Description

1) Background
In 1996 an International Group of Experts, including experts from Ukraine, elaborated a study of alternative solutions to convert the Chernobyl Unit 4 and its present shelter (Ukritiye) into an environmentally safe status. The study report issued 29 November 1996 (see TACIS contract number 96-5029) proposed a Recommended Course of Action (RCA), comprising three phases, as follows:

- Phase 1: Stabilisation and other Short Term Measures;
- Phase 2: Preparation for Conversion Into an Environmentally Safe Site;
- Phase 3: Conversion Into an Environmentally Safe Site.

The Recommended Course of Action (RCA) defined a frame concept including a series of steps designed to result in a safe condition for the damaged Unit 4 and its current confining structure. The recommendation is a combination of different scenarios and additional measures proposed by the experts. Although a cost estimate was developed for each scenario, the cost estimate for the Recommended Course of Action was based on combining parts of various scenarios and expert judgements for measures not included in the scenarios.

The G7 Nuclear Safety Working Group (G7-NSWG) met with representatives of the Government of Ukraine (GoU) on 17 December 1996 in Slavutych, Ukraine and again on 11 February 1997 in Washington, D.C. and agreed in principle to proceed with the implementation of Phases I and 2 of the course of action. These Phases address the need for detailed studies to resolve open questions. The GoU representatives placed additional emphasis on the potential early removal of Fuel Containing Material (FCM). It was agreed that this would be defined and investigated in more detail during the course of action.

In order to implement the agreement to proceed, referred to as the Recommended Approach, it was decided that an integrated Shelter Implementation Plan (SIP) should be developed under G7 sponsorship. Terms of Reference were established by the G7-NSWG and GoU for developing the Shelter Implementation Plan. This contract represents the implementation of those TORs.

2) Objectives
The main objectives of the SIP were:

- To provide a detailed plan of action for the recommendations developed under the RCA taking into account the Ukrainian position;
To develop a preliminary cost estimate suitable to support international pledging of funds, including annual cash flow requirements.

The Shelter Implementation Plan was elaborated by a joint effort of international experts coming from Ukraine, US, Europe, and Japan. The involved organizations were in alphabetical order:

- Argonne National Laboratory, US;
- Bechtel, US;
- CEA Udin, France;
- Chernobyl Nuclear Power Plant, Ukraine;
- Ismes spa, Italy;
- JGC Corporation, Japan;
- National Academy of Sciences of Ukraine;
- Interdisciplinary Scientific & Technical Center Shelter, (ISTC Shelter), Ukraine;
- National Chernobyl Center, Ukraine;
- NUS Scientech, US;
- Ove Arup, United Kingdom;
- Pacific Northwest National Laboratory (PNNL), US;
- Parsons, US;
- Research Institute of Building Constructions (NIISK), Ukraine;
- Science Applications International Corporation (SAIC), US;
- SGN, France;
- Stone&Webster, US;
- Taywood, United Kingdom;
- Technocenter, Ukraine;
- Trischler und Partner GmbH, Germany.

The project had to address open questions related to the Recommended Approach and specifically, inter alia, long term behavior of buildings and structures, soil behavior, nuclear safety and radiological issues.

Primary activities and deliverables for developing the SIP were defined as follows:

- List of open questions, definition of a schedule, milestones, and evaluation of pre-feasibility;
- Definition of the activities needed to implement the Recommended Approach including the major functional and design requirements for each activity;
- Development of work, resource and cost estimates sufficient for pledging purposes, including development of a resource allocation plan to include manpower, training and support facilities needs for each of the activities of the SIP;
- Development of a conceptual outline for a milestone-based regulatory approval plan;
- Identify as early as possible discrete projects which can be implemented as soon as money is available;
- Define tasks related to fuel-containing material (FCM) remaining in Unit 4, specifically to establish feasibility, cost, and risk-related benefits of different options for FCM removal.

In addition to describing the process for development of an integrated plan with a sound cost estimate, the Terms of Reference also called for the identification and definition of conceptual discrete biddable projects for possible early implementation, and a conceptual
Ukrainian regulatory approval plan.

3) Project Results–Achievements (with reference to the TORs)

The SIP (Shelter Implementation Plan) was developed for the stepwise conversion of the Ukritiye into an environmentally safe site.

