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Refinery Bío Bío, Concepción/Talcahuano, Chile

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Abstract	Report of the satellite based analysis carried out over the Refinery of Bío Bío, Concepción/Talchuano, Chile, prior and posterior to the 8.8 magnitude earthquake on 27.02.2010, 3:40 local time
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1 Introduction

This briefing note covers Enap Refinerias Bío Bío in Talcahuano Chile and provides image analysis of the facilities of the refinery with particular regard to any observed damage due to the recent earthquake (February 27, 2010, at 03:34 local time (06:34 UTC)). The note has been produced using a pre-crisis WorldView image, dated 27th of January, which has been combined with open source collateral information. An additional post-crisis Rapid Eye image, dated 27th of February was used. The information cut-off date of this briefing note is 04 March 2010.

2 Background Information

At the site of interest, two major plants can be discriminated: the biggest is the Enap Refinerías, Bío Bío and the small one is the Petroquim S.A.

The **Enap Refinerías, Bío Bío** is part of the ENAP group. ENAP or Empresa Nacional del Petrólio is an energy company, 100% owned by the state of Chile. In Chile, there are three refineries which are operated by ENAP. These three refineries have a capacity for processing 230,000 barrels of oil a day and together produce around 13 million cubic meters a year, representing 85% of the demand for fuels in the Chilean market. The Bío Bío refinery near the quake's epicenter in Concepción sends out approximately 116,000b/d. (B/d = barrel / day).

Petroquim S.A. is the only producer of polypropylene in Chile. It began operation at the end of 1999. The Petroquim polypropylene plant is strategically located, next door to ENAP Refinerías Bío-Bío, the principal provider of raw materials.

3 Description of facilities

Site of Refinería, Bío Bío is +- 3.2 sq km.

It has 4 entrances:

- The main entrance is in the NE at the Camino a Lenga – it includes several parking lots and the administrative buildings are adjacent.
- Two entrances in the SE at the Camino Ramuncho - of which one also has a parking lot and adjacent work shops.
- The entrance in the NW at Camino a Lengo is the Tank Truck Loading place.

The crude oil is brought in through pipe lines (more then 4km of length) directly from the sea. The crude oil is stored in a big tank farm (probably in the West of the site) before it is taken for the effective refinery.

The main production zone is situated centrally (Center-NE). This is the place were the crude oil is distillated/cracked into the different end products. It contains boilers (usually with high pressure steam to temperatures of about 1112 degrees Fahrenheit / 600 degrees Celsius), the primary distillation unit and probably also other installations like vacuum distillation unit, catalytic cracking, catalytic polymerisation and catalytic reforming. Discrimination of all these different units was however not possible with the available data. Probably also another smaller production zone is situated at the South of the plant.

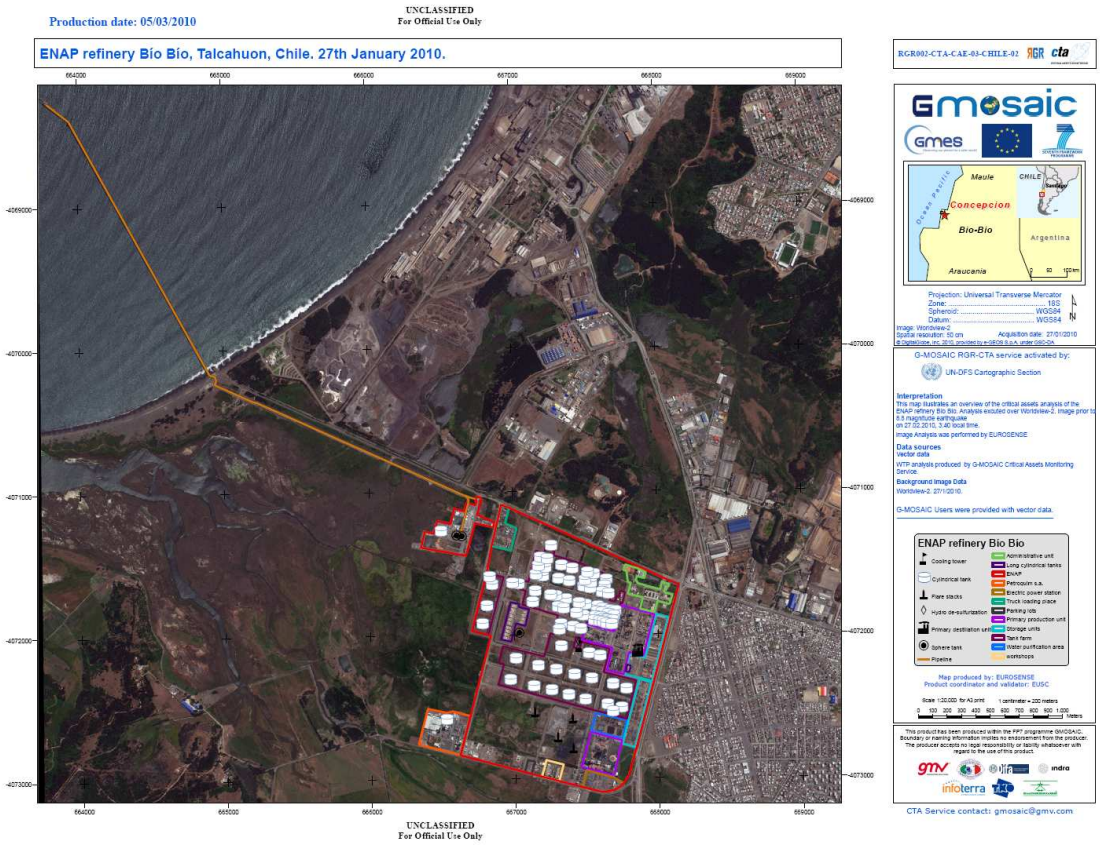

Figure 1: Pre-event analysis of ENAP refinery Bío Bío

The (end and intermediate) products, like Diesel Oil, Kerosene, Petroleum coke, Asphalt, Fuel oil, LPG, Sulphur and Butane are stored on-site. Several big tank farms can be observed (see figure 1). Besides crude oil, they store all different derived liquid petroleum products. Also cylindrical and spherical tanks can be observed. The former are generally used for storage of volatile liquids (e.g. gasoline) whereas the latter are generally used for storage of condensable (e.g. propane under pressure) or non-condensable gases (e.g. methane).

