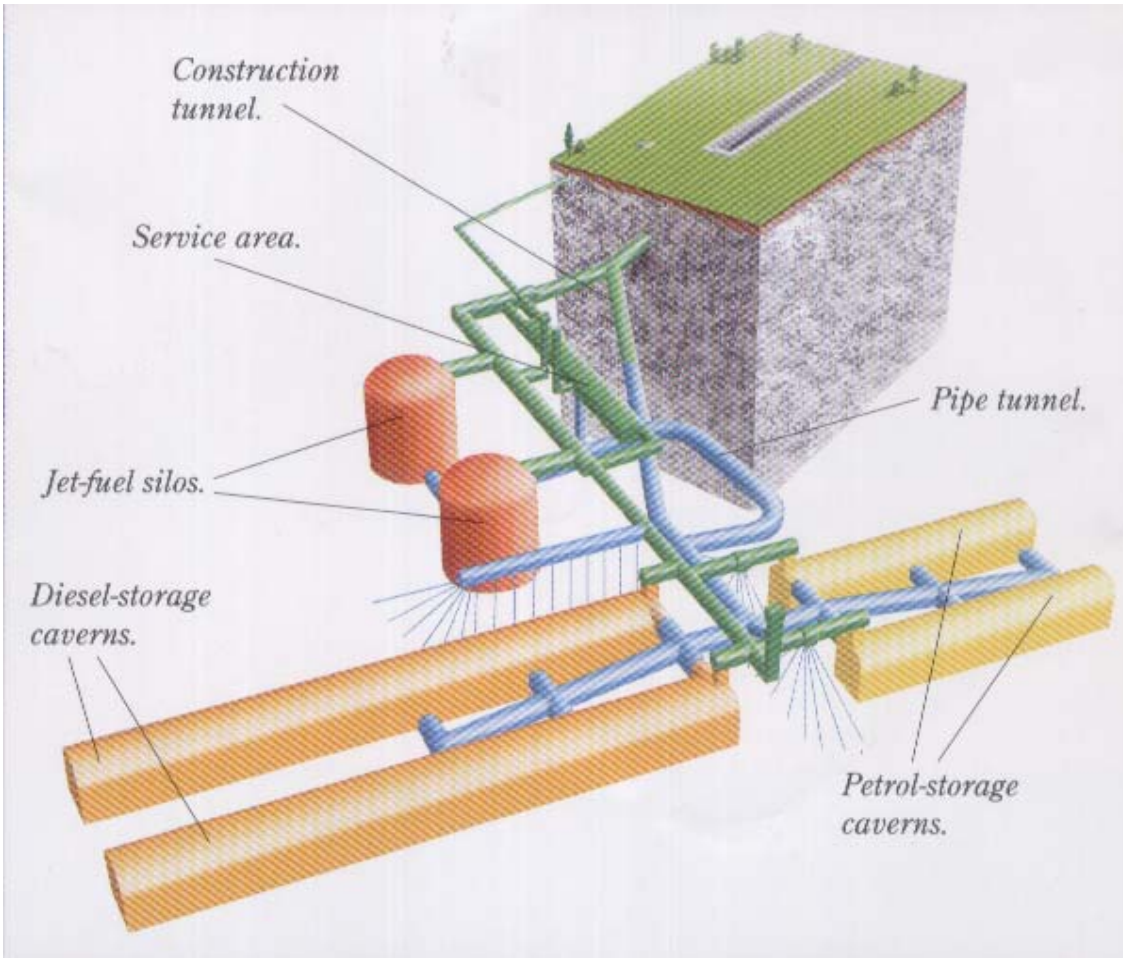
FEASIBILITY STUDY ON CONSTRUCTION OF CRUDE OIL STORAGE COMPLEX IN UNLINED MINED CAVERNS OF PROPOSED HPCL SITE AT CHEMBUR, MUMBAI

BACKGROUND

Storing petroleum products in unlined underground caverns instead of above ground in steel tanks are being practiced in all the developed countries due to the advantages in terms of cost (for low storage volume), less maintenance, low leakage and evaporation, requirement of less surface area and low impact on environment. Further the risk and hazards such as sabotage, fire storms, earthquake and explosion are minimized. The USA took lead in this direction for the salt dome deposits at a depth of 1 km from surface. Germany, France and Russia followed the technique. The technique is widely used in Norway, (rock mass of Precambrian gneiss), Sweden (in compact, non-carbonic, and non-volcanic rock masses), Greece (in limestone and dolomite formations), Japan (in granite), South Korea (in andesite & granite) and in Southi Arabia. The schematic diagram of an oil storage cavern is shown in the following figure.

