key plant parameters within the limits that define a safe plant condition.

b) It is not required to identify an initiating event to determine which procedure developed with the PSTG should be used. Similarly, the operator actions prescribed are appropriate regardless of the initiating event or the sequence in which subsequent events may occur.

c) The specified actions of the operator are consistent with the manner in which control room operators actually operate, including the performance of concurrent or parallel actions.

d) The operator actions specified are based on the existing configuration of the Structures and Systems of the plant, with the exception of instrument ranges, regardless of changes that may be proposed or adopted in the future.

e) All possible plant conditions that can have general operation guidelines are covered, regardless of their occurrence probability. This is why the PSTG cover a wide range of conditions that include both the most and least severe conditions in comparison to those which were considered to develop the design basis of the plant. These conditions include multiple equipment failures and human errors.

f) Although there are guidelines to respond to plant conditions that may extend beyond the original design basis of the plant, there is no intention or purpose to extend any design basis above what is currently established.

g) The plant systems that can be used to respond effectively to plant emergency conditions are identified, regardless of their safety class or the qualification of the system equipment and components.

h) The operator actions, the limits and action levels are based on engineering calculations using best estimate methods, contrasting with the traditional analytical methods and assumptions of licensing and design basis.

i) The best possible operation guidelines are specified, regardless of the licensing assumptions or requirements, and the design basis. For example, the operator actions are not necessarily conditioned on a waiting time (approximately, 10 minutes) assumed as input to a licensing analysis.

– **Establishment of event based and/or symptom based emergency operating procedures**

Introduction

The procedures that are used at LVNPS to respond with anticipation to operational incidents and accidents are divided into: 1) Abnormal Operating Procedures, which are based on events; and 2) Operating Emergency Procedures which are based on the PSTG indicated in the preceding overview item of this National Report.

Abnormal Operating Procedures

An evaluation was performed on the design of LVNPS Units 1 and 2 to verify its response to foreseen operational incidents and accidents considered as design basis. These are classified into five categories as show below:

Category	Type of event	Occurrence Event/Year
I	Normal Operation	Normal
II	Anticipated Transients	1 – 1/20
III	Infrequent Transients	< 1/20 – 1/100
IV	Design Basis	1/100 – 1/10,000
V	Special	N/A

The response to the transients shown in the previous categories is carried out using the Abnormal Operating Procedures.

Emergency Operating Procedures

An overview of the Emergency Operating Procedures structure and interrelationships is shown in Figure 19.1 It can be seen that there are twelve critical parameters controlled by the EOP: three for Reactor Control, five for Primary Containment Control, three for Secondary Containment Control and one for Radioactivity Release Control. Only three of them require transferring its control among different portions of the EOP, these are:

a) Reactor water level.

b) Reactor pressure.

c) Suppression pool water level.

- **Establishment of procedures and guidelines to prevent severe accidents or mitigate their consequences and establishment of procedures and guidance to manage accident situations at multi-unit nuclear installations and/or multi-facility sites;**

The CFE has developed the Severe Accidents Management Guidelines (SAMG) based on the guidelines for the Emergency Procedure Guidelines / Severe Accident Guidelines EPG / SAG Rev. 3 of the BWR Owners Group. The SAMG, coordinate the control of the key parameters of the plant under severe accident conditions, and provide guidelines for flooding the core and its debris.

Additionally, support procedures have been developed for the SAMG, which contain the information to perform the necessary actions to carry out the alignments, connections and disconnections required for the monitoring of the SAMG.

- **Regulatory review and control activities**

CNSNS used in 1992 the guidelines established in NUREG/CR-2005, Rev. 1, "Checklist for Evaluation of Emergency Operating Procedures Used in Nuclear Power Plants" in order to verify the proper implementation of the EOP in the LVNPS simulator.

During the 2019-2021 period, CNSNS performed inspections to the Training Departments, as well as the application of operational examination to licensed personnel in the simulator, both to grant new Reactor Operator (RO) licences and renew the licences of ROs and Senior Reactor Operators of LVNPS. During these activities, which are scheduled annually

During these activities, in relation to Emergency Operating Procedures, it was verified that:

a) If there were significant changes to the EOP, LVNPS should meet the regulatory commitments and requirements.

b) If there were significant changes to the EPG of the BWR owners group, LVNPS's procedures were technically suitable for incorporating these changes, and some deviations from the EPG were completely justified.

c) The entry and exit conditions from the EOP were easy to follow, and that the transition among the normal, abnormal and emergency operating procedures was properly defined and that could be easy to follow.

d) The use of the notes and cautions of the EOP was consistent and correct.

e) The Reactor Operators and the Senior Reactor Operators received the training required before the changes to the EOP were implemented for application in the Main Control Room.

Article 19 (5) Engineering and technical support

- **General availability of necessary engineering and technical support in all safety related fields for all nuclear installations, under construction, in operation, under accident conditions or under decommissioning**

  LVNPS has an engineering office that provided technical support during the construction and commissioning phases of both LVNPS units. Currently, this office provides continuous technical support, during LVNPS normal operation, to maintain the design bases, and safe and reliable operation of systems, equipment and components of both Units.

- **General availability of necessary technical support on the site and also at the licence holder or utility headquarters, and procedures for making central resources available for nuclear installations**

  To provide the technical support that both LVNPS units require on an immediate or short-term basis, the Engineering office has a group of Systems Engineers, a group of Program and Component Engineers, including the Rapid Response Engineering Group, a group of Purchasing Engineering, and a group dedicated to documenting and procedure control at the power plant site. The Technical Design Support and Document Configuration Engineering group, located off-site the power plant, is responsible for providing the technical support required to maintain safe and reliable operation in the medium and long term.

- **General situation with regard to dependence on consultants and contractors for technical support to nuclear installations**

The LVNPS Engineering Office has all the design documentation, including: architectural and engineering drawings, calculation logs, technical drawings, procurement technical specifications, etc., which is necessary to provide independent technical support. It is important to mention that the turbine generator set originally installed in LVNPS units was designed, manufactured and supplied by Mitsubishi Heavy Industries who supported all the time the modifications and major maintenance while its equipment was in operation. With the Extended Power Uprate project for a power uprate up to 120% of the RTP, the turbo-generator set of both LVNPS units was replaced with ALSTOM equipment. General Electric recently acquired ALSTOM with whom a relationship is maintained of technical support for LVNPS.

- **Regulatory review and control activities**

As mentioned in Article 14, CNSNS verifies annually the Engineering and Technical Support areas through its Baseline Inspection Programme. During refuelling outages, CNSNS also verifies that the service suppliers meet the following: their Quality Assurance Programmes or they are included in LVNPS's QAP; comply with the training and qualifications required for the activities that will develop; the Radiation Protection and Industrial Safety controls established by LVNPS.

Article 19 (6) Reporting of incidents significant to safety

- **Overview of the Contracting Party's arrangements and regulatory requirements to report incidents significant to safety to the regulatory body**

According to the regulatory framework, LVNPS must notify to CNSNS the occurrence of all incidents covered by categories defined in 10 CFR 20.2202, 10 CFR 20.2203, 10 CFR 50.72, 10 CFR 50.73 and NUREG-1022 Rev. 3. The notification is sent to the CNSNS Resident Inspector at LVNPS and, and depending on the classification of the event within: 1 hour, 4 hours and 8 hours.