4 flare stacks were identified in the South of the site. These are combusting waste gas released by pressure relief valves during unplanned over-pressuring of plant equipment.

Other points of interest:

- In addition to making the oil-based products, refineries must also treat the wastes involved in the processes to minimize air and water pollution. Waste water purification and probably other related activities can be found in the South-East.
- Also in the South-East an electric power storage is situated.
- A cooling tower is found in the centre, with possibly a hydro de-sulphurization activity adjacent (TBD).
- Water comes in from the West directly through small canals.
- The site is partly wall- and partly fence-secured.

Site of Petroquim S.A. is on a plot of 14 hectares:

It produces polypropylene. That is a thermoplastic obtained by the polymerization of propylene, a gaseous sub-product of petroleum refinement, in the presence of a catalyst and under careful control of temperature and pressure. On the site, hence this production zone and a spherical tank (probably for propylene) can be found.

4 Damage Assessment

Most important information (up to writing of this report – 04/03/2010) found on damage statements of the Enap Refinerías, Bío Bío site through various Chilean and international new sites are bundled below:

- Empresa Nacional del Petróleo (ENAP) reports that the earthquake that affected the center-south of Chile has caused disturbances to the operations of its Bío Bío and Aconcagua refineries, mainly due to power cuts and structural damage which have forced the suspension of production for safety reasons. Both refineries were shut immediately. Aconcagua refinery should be back in operation by next week, but there is no set timetable for the resumption of service at the Bío Bío refinery. *(Published: Tuesday, March 2, 2010 16:46 (GMT-0400) - Business News Americas)*

- Bio Bio Refinery - "No date yet" to resume the operations of the Chilean oil refinery Bio Bio, affected by the earthquake over the weekend, said the manager of the plant at Reuters. Pedro Villarreal said the tsunami waves did not reach the plant, with capacity of 116,000 bpd. Earlier, the Minister of Mining, Santiago González, told Reuters it would take no more than a month to start-up again the Bio Bio operations. The refinery has no visible damage seen from outside, according to a Reuters witness. *(Published: Wednesday, March 3 – El Universal)*

- Astronauts living on the International Space Station (ISS) have taken photographs of Chile in the aftermath of the devastating 8.8-magnitude earthquake that struck the country, revealing a bird's-eye view of the damage wrought by the temblor. One photograph of Chile from space released by NASA shows the hard-hit cities of Concepción and Hualpen seven hours after the earthquake struck the South American country on Saturday. While the image is not detailed enough to see damage to individual buildings or roadways, some indicators of earthquake damage are visible," NASA said in a photo description. "A dark smoke plume is visible at lower-left near an oil refinery in Hualpen." *(Posted on 03 March 2010 11:02 am ET – Space.com)*

Figure 2: A zoom on the Bío Bío site of the above mentioned ISS image (taken 7 hours after the earth quake); the red arrow shows the location of the origin of the plume.

Based on image analysis of the satellite image Rapid Eye of 27th of February, following statements can be made:

- The big dark smoke plume as can be seen on the ISS imagery (figure 2), is also visible on the Rapid Eye image. The plume comes from different flare stacks situated in the South of the plant (see the red flare stack icon in figure 3). The flare stacks are part of a blowdown system, which permits the removal of liquids and vapors from process units in order to permit shutdown of the process unit for maintenance/repair or to prevent dangerous high temperature or high pressure conditions from occurring in it. A refinery blowdown system allows safe transfer of process liquids or vapors out of each process unit. The flare stacks are responsible for destroying these high concentration air emissions. Flaring of natural gas from oil & gas wells is a significant source of greenhouse gas emissions.

- Except for this big plume, no major damage can be seen directly on the available Rapid Eye satellite image. Important to notice: The resolution of the received satellite image was too coarse to visualize major structural damages and the image did not cover the complete site of interest. Moreover, the absence of any visual damage does not mean that there is no effective major damage on the ground. The damage may have occurred to the interior of buildings, tanks and production units and also technical equipment essential to maintain the full operational status of the refinery.

Figure 3: Post-event analysis of ENAP refinery Bío Bío.

Additional analysis of imagery available on the web, showed following additional damage:

- Several tanks have considerable damage. 2 of them (see red tank icon in figure 3) at least are seriously damaged and oil has leaked in a rather big proportion out of the tank. For at least 4 other tanks (see orange tank icon in figure 3) there are some indications of damage; however this cannot be stated decisively.

5 Conclusions

The Refinery Bío Bío in Talcahuano is a clear critical asset affected by the earthquake on 27.02.2010. Reports and direct visual image analysis indicated serious operational problems and damage on the site.

6 Disclaimer

Important to notice is that all activities (mapping and reporting) are executed in the best possible way (in the limited timeframe and with the data available on that time), but could not be verified. In this context the authors cannot be held responsible for any errors.