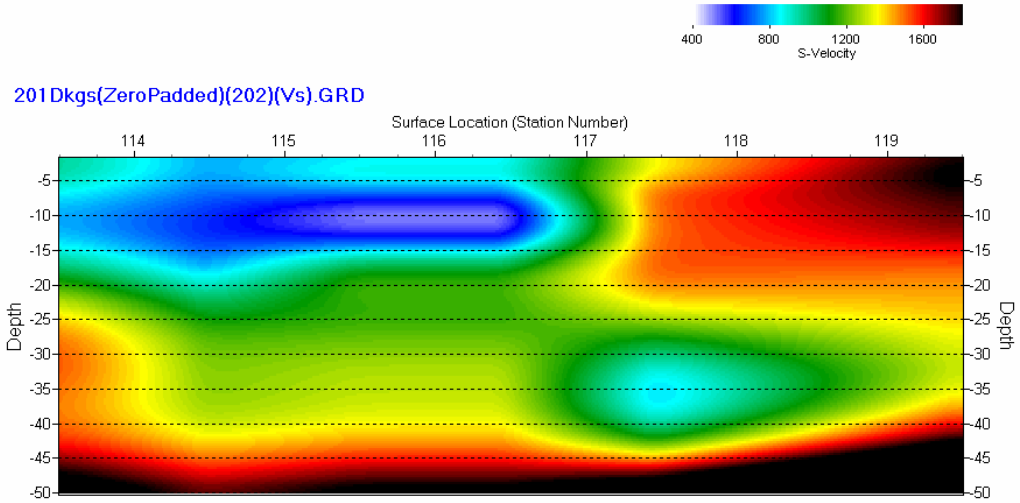


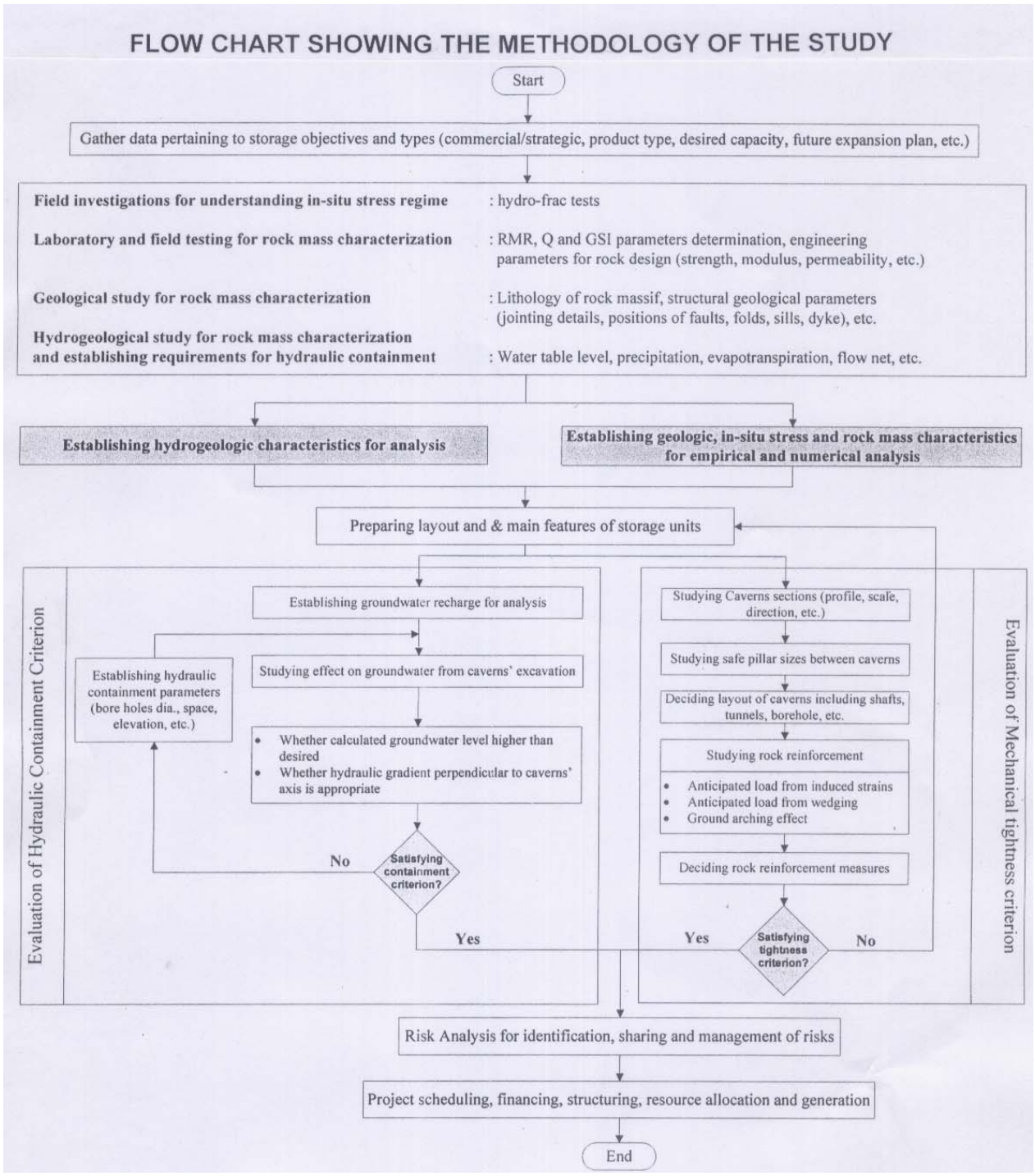
The first crude oil cavern in India is proposed to be constructed in Chembur, Mumbai at M/S Hindustan Petroleum Corporation Limited site. The CMRI (presently CIMFR) Regional Centre, Nagpur was entrusted to prepare the feasibility report of the construction beneath the sea-level in basaltic formations at a depth of 60-100m. The total storage capacity requirement is 6,50,000 Mt or more. The feasibility study encompassed rock mass characterization through seismic profiling, electrical resistivity profiling cross-hole tomography, assessment of post failure criteria of rock, geological information, hydro-geological information, determination of in-situ stress and hydraulic contamination, numerical modelling, detailed design of caverns indicating shape, size etc., risk assessment and sharing and design of construction schedule.