Subsequently, and within a period not exceeding 24 hours of the event, LVNPS must send to the CNSNS headquarters, a notification through the format identified as Notification of Reportable Event (NRE). Such format includes a summary of the event; immediate corrective actions; status of the core emergency cooling system and engineering safeguards system conditions; as well as information on radiological conditions as applicable.

Finally, and within 60 days after the event occurred, LVNPS must send to the CNSNS a Licensee Event Report (LER), where the event is fully described, the result of the root cause analysis and the proposed corrective and preventive actions, in order to avoid recurrence.

- **Overview of the established reporting criteria and reporting procedures for incidents significant to safety and other events such as near misses and accidents**

  The notification and reporting of the LVNPS safety important events are carried out according to the notification and reporting criteria set in the Procedure "LVNPS Event Notification and Reporting to CNSNS". This procedure is based on 10 CFR 20.2202, 10 CFR 20.2203, 10 CFR 50.72, 10 CFR 50.73, and NUREG-1022 "Event Reporting Guidelines: 10 CFR 50.72 and 50.73".

- **Statistics of reported incidents significant to safety for the past three years**

  Figure 19.2 shows a plot for the events that have occurred in both LVNPS units from the start of operation through 2021.

  The most important events at LVNPS during the 2019-2021 period are described below.

  1. Manual SCRAM of the Reactor due to loss of vacuum in the Main Condenser.

     On February 03, 2019, the manual SCRAM of the Unit 2 Reactor was performed due to the loss of vacuum of the Main Condenser during the application of the procedure for the Main Turbine Valve Test, requiring putting into service the loop A of the Residual Heat Removal System (RHR) to cool the Suppression Pool and subsequently, manually put into service the Reactor Core Isolation Cooling System (RCIC) to control the level and pressure of the Reactor.

     The cause of the event was that the failed section of pipe was made of carbon steel material instead of chrome-molybdenum, which was confirmed in the 16th Unit 2 refueling by metallographic analysis.

  2. Room No. RX-211 unlocked, this being a High Radiation Area.

     On February 12, 2019, during the preparations for the leak test to the return valve of the Cooling and Cleaning System of the Suppression Pool of Unit 1, the Predictive Maintenance personnel reported to the Reactor checkpoint technician that the barrier to controlling the access to the High Radiation Area was not in place.

     The cause of this event was that a double check was not carried out to ensure that access to the room was closed and secured, since the annexe of the Radiation Protection procedure does not have a specific field to document such simultaneous verification.

3. Unit 2 Reactor Automatic SCRAM due to Main Turbine Trip.

   On April 09, 2019, occurred the actuation of both channels of the Reactor Protection System (RPS) by the trip of the Main Turbine, upon actuation of a component of the Main Generator. In this event, all systems operated as designed.

   The cause of the event was that the new requirements for digital components were not reviewed so in Unit 2 these components were still required to operate at a temperature that no longer corresponded to them.

4. Isolation of the Residual Heat Removal (RHR) System in its Standby Cooling mode.

   On April 22, 2019, after starting the RHR System in its Shutdown Cooling mode, the isolation of this system occurred due to the actuation of an instrument, closing an external isolation valve.

   The cause of the event was the gradual accumulation of dirt and rust in the low- pressure line of the actuated instrument.

5. Startup by human error of the main pump of the low-pressure Core Spray (LPCS) System during the application of a maintenance procedure.

   On April 15, 2019, while performing a maintenance procedure on a valve of the Residual Heat Removal (RHR) System heat exchanger "A", Unit 2, the automatic startup of the LPCS main pump occurred. The maintenance technician reported that he misplaced a jumper, resulting in the system startup.

   The root cause of this event was a failure to improve Electrical Maintenance to identify and raise awareness of the risk involved in working on critical components or critical activities.

6. Manual start of pump "B", Division I, of the Nuclear Service Water (NSW) System due to low pressure and low flow of pump "A", Division I, of the same system.

   On May 18, 2019, low flow and low-pressure alarms were present in the NSW System, pump "A" division I, of Unit 2. Subsequently, pump "B" was manually started, restoring the nominal pressure and flow conditions in division I of this system.

   The causes of the event were inadequate risk analysis of the diving activity in the suction bay of the system, inadequate use of error prevention tools and weaknesses in the equipment restriction control.

7. Automatic SCRAM of the Reactor by actuation of both Reactor Protection

System channels.

On October 02, 2019, automatic actuation of both channels of the Unit 2 Reactor Protection System occurred, with automatic opening of a Safety and Relief Valve (SRV). The Reactor Water Cleanup (RWCU) system was isolated due to a disturbance in an instrument, the Reactor was manually isolated due to a rapid decrease in Reactor pressure. The Reactor Core Isolated Core Cooling (RCIC) System was started for reactor level and pressure control, and the Residual Heat Removal (RHR) system was started to cool the Suppression Pool. Two SRV valves were opened for Reactor pressure control.

The cause of the event was a deficiency in the operation of the system, which occurs at a level where users do not have access to make modifications or changes, since the failure corresponds to a level of the design developer. This type of control system should be updated based on reviews, operational experiences of users and investigations by the manufacturer.

8. Room No. TB-313 unlocked, this being a High Radiation Area.

On November 16, 2019, Unit 1 was operating at 85% power following routine power reduction activities, Physical Security personnel notified the Radiation Protection (RP) technician on duty that the door leading to room TB-313 (considered a High Radiation Area) was closed; however, the padlock was poorly placed and did not secure the lock on the pin. Physical Security personnel took control, remaining in the area to prevent access. Room TB-313 was finally secured; however, there is an administrative record that the door should have been secured approximately two hours earlier.

The cause of the event was that the RP technician omitted to assign a custodian with whom he would perform the double verification of the door security, as it should be done in High Radiation Areas.

Once the dose records were reviewed, it was concluded that there were no personnel entering the room in question, so there was no dose to personnel due to unplanned exposure.

9. Automatic Reactor SCRAM due to Turbine trip.

On November 30, 2019, there was an automatic tripping of both channels of the Unit 2 Reactor Protection System, due to the Turbine trip, which was caused, in turn, by the trip of the Main Generator due to the trip of a relay, leading finally to the automatic opening of a Safety and Relief Valve (SRV).

The root cause was that the design review during the Extended Power Uprate (EPU) project did not identify the conditions under which the heating elements should operate without challenging or stressing the service components.

10. Operation of Unit 2 with 100.3% power.

    On January 09, 2020, while Unit 2 was in a stable condition, trip alarms from the hydraulic power unit "B" of the Recirculation System (RRC) occurred; when it got back in service an increase in the loop "B" flow and decrease in the position indication of the loop flow control valve was observed. An unsuccessful attempt was made to decrease the loop "B" flow. Later on, it was observed that the power was above 100% of the Nominal Power with a value of 100.3%, so it was proceeded to decrease the power with the flow control valve "A" until reaching 97% of power.

    The cause of the event was the fracture and fatigue of a coupling since it had been installed for more than 20 years.

11. The Reactor Core Isolation Cooling (RCIC) System inoperable due to velocity and flow oscillations during the application of a procedure.