A work breakdown structure (WBS) was developed for the whole project. The WBS was then utilized to define and schedule the work and develop cost estimates. The labor, equipment and material necessary for each Task were used to define required resources. The main components of the WBS were identified as in the following:

Reduce Collapse Probability - Structural Stabilization
- Task 1 Stabilization and Shielding Design Integration and Mobilization
- Task 2 Stabilization and Shielding of Western Section
- Task 3 Stabilization and Shielding of Mammoth Beam and Southern Section
- Task 4 Stabilization and Shielding of the Eastern and Northern Sections
- Task 5 Stabilization of the Roof, Roof Supports, and Covering
- Task 6 Structural Investigation and Monitoring
- Task 7 Geotechnical Investigation
- Task 8 Seismic Characterization and Monitoring

Reduce Collapse Accident Consequences
- Task 9 Emergency Preparedness
- Task 10 Dust Management
- Task 11 Emergency Dust Suppression System

Improve Nuclear Safety
- Task 12 Criticality Control and Nuclear Safety
- Task 13 Contained Water Management
- Task 14 Fuel Containing Material (FCM) Characterization

Improve Worker and Environmental Safety
- Task 15 Radiological Protection Program
- Task 16 Industrial Safety, Fire Protection, Infrastructure and Access Control
- Task 17 Integrated Monitoring System
- Task 18 Integrated Database (Configuration Management)

Long Term Strategy and Study for Conversion to an Environmentally Safe Site
- Task 19 FCM Removal and Waste Management Strategy and Study
- Task 20 FCM Removal Technology Development
- Task 21 Safe Confinement Strategy
- Task 22 Implementation of a Safe Confinement to Support Deconstruction and FCM Removal

Moreover, three major programmatic milestones were identified as key decisions because of their importance for project guidance and completion. These key milestones were:

- The stabilization and shielding strategy decision, which is the point at which the feasibility of
currently proposed stabilization and overall scope for the other selected stabilization activities is defined. This includes needed accesses and worker protection by shielding and other means;

- The FCM removal strategy decision, which determines methods and time for optimum removal of the FCM, based on feasibility and cost-benefit analyses;
- The confinement strategy decision, at which point it will be decided what its design and functions shall be, based on the FCM removal strategy, stabilization and shielding decision confirmation and designs, and a conceptual design for a confinement.

Many Early Biddable Projects were identified for implementation as soon as funding is available. These projects are:

- Development of Emergency Preparedness;
- Radiological Protection Program;
- Industrial Safety, Fire Protection, Infrastructure, and Access Control Program;
- Structural Investigation;
- Geotechnical Investigation;
- Seismic Characterization;
- Completion of Stabilization and Shielding Integrated Design and Mobilization with some possible early implementation;
- Continuation of Emergency Dust Suppression System design;
- Dust Management activities;
- Criticality and Nuclear Safety monitoring;
- Design for Integrated Monitoring Systems;
- Design for Integrated Database;
- Contained Water Management system conceptualization;
- Initial work on FCM Characterization;
- A FCM Removal and Waste Management Strategy and Study;
- Safe Confinement Strategy pre-conceptual engineering.

The overall project was estimated at an approximate total cost of around 758 million dollars. This amount included provision of safe confinement based mainly on a former cost estimate. However, a decision about confinement configuration was foreseen in the SIP, based on completion of feasibility and cost benefit studies in accordance with the ToR, which would permit review of the estimate during the implementation process. Contingencies included in the cost estimates vary at the activity level based on uncertainty and task complexity. Uncertainty remained for some structural stabilization for which detailed designs were not made available and clarification in these parts would be only possible after review of design including dose uptake calculation.

The technical specifications and terms of reference for procurement of engineering and construction services required to implement the Shelter Implementation Plan were written by a parallel working group (the Project Specifications Group) authorized by the GoU and the NSWG and worked under separate disclosure agreements. Participation in the Project Specifications Group excluded participants from participating in subsequent tendering for the Early Biddable Projects; while participation in the International Expert Team will not exclude individuals or their organizations from subsequent tendering.

4) Comments (quality of the results, lesson learnt, recommendations for follow-up)
The project met the objectives stated in the TORs. The management of the project was very sound: the main deliverable (the SIP document) was considered a milestone in the stabilisation of the Shelter at Chernobyl site, both for the technical and managerial viewpoints.

**Further Information**
Further information on the project results could be sought from the beneficiary organizations.

The Project Final report is available at the JRC-IE archive.

**General Information**

**Title:** Shelter Implementation Plan Chernobyl Unit 4  
**Programme:** TACIS  
**Amount:** € 292,077,00  
**Budget year:** 1994  
**Meta geographical zone:** Chernobyl  
**Countries:** Ukraine  
**Nature:** Services  
**Types of activities:** Design safety  
**Sector:** DS - Design safety (incl. Off-Site Emergency Preparedness)  
**NPP:** Chernobyl  
**Installation types:** RBMK  
**Duration (months):** 7  
**Contracting authority:** European Commission  
**Partner (Beneficiary):** Chernobyl NPP  
**Contractors:** Trischler und Partner  
**Status:** Closed  
**CRIS number:** 24561  
**Old reference:** 97-0077  
**Decision number:** TACIS/1994/000-386  
**Method of procurement:** Direct Agreement  
**Signature date:** 15/03/1997  
**Effective contract date:** 15/03/1997  
**Contract end date:** 15/10/1997  
**Closure date:** 15/10/1997