The methodology of construction of crude oil storage caverns is unique in the sense that a water curtain with pressure (equal to water head from the surface to the crown of the cavern) will be maintained permitting water to percolate in the fissures of the unlined cavern to prevent leakage and dissemination. The cavern remains partially filled with water at the bottom and is kept empty at the top to accommodate the evaporated oil.

The proposed methodology and work elements to carry out the study is shown in the flow chart.

The S-wave seismic profiling done to assess the underneath rock mass upto a depth of 50 m and finalizing the exploratory drill hole locations are shown below:




FLOW CHART SHOWING THE METHODOLOGY OF THE STUDY
Start
Gather data pertaining to storage objectives and types (commercial/strategic, product type, desired capacity, future expansion plan, etc.)
Field investigations for understanding in-situ stress regime : hydro-frac tests
Laboratory and field testing for rock mass characterization : RMR, Q and GSI parameters determination, engineering parameters for rock design (strength, modulus, permeability, etc.)
Geological study for rock mass characterization : Lithology of rock massif, structural geological parameters (jointing details, positions of faults, folds, sills, dyke), etc.
Hydrogeological study for rock mass characterization and establishing requirements for hydraulic containment : Water table level, precipitation, evapotranspiration, flow net, etc.
Establishing hydrogeologic characteristics for analysis
Establishing geologic, in-situ stress and rock mass characteristics for empirical and numerical analysis
Preparing layout and & main features of storage units
Evaluation of Hydraulic Containment Criterion
Establishing groundwater recharge for analysis
Establishing hydraulic containment parameters (bore holes dia., space, elevation, etc.)
Studying effect on groundwater from caverns' excavation
Whether calculated groundwater level higher than desired
Whether hydraulic gradient perpendicular to caverns' axis is appropriate
Satisfying containment criterion?
No
Yes
Studying Caverns sections (profile, scale, direction, etc.)
Studying safe pillar sizes between caverns
Deciding layout of caverns including shafts, tunnels, borehole, etc.
Studying rock reinforcement
Anticipated load from induced strains
Anticipated load from wedging
Ground arching effect
Deciding rock reinforcement measures
Satisfying tightness criterion?
Yes
No
Evaluation of Mechanical tightness criterion
Risk Analysis for identification, sharing and management of risks
Project scheduling, financing, structuring, resource allocation and generation
End