    On October 04, 2020, when applying an operating verification procedure, the turbine of the RCIC system of Unit 1 was put into service and the speed was adjusted with the corresponding controller in manual mode, according to the instructions of the same procedure. Subsequently, the controller was put in automatic mode and then speed and flow oscillations occurred, so the verification was suspended and declared unsatisfactory. Later on, the RCIC system turbine was put on standby according to the same procedure, with no oscillations in the control when the controller was put on automatic.

    The root cause of this event was a deficiency during change control management in maintenance tests, since the gain of the RCIC system flow controller was modified during post-maintenance tests, having different system parameters from the nominal ones, without documenting them adequately, and finally having an erroneous gain value.

12. Reactor Manual SCRAM due to Recirculation System pump "B" trip.

    On November 07, 2020, during the low speed transfer of the Unit 2 recirculation pumps, according to a system operating procedure, pump "B" did not transfer to low speed, so a manual SCRAM of the Reactor was performed according to an abnormal operation procedure.

    The most probable cause of the event is that due to a lack of attention to detail during the maneuver, the operator did not properly manipulate the position of the handles, as he did not observe all the required parameters.

13. Failure of explosive valve "A" of the Traversing Incore Probe (TIP) during the application of a procedure for valves and pumps.

On December 1, 2020, during the periodic operability test of the explosive charges of the TIP system valves, the charge corresponding to valve "A" did not detonate.

The direct cause of the event was a deformation in the explosive valve connector. The root cause of the event was a situation not covered by the respective procedure for valves and pumps, since, although it is performed step by step, it did not consider in detail the sequence of connection and disconnection of the TIP valve connector, which would prevent damage to this connector.

14. Trip of the Main/Normal Auxiliary Transformer and satisfactory startup of the Diesel Generators Div. I and Div. II.

On December 20, 2020, the Main/Normal Auxiliary Transformer tripped, resulting in a loss of external power due to the absence of the Standby Transformer (T23), and consequently the automatic startup of the Diesel Generators Div. I and Div. II of Unit 2 occurred satisfactorily.

As a consequence of the power loss, pump "A" of the Residual Heat Removal (RHR) System and pump "A" of the Fuel Pool Cooling and Cleaning System tripped and were immediately restored to service. Reactor cavity draining was suspended in accordance with a general operating procedure and an Unusual Event was declared.

The Substation Operator reported that the Main Transformer protections were tripped due to an error by the Electrical Protections personnel, so that after the electrical protections were restored, the Main/Normal Auxiliary Transformer was energized and, therefore, the non-critical 4.16 kV buses were energized, ending the emergency.

The root cause of this event was that the electrical maintenance personnel did not conduct an effective pre-work meeting, so the error prevention tools were not properly used to perform the task.

15. Automatic Reactor SCRAM due to Main Turbine trip.

On January 20, 2021, there was an automatic trip of both channels of the Reactor Protection System (RPS) due to the trip of the Main Turbine of Unit 1, which was caused by a relay trip. There was a fast transfer of auxiliaries from transformer T11 to transformer T12, automatic opening of two Safety and Relief Valves (SRV) and the Alternate Rod Insertion (ARI) actuation.

During the bypass actuation, a high Reactor level and the tripping of the feedwater Turbo-pump "A" occurred, which was reset for reactor level control. The Reactor was manually isolated at 35 kg/cm^2 for pressure control according to an abnormal operating procedure.

The cause of the event was that a preventive maintenance procedure for transformer T11 did not contain instructions for the inspection and replacement of seals of the conduit boxes of the protection circuit cables, which led to the degradation of the seal of the conduit covers (conduit and accessories), causing the entry of water that, in chronic contact with the cables, led to the accelerated degradation of the wiring PVC insulation.

16. Unit 1 shutdown declared by Technical Specifications (TS).

    On January 22, 2021, a low count was observed in monitor "E" of the Startup/Intermediate Range Neutron Monitor (SRNM) System. Then, due to the failure of monitor "E", coinciding with the failure of monitor "G", the action of TS 3.3.1 was taken and channel "A" of the Reactor Protection System (RPS) was tripped. Subsequently, the shutdown was declared by the TS. Finally, the Reactor Mode Selector was switched to "Off" and Operating Condition 3 "Hot Standby" was reached.

    The root cause of the event was an Instrumentation and Control maintenance procedure that contained two instructions in a single step, which caused the Instrumentation and Control (I&C) personnel to omit the second instruction to deliver the data obtained to the Engineering organization for graphing and analysis, preventing them from identifying the failure or degradation in the “E” and “G” monitors and determining their replacement during the 20th Refueling.

17. Failure to close a circuit breaker, during the application of an operating verification procedure of the Diesel Generator Div. III.

    On May 24, 2021, in Unit 2, during the scheduled execution of an operating verification procedure, having conditions to synchronize, the breaker of the Diesel Generator Div. III did not close.

    The root cause of the event was that the respective preventive maintenance procedure of the mentioned breaker did not detail the instructions to effectively perform the calibration of the trip arm of this breaker.

18. Failure of Division III essential cooling pump.

    On September 29, 2021, in Unit 1, the Division III essential cooling pump was put into service in accordance with a systems operating procedure, due to the injection of biocide into the Nuclear Service Water (NSW) System bays, with the general assistant reporting normal operation of the pump. Ten minutes later, there were alarms in the Main Control Room (MCR) on two panels due to the tripping of the feeder breaker of the Division III essential cooling pump. On preliminary inspection of the equipment, the general assistant reported the characteristic odor of overheating and evidence of damage in the motor windings.

The most likely cause of this event was a degradation of the motor winding insulation due to moisture/salinity ingress, as evidence was found of overheating in the stator winding due to a short circuit fault in the motor stator. As an immediate preventative action, a cover was placed on the marine ladder opening of the man inlet on the pump room floor to minimize moisture ingress.

19. Reactor manual SCRAM due to decreasing the period in the Startup Range Neutron Monitors in Operating Condition 2 "Startup".

    On October 22, 2021, during the shutdown of Unit 2, while in Operating Condition 2 "Startup" (approx. at 1% power), the reactor pressure began to decrease when the main turbine bypass valves were closed. During the course of the pressure decrease, a reduction in the reactor period was observed, so it was decided to trip the reactor manually.

    The cause of the event was that the Reactor Operator did not use the respective system operating procedure when performing the main steam realignment to ejector "A" and the supervision did not ensure that the activity was performed according to said procedure.

20. Startup of Safeguard Systems due to Main Transformer T2 trip, without fast transfer of auxiliaries.

    On October 30, 2021, in Unit 2, the main transformer (T2) tripped due to a relay trip, without the automatic transfer of power to the non-critical buses and critical buses, so the automatic startup of the Emergency Diesel Generators Div. I / II / III was initiated, energizing the critical buses and taking their loads satisfactorily, starting the emergency filter trains of the Main Control Room Div. I / II. Pump "A" of the Residual Heat Removal System (RHR) was tripped in Shutdown Cooling Mode and once the non-critical buses were energized from transformer T23, the pump was put back in service.

    The root cause of this event was the lack of attention to detail during the development of the electrical modification packages used to change the protections during the Extended Power Uprate (EPU) project due to the excessive amount of work. The EPU was an atypical project that exceeded the attention capacity in some areas of the Engineering Department. After the EPU was completed, a procedure was created for the planning and evaluation of future macro projects at the power plant, in order to improve the planning and scheduling of activities.

21. Failure of a spring-loading switch, during application of a procedure.

On November 30, 2021, in Unit 1, during the functional test, the Diesel Generator Div. III was unloaded and the machine breaker was opened according to the operating verification procedure. During the application of the checklist of the aforementioned procedure and by local indication of spring loading, it was determined that the aforementioned breaker had some unloaded springs, therefore the Diesel Generator Div. III was declared inoperable.

On December 27, 2021, during the following functional test, the event occurred again, which was in the process of analysis.

The cause of the event was that, during the preparation and review of the maintenance procedure in 2004, relevant information on the mechanical adjustments to be inspected and parts to be lubricated in the circuit breaker was not included, as indicated in the vendor's manual. Additionally, in the process of reviewing and issuing procedures, it was not ensured that all the detailed information was included.

- **Documentation and publication of reported events and incidents by both the licence holders and regulatory body**

Licence holders

The notification and reporting of LVNPS safety significant events are done through the Licensee Event Reports which are sent to CNSNS in accordance with the regulatory provisions.

Also, LVNPS shares its operational experience with the international nuclear community through the World Association of Nuclear Operators (WANO), which publishes the most significant operational events.

Regulatory body

CNSNS participates in the International System for Notification of Events meetings, based on the International Nuclear and Radiological Event Scale (INES) and the International Reporting System for Operating Experience (IRS) meetings, which are jointly held by the IAEA and the Nuclear Energy Agency (NEA)/ Organization for Economic Co-Operation and Development’s (OECD). The objective is to notify and share the experience of the events that occurred during the operation of the nuclear facilities and radiological facilities of Mexico, with the member countries of the international community; as well as take the lessons learned from the member countries. If applicable this experience and lesson learned, they are implemented in Mexican facilities and thus prevent such events from occurring in our country.

- **Policy for use of the INES scale**

Mexico, like all member countries of the INES reportability system, established the policy of informing the IAEA notification system of all radiological events that fall within the scale and of all nuclear events classified as level 2 or higher.

- **Regulatory review and control activities**

CNSNS verifies the Event Reports presented by CFE, are documented in compliance with the current regulations established in the regulatory framework. When a safety significant event or safety special interest event occurs at LVNPS, CNSNS performs an in-depth assessment and investigation of the causes that originated the event, verifies the existence of recurrent events and based on the initial evaluation of reportable events in accordance with internal procedures, determines the feasibility of carrying out a Special Inspection, in order to verify the actions carried out by LVNPS during the event.

For the analysis of the events, CNSNS prepares statistics to determine the trends on the type of event, the root cause, the recurrences, and the areas involved in the events, among others, in order to define whether arises the need to apply some regulatory action.

In addition to the above, the CNSNS has the authority to question or impose the scope of the corrective actions, and/or their deadline for completion, when deemed necessary.

As mentioned in Article 14, in 2009 CNSNS started categorizing the operational events according to their safety significance. This exercise has the purpose of determining performance indicators similar to USNRC Reactor Oversight Process (ROP) Performance Indicators to compare LVNPS performance with similar plants and emulate the best international practices.

Article 19 (7) <u>Operational experience feedback</u>

- **Overview of the Contracting Party’s arrangements and regulatory requirements on the licence holders to collect and analyse and share operating experience**

The authorisation for commercial operation states that LVNPS shall continue with the feedback from the national and international operational experience and implement changes to relevant legislation that CNSNS considers applicable and within the deadlines established according to the size of the changes, to increase safety and, public and environmental protection.

- **Overview of programmes of licence holders for the feedback of information on operating experience from their own nuclear installation, from other domestic installations and from installations abroad**

Introduction

The programmes for both the internal and external operational experience feedback are carried out according to the guidelines set in the internal procedure named “Programme for Reviewing External Operational Experience of the Nuclear Corporate Coordination” and the procedure “Activities of the Operational Experience Programme of the Nuclear Corporate Coordination".

External operational experience

LVNPS has a procedure that provides the methodology, guidelines, and scope of the external operational experience review process; also describes each stage of the process and the people responsible; and the interfaces between different organisations involved in the review process.

The review process begins with an information search of events that have occurred in the nuclear industry and non-nuclear industry. This search is carried out mainly on the websites of the Institute of Nuclear Power Operations (INPO), the World Association of Nuclear Operators and the United States Nuclear Regulatory Commission. The procedure differentiates two types of documents: those that are just for information (e.g., guides, best practices, etc.); and those that document events that require an evaluation to determine if similar events could happen at LVNPS. The first type of document is translated into Spanish and disseminated to LVNPS staff through the intranet, newsletters, e-mail, posters, and presentations in supervisor and working group meetings. For the documents that require an evaluation, a preliminary screening is carried out to identify events potentially applicable to LVNPS. These events are assigned to specialists for a detailed review and accurately determine if similar events could happen at LVNPS. If that is the case, actions to prevent their occurrence are implemented.
According to the observation of trends in industry events, internal to the plant or at the recommendation of an external or internal organization, the reports of the most significant events are re-evaluated to verify if the actions that were initially implemented continue to be valid or are necessary additional actions.

Internal operational experience

Regarding the internal operational experience, the events at LVNPS are documented in the Corrective Action Programme. The events are reviewed by specialists in the corresponding technical area, who define and implement the corrective actions to prevent the occurrence of similar events.

- **Procedures to analyse domestic and international events**

The analysis of LVNPS internal events is performed according to the internal procedure named "Analysis of Events." This procedure provides guidelines and instructions to determine the root cause, the apparent cause or the direct cause (evaluation of the condition) of the events, depending on the significance level assigned to them based on a systematic evaluation considering the significant risk and uncertainty about the cause of the event to determine the level of evaluation that could be applied to a condition, as established by the internal procedure "Corrective Action Programme". The root cause is determined for events classified as levels 1 and 2 (reported to CNSNS); the apparent cause is determined for level 2 events; o Partial Apparent Cause Analysis (where the extension of condition and evaluation of operational experience are not required) and the direct cause is determined for level 3 events. The methodologies of procedure "Event Analysis" used for the research and analysis of the events are: Job Task Analysis, Cause-and-Effect Analysis; Event Trees and Causal Factors Analysis; Tap Root Analysis; Fault Tree Analysis, Change Analysis, Barrier Analysis; and Human Performance Assessment. The methodology used depends on the complexity and nature of the event, using the summary of different methods provided in the procedure "Event Analysis" as an aid. More than one methodology may be used.

The events in foreign power stations are evaluated following the guidelines and instructions of procedure "Review Programme of External Operational Experience of the Nuclear Corporate Coordination." Taking into account that these events were analysed and the actions to prevent their recurrence were defined using the procedures of such foreign plants in which they occurred, or if they were significant generic events that occurred at several plants and the analysis was performed by INPO/WANO, the LVNPS evaluation is performed from the prevention perspective to determine if similar events could happen at LVNPS. In such cases, if the appropriate prevention barriers are not in place or are missing, they are implemented.

- **Procedures to draw conclusions and to implement any necessary modification to the installation and to personnel training programmes and simulators**

Internal and external operational experience is analysed to determine the real or potential impact of said experience at LVNPS, and consequently, take preventive actions to avoid its occurrence. This analysis is carried out by the department that would be responsible if a similar event occurred at LVNPS. The department determines the appropriate actions in accordance with the Corrective Action Programme. Modifications to the installation are made according to the administrative procedure "Process for permanent modifications in Laguna Verde Nuclear Power Station". Generally, corrective and preventive actions are logged and controlled through the Corrective Action Programme. Often the corrective actions result in plant modifications, processes, and/or training programmes, including simulator training (full scope and process). Such changes are made in accordance with procedures “Licensed Personnel Training”, “Initial training for RO and SRO”, and “Non-Licensed personnel training”, as well as the procedures “Simulator Test Control”, “Simulator Test Management”, and “Management of the modifications to the Simulator”. In addition, training committees have been established for the departments covered under the Systematic Training Method, which periodically review personnel performance and training needs that are incorporated into training programmes. Any employee may request a training needs analysis, which is reviewed by the training committees for assessment and scheduling.

- **Mechanisms to share important experience with other operating organisations**

The mechanisms for sharing important experiences with other organisations are established in CFE’s Procedure PAS-26 “Program of Operational Experience Programme of the CFE’s Nuclear Corporate Coordination". This procedure sets the criteria to select or define what LVNPS operational events should be shared with other organisations. These criteria are the same ones set in WANO’s “Operating Experience Program Reference Manual”, which are applicable to all nuclear power plants. The WANO’s reference manual is followed regarding the event reports content and format, and the event index system used for Category, Consequences, Systems, Components, Condition, Activity, Group, Direct Cause, Root Cause and Causal Factors.

- **Use of international information databases on operating experience**

The main databases of information on operational experience of events that have occurred in plants of other countries used in LVNPS include those of the Institute of Nuclear Power Operations, the World Association of Nuclear Operators, the US Nuclear Regulatory Commission, and NEA/OECD International Reporting System for Operating Experience.

- **Regulatory review and control activities for licence holder programmes and procedures**

As mentioned in Article 14 of this National Report, CNSNS verifies every two years the external operational experience through its Baseline Inspection Programme. Also, during the inspections carried out to different safety-related areas it is performed a systematic follow-up of the internal operational experience and the feedback to all staff. Additionally, the inspection to the Corrective Action Programme includes a follow-up to the trend analysis and self-assessments performed by LVNPS staff, related to internal and external operational experience.

CNSNS’s staff reviews the operational experience documented in the generic letters and bulletins issued by the USNRC, and forwards to LVNPS any applicable one that requires a response from the installation.

- **Programmes of the regulatory body for feedback of operational experience and the use of existing mechanisms to share important experience with international organizations and with other regulatory bodies**

As mentioned earlier, in Article 19 (6), CNSNS participates in the International Reporting System for Operating Experience and the International Nuclear and Radiological Event Scale (INES) meetings jointly held by the IAEA and the Organization for Economic Co-Operation and Development (OECD) / Nuclear Energy Agency (NEA). The objective is to report and share the operational experience of the Mexican nuclear installation with member countries of the international community, and to collect and implement the international experience in Mexico.

Article 19 (8) Management of spent fuel and radioactive waste on the site

- **Overview of the Contracting Party's arrangements and regulatory requirements for the on-site handling of spent fuel and radioactive waste**

Regarding the spent fuel, LVNPS originally adopted the strategy to store all the spent fuel generated during the useful lifetime of both units in the Spent Fuel Pool (SFP), one for each LVNPS unit. However, it is already available an Independent Spent Fuel Storage Installation (ISFSI) on the LVNPS site designed to store 130 HI-STORM canisters, which house a multi-purpose container (MPC) with the capacity to store 89 spent fuel assemblies. In 2018 was performed the first campaign in which transferred one cask containing 89 fuel assemblies and in 2020 a second campaign with four more containers with 89 assemblies each, for a total of 445 spent fuel assemblies removed from the fuel pool of both LVNPS units.

The applicable requirements relating to radiation safety associated with spent fuel management are those stated in the General Regulation for Radiation Safety. The applicable requirements for the pools and support system design are the requirements established in Parts 20, 50, 51, 71, 72, 73, and 100 of Title 10 "Energy" of the United States Code of Federal Regulations (CFR).

For the on-site Independent Spent Fuel Storage Installation at LVNPS, CNSNS issued a regulatory framework based on the following USNRC laws and regulations:

- 10 CFR 72: Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater than class C waste.
- Regulatory Guide 3.48 Rev. 1: Standard format and content for the safety analysis report for an independent spent fuel storage installation or monitored retrievable storage installation (dry storage).
- Regulatory Guide 3.50 Rev. 1: Standard format and content for a licence application to store spent fuel and high-level radioactive waste.

- NUREG-1567: Standard review plan for spent fuel dry storage facilities.
- 10 CFR 51: Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.

With regard to radioactive waste, the current regulation, which is founded on the General Regulation for Radiation Safety and is applicable to the radioactive waste management at nuclear installations, is the following:

- NOM-004-NUCL-2013 Classification of radioactive wastes.
- NOM-008-NUCL-2011 Radioactive contamination control.
- NOM-018-NUCL-1995 Methods for determining the activity concentration and total activity in radioactive waste packages.
- NOM-028-NUCL-2009 Radioactive waste management in radioactive facilities using open sources.
- NOM-035-NUCL-2013 Criteria for the disposal of radioactive waste.
- NOM-036-NUCL-2001 Requirements for radioactive waste treatment and conditioning installations.

As mentioned above, radioactive waste management shall comply with the applicable requirements relating to radiation safety stated in the General Regulation for Radiation Safety and the applicable regulation, as well as in the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, which entered in force on May 17, 2018.

The CNSNS established in May 2017 the regulatory requirements that apply to LVNPS´s Radioactive Waste and Spent Nuclear Fuel Management Plan, as well as requirements for radioactive waste storage at the LVNPS.

– On-site storage of spent fuel

The Spent Fuel Pool (one per LVNPS unit) was originally designed in 1972 for a capacity of just 580 fuel assemblies, equivalent to an 18-month fuel cycle (1.3 times de core capacity). Towards the end of 1989, analyses were performed for the final arrangement of fuel racks in the SFP, based on the use of steel racks having special receptacles to retain Boron. LVNPS submitted these analyses to CNSNS, which after evaluating the heat removal capacity from the SFP cooling systems as well as the sub-criticality factor, granted authorisation to increase the capacity of each Spent Fuel Pool to up to

7.16 cores (3,177 fuel assemblies), from which 6.16 cores (2,733 assemblies) are designated for routine storage and a complete core for emergencies.

As a result of the Renewal of Operating Authorisation project, the useful life of LVNPS Units 1 and 2 will be increased. Their continued operation will generate more spent fuel than originally planned, requiring that spent fuel continue to be stored in the spent fuel pools (SFP).

Because the SFP were not designed with sufficient capacity to store the spent fuel that will be generated during the plant's useful life, now considering the Extended Power Uprate (EPU) modification and the Renewal of Operating Authorisation for both units, the need to augment the facilities capacity for spent fuel storage until it is moved to a permanent disposal site has emerged. Therefore, in 2015-2016 an Independent Spent Fuel Storage Installation (ISFSI) was built at LVNPS site.

The purpose of building this facility is to provide LVNPS with the installed capacity of spent fuel storage, and to recover the storage capacity of both LVNPS units. Then, it will be carried out "campaigns" in which spent fuel assemblies of the SFP of both units are removed and confined in dry storage systems.

LVNPS successfully completed its Pre-Operational Testing and, as the cut-off date of this National Report, has already hosted five dry storage casks at the ISFSI, containing 445 spent fuel assemblies. The facility's capacity will allow the storage of up to 130 storage systems, which would translate into 11,570 spent fuel assemblies, thus allowing the plant to operate for up to 60 years.

– **Implementation of on-site treatment, conditioning and storage of radioactive waste**

Liquid waste treatment

The liquid waste collected comes from different sources, so they are divided as follows: equipment drains, floor drains, regeneration and chemical drains, detergents and laundry drains, and miscellaneous drains.

The treatment process is carried out in batches, maintaining surveillance and control of the chemical quality through analysis and sampling. The specific actions depend upon the two following activities:

a) For recycling, LVNPS procedures set the chemical parameters that need to be complied with.

b) For release to the environment, the radioactive material is analysed to ensure that any discharge is As Low As Reasonably Achievable (ALARA) and in conformance with the requirements specified in 10 CFR 20 and 10 CFR 50, including the dose design objective specified in 10 CFR 50 Appendix I.

Likewise, with the aim of continuous improvement, in 2008 the "Reverse Osmosis" system is put into operation to improve radioactive waste processes. The filtering system, with the use of backwash flow filters (BFF), coal beds, ion exchange resins, Ultra Filtration (UF) and two stages of reverse osmosis, allows LVNPS to treat all high conductivity liquid wastes and high activity that are collected in the Radioactive and Purification Waste Buildings. The above with the purpose of obtaining water with chemical quality that allows it to be re-used in the water-steam cycle.

Additionally, in the years 2017-2018, the installation of a new Alternate System for the Treatment of High Conductivity and Activity Liquid Waste (ATREX / G60) or High Conductivity Waste Processing (HCWP) System was carried out in the Radioactive Waste Building, Elevation 25.10, with the objective of providing greater processing efficiency of high conductivity and activity wastes. The system has the capacity to process the contributions to the Chemical Waste Concentrator (CWC) System in order to achieve effluents with suitable chemical characteristics to be processed through the Radioactive Floor Drain System (FDR) for liquid radioactive waste, of the Reverse Osmosis System, radioactive distillate filters (MWR) or be discharged into the sea when the chemical and radiological characteristics allow it.

Gaseous waste treatment

The gaseous treatment systems are designed according to the origin and radiation levels expected in the following LVNPS extraction and ventilating systems: Radioactive Gaseous (Off-Gas) Waste Treatment System, the Turbine Gland Seal System and Ventilation Systems of different process buildings of the installation.

It has been verified that the off-gas treatment system is designed to collect and delay exhaust of noble gases produced by fission, which are removed from the condenser by means of steam jet ejectors. The noble gas process continues through a heater, a hydrogen recombiner, a condenser, two 10-minute retention tanks, a pre-filter system, activated carbon beds and high-efficiency air filters, and finally, through a ventilating air current, which is monitored before being sent to the atmosphere.

This hydrogen recombiner system is designed to support postulated hydrogen (generated by radiolysis) explosions. It has alarms that actuate if a high concentration is detected, which alert the Main Control Room operator to isolate the faulty recombiner and put the redundant train into service.

Environmental dosimetry studies performed considering LVNPS in operation have demonstrated that design basis assumptions of gas treatment systems are adequate. Based on the above, it is considered that gas treatment satisfies its function of limiting the release of radioactive material in a gaseous form.

Solid waste treatment

This subsystem is designed to collect and process the humid and dry solid waste generated at LVNPS to confine them safely and reliable inside containers appropriate for its eventual isolation. These can be stored in steel containers or high-density polyethylene high-integrity containers (HICs).

The solid waste processing is controlled by the guidelines of the LVNPS Process Control Programme (PCP), which complies with the Technical Specifications, according to 10 CFR 61 and compliant with the standard NOM-019-NUCL-1995 (see Annexe 7.3 of this National Report).

The wet solid wastes are treated by the cyclical draining process inside a high-integrity container where the free water content is reduced to less than 1% by volume.

The dry solid wastes can be treated by one of the following processes:

a. For the compactable waste, hydraulic compressing with a 4:1 compacting ratio.

b. For non-compactable waste, direct packaging.

The sources of wet solid waste are: spent ion exchange resins, sludge of the phase separators, concentrated chemical laboratory waste, regeneration and decontamination solutions. The sources of dry solid waste include: cartridge filters, clothing, paper, plastics, thermal insulation, sand, grit and contaminated replacement components.

The drums and high-integrity containers with high-level radioactive waste already processed coming from both LVNPS units are initially stored in the decay area, within the Radioactive Waste Building. Later the drums and containers are transferred to the Temporary On-site Storage, which is located in the facility site.

The polyethylene or steel-shell polyethylene HICs and the steel drums are manufactured with radiation resistance, structural strength, and corrosion resistance, and are consistent with the requirements for seismic design and quality assurance.
LVNPS has three areas for the temporary storage of radioactive solid waste:

1. In-plant temporary storage (ATP, abbreviation in Spanish). It is inside the Radioactive Waste Building, with a storage capacity for HICs and steel drums of 55 gallons, for wet and dry solid waste for two years of waste generation.
2. On-site Temporary Storage (ATS, abbreviation in Spanish). It is located outside the double fence area but on-site. This storage has two warehouses; Warehouse I stores HICs and steel drums of 55 gallons for wet solid waste and is completely full. Warehouse II stores only HICs from the operation of both LVNPS units.

3. Dry Solid Radioactive Waste Repository (DDRSS, abbreviation in Spanish). It is outside the double fence but on-site, to store steel drums of 55 gallons and metallic containers B25, B12 or special shape for dry solid waste.

During LVNPS Unit 1 start-up, it was decided to design and build an On-site Temporary Storage installation for wet low and medium radioactive waste; since there was no final repository site. This On-site Temporary Storage was authorized as an extension of the storage area of the Radioactive Waste Treatment Building. This installation was constructed in 1991, with an initial storage capacity for 5 years of operation of LVNPS in both units, considering the original design output of waste. Based on the LVNPS policy for waste reduction, the waste treatment process was improved; and the storage area was restructured, so its capacity was optimised, resulting in an increased storage capacity to accommodate waste up to 2007. The LVNPS wet solid waste storage installed capacity has increased with the construction of the industrial Warehouse II at the On-site Temporary Storage, which is currently in operation.

Also, a "Dry Solid Radioactive Waste Repository" was enabled and CNSNS granted the authorisation in 1993 to have sufficient storage capacity for dry radioactive waste, which provided an optimised capacity through 2015, assuming a production similar to current volumes. In 2006, studies for the implementation of additional volume reduction methods were started to increase the storage capacity; since the storage is about to be full. In 2007, a super-compaction process was carried out, which reduced the volume by a factor of approximately 3:1 of 6,000 compactable solid waste drums.

As part of the continuous improvement effort, CFE installed a subsystem of the reverse osmosis system, which consists of a dryer and granulator (currently in standby) that is available to serve both LVNPS units and replaces the evaporators-extruders that have operated for 15 years (which nowadays are inoperable and out of service). In addition, the subsystem technology reduces the final waste compacting ratio to 4:1. With these actions, CFE intends to maintain a reliable waste solidification and reduce the wet solid waste volume. The purpose of this subsystem is to treat the concentrated liquid waste generated during the different stages of the filtering process and the concentrates produced by the waste evaporator system, in order to obtain a dry solid waste with a moisture of less than 1 %. The dry solid waste will be packed in 55-gallon drums for its final disposal.

Spent Fuel Storage

The ISFSI is designed to store spent fuel from the commercial operation of LVNPS Units 1 and 2, taking into account the life extension resulting from the Renewal of Operating Authorisation of 30 years. Its purpose is to store the spent fuel assemblies in a safe and reliable manner in suitable containers, which subsequently can be used during transportation to the final disposal site. The HI-STORM FW container system consists of a multi-purpose container (MPC) within an outer casing made of steel and concrete. The outer casing has penetrations in the bottom to allow air circulation to cool the MPC, and therefore, the spent fuel contained within it. In addition, the MPC has a thermal siphon capacity that allows cooling of the fuel assemblies through the flow of helium in the container. The MPC consists of a basket that holds the fuel assemblies. The basket is made of neutron-absorbing material called Metamic-HT, with properties that ensure control of temperature, reactivity, and structural performance.

The spent fuel storage complies with the technical specifications for the ISFSI, 10 CFR 72, and the standards NOM-004-NUCL-1994 and NOM-035-NUCL-2000.

- **Activities to keep the amount of waste generated to the minimum practicable for the process concerned, in terms of both activity and volume**

In relation to LVNPS radioactive waste generation minimising processes, several strategies are being put in place by CFE, including:

1. Separation of radioactive material and more efficient, cleaner and expeditious decontamination of tools and objects contaminated, in new separation and decontamination workshops.
2. For compactable solid radioactive waste, super-compacting and fragmenting; for not compactable waste, selective decontamination mainly of metallic waste.
3. Optimising the use of materials to maintain equipment, tools and items free of contamination.

- **Established procedures for clearance of radioactive waste**

CFE has a Technical Manual for the Process Control Programme, which is mandatory as prescribed by Technical Specification 3/4.11.3. The manual objective is to ensure that the treatment and conditioning processes are carried out for all the different types of low-level solid radioactive waste generated at LVNPS, such as: spent resins, temporary resins, precoat sludge, sludge from cleaning, sludge concentrates, activated carbon, active dry and other wastes.

- **Regulatory review and control activities**

As mentioned in Article 14, CNSNS verifies annually the Radioactive Waste Management through its Baseline Inspection Programme. In particular, the inspection verifies the radioactive waste confinement, stability and control at LVNPS installations dedicated to these activities.

Additionally, during the 2019-2021 period, relating to radioactive waste management, the activities presented below were carried out.

LVNPS storages for radioactive contaminated materials (AMAC)

Due to the implementation of the Extended Power Uprate (EPU) project in both LVNPS units, in 2007 the Federal Electricity Commission (CFE) initiated the procedures for the construction authorisation of the Storages for Radioactive Contaminated Materials (SRCMs, named AMAC in Spanish) for the temporary storage of dry solid radiologically contaminated materials that resulted from the implementation of the aforementioned project. Of the five AMAC storages proposed, only two were built and authorized by the CNSNS.

Subsequently, CFE requested CNSNS that the SRCMs could also temporarily store dry solid materials, radiologically contaminated free of transferable contamination, which were generated in LVNPS during its normal operation, refuelling outages and special projects.

In December 2017, CFE requested CNSNS to extend the operation validity of SRCM storages. Since the authorisation for the operation of these storages would expire on December 31, 2018, in addition, the CFE requested in 2018 that CNSNS authorize the storage of residues with dry solid radioactive material in the SRCMs.

Finally, in November 2020, the Authorisation to extend the Operating Term of the Storages for Radioactive Contaminated Materials, SRCM 1 and 2, of the LVNPS was granted, as well as an amendment to said authorisation to include the storage of waste with dry solid radioactive material.

LVNPS storage for radioactive contaminated materials called “4 Naves”

CFE informed CNSNS that had the necessity for sufficient space for temporary and safe storing of metal containers type B12, B25, ISO and other special forms for the temporary storage of radioactively contaminated dry solid materials, free from transferable contamination, which were generated at LVNPS during normal operation, refuelling outages, and special projects. In the year 2010, CFE requested CNSNS an authorisation for the reconditioning and operation of one LVNPS Storage for Radioactive Contaminated Materials called "4 Naves" as a warehouse for this type of containers. The operating authorisation granted for the "4 Naves" warehouse expired on December 31, 2018.

The CFE had planned to carry out the management of the materials stored there during the years 2019 and 2020, so at the end of 2018 requested the CNSNS to grant the authorisation to cease of operations for this warehouse. Additionally, the CFE requested the CNSNS authorisation to store dry solid radioactive material. This request was subsequently cancelled by the CFE in January 2021. In September 2021 the CFE informed that the management of the materials stored in the "4 Naves" warehouse will conclude in December 2022.

Finally, in November 2021, the Authorisation to Cease of Operations of the "4 Naves" Radiologically Contaminated Materials Warehouse was granted.

Radioactive Waste Storage ADYR

In October 2021, the CFE requested authorisation from the CNSNS for the siting stage of the Radioactive Waste Storage Facilities (ADYR). The evaluation of this request began in 2022.

On-site Independent Spent Fuel Storage Installation (ISFSI) at LVNPS

In July 2015, CNSNS, anticipating CFE's application, issued the construction authorisation for the facility to be located on the LVNPS property. This authorisation was supported by an evaluation of the respective safety analysis report and a focused inspection of the construction process.

Also during 2014 and 2015, CNSNS evaluated the Safety Analysis Report, putting into consideration three private international companies that competed with CFE for its fuel assemblies storage cask technology to be adopted for the ISFSI.

Subsequently, the CFE submitted to the CNSNS the request to operate this facility. This request was composed of the Final Safety Analysis Report, Quality Assurance Program, Environmental Report, Technical Specifications (TS) and Report 10 CFR 72.212. The regulatory evaluation covered the items of evaluation, inspection, physical security and safeguards, and generated 119 Requests for Additional Information. The CNSNS also witnessed the Pre-Operational Tests: Welding, Drying and Filling, Container Loading and Transfer to the ISFSI.

Currently, the CFE has the Operating Authorisation issued by CNSNS in June 2019 with a 40-year validity and two transfers, called "campaigns", of fuel containers from the LVNPS Buildings to the ISFSI warehouse have already been carried out.

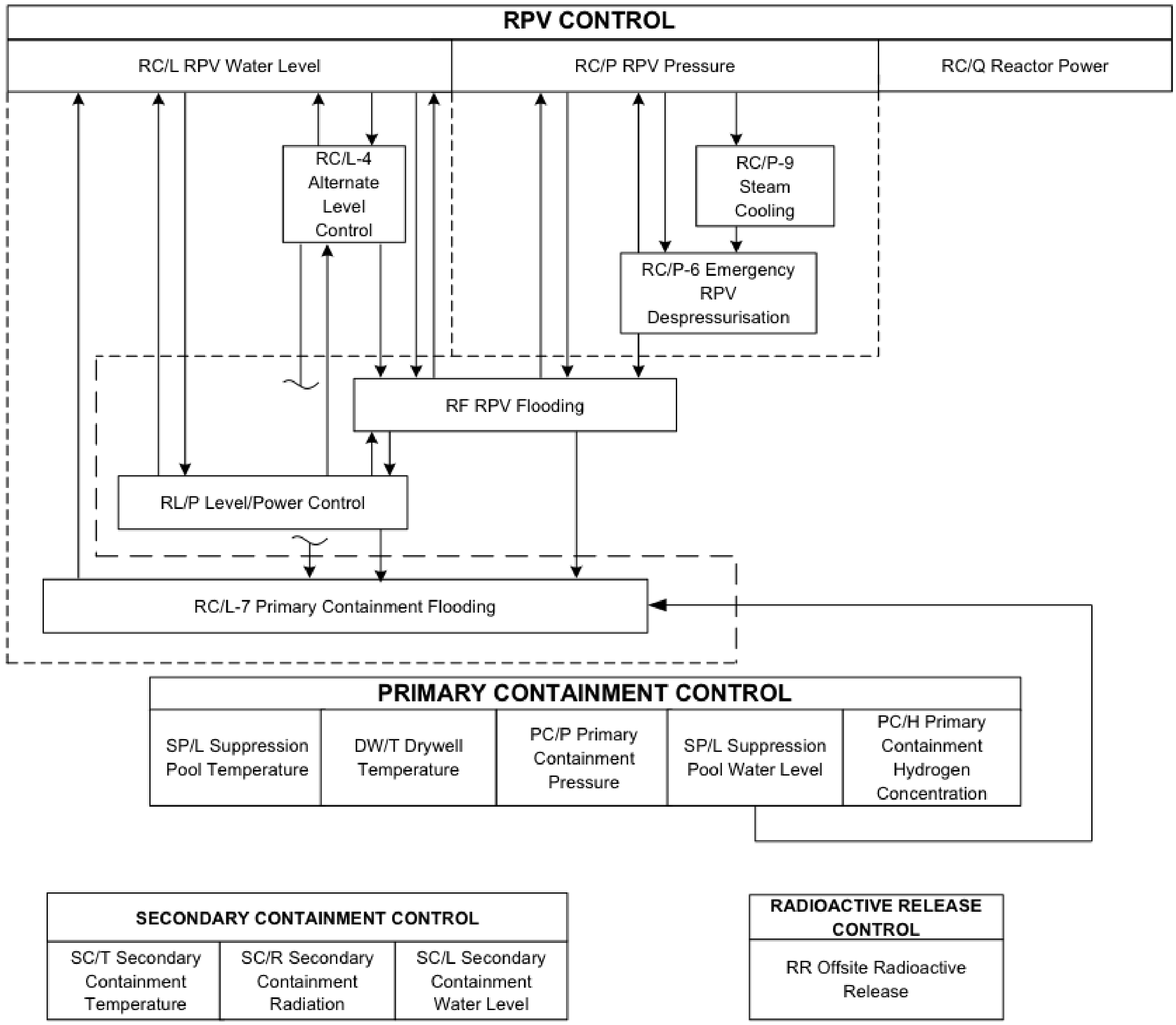
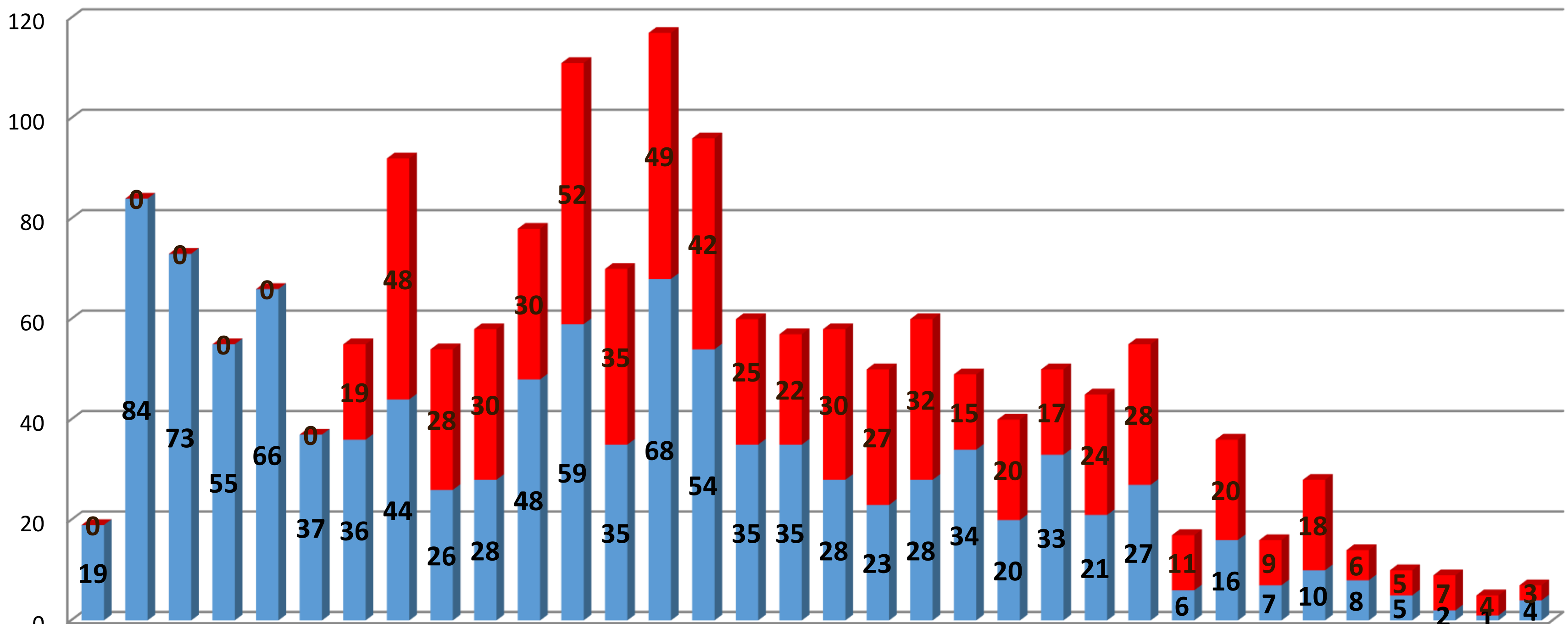


Figure 19.1 Emergency Operating Procedure structure



	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
U-2	0	0	0	0	0	0	19	48	28	30	30	52	35	49	42	25	22
U-1	19	84	73	55	66	37	36	44	26	28	48	59	35	68	54	35	35

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
U-2	30	27	32	15	20	17	24	28	11	20	9	18	6	5	7	4	3
U-1	28	23	28	34	20	33	21	27	6	16	7	10	8	5	2	1	4

Figure 19.2 Events since Start-Up through 2021 for LVNPS U-1 and